A STUDY IN TEACHING SELECTED INTELLECTUAL SKILLS TO KINDERGARTEN CHILDREN

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This is to certify that the

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ABSTRACT

A STUDY IN TEACHING SELECTED INTELLECTUAL SKILLS TO KINDERGARTEN CHILDREN

by Thomas Francis Edwards

This study was conducted in Normal, Illinois during the school year 1965-66. Kindergarten children in the Brigham, Towanda, and Thomas Metcalf Elementary Schools participated in the study.

The purposes of this study were: 1) to construct lessons in science designed to teach selected intellectual skills to kindergarten children and 2) to develop group non-reading tests which would measure the growth of the intellectual skills of observation, classification, data treatment, and measurement in kindergarten children.

The lessons and evaluations used in this study were written by the author. All children in the study were post-tested with the group non-reading Skills Test developed by the writer. All children were tested with four group non-reading tests developed by the writer. A random selection of the children were tested with the individual appraisal items found in each of the lessons.

Some of the eighteen science lessons used in this study were an outgrowth of a pilot study conducted by the writer during the school year 1962-63. Each lesson used in the study was evaluated by teaching colleagues on the science faculty of Illinois State University. The

lessons were duplicated and placed in the Brigham and Towanda Elementary Schools. In light of feedback received from the teachers in these schools, the lessons were re-written and used by two teachers in Thomas Metcalf Elementary School.

All data to which statistical tests were applied were secured from scores made by children in the study on tests developed by the writer. These data were analyzed to determine whether or not the children had made significant gains towards meeting the objectives of the study. Significance was determined by calculating t-ratios.

On the basis of the data presented in this study, the following conclusions seem warranted:

1. The lessons used in this study were effective in helping kindergarten children develop selected intellectual skills considered a part of the scientific endeavor.

2. The instructional materials used in this study were effective in helping kindergarten children meet the objectives of the study.

3. The procedures used by the writer in developing, refining, and testing the instructional materials can be used with success by curriculum workers, science educators, and teachers.

4. The methods of testing used in this study are appropriate ways of assessing concept and skill development in kindergarten children.

5. The instructional materials used in this study were effective in helping kindergarten children form many science concepts.

6. The instructional materials used in this study appeared to have some affect on the reading readiness scores of the children involved in the study as revealed by their scores on the tests used.

A STUDY IN TEACHING SELECTED INTELLECTUAL SKILLS TO KINDERGARTEN CHILDREN

By

Thomas Francis Edwards

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CHAPTER I

INTRODUCTION

Since the introduction of science as a recognized part of the elementary school curriculum, writers have produced materials for teaching science to children. In recent years, scientists and science educators have been working with renewed interest to develop new materials. The materials, though diverse in content, have provided elementary teachers with suggestions for teaching science concepts to children. The instructional materials have provided elementary teachers with some tested and refined procedures and techniques which facilitate the development of various skills, processes, or abilities which are considered to be a part of the scientific endeavor. In general, the materials which have been produced may be placed in two categories; those that are primarily content oriented and those that are basically process oriented.

Examples of projects which are primarily concerned with content and concept formation are the Science Curriculum Improvement Study and the University of Illinois Elementary School Science Project. Karplus[1] and his associates have shown that children can master many concepts

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[1] Robert Karplus. "The Science Curriculum Improvement Study." Journal of Research in Science Teaching 2: 293-303; 1964.

which have usually been reserved for later work in science. Atkin[2] has shown that intermediate grade children can master concepts of acceleration, velocity, parallax, and retrograde motion. Keislar and McNeil[3] have shown that visual materials can be organized so as to lead primary grade children to develop concepts of molecular motion. Each of these projects has tended to offer some support to a position taken by Bruner in 1961. At that time, he maintained that ". . . any subject can be taught effectively in some intellectually honest form to any child at any stage of development."[4]

In a more recent publication, Bruner takes a different position with respect to teaching content. He now maintains that:

> To instruct someone in the disciplines is not a matter of getting him to commit results to the mind. Rather, it is to teach him to participate in the process that makes possible the establishment of knowledge. We teach a subject not to produce little living libraries on that subject, but rather to get a student to think mathematically for himself, to consider matters as a historian does, to take part in the process of knowledge getting. Knowledge is a process, not a product.[5]

Science--a process approach, directed by John Mayor[6] has as its major goal the organizing of learning experiences in science in such

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[2] J. Myron Atkin. "University of Illinois Elementary School Science Project--1964." Journal of Research in Science Teaching 2: 328-29; 1964.

[3] Evan R. Keislar and John D. McNeil. "Teaching Scientific Theory to First Grade Children by Auto-Instructional Devices." Harvard Educational Review 31: 73-83; Winter, 1961.

[4] Jerome S. Bruner. The Process of Education. Cambridge: Harvard University Press, 1961. p. 33.

[5] Jerome S. Bruner. Toward a Theory of Instruction. Cambridge: Harvard University Press, 1966. p. 72.

[6] American Association for the Advancement of Science. Science --A Process Approach. Washington: The American Association for the Advancement of Science, 1964.

a manner that the child will be led to develop selected process abilities which are considered to be part of the scientific endeavor.

The Illinois Studies in Inquiry Training has been trying to develop inquiry skills in elementary school children. Suchman[7] contends that inquiry skills do transfer, not method in itself but a kind of attitude, a sense of self-confidence that the child has to handle data and to build and test theories.

These curriculum projects in elementary school science have created a great deal of interest on the part of parents, educators, and teachers and may have considerable impact upon the science offerings in the elementary school. Results of these curriculum ventures have provided new information concerning the learnings elementary school pupils can acquire. The projects have shown that elementary school children can be taught certain processes which are considered to be a part of the scientific enterprise.

This study originated as a result of: (1) the recognized need for science materials appropriate for kindergarten children; (2) the findings of the current curriculum projects; (3) the trend for the kindergarten to be a classroom primarily occupied with preparatory academic experiences; and (4) the past experiences of the writer in teaching science to kindergarten children.

Background. During the academic year of 1962-63, the writer was co-investigator in a pilot study with kindergarten children in the Thomas Metcalf School, the laboratory elementary school of Illinois State University at Normal, Illinois. The principle goal of the study

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[7] J. Richard Suchman. "The Illinois Studies in Inquiry Training." Journal of Research in Science Teaching. 2: 230-232; 1964.

was to gather evidence relative to two major questions. These questions were:

1. Will structured classroom experiences built around basic concepts in science lead to an identifiable attainment of intellectual skills?

2. What differences exist between the experimental group and the control group as a result of the treatment?

Analysis of the data gathered in this pilot study[8] resulted in an "F" ratio which was significant at the .01 level for each of these major questions. All test data were based upon tests developed by the writers in the pilot study.

Insights into the nature of children's thinking, the relative success of the structured experiences, the enthusiasm of the classroom teacher and the pupils, and a genuine concern for children and the quality of science program which they receive at the kindergarten level are some of the factors which indicated that further investigation was needed.

Statement of purposes. The main purposes of this study were to write lessons in science designed to teach selected intellectual skills to kindergarten children; to construct evaluation instruments which would measure the selected intellectual skills; and to ascertain the achievement in these intellectual skills made by kindergarten children in selected Normal, Illinois elementary schools.

Need for the study. A review of the literature indicates

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[8]Thomas F. Edwards. Developing Intellectual Skills in Science --Kindergarten. Unpublished Research Report, Project No. 62-3. Normal, Illinois. Illinois State University, 1963. p. 3.

concern over the scarcity of science materials designed specifically for the kindergarten child. The recommendations for topics to be pursued with kindergarten children are usually stated in very broad categories. The Fifty-Ninth Yearbook maintains that it is the function of the school to impart the skills, attitudes, and understandings in the major fields of knowledge. The recommendation is made that:

> . . . we must, then be centrally concerned with what the child learns, the conditions under which different individuals achieve this learning most rapidly and the evidence each child gives of having achieved the objectives of education.[9]

At the recent conferences held at Stanford and Cornell Universities on cognitive studies and curriculum development, Piaget made a plea that children be allowed to do their own learning. He said that:

> Good pedagogy must involve presenting the child with situations in which he himself experiments, in the broadest sense of the term --trying things out to see what happens, manipulating symbols, posing symbols, posing questions and seeking his own answers, reconciling what he finds one time with what he finds at another, comparing his findings with those of other children.[10]

Currently there is growing acceptance of the idea that early childhood is a period when many basic patterns of thinking are established. Almy[11] contends that individual conceptual styles established by the age of five or so may manifest themselves in important ways in

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[9] National Society for the Study of Education. Rethinking Science Education. Fifty-Ninth Yearbook, Part 1. Chicago: University of Chicago Press, 1960. p. 299.

[10] Jean Piaget. "Development and Learning." A Report of the Conference on Cognitive Studies and Curriculum Development. Ithaca: School of Education, 1964. p. 2.

[11] Millie Almy. "Young Children's Thinking About Natural Phenomena." New York: Teachers College, Columbia University, 1962. p. 1.

children's reactions to intellectual tasks in school.

During a presentation at the Regional Conference of the National Association of State Directors of Teacher Education and Certification and the American Association for the Advancement of Science studies held in Chicago, Illinois on December 12-15, 1961, Dr. Robert D. Hess stressed the need for early stimulation of the mental capacities of the child when he said:

> There is reason to believe that the potentialities of the human mind as genetically determined do not unfold naturally and inevitably, but require active participation of a stimulating environment in order to attain normal development. It is of utmost importance that this stimulation occur as early as possible in the child's experience. One of the primary purposes of elementary school education is the maximizing of mental capabilities by systematic stimulation and exercise of mental faculties.[12]

An awareness of the need for primary grade educational experiences to develop in the child certain selected intellectual skills has prompted numerous studies of the effect of science activities on the development of some of these skills. Cox[13] reports that through scientific activities, children developed and used attitudes and behaviors that could readily be identified as critical thinking. She recommended that similar studies be initiated to identify more fully the kinds of behavior patterns which could be developed in kindergarten children through the use of science experiences.

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[12]Robert D. Hess. "The Latent Resources of the Child's Mind." Address presented at Regional Conference, National Association of State Directors of Teacher Education and Certification and American Association for the Advancement of Science, Chicago, Illinois, Dec. 12-15, 1961. p. 11.

[13]Louise Cox. "Working with Science in the Kindergarten." Science Education 47: 137-44; March, 1963.

The research of Crutchfield and Covington[14] offers evidence that training which encourages the child to formulate new questions, restate the problem in their own words, and generate ideas, develops a generalized tendency in children to do this even when they are presented with entirely new and different problems. These findings imply that schools should place emphasis on generalized ways of attacking problems by developing in children intellectual skills and abilities which will serve them in new situations.

Prior to 1961, there were only a limited number of studies which dealt with the problems of education at the kindergarten level. In a review of the research to that date, Fuller made the following recommendations:

> 1. There is a necessity of exposing five year olds to a broad and varied sample of content of many subject matter fields--devoting a regular portion of the day to set and formal instruction in a single subject automatically deprives other subjects of their fair share of attention.
>
> 2. There must be developed methods of evaluation of the kindergarten child's progress.
>
> 3. Various curriculum arrangements must be made to adequately evaluate the kinds and nature of instructional materials that best serve the needs of the kindergarten program.
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> 4. There exists a need to explore the teaching of science in the kindergarten.[15]

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[14] R. S. Crutchfield and M. V. Covington. "Facilitation of Creative Problem Solving." Programmed Instruction 4: 3-5, 1965.

[15] Elizabeth M. Fuller. About the Kindergarten. What Research Says to the Teacher. Department of Classroom Teachers. American Educational Research Association of the National Education Association. Bulletin No. 22. February, 1961.

In 1962-63, a study completed by Langston[16] was closely related to recommendations three and four made by Fuller. The Langston study examined the affect of structured exercises in science on reading readiness. This study recommended that further investigation be conducted to determine if development of skills in one discipline affected reading readiness.

Examination of the third recommendation of Fuller, as cited above, suggests that there is a scarcity of tested materials appropriate for the kindergarten child. One of the kinds of materials needed by kindergarten teachers are lessons in science which guide the child to discover relationships.

On the basis of an analysis of the research on cognitive studies and curriculum development, Cronbach makes the following recommendation:

> What research seems to say is that leaving the child to discover is not nearly so good as providing him with a guided sequence to maximize the possibility of early discovery.[17]

Many elementary teachers have voiced a plea for more materials in science appropriate for kindergarten children. Their requests may be based upon research in psychology which rather thoroughly substantiates that personal involvement in the learning process results in more effective and permanent learning. Their requests may be based on their own personal conviction that the outcomes of science experimentation contribute to development in children of those skills and

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[16] Genevieve Langston. "A Study of the Affect of Certain Structured Experiences in Science, Social Science, and Mathematics on Beginning Reading in Gifted Five Year Olds." Unpublished Doctoral Dissertation. Urbana: University of Illinois, 1963. 167 p.

[17] Lee J. Cronbach. "Learning Research and Curriculum Development." Journal of Research in Science Teaching. 2: 204-7; 1964.

abilities that are considered part of scientific inquiry and essential for later success in school.

Since there is a lack of substantiating evidence as to the role of planned structured science experiences in aiding the development of intellectual skills in kindergarten children, it is appropriate that this study investigate the effect of a series of structured science lessons on the development of selected intellectual skills.

Design of the study. The study was conducted at Normal, Illinois. Eighty children from the Towanda and Brigham Elementary Schools in Community Unit District No. 5, and forty children from the Thomas Metcalf Elementary School, the Laboratory school of Illinois State University, comprised the total population. The children who comprised the sample in this study represent a typical group of kindergarten children ranging in intelligence from below average to superior. They come from homes in a rapidly growing urban-rural community which may be classified as predominantely middle class.

The study began in January, 1966 and continued for the remainder of the school year. Eighteen science lessons constructed by the writer were used as the instructional materials in the study. The lessons emphasized pupil experimentation, manipulation, and participation. The lessons were first used by teachers in the Towanda and Brigham Schools, hereafter referred to as the Trial Group. In light of feedback received from these teachers, the lessons were re-written prior to their use by the teachers in the Thomas Metcalf School, hereafter referred to as the Sample Group.

The children in all kindergarten classes were taught by the regular classroom teacher. All testing which was an integral part of

this study was under the immediate supervision of the classroom teacher. The testing instruments used in this study were developed by the writer.

<u>The nature of the materials</u>. The instructional materials used in this study were developed by the writer during the fall of 1965. Some of the lessons used in the study are based upon lessons which had been used with a high degree of success in the pilot study. Others were developed for their specific relevance to one of the intellectual skills selected for this study. Each of the lessons used in the study was checked for logical development and scientific accuracy by teaching colleagues on the science staff of Illinois State University at Normal, Illinois.

The instructional materials included a teacher's commentary which provided background information, objectives for the set of lessons, a brief discussion of each integral part of the lessons, and specific comments which were believed would be helpful in evaluation of the lessons.

The eighteen science lessons used in this study were designed to be a completely self-contained plan for teaching a given concept or one of the intellectual skills selected for this study. It was assumed that the teachers could follow the recommendations presented in the lessons with no help from the investigator.

Testing in this study was accomplished by using either individual or group non-reading tests constructed by the writer. All children in the study were pre-tested with the Preliminary Test and post-tested with the Skills Test developed by the writer. Children in the Sample Group were also pre-tested with the Skills Test.

Hypotheses to be tested. This study was designed to measure the growth of selected intellectual skills in kindergarten children. In order to do this, it was necessary to prepare lessons designed to teach these skills, and evaluative instruments which could be used to measure the growth of these skills in the children involved in this study.

A hypothesis was rejected when the value of a statistical test indicated that the results obtained could occur by chance alone no more than five times in one hundred. The following null hypotheses were tested.

1. There will be no difference between the mean scores of the children in the Trial and Sample Groups on the Preliminary Test. (H_{01}: $MPT_{sg} = MPT_{tg}$)*

2. There will be no difference between the mean scores of the children in the Trial and Sample Groups on the Skills Test. (H_{02}: $MST_{sg} = MST_{tg}$)

3. There will be no difference between the means of the pre- and post-test scores made by children in the Sample Group on the Skills Test. (H_{03}: $M_{x1} = M_{x2}$)

4. There will be no difference between the means of the pre- and post-test scores made by children in the Sample Group on those items in the Skills Test which measure observation. (H_{04}: $M_{01} = M_{02}$)

5. There will be no difference between the means of the pre- and

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*In each of the null hypotheses stated, M symbolizes the mean; 1 symbolizes the pre-test; 2 symbolizes the post-test; sg symbolizes the sample group; tg symbolizes the trial group; and 01, 02, 03 symbolizes each respective hypothesis.

post-test scores made by children in the Sample Group on those items in the Skills Test which measure classification. $(H_{05}: M_{c1} = M_{c2})$

6. There will be no difference between the means of the pre- and post-test scores made by children in the Sample Group on those items in the Skills test which measure data treatment. $(H_{06}: M_{dt1} = M_{dt2})$

7. There will be no difference between the means of the pre- and post-test scores made by children in the Sample Group on those items in the Skills Test which ascertained measurement. $(H_{07}: M_{m1} = M_{m2})$

8. There will be no difference between the mean scores made by children in the Sample and Trial Groups on the Metropolitan Reading Readiness Test, Form R. $(H_{08}: MMRR_{sg} = MMRR_{tg})$

9. There will be no difference between the mean scores made by children in the Sample Group and children not involved in this study on the Metropolitan Reading Readiness Test, Form R. $(H_{09}: MMRR_{sg} = MMRR_{oc})$

10. There will be no difference between the mean scores made by children in the Trial Group and children not involved in this study on the Metropolitan Reading Readiness Test, Form R. $(H_{010}: MMRR_{tg} = MMRR_{oc})$

Basic assumptions. This study was designed to be a self contained investigation for securing information particularly pertinent to the development of the intellectual skills of observation, classification, data treatment and measurement as a result of using lessons developed by the writer to teach science to kindergarten children in Normal, Illinois. In view of the nature of the study and the materials produced, the following basic assumptions were made:

1. Differences in teachers due to training, experience, and available school facilities were such that they would produce no significant differences in student achievement as measured by the Skills Test.

2. The Skills Test developed by the writer was valid since it had been reviewed by scientists, psychologists, and primary grade teachers.

3. The method of selection of the teachers to participate in the study would produce no significant differences in student achievement as measured by the Skills Test.

4. The lessons which were designed could be used with kindergarten children without alteration.

5. The concepts around which the lessons were organized were appropriate for kindergarten children.

6. The provision of a standard set of materials for each classroom would lead to adequate uniformity in the presentation of the lessons.

7. The participating teachers would follow the suggestions of the respective lessons.

8. The practice effect of using the pre-test as the post-test with the Sample Group would not produce significant differences in student achievement as measured by the Skills Test.

Definitions of terms. For the purposes of this study, the terms were defined as follows:

1. Intellectual skill: . . . mode of operation and a generalized technique for dealing with problems.[18] Intellectual skills selected for this study include:

a. observation: an intellectual skill which requires the utilization of the senses to identify and collect data concerning environmental and experimental phenomena.

b. classification: an intellectual skill which includes the ordering of data, the establishment of categories, the seeking of relationships between categories, and the search for unifying characteristics of a group of objects or environmental phenomena.

c. data treatment: an intellectual skill which requires

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[18] Bloom, *op. cit.*, p. 38.

the child to record data, to recognize trends in data recorded, to interpret and predict from both a line and a bar graph.

d. measurement: an intellectual skill which includes the ordering of objects with reference to height and length, specifying the length of an object as so many times an arbitrary unit, and measuring the length of an object using a ruler.

2. Knowledge: includes those behaviors and test situations which emphasize the remembering, either by recall or recognition, of ideas, concepts or phenomena.

3. Data: quantitative information collected and or recorded by children concerning environmental phenomena.

4. Structured exercise: a specifically constructed series of experiences designed to teach children a given skill or concept.

5. Evaluation: the assessment of the presence or absence of specific human capabilities.

6. Behavioral objective: a specified performance on the part of the child as a result of knowing a given fact, principle, or concept, or as a result of possessing a given skill, ability or process.

7. Concept: abstraction which organizes the world of objects and events into a smaller number of categories.

Limitations. The major limitations of this study were as follows:

> 1. While the writer is aware of the need for reexamination, evaluation, and possible revision of the science offerings at all primary grade levels, this study was limited to the science offerings at the kindergarten level.
>
> 2. Evaluation was confined solely to the pupils using the lessons developed in this study and no effort was anticipated or made to compare pupil achievement in this study with pupils who did not use the lessons developed for this study.

3. Evaluation was limited to the operational definitions of the intellectual skills selected for this study. No attempt was made to evaluate many other worthwhile objectives or skills.

4. Although a probable outcome of using the set of lessons was an increase in pupil interest in science, no evaluation of this outcome was contemplated or carried out.

Organization of the thesis. The need for science materials appropriate for kindergarten children as evidenced by a pilot study completed by the writer and recommendations from the literature citing this need have been presented in this chapter. The basic assumptions, limitations, and hypotheses to be tested have been presented. In Chapter II, the literature concerning the history, growth, and development of science education and the kindergarten plus recommendations from research concerning the kinds of experiences necessary for learning science at this age level are reviewed. The nature of the lessons produced, the evaluation procedures employed, sample lessons and test items, and procedures used to implement the lessons into the existing kindergarten programs are described in Chapter III. Data are treated in Chapter IV, and Chapter V contains the conclusions of the investigation and recommendations for further study.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

Introduction. In this chapter, a summary of the early movements in elementary school science and in kindergarten programs is presented. The recommendations of research and national study groups which have brought about changes in elementary school science and kindergarten practices are discussed. Findings which pertain to concept development in young children, the importance of early experience on learning, and those which suggest the general organization of appropriate learning experiences for the kindergarten child are reviewed. Results of research projects dealing specifically with teaching science in the primary grades and kindergarten, and studies appropriate to evaluation of learning at the primary grade level are cited.

The growth and development of science in the elementary school. Elementary education programs in this country are a direct descendant of the programs which were in existence on the continent when the Pilgrims journeyed to this country. Elementary education during the Colonial Period was narrowly conceived, socially divisive, and autocratically administered. The core of the program was traditionally religious, and of a moral disciplinarian nature. The town elementary schools and the church charity schools represented the educational opportunities of the poor man. Since the Latin Grammar Schools would

not accept pupils who had not mastered the alphabet and acquired some ability to read, the well-to-do parents secured private tutors, or employed a dame in the community for instruction in the letters.

All materials used in the classrooms were English in origin, and by the close of the seventeenth century included the hornbook, the Psalter, the Bible, and a primer. Drake[1] notes that the New England Primer made its first appearance in 1690, consisted of some eighty pages, and was distinctly religious in tone and content.

The simple fact that an elementary school system was not established in the eighteenth century delayed the development of a democratic school system for more than a century. Three types of elementary schools established in the early nineteenth century laid the groundwork for the growth of a public elementary school after 1840.

The Infant Schools, which first appeared in the larger American cities of Boston, New York, Providence, Philadelphia, and Baltimore, stressed cleanliness, the art of getting along together, and plays and games. Later, reading, writing, arithmetic, and the elements of geography and natural history were added.

The Sunday School in America was first established in 1785[2] in Hanover County, Virginia. Organized for the poorer children, the program consisted of reading and writing, and the study of Bible stories.

A Lancasterian Monotorial School opened in New York City in 1806 and spread rapidly to other parts of the country. The Monotorial plan was considered effective in the teaching of reading, writing,

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[1] William F. Drake. The American School in Transition. Englewood Cliffs, New Jersey. Prentice-Hall, Inc., 1955. p. 79

[2] Ibid., p. 150.

spelling, arithmetic, and the catechism.

The study of science was finding its way into the curriculum, but no broad developments in the field were evident until the later eighteenth and early nineteenth century.[3] The final acceptance of science as a part of the curriculum was a nineteenth century movement.

Since the early part of the nineteenth century, some form of science has been included in the elementary school curricula. Two specific influences can be identified as early as the decade of the 1850's. One of these was the literature brought into this country from England and adapted and reprinted by American publishers. This instructional material reflected its origins in an aristocratic conception of education in that it was designed for private tutors, or for parents who chose to teach their children at home. Most of this material stressed children's observations and study of natural phenomena. When the National Education Association was established in 1857,[4] the task of adapting some of the material for use in school classrooms was undertaken.

The second influence on the science programs in the elementary school can be traced directly to the "Pestalozzian object teaching" movement during the late 1850's. This movement was very widespread and reached the height of its development in America in Oswego, New York. Due to the support received from the National Education

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[3] Ibid., p. 155.

[4] H. A. Smith. "Educational Research Related to Science Instruction for the Elementary and Junior High School: A Review and Commentary." Journal of Research in Science Teaching 1: 200; 1963. p. 200.

Association, the "Oswego Method"[5] was given nearly universal acceptance in this country.

The methodology of object teaching had a highly formal structure which tended to obscure the purposes of science education. Object teaching emphasized the description of animate and inanimate objects and failed to emphasize interpretation and understanding of environmental phenomena. Relationships existing between observations of objects became lost as a result of the emphasis placed upon observations and descriptions of the objects themselves.

Object teaching was a system of mental development based on faculty psychology, and had as its chief object the developing of certain habits and powers, particularly those of accurate observation and fixed attention. Its proponents explicitly stated that it had no concern with the subject matter taught. The emphasis in faculty psychology on observation and memorization was based upon the assumption that very young children were able to observe and identify objects, and further training of the faculties would discipline the mind so that the child would be able to reason and interpret phenomena.

In addition, the methodology of object teaching, which excluded the use of books, made heavy demands upon the knowledge and ability of the teacher. It placed great emphasis upon strengthening of the faculties through mental discipline. The utility of the concepts and facts learned was of little consequence. The important idea was that mental powers developed in the study of one area automatically carried

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[5] Theresa J. Lammers. "The Thirty-First Yearbook and 20 Years of Elementary Science." Science Education 39: 39-40; February 1955.

over to all aspects of life calling for the same mental powers.

By 1870, the rising importance of science and technology caused educators and the public to consider science as a field of study appropriate to all levels of instruction. It became apparent that old patterns of teaching and learning did not reflect the needs of the time and were inconsistent with characteristics of the learning process.

Near the end of the nineteenth century, the National Education Association sponsored an extensive study of the secondary school level. The report of the Committee of Ten placed emphasis upon laboratory and other direct experiences in the teaching of science. Although primarily concerned with the educational program at the secondary school level, the recommendations of this Committee influenced the textbooks, syllabi, and other instructional materials at all levels. It was only after the report of the Committee of Ten that materials designed for pupil use and teacher planning appeared in the elementary school.

Underhill[6] notes that William T. Harris is generally credited with formulating the first general plan for an elementary school science curriculum of sufficient detail to be significant. Harris had a wide and thorough knowledge of philosophy, science, and logic, and has been called the foremost interpreter of Hegel in this country.

General philosophies of education supporting nature study were

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[6] Orra E. Underhill. The Origin and Development of Elementary School Science. Chicago: Scott Foresman and Co., 1941. p. 100.

developed by G. Stanley Hall[7] and Francis W. Parker.[8] These philosophies opened the way for others to experiment and work out detailed programs in elementary school science.

At the Practice School of the Cook County Normal School, Chicago, Illinois, experimental work was done by Henry H. Strait and Wilbur S. Jackman.[9] The work of Jackman represents a connecting link between the early writers of children's literature and modern elementary science. Jackman's knowledge of children and science is evident in his book, "Outlines of Natural Science for the Common Schools--1891." The work of Strait is recognized on the basis of his conviction that the sciences were especially adapted to fit the individual for life.

Liberty H. Baily and his colleagues at Cornell University were the prime advocates of the nature study movement. The Handbook of Nature Study by Mrs. Anna Botsford Comstock is still widely used. The Cornell Rural School leaflets are still distributed to many schools.

Smith[10] has observed that like object study, nature study was based on the principles of faculty psychology and on the alleged serial development of traits. Nature study had been developed by science specialists who lacked the understanding of children possessed by later writers of science materials for elementary school children.

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[7]G. Stanley Hall. Aspects of Child Life and Education. New York: Appleton Century, 1921. 326 p.

[8]Francis W. Parker. Talks on Pedagogies. New York: Kellogg, 1894. 491 p.

[9]Underhill, op. cit., p. 102.

[10]Smith, op. cit., p. 202.

In the early 1920's, the work of such men as Charles Pierce,[11] William James,[12] and John Dewey[13] began to have an impact upon educational programs. As a result of their work showing the link between concept and experience, the nature study movement slowly died out. Dewey's contention that the methodology of science is at least of equal--or perhaps of greater significance than the actual knowledge accumulated was to have great impact upon subsequent science programs. The current emphasis on "science as inquiry" would seem to be a reaffirmation of the position which Dewey took over a half century ago.

In 1927, a thesis written at Columbia University by Gerald S. Craig[14] marked the beginning of a sequential program in science at the elementary school level. Craig's thesis and the textbooks he wrote have perhaps had the most far reaching influence on the development of elementary science of any single event in the history of the field to the present time. Craig saw the function of science in the elementary school to be significant in terms of general education, and pointed out that the laws, generalizations, and principles of science have vital meanings to individuals regarding numerous questions which confront them. His study shows his awareness of the cognitive aspects

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[11] Charles S. Pierce. Philosophical Writings of Pierce. New York: Dover Publications, Inc., 1955. 386 pp.

[12] William James. The Principles of Psychology. New York: Holt and Co., 1890.

[13] John Dewey. Democracy and Education. New York: Macmillan, 1916.

[14] Gerald S. Craig. Certain Techniques Used in Developing A Course of Study in Science for the Horace Mann Elementary School. New York: Bureau of Publications, Teachers College, Columbia University, Contributions to Education, No. 276, New York, 1927.

of science instruction and the importance of science in developing in children attitudes, appreciations, and interests.

The publication of the Thirty-First Yearbook[15] of the National Society for the Study of Education in 1932 marked the beginning of a trend which has continued to be emphasized to the present time. This trend has been the genuine concern of national groups over the place of science in the educational program of all children. The Yearbook Committee took a definite stand in its support of elementary science rather than nature study, and as a result, it contributed to the rapid advancement of science in the elementary school.

The Forty-Sixth Yearbook, published in 1947, shows the impact which science has upon the social, cultural, and economic affairs of men. This is evidenced by the following statement of the role of science instruction in the schools:

> Science instruction has not only a great potential contribution to make but also a responsibility to help develop in our youth the qualities of mind and the attitudes that will be of greatest usefulness to them in meeting the pressing social and economic problems that face the world.[16]

The Fifty-Ninth Yearbook of the National Society for the Study of Education, published in 1960, takes cognizance of the increasing dependence of society on science. The Yearbook Committee stresses the processes or inquiry characteristics of science in the following statement:

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[15] National Society for the Study of Education. A Program for Teaching Science, Thirty-First Yearbook, Part 1. Bloomington: Public School Publishing Company, 1932. 364 pp.

[16] National Society for the Study of Education. Science Education in American Schools. Forty-Sixth Yearbook, Part 1. Chicago: University of Chicago Press, 1947. p. 1.

One function of the elementary school has always been to help children learn a part of what they need to know from the world's storehouse of knowledge. In recent years, this function has embraced more and more science. Scientific methods of investigation by which knowledge may be acquired and tested, are now very much a part of our culture. The elementary school should help children become acquainted with these methods.[17]

The growth and development of the Kindergarten in the United States. The Association for Childhood Education[18] designated 1937 as Kindergarten Centennial Year, dating the birth of the kindergarten from the founding of a Klienkinderbeschaftingungsanstalt (small-children-occupation-institute) by Friedrich Froebel in Blankenburg, Germany. This unwieldly title was long ago changed to "kindergarten".

In 1856, the first kindergarten in America was established in Watertown, Wisconsin, by Mrs. Carl Schurz, a German immigrant.[19] Under Mrs. Schurz's influence, Elizabeth Peabody opened the first English speaking kindergarten in America in Boston in 1860.

Ten years later, in 1870, Boston founded the first public school kindergarten. This first kindergarten survived for only one year and it was not until 1887 that other kindergartens were established in Boston.

St. Louis, Missouri was the first city to include the kindergarten as an integral part of the public school system in 1873. From

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[17] National Society for the Study of Education. Rethinking Science Education. Fifty-Ninth Yearbook, Part 1. Chicago: University of Chicago Press, 1960. pp. 112-113.

[18] Association for Childhood Education. The Kindergarten Centennial, 1837-1937. Prepared for the A. C. E. Centennial Committee. Washington: Association for Childhood Education International, 1937. 24 p.

[19] National Education Association. Kindergarten Practices, 1961. Washington: National Education Association, 1962. p. 5.

here, the movement to establish kindergartens as an integral part of the public school system spread. Usually, kindergartens were established in the larger cities through the work of educators who were staunch supporters of the movement.

The educational philosophy of the kindergarten was based upon principles first stated by Froebel:

> People think the child is only seeking amusement when it plays. This is a great error. Play is the first means of development of the human mind, its first effort to make acquaintance with the outward world, to collect original experiences from those things and facts, and to exercise the powers of body and mind.
>
> In the kindergarten (children) are guided to bring out their plays in such a manner as really to reach the aim desired by nature, that is, to serve for their development.[20]

Status of the Kindergarten in the United States. In 1961, the Research Division of the National Education Association[21] surveyed the available literature on kindergartens and found that since 1925, with the publication of Mary Dabney Davis's *General Practice in Kindergarten Education in the United States*, no general studies of kindergarten practices have been published.

Through the years, the U. S. Office of Education has included kindergartens in their statistical studies. These studies indicate that kindergartens are well established in the public schools. Over seventy percent of all cities with populations of 2,500 or more support public kindergartens. Today, a majority of the states provide funds for the support of kindergarten programs.

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[20] Association for Childhood Education, *op. cit.*, p. 5.

[21] National Education Association, *loc. cit.*

Kindergarten practices. A few of the conclusions drawn by Davis are worthy of note as they pertain to the general practices in the kindergarten. Davis reports:

> There is no set time in the kindergarten schedule for any one activity. There are, however, fairly regular tendencies to particular times during the day.
>
> It is safe to say that the day in kindergarten devotes 36 percent of its time to physical education, 33 percent to the general arts, 16 percent to general assemblies, 9 percent to literature and language, and 6 percent to music.[22]

In contrast to these findings reported by Davis in 1925, the survey conducted in 1961 by the National Education Association shows the following general practices as being prevalent.

1. Definite time allotments and sequence observed for each activity.

2. Seventy-nine percent (79.8%) of the kindergartens reported they had science equipment which was used regularly in their program.

3. Eighty-two percent (82.1%) of the kindergartens reported they had science activity centers as an integral part of their program.

4. Well over ninety percent (90%) of the kindergartens listed the following regular activities.

listening to stories	singing
counting	conversation
games	rhythms
rest periods	coloring
drawing	telling stories[23]

In a more recent study, Scholten attempted to determine the precise nature of the kindergarten program today. He concluded that:

> The typical kindergarten on the national scene is seen as a classroom pre-occupied with activities which are largely of a

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[22] Mary Dabney Davis. General Practice in Kindergarten Education in the United States. Washington: National Education Association, 1925. p. 62.

[23] National Education Association, op. cit., p. 25.

conforming, academic preparatory nature.

> The instructional program of the kindergarten is highly structured program involving reading, numbers, and writing for all children.[24]

Purpose and value of the kindergarten. The National Education Association Research Division survey[25] revealed that the broad majority of kindergarten teachers felt that the function of the kindergarten was individual personality development, preparation for success in school, and preparation for group membership.

The following reply of a kindergarten teacher responding to the survey rather adequately describes the predominant aim of the modern-day kindergarten.

> Kindergarten should teach a child to question, to explore, to seek answers. It should teach him to discriminate, choose, sort, and arrange. It should teach him to look and to see, to feel and to touch, to taste and to smell, to listen and to remember.[26]

The findings of the National Education Association survey tend to support Fuller's analysis of research about the kindergarten and its implications to teaching. Her interpretation of the research calls for:

1. The necessity of exposing five year olds to a broad and varied sample of content of many subject matter fields--devoting regular portions of the day to set and formal instruction in a single subject automatically deprives other subjects of their fair share of attention.

2. The need to develop appropriate defensable evaluation methods for appraising kindergarten pupil progress.

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[24] Eugene Alvin Scholten. "School Readiness, A Study Comparing The Attitudes of School Psychologists and Kindergarten Teachers." Unpublished Doctor's Dissertation. Lansing: Michigan State University, 1965. p. 21.

[25] National Education Association, *op. cit.*, p. 26.

[26] *Ibid.*

3. The development of kinds and amounts of instructional materials that adequately serve the needs of kindergarten pupils.

4. Studies related to the teaching of science in the kindergarten are needed.

5. Broad exposure to fundamental learnings underlying all subjects is better for five year olds than narrow mastery of a few subjects.[27]

Concept formation in young children. A concept is basically a system of learned responses. It is an abstraction which orders the objects and events of the world into a smaller number of categories. Past experience is automatically applied to present contingencies through the use of concepts. Usually, concepts are associated with specific words or phrases. Vinacke suggests the following criteria for defining concepts:

1. Concepts are not themselves sensory data, but systems which are the products of our past responses to characteristic stimulus situations.

2. Using concepts is simply applying past learning to a present situation.

3. Concepts relate sensory data.

4. In human beings, words or other symbols are the means of linking discrete items of experience.

5. Concepts have at least two ways of functioning; the extensional use and the intensional use.

6. Not all concepts are rational or even meaningful.

7. Finally, concepts need not be consciously formulated.[28]

Concepts, then, are complex systems of higher-order responses in terms of which our more basic response patterns are organized. The

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[27] Fuller, op. cit., pp. 5-29.

[28] W. E. Vinacke. The Psychology of Thinking. New York: McGraw-Hill Book Company, Inc., 1952. Chapter 7, 392 p.

chief function of concepts is to relate previous learning to current situations arising within the subject's present experience, and to influence and organize each other. In time, concepts form a complex system which can influence the course of behavior quite independently of sensory stimulation.

One of the leading investigators of concept formation in children has been Professor Jean Piaget of the Universities of Paris and Geneva. His work falls into two main phases. Between 1924 and 1937, he published five books on the development of child thought in which he showed how radically different it is from adult thinking up to the age of seven or eight. During these early years, the child's thinking is dominated by an egocentric attitude and influenced by the wishes and inner needs of the child rather than a grasp of the environment and its characteristics. From 1937 to the present, Piaget has endeavored to trace the growth of reasoning capacities from birth to maturity in normal European subjects. Piaget's approach is a genetic one. He attempts to distinguish levels or stages of development in the evolution of thought and to show how each stage reveals a progressive sequence from simpler to more complex levels of organization.

General theories of intellectual development advanced by Piaget and his collaborators[29,30,31] include age-level changes in at least four major areas of cognitive functioning, namely, perception,

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[29] Barbal Inhelder and J. Piaget. The Growth of Logical Thinking From Childhood to Adolescence. New York: Basic Books, 1958. 356 p.

[30] Jean Piaget. The Psychology of Intelligence. New York: Harcourt, Brace, 1950. 182 p.

[31] Jean Piaget. The Construction of Reality in the Child. New York: Basic Books, 1954. 386 p.

objectivity-subjectivity, the structure of knowledge and ideas, and the nature of problem-solving. As children increase in age, they tend to perceive the stimulus world more in general, abstract, and categorical terms and less in tangible, time-bound, and particularized contexts;[32] they demonstrate increasing ability to comprehend and manipulate abstract verbal symbols and relationships, and to employ abstract classificatory schemata;[33] they are better able to understand ideational relationships without the benefit of direct tangible experience, of concrete imagery, and of empirical exposure to numerous particular instances of a given concept or proposition;[34] they tend more to infer the properties of objects from their class membership rather than from direct experience of proximate, sensory data;[35] they tend to use remote and abstract symbols rather than concrete attributes in classifying phenomena, and to use abstract symbols rather than concrete imagery to represent emerging concepts;[36] and they acquire an ever increasing repertoire of more inclusive and higher order abstractions.[37]

Piaget's starting-point is that higher psychological functions

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[32] M. C. Serra. "A Study of Fourth Grade Children's Comprehensions of Certain Verbal Abstractions." Journal of Experimental Education 22: 103-18; 1953.

[33] Inhelder and Piaget, *loc. cit.*

[34] Inhelder and Piaget, *loc. cit.*

[35] I. E. Sigel. Developmental Trends in the Abstraction Ability of Children." Child Development 24: 131-44; 1953.

[36] M. Annett. "The Classification of Instances of Four Common Class Concepts by Children and Adults." British Journal of Educational Psychology 29: 233-36; November 1959.

[37] L. A. Welch. "A Preliminary Investigation of Some Aspects of Heirarchical Development of Concepts." Journal of General Psychology 22: 359-78; April 1940.

grow out of biological mechanisms. Adaptation, the balance between assimilation and accommodation, tends to lead to states of equilibrium. Assimilation, according to Thomson,[38] is a term derived from the physio-chemical function, characteristic of every living creature, in which substances from the environment are absorbed and changed in order to sustain the organism. Accommodation refers to the fact that the organism is changed by the action of the environment upon it.

Piaget contends that adaptation develops through a series of phases from birth to maturity. It is never quite complete. In the evolution of adaptability there are many key factors, and it is these which Piaget wishes to discover and study. Two of these key factors are emphasized in his writings.

The first factor is the extent to which an organism can control shifts of orientation. To be able to do this is decentering, a concept closely related to the Gestalt psychologists recentering in problem-solving.

The second factor is the development of operations. An operation is an action which has been internalized. They are internalizable since they can be carried out symbolically without losing their character as actions. Operations and their groupings are the main objects of Piaget's developmental approach to concept formation.

At a recent conference held at Cornell University, Piaget identified four main phases or stages in the growth of concepts. The stages or phases which he identifies are the result of innumerable tests and experiments with children of different age groups. Not every child

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[38] Robert Thomson. The Psychology of Thinking. Baltimore: Penguin Books, 1959. p. 90.

follows these stages in its individual growth--the bright child achieves a particular level earlier than the average child, and the dull child fails to reach the final stages of maturity. The four phases or stages are:

> 1. The first is a sensory motor, pre-verbal stage, lasting approximately the first 18 months of life. During this stage is developed the practical knowledge which constitutes the substructure of later representational knowledge.
>
> 2. In a second stage, we have pre-operational representation--the beginnings of language, of the symbolic function, and therefore of thought, or representation.
>
> 3. In a third stage the first operations appear, but I call these concrete operations because they operate on objects, and not yet on verbally expressed hypotheses. For example, there are operations of classification, ordering, the construction of the idea of number, spatial and temporal operations, and all the fundamental operations of elementary logic of classes and relations, or elementary mathematics, of elementary geometry, and even of elementary physics.
>
> 4. Finally, in the fourth stage, these operations are surpassed as the child reaches the level of what I call formal or hypothetic-deductive operations; that is, he can now reason on hypotheses, and not only on objects. He constructs new operations, operations of propositional logic, and not simply the operations of classes, relations, and numbers.[39]

The sensory-motor stage is apparent in the child's actions from birth to age two. The pre-operational stage is evident in the child's behaviors from age two to four. The child develops the ability to carry on operations of increasing complexity from the age of four through eleven. Formal operations are developed by the child from the ages of eleven through fourteen.

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[39] Jean Piaget. "Development and Learning." A Report of the Conference on Cognitive Studies and Curriculum Development. Ithaca: School of Education, 1964. pp. 9-10.

Piaget[40] identifies four factors as affecting development from one set of structures to another. These are, maturation, experience, social transmission, and equilibration.

Piaget's severest critics concede that there is gradual improvement with increasing age in the quality of children's causal explanations.[41] Much overlapping prevails between age groups. All kinds of causal explanations are found at all age levels, and some adolescents and adults give responses characteristic of young children. Changes tend to occur gradually, and the quality of causal thinking shows much specificity and dependence on particular relevant experience.[42]

In the past few years, the findings of other investigators[43,44,45] have, on the whole, been in general agreement with Piaget's more recent formulations regarding stages of intellectual development. They differ from Piaget's findings less in terms of the developmental sequences involved than in the specification of different age levels for particular stages.

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[40]Ibid.

[41]M. E. Oakes. Children's Explanations of Natural Phenomena. New York: Bureau of Publications, Teachers College, Columbia University, 1946.

[42]J. M. Deutsche. The Development of Children's Concepts of Causal Relationships. Minneapolis: University of Minnesota Press, 1937.

[43]M. D. Braine. "The Ontogeny of Certain Logical Operations: Piaget's Formulations Examined by Nonverbal Methods." Psychological Monograph 73: # 5, Whole # 475, 1959.

[44]D. Elkind. "The Development of Quantitative Thinking: A Systematic Replication of Piaget's Studies." Journal of Genetic Psychology 98: 37-48; March, 1961.

[45]K. Lovell. "A Follow-up Study of Some Aspects of the Work of Piaget and Inhelder on the Child's Conception of Space." British Journal of Educational Psychology 29: 104-117; June, 1959.

<u>The role of early experiences in learning</u>. One of the major goals of educational research is to discover ways and means for the schools to optimize learning. Research provides some evidence as to the processes and methods by which children's learning can be most efficiently developed. The findings of psychologists during the past few years have indicated the possibility of a more efficient organization of learning experiences for children.

Hess maintains that once early deprivation of experience and stimulation has occurred, it is not possible to compensate these early losses entirely, even with enriched environments at later periods in the developmental cycle.[46]

The findings of Helen Dawe of the University of Wisconsin tend to support Hess' position. She attempted to increase the language skills of preschool orphanage children and discovered a high correlation between the age at which training begins and an increase in verbal skills. This affect was observable even after adjustment was made for length of the training period.

Since it is the unique function of the school to provide learning experiences which will develop the resources of the child's mind, Hess makes the following recommendations to educators:

1. There is reason to believe that the potentialities of the human mind as genetically determined do not unfold naturally and inevitably, but require active participation of a stimulating environment in order to attain normal development.

2. It is important that this stimulation occur as early as possible in the child's experiences.

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[46] Hess, <u>op</u>. <u>cit</u>., p. 8.

3. The range and variety of early experience directly affect the possibilities of later learning and set limits to the flexibility and adeptness of the adult mind by limiting or expanding the network of concepts, meanings, and symbols through which the individual experiences his world.

4. One of the primary purposes of elementary school education is the maximizing of mental capabilities by systematic stimulation and exercise of mental faculties.[47]

The writings of Piaget suggest that the educational program of children be built around a wide variety of experiences, since experience is always necessary for intellectual development. His findings imply a direct relationship between sensory experiences and learning. Piaget's[48] work shows that the child's ability to deal with the broad concepts of space, time, matter, and causality depends upon a type of thinking that slowly develops from the direct sensory experiences of the child.

Peel,[49] who is primarily recognized for his work on the development of language patterns in children, has recommended that science education in the primary school be based on experience leading to the formation of concepts. Essentially, the same recommendation is made by Wohlwill:

> I would place the emphasis on teaching scientific and mathematical subjects to young children on a focused enrichment of their experiences aimed at generalizations and transfer, rather than acceleration per se--providing the child with a broad base of experience which assures him extensive practice in abstracting structural similarities and common principles from diverse material contents or specific tasks may surely be expected to influence the

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[47] Ibid., p. 11.

[48] Inhelder and Piaget, loc. cit.

[49] E. A. Peel. "Learning and Thinking in the School Situation." A Report of the Conference on Cognitive Studies and Curriculum Development. Ithaca: Cornell University, 1964. p. 102.

development of his cognitive skills in a very favorable sense.[50]

Writing in the Fifty-Ninth Yearbook of the National Society for the Study of Education, Tyler[51] recommended science education as the extension and more adequate development of children's curiosity through the process of exploration and learning by experience. In this same volume, Rogers[52] suggests that the schools provide laboratory work on a simple scale for all pupils.

The psychological basis for pre-school enrichment are fairly well accepted. Writing to this point, Hunt notes that:

> It was commonly believed before World War II that early experience was important for emotional development and for development of personality characteristics, but unimportant for the development of the intellect or intelligence.
>
> It looks now as though early experience may be even more important for perceptual, cognitive, and intellectual functions than it is for the emotional and temperamental functions.[53]

Hodges and McCandless view the role of experience in learning as of much greater importance than the view expressed by Hunt. They maintain that:

> It is now almost universally accepted (and on the basis of hard data for children and adults, as well as even harder data

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[50] J. F. Wohlwill. "Cognitive Development and Learning of Elementary Concepts." Journal of Research in Science Teaching 2: 222-26; 1964.

[51] Ralph W. Tyler. "The Behavioral Scientist Looks at the Purposes of Science Teaching." In: National Society for the Study of Education. Rethinking Science Education. Chapter 2, p. 33. Fifty-Ninth Yearbook, Part I. Chicago: University of Chicago Press, 1960.

[52] Eric M. Rogers. "The Research Scientist Looks at the Purposes of Science Teaching." In: National Society for the Study of Education. Rethinking Science Education. Chapter 2, p. 22. Fifty-Ninth Yearbook, Part I, Chicago: University of Chicago Press, 1960.

[53] J. Mc V. Hunt. "The Psychological Basis for Pre-School Enrichment." Merrill Palmer Quarterly. 10: 222-23; July 1964.

for animals) that intellectual power, agility, and discipline develop through experience.[54]

The Forty-Sixth Yearbook[55] Committee stresses that the lack of enough varied experience often leads to errors in concepts, hence, a great many opportunities are needed to relive experience through other sensory and motor experiences. The role of experience in learning is further substantiated by the work of Lewin[56] which has shown that experiences through which a child learns are not neutral to him; they are in fact, almost compulsive determiners of the direction of his behavior. The evidence is overwhelming that the essay in discovery is a native drive of children from kindergarten through high school.[57]

Butts[58] maintains that experience with phenomena of science is a necessary and sufficient condition for concept development. The importance of early experience in science on learning was recognized by Hefferman when she recommended that schools:

> . . . base a preschool program on significant firsthand science experiences so children have faith in their own observations and conclusions based on experience.[59]

Research in teaching kindergarten pupils science. Most of the

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[54]Walter Hodges and Boyd McCandless. "Shall Pre-Schoolers Read or Play?" Indiana University, 1964. p. 3. (Mimeograph.)

[55]National Society for the Study of Education, *op. cit.*, p. 79.

[56]*Ibid.*, p. 69.

[57]*Ibid.*, p. 63.

[58]David Butts. "The Degree to Which Children Conceptualize From Science Experience." *Journal of Research in Science Teaching*. 1: 141; 1963.

[59]Helen Heffernan. "Concept Development in Science." (Address at 14th Annual Convention of National Science Teachers Association, New York, April, 1966.) p. 7.

research dealing with science in the kindergarten has been conducted through interview techniques, analysis of tape recordings of children in varying situations, or analysis of anecdotal records. Little systematic research into the relative effectiveness of various methods and materials on learning science can be found in the literature. There are, however, several studies which merit a brief discussion for their relevance to this study.

One of the earliest studies of children's interest in science was conducted by Laura Mau.[60] She submitted a series of animal, physical object, and plant pictures to 2,000 children in order to discover what the child preferred. Her findings indicated that children preferred animals, plants, and physical objects in that order.

Millie Almy[61] pursued through the interview demonstration technique young children's thinking about natural phenomena. She found that the ability to predict correctly probably reflects the child's keenness of observation and the amount of experience the child has had with a particular phenomena.

Numerous studies have focused their attention on children's understandings of natural phenomena. Katherine E. Hill[62] observed the growth in perceptivity apparent in children's ability to question, speculate, recognize relationships, and draw conclusions when there is

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[60] Laura E. Mau. "Some Experiments With Regard to the Relative Interests of Children in Physical and Biological Nature Materials in the Kindergarten and Primary Grades." The Nature Study Review 8: 285-290, November 1912.

[61] Almy, *op. cit.*, p. 27.

[62] Katherine E. Hill. *Children's Contributions in Science Discussions*. New York: Bureau of Publications, Teachers College, Columbia University, 1947, p. 97.

ample time for them to have science discussions.

In a study similar to those of Mau and Almy, Inbody investigated children's understanding of natural phenomena. On the basis of his findings, he states that:

1. Science instruction for children is most profitable when concerned with observable phenomena.

2. Instruction based on deduction which seems logical to the adult may be pointless to the child.

3. A child's understanding of a phenomena cannot be assumed even if he uses correct terms and gives correct explanations.

4. Children need many experiences involving different manifestations of the same phenomena.

5. Children should be taught to observe phenomena carefully, and should be helped to interpret observations.

6. Some phenomena are difficult for young children to interpret because they do not understand related phenomena.[63]

In a study of the possible learnings resulting from science experimentation by a class of first grade children, Jones[64] found that when opportunities are provided for children to experiment, the skills, attitudes, and concepts consistent with the scientific method were developed.

The work of Jones lends support to the earlier research of Haupt[65]

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[63] Donald Inbody. "Children's Understandings of Natural Phenomena." Science Education 47: 270-78, April 1963.

[64] Mary Ellen Jones. "A Study of the Possible Learnings Resulting from Science Experimentation by a Class of First Grade Children." Science Education 43: 355-77, October 1959.

[65] George W. Haupt. "Generalization in Elementary School Science." School Science and Mathematics 34: 574-77, July 1934.

and Croxton[66] which presented evidence that children are able to draw appropriate inferences from observation and other experiences in science.

Helfrich completed a descriptive study of certain science learnings known by entering kindergarten children. Though little of the actual findings of the Helfrich study pertain to the actual learnings known by the kindergarten child, he offers the following recommendations for science in the kindergarten.

1. The five year old would seem to profit from experiments.

2. Kindergarten would be an ideal time to start exploring cause and effect relationships.

3. Much use should be made of concrete, or real materials with children of this age.

4. Science should have a prominent place in the kindergarten program.[67]

The elementary school child's dependence on concrete, empirical experience for meaningful understanding of abstractions requires that much teaching in the elementary school be directed toward an inductive type of learning. This does not mean, that all or even most teaching must be conducted on the inductive, problem solving, and non-verbal basis. However, it does mean that the one essential for learning relational concepts is the availability of firsthand, concrete, and empirical evidence.

After a careful analysis of the findings of recent research in elementary science education, Paul Blackwood, Specialist for Elementary

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[66] Walter C. Croxton. "Pupils Ability to Generalize." School Science and Mathematics 36: 627-34, June 1936.

[67] J. E. Helfrich. "A Descriptive Study of Certain Science Learnings Known by Entering Kindergarten Children." Unpublished Doctor's Dissertation. Detroit: Wayne State University, 1963. 158 pp.

Science for the U. S. Office of Education, reached the following conclusions:

1. Involving children in activity type science programs helps them learn more science facts and concepts than in a reading, non-activity type program.

2. In activity type programs, children with purposes continually being clarified, learn the skills and attitudes of sound inquiry associated with science.

3. Studies do not show that there is one best way to learn science. They continue to confirm that children must have opportunities to explore, to investigate, to be like scientists if the goals of science education are to be achieved.[68]

Throughout history of this country, one can observe a close relationship between the goals of education and the changes which occur in society. As a result of the rapid explosion of knowledge and an awareness on the part of educators of the existing need for scientific manpower, the stated goals of science education have changed.

The particular role that the elementary school has to play in science education is rather explicitly defined by Jacqueline Mallinson. She maintains that it is the responsibility of the school to provide a science program that will develop in the child:

1. The ability to observe the objects that exist and the phenomena that take place in the child's environment, and to report accurately what he observes. In other words, the student should be taught to describe.

2. The ability to compare objects and phenomena with respect to their (a) likeness and (b) differences. These two skills are not the same.

3. The ability to rank information in terms of relative importance.

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[68] Paul E. Blackwood. "Implications of the Findings of Recent Research in Elementary School Science Education." <u>School Science and Mathematics</u> 60: 357-60; May 1960.

4. The ability to determine whether or not there is enough evidence available to warrant making a conclusion or even a tentative answer. In other words, to decide how much of an answer can be drawn from the information available.

5. The ability to determine what kind of information is still needed in order to formulate an answer to a question, or locate data on a problem.

6. The ability to decide on the most efficient way to obtain the needed information to answer a question or problem.

7. The ability to carry out an experiment with materials available, if it is decided that an experiment is the best way to answer the problem.[69]

The research findings and recommendations growing out of these findings show rather clearly the direction and dimensions of science in the early primary grades. Inhelder suggests that we:

> . . . devote the first two years of school to a series of exercises in manipulating, classifying, and ordering objects in ways that highlight basic operations of logical addition, multiplication, inclusion, serial order and the like. For surely these logical operations are the basis of more specific operations and concepts of all mathematics and science. It may be indeed, the case that such an early science and mathematics 'precurriculum' might go a long way toward building up in the child the kind of intuitive and more inductive understanding that could be given embodiment later in formal courses in mathematics and science. The effect of such an approach would be, we think, to put more continuity into science and mathematics, and also to give the child a much better and firmer comprehension of the concepts, which until he has this early foundation, he will mouth later without being able to use them in any effective sense.[70]

Non-verbal testing. A major obstacle to the evaluation of instructional procedures in elementary school science has been the lack of instruments to measure growth of pupils toward the desired goals of science education. Existing tests have tended to measure definitions of words, factual information, and to a lesser degree, problem solving

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[69] Jacqueline Mallinson. "Role of Elementary School Science in Modern Curriculum." School Science and Mathematics 60: 525-28; October 1960.

[70] Bruner, op. cit., p. 46.

skills. This major obstacle is further compounded when one considers the problems inherent in evaluating the outcomes of science instruction at the kindergarten level. In view of the limited ability of the kindergarten child to show by written evidence his growth of knowledge or skill, evaluation must be based either on anecdotal records, interview techniques, or non-verbal tests.

The majority of school systems do not have the financial assets to support individual interviews of all kindergarten children as a means of determining what concepts are known and what skills the child has developed as a result of pre-school experiences. Anecdotal records, though invaluable as an aid in determining pupil progress, as a result of their very nature, are incidental, may well be biased, and probably do not represent a complete picture of what the child knows or can do. Non-reading* tests allow the teacher to evaluate all pupils on their ability to do certain tasks which necessitate the knowledge of a given fact, or set of facts.

While working in the early elementary grades of the Minneapolis Public Schools, Charlotte M. Boener[71] developed a Picture Test for Comprehension of Science Concepts. In her preliminary work, she observed that the science education literature and Buros' Tests in Print list no group science tests for the early elementary grades. An analysis of her work provides evidence which indicates that it is

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*The literature refers to tests which require children to react to teacher directions read orally as non-verbal tests. If there is any communication, including oral, from teacher to pupil, the test is not a non-verbal test. It is a non-reading test.

[71]Charlotte M. Boener. "Picture Test for Comprehension of Science Concepts." School Science and Mathematics 66: 409-14; May, 1966.

possible to create an objective teacher administered non-reading, group science test.

The work of Haney,[72] although applicable at a higher grade level, is helpful for its suggestions relative to the development of non-verbal tests. Braine[73] has tested stages of development in children through non-reading tests, and his work gives some insights into the kinds of items needed to test skills and abilities.

Working with the Elementary Curriculum Materials Project at Illinois State University, Robert Rumery[74] and his associates have developed and tested two non-reading group tests in science for primary grade children. These tests assess the child's knowledge of atomic and molecular structure.

The Commentary for Teachers of Science--a process approach contains suggestions for evaluation which, if heeded, may represent a major accomplishment in evaluation of science concepts and skills in the elementary school. Their premise is that evaluation of science should be based upon the objectives of science education. These objectives of science education should be stated in the form of the expected behavior, or performance, on the part of the child as a result of

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[72] Richard E. Haney. "The Development and Analysis of a Non-Verbal Test of Certain Concepts Children Have of Animals." (Paper presented at the Second Annual Meeting of the Wisconsin Educational Research Association.) Milwaukee: University of Wisconsin. October 13, 1962. 16 pp.

[73] Braine, loc. cit.

[74] Robert E. Rumery. "Tests of Atomic Structure." Unpublished Test. Elementary Curriculum Materials Project. Normal: Illinois State University, 1965.

knowing a specific fact or set of facts. Is is Walbesser's[75] contention that the child "understands" when he can identify, or construct, or demonstrate, or describe, or order events and/or phenomena.

Teaching children skills. "Science--a process approach", the elementary science curriculum project of the Commission on Science Education of the American Association for the Advancement of Science has shown that the content of science can be organized in such a manner that children will be led to develop certain skills and abilities which are considered a part of the scientific endeavor. The instructional materials prepared by the writers in this project are based upon the following premises:

1. The scientists' behaviors in pursuing science constitute a highly complex set of intellectual activities which are, however, analyzable into simpler activities.

2. These intellectual activities (processes) are, as most scientists would agree, highly generalizable across scientific disciplines.

3. These intellectual activities of scientists may be learned, and it is reasonable to begin with the simplest ones and build the more complex activities out of them, since this seems to be in fact the way they are organized.

4. Accordingly, one can construct a reasonable sequence of instruction which aims to have children acquire process skills, beginning with simple kinds of observation, and building progressively through classification, measuring, communicating, quantifying, organizing through space and time, to making inferences and prediction.

5. At the end of such instruction, the student will not necessarily know anything which can be identified as physics, or

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[75] H. H. Walbesser. "Curriculum Evaluation by Means of Behavioral Objectives." Journal of Research in Science Teaching 1: 296-301; 1963.

chemistry, or biology, or geology.[76]

The philosophy underlying this program is quite different from other curriculum projects in elementary school science. The Commission states the assumption:

> That science is much more than an encyclopedic collection of facts, and that children in the primary grades will derive much benefit from experiences which will enable them to acquire the use of certain processes that are essential for the learning of science.[77]

In order to teach children these processes, a wide variety of content is used. A child may be studying sea shells one day, rocks the next day, and bouncing balls the third day. The particular sequence of topics which are studied represent a departure from traditional spiral or block organization of science content in the elementary school. The method used to select the content is summed up in the following statement. "Content is sometimes dictated by the particular process one wishes to teach."[78]

The writers of Science--a process approach contend that:

> The explosion of knowledge in science which is presently upon us makes it impossible for scientists themselves to "keep up with science." In education we can no longer hope to teach a child "all about science" during his twelve to sixteen years of schooling. If we even tried to do this, many facts we might teach may be unimportant a few years from now. New answers to old questions

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[76] Robert M. Gagne. "Psychological Issues in Science--A Process Approach." In: The Psychological Bases of Science--A Process Approach. Washington: The American Association for the Advancement of Science, Miscellaneous Publication 65-8, 1965. pp. 4-5.

[77] Commission on Science Education. Science--A Process Approach. Commentary for Teachers. Washington: American Association for the Advancement of Science, Miscellaneous Publication 64-16, 1964. p. 18.

[78] Ibid., p. 21.

are being formulated every day.[79]

In view of these facts, the project members offer the following suggestions for elementary school personnel as they consider the science curriculum.

> The only alternative which is apparent at the moment seems to be that we must equip the child with skills and processes which he can use to find solutions to science problems which he may encounter in the future. Most children will become voters and consumers, and will need to be "scientifically literate" to exercise good judgment as adults in a society which is so largely influenced by a scientific and technological progress. Future citizens will need to know how a scientist works, and to be able to use science skills in other areas where they are useful. Observation and communication, for instance, are two process skills which are absolutely essential for an individual to be able to "identify" with his fellow man, and to feel a sense of personal worth.[80]

Summary. A review of the literature concerning the purposes and trends in science education at the kindergarten level indicates the need for: (1) materials designed to develop skills, abilities, processes, inherent in the scientific endeavor and (2) evaluation instruments which assess the level of development of these skills, abilities, or processes in children.

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[79] Ibid.

[80] Ibid.

CHAPTER III

DESCRIPTIVE FEATURES OF THE STUDY

Introduction. In this chapter, a description of the children, teachers, and schools involved in the study is presented. The techniques used by the writer in developing the lessons and the non-reading tests used to measure the selected intellectual skills in kindergarten children are discussed. The procedures used in evaluating achievement of the children in this study are described. Where appropriate, sample lessons, test items, and feedback forms used in the study are included.

Design of the study. A major portion of this study consisted of writing eighteen science lessons and evaluating their affect on the growth of selected intellectual skills in kindergarten children. The techniques and procedures used by the writer in this study for constructing and refining the series of lessons were developed prior to the release of Toward a Theory of Instruction. In retrospect, it seems that the plan used by the writer is in close agreement with Bruner's contention that a theory of instruction is a normative theory. It sets up criteria and states the conditions for meeting them.[1] Bruner outlines the following criteria for a theory of instruction:

1. It should specify the experiences which most effectively implant in the individual a predisposition toward learning.

2. It must specify the ways in which a body of knowledge should

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[1] Jerome S. Bruner. Toward a Theory of Instruction. Cambridge: Harvard University Press, 1966. p. 40.

be structured so that it can be most readily grasped by the learner.

3. It should specify the most effective sequences in which to present the material to be learned.[2]

The plan of this study is in close agreement with the suggestions of Bruner from still another point. The feedback received from the Trial Group teachers was used for immediate revision of the instructional materials prior to their use by the Sample Group. This seems to be what Bruner is talking about when he makes the plea that instructional materials could be tried out under experimental conditions so that revision and correction could be based upon immediate knowledge of results.[3]

The following flow sheet summarizes the procedures used by the writer in developing and refining the science lessons designed to teach kindergarten children the intellectual skills of observation, classification, measurement and data treatment.

PILOT STUDY MATERIALS
↓
RE-WRITE
↓
TRIAL GROUP
↓
FEEDBACK
↓
RE-WRITE
↓
SAMPLE GROUP

Eighty children in two different kindergarten classrooms in Community Unit District No. 5 comprised the Trial Group. Twenty-seven of these children attended school at Towanda Elementary School, located approximately seven miles north of Normal, Illinois. The kindergarten teacher at Towanda, who also serves as building principal, possesses

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[2]Ibid., pp. 70-72.

[3]Ibid., p. 55.

the Master's Degree, has participated in numerous research projects under the direction of Illinois State University at Normal, Illinois, and was judged by the Curriculum Director of Unit District No. 5 to be an outstanding teacher.

Fifty-three of the children in the Trial Group attended school at Brigham Elementary School, located approximately six miles south of Normal, Illinois. The kindergarten teacher at Brigham taught both morning and afternoon sections of kindergarten, possesses the Master's Degree, has participated in numerous research projects under the direction of Illinois State University at Normal, Illinois, and was judged by the Curriculum Director of Unit District No. 5 to be an outstanding teacher.

Children in these two kindergarten classrooms were pre-tested in January 1966 with the Preliminary Test developed by the writer. The procedures and techniques used to develop this test, and the testing schedule are described in detail later in this chapter. As each lesson was used, the two teachers completed feedback forms designed by the writer for the purpose of gaining immediate assessment of the lessons. In light of the suggestions and recommendations of the feedback forms, the writer re-wrote the lessons prior to their use with the Sample Group of kindergarten children.

Forty children in two different kindergarten classrooms in the Thomas Metcalf Elementary School, the laboratory school of Illinois State University at Normal, Illinois constituted the Sample Group. All teachers on the staff of Illinois State University are required to possess the Master's Degree. Each of these teachers participated in research projects conducted by the University, and both were considered

outstanding by the school Principal, fellow teaching colleagues, and teachers throughout the community.

Children in the Sample Group were pre-tested in January 1966 with the Preliminary Test developed by the writer. They used the instructional materials which had been re-written as a result of feedback information received from the Trial Group teachers.

The results of the Preliminary Test were used to compare the children in the Sample and Trial Groups and to gain information which would show some of the concepts possessed by these kindergarten children after the completion of one semester of formalized education. The results of the Skills Test were used to measure the growth or achievement of the intellectual skills as a result of studying the lessons used in this study.

The writer assumed the responsibility of providing the necessary science materials. The materials were assembled, and packaged in envelopes which were labeled to correspond with the specific lessons.

Development of the lessons. The lessons used in this study attempted to set a learning situation in which overt activities were a result of the individual's own internal processes rather than response to a specific directive or stimuli by the teacher. In essence, the lessons may be classified as directed discovery lessons. In the words of Atkin, ". . . if children are going to discover relationships such as science concepts, teacher direction is needed. The teacher must furnish a conceptual framework for learning."[4]

Since it was assumed by the writer that it is the responsibility

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[4] J. Myron Atkin. "Science in the Elementary School--Teaching Science." Review of Educational Research 34: 265-66; June 1964.

of the schools to teach children certain skills and abilities, objectives were selected which clearly spelled out the hoped for achievements of children as a result of studying science in the manner prescribed in the lessons. The objectives for the entire set of lessons were to develop in children the ability to:

1. Classify objects in various ways--size, shape, color, texture, and odor.

2. Arrange objects in ordered series according to their positions along each of a number of dimensions, such as size, color, smoothness, and roughness.

3. Observe and describe similarities and differences in objects according to the presence or absence of certain characteristics, or the degree to which the objects represent certain characteristics such as hardness, elasticity, luster, smoothness, and roughness.

4. Notice and describe changes in various objects in such characteristics as size, shape, color, and position.

5. Notice and describe changes in the relationships of objects as to distance and direction.

Bloom notes that "educational objectives are explicit formulations of ways in which students are expected to be changed by the educative process."[5] Recognizing the importance of objectives in planning educational experiences, the writer included two kinds of objectives in each of the lessons. The behavioral objectives in the lessons specified the performances expected of children as a result of studying a particular lesson. Content objectives included in each of the lessons

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[5]Benjamin S. Bloom. Taxonomy of Educational Objectives. New York: David McKay and Co., Inc., 1964. p. 38.

specified the facts, principles, and concepts which children should acquire as the result of studying the lesson.

Content selection. The content used in this study was selected on the basis of the following criteria: (1) it could be taught meaningfully to children of this age, (2) there exist appropriate experiments by which children could be led to discover the desired concept, (3) the content was appropriate for developing skills and abilities in children, (4) the content would be interesting to children, and (5) the content could be useful as a basis for further study in science.

On the basis of these criteria, the writer selected the broad area of the Nature of Matter as the major content. The specific topics of solids, liquids, and gases were used in a majority of the lessons. The topic of weather was also used for its particular relevance to criteria two and three listed above. In the systematic study of weather, there exist many opportunities for children to gather and record information relative to environmental phenomena.

Intellectual skills. The intellectual skills selected for this particular study are those which are developed to some degree by all children as a result of maturation and progress through school. The findings of the AAAS[6] have shown that children develop the skills of observation and classification to some degree in grades K, 1, 2, and 3. Their findings also show that development of these skills may be accelerated through the use of materials specifically designed to teach these skills.

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[6] Commission on Science Education. An Evaluation Model and Its Application. Washington: American Association for the Advancement of Science, Miscellaneous Publication 65-9, pp. 54-55.

This study is similar to the AAAS approach in many respects. It differs however in two distinct ways. First, this study utilizes a logical sequence of content as the vehicle for developing skills in children. The content used for developing skills in the AAAS project follows no logical or systematic pattern. Lessons designed to teach children a given skill, or process are organized around content selected from the various segments of scientific knowledge. Second, the lessons which comprise a major portion of this study were re-written on the basis of immediate assessment rather than being re-written after the lapse of a considerable period of time, as is the practice of the Commission on Science Education.

Observation may be described as the utilization of the senses of sight, touch, smell, hearing, and taste as a means of gathering information of environmental phenomena. Careful, critical observation plays a major role in keeping scientific curiosity and inquiry alive for children. By being aware of phenomena in his environment, the child finds many new and challenging questions.

Observation involves the directing of one's senses to objects and phenomena. The importance of observation as it relates to science was recognized by Westaway when he maintained that:

> It is the essence of good observations that the eye should not only see a thing itself, but of what parts that thing is composed. And if an observer is to become a successful investigator in any department of science, he must have an extreme acquaintance with what has already been done in that particular department. Only then will he be prepared to seize upon any one of those minute indications which often connect phenomena apparently quite remote from each other. His eyes will thus be struck with any occurrence which, according to received theories, ought not to happen; for these are the facts which

serve as clues to new discoveries.[7]

Observation is a fundamental skill in the work of the scientist, and the basis, at least in the beginning, for all knowledge. It furnishes the descriptions that are the basis for the process of classification which necessitates the recognition of similarities and differences. It provides the descriptions necessary for devising hypotheses which may be tested by further accurate observations. All children possess the ability to observe, but like any skill, it must be refined and developed to its maximum level of efficiency through practice.

Five lessons were designed to help children develop, refine, and increase the precision of their observational ability. These lessons provided opportunities for children to see a variety of colors, to handle a variety of objects, to discriminate between objects on the basis of odor, to orient themselves in space with reference to a given object, and to make comparisons on the basis of the presence or absence of various characteristics.

Classification is primarily an intellectual activity, not a physical activity. It reduces the complexity of our environment and thus makes it easier to deal with. Classification is a means of knowledge, a way of grasping the unity of certain things, the relation between various kinds of things.

The role that classification plays in the scientific method is clearly defined by Abraham Wolf in his book, Essentials of Scientific Method. He states that:

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[7] F. W. Westaway. Scientific Method. New York: Hillman-Curl, 1937. p. 196.

Classification, then, is in some ways the earliest and simplest method of discovering order in nature. To recognize a class is to recognize the unity of essential attributes in a multiplicity of individual instances.

The method of classification is the first method employed in every science. Long before there is deeper insight into facts, which is required for the more advanced methods of science, the method of classification can be, and has to be employed.

Classification is a method of science, it is a way of knowing or regarding things.

The essence of classification consists in the fact that certain things are thought of as related in certain ways to one another.

The man of science is not supposed to invent or create, but only to discover the sameness or similarity of character in the things, processes, etc., which he classes together.

The aim of scientific classification is to see things according to their actual objective relationships. Such classification is what is meant by natural classification.

All classifications are based on the presence or absence, or the presence in varying degrees of certain attributes; and those classifications are the most natural in which the attributes selected as the bases of the classifications are such as carry with them the presence or absence, or the presence in varying degrees of other attributes.[8]

Four lessons were constructed for the specific purpose of teaching children to classify. These lessons specified a variety of experiences which would allow children to place related objects in a group, recognize the common features among a group of related objects, discover the unique feature of a group of seemingly non-related objects and to group objects on the basis of a single criterion.

The ability to recognize relationships existing in quantitative data, the ability to infer and predict from quantative data, and the

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[8]Abraham Wolf. Essentials of Scientific Method. London: George Allen and Unwin LTD, 1928. pp. 30-31.

ability to interpret quantitative data are considered to be an integral part of the intellectual skill of data treatment. In the sciences, it is desirable that children learn to record, interpret, and use data gathered from environmental and experimental phenomena.

Since there exist in traditional kindergarten programs many opportunities for children to gather data regarding environmental phenomena, there were no specific lessons designed to teach children the intellectual skill of data treatment _per se_. In the weather lessons written for this study, children are requested to check and record the temperature daily, determine and record the direction of the wind, measure and record the amount and kinds of precipitation. Specific instructions for the teachers included having children predict from these records, interpret the records they had made, to recognize trends in the records, and to recognize highs and lows in the graphs they had made. Therefore, the activities of recording the daily temperature, wind direction, and amount of precipitation were assumed to provide sufficient activity on the part of each child to facilitate the development of the skill of data treatment.

The findings of _Science--a process approach_[9] show a need for instruction in graphing in the primary school curriculum. It is therefore appropriate that this study chose to investigate ways of developing in children some competency in the recording, interpretation, and handling of data.

Measurement is an essential part of all quantitative experimentation. By precise measurement, the scientist is able to achieve a

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[9] Commission on Science Education, _op. cit._, p. 56.

high degree of accuracy in his experimental work. The ability to measure is an important skill needed by all children and may be developed to an appreciable level by primary grade children.

Since all measurement is approximation, the primary grade child can profit from experiences which call for him to order objects with reference to size, height, and length. Many opportunities exist in the primary grades for measurement and the utilization of measuring devices.

Four lessons were constructed which called for the child to distinguish between objects as to length and height, order objects according to length, specify the length of an object as so many times an arbitrary unit, and measure the length of an object using a ruler.

Description of the lessons. Each lesson in this study contained a statement of objectives, a rationale, a vocabulary list, a list of materials, the procedures to be used, and appraisal activities. The lessons were numbered sequentially.

Each lesson contained two sets of objectives. The behavioral objectives specified the performances expected of a child as a result of having participated in the experiences specified in a lesson. As an example, a behavioral objective from Lesson 1, Direction, specifies that children should be able to walk in a given direction, and then turn the proper direction when told to do so. The content objective for Lesson 1 specifies that children should know the names of the directions upon completion of the lesson.

The rational included explanatory statements concerning the content or the particular skill emphasized in the lesson. The rationale varied from one exercise to another according to what the writer believed would be most helpful to the teacher in establishing the intent

and purpose of the particular lesson. The rationale of Lesson 1 states that one of the fundamental concepts which should be developed as a result of early school experiences is the concept of direction. This concept is necessary for understanding of simple maps, and must be developed prior to any formalized discussion of weather and the seasons.

The vocabulary list consisted of new words or special phrases included in the lesson. It was the responsibility of the teacher to teach the children to recognize and use these words. The method of teaching children these words was left to the discretion of the teacher. The vocabulary list for Lesson 1 includes the words west, east, north, south, left, right, in-front of, and behind. It is possible that this emphasis upon vocabulary would affect reading readiness ability.

The materials list included all of the items which would be needed by the teacher to provide the experiences in each of the lessons. The majority of the science materials were packaged and provided for the teacher in sufficient quantities by the writer.

The procedure included suggestions for the teacher which the writer assumed would be helpful in teaching children the concept or skill. The suggested activities in the procedure were organized from the simple to the complex. Teachers were instructed to follow the procedures as they were written. The following is part of the procedure for Lesson 1.

Prior to this exercise, place the names of the directions (north, south, east, and west) on the four walls of the classroom. Make these names large enough to be seen clearly by all children. Walk around the room and point these directions out to children. At the completion of the following activities, remove the words north, south, east, and west

from the walls.

The appraisal activities for each lesson constituted the evaluation of the lesson. These appraisal activities called for overt behaviors on the part of children which could be used to indicate the presence or absence of a particular skill or concept. The following appraisal activity is an outgrowth of a specific behavioral objective for Lesson 1.

Appraisal 4, Lesson 1 reads: "Ask a girl to stand up and face the east. Have her walk toward the east and then turn and walk toward the south."

Each lesson was designed to be a self contained lesson plan which placed upon the teacher the task of directing specified learning experiences. It was assumed that each lesson could be completed in a maximum of forty minutes.

As each lesson was completed, it was submitted to Mr. Harry O. Jackson, Assistant Professor of Biological Science, and Mr. Ronald Cook, Assistant Professor of Chemistry at Illinois State University. These men reviewed the lessons with regards to their logical development and scientific accuracy. In light of their recommendations and criticisms, the lessons were revised or re-written. The lessons were then duplicated and distributed to the teachers whose children comprised the Trial Group.

Lesson 8, Observation 2 which follows illustrates the format used in each of the lessons. Key words to be emphasized by the teacher are underlined. This lesson, reproduced here in its entirety, is one of the lessons used by the teachers of the Trial Group. All lessons used by the Trial Group teachers are to be found in Appendix A and the

lessons used by the Sample Group teachers are included in Appendix B.

ETSKA 66 Lesson 8*

OBSERVATION 2. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. identify the shape of objects.
2. identify the texture of objects.

Content: Upon completion of this exercise, children should know:

1. the difference between round and square objects.
2. the difference between smooth and rough objects.

RATIONALE:

As preparation for later exercises in science, children should develop the ability to use the sense of touch as a means of gaining information relative to objects and their properties.

VOCABULARY: round, smooth, rough, square, texture.

MATERIALS: styrofoam balls, marbles, 1" x 1" wooden blocks, blindfolds.

PROCEDURE: Tell the children you want them to make some observations today without using their eyes. You have some blindfolds for them and you want them to find out all they can about some objects without using their eyes.

1. Pass out the blindfolds. Have each child put their blindfold on and check that they cannot see.

2. Walk around the room and give each child the envelope which contains 1 marble, 1 styrofoam ball, and the 1" x 1" block.

3. Have the children open the envelope and examine the objects.

4. Ask <u>all</u> children to hold up the <u>rough</u> <u>round</u> ball.

5. Ask <u>all</u> children to hold up the <u>square</u>.

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*The lessons cited in the thesis are those actually used by the teachers and it is recognized that there may be errors which would need to be corrected in any re-use of the materials.

6. Remove the blindfolds and repeat items 4 and 5.

APPRAISAL:

1. Choose one child and have him reach into a sack and choose the <u>rough</u> <u>round</u> ball.

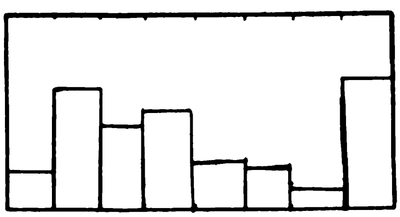
2. Repeat with another child and ask for the <u>square</u>.

<u>Development of tests</u>. It was pointed out in Chapter II that there exists a scarcity of evaluation instruments designed to measure skills and abilities of primary grade children. The need for evaluative instruments appropriate for primary grade children led the writer to construct two group non-reading tests. The items which comprised these tests were constructed on the basis of the following criteria: (1) each item tested a single concept, (2) the item required from the child an overt behavior, such as selecting, coloring a specific part of a sequence or series of pictures, or measuring the length of a line, (3) each item tested for an ability which has been defined as a part of one of the selected intellectual skills of observation, classification, measurement, and data treatment, (4) each item should be understandable on the part of the child with a minimum of teacher direction, (5) each item should be capable of being answered with either an "x" or by coloring a specific part of the item, and (6) each item should be capable of being scored on a binary scale, 0 for incorrect and 1 for correct.

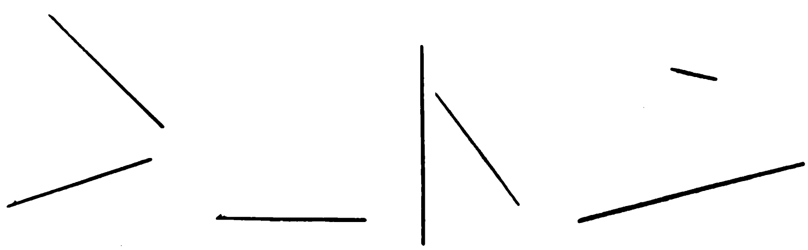
The writer constructed a Preliminary Test of twenty items which met one or more of these criteria. This Preliminary Test was administered by the investigator to fifty first grade children in the Thomas Metcalf School, the laboratory elementary school of Illinois State University during the month of October, 1965. The two first

grade teachers who observed all the testing were requested to furnish comments and criticisms relative to the vocabulary, instructions, and construction of each individual item. On the basis of these comments and criticisms, and personal knowledge gained through individual conferences with some pupils who took the test, many of the items were refined and subsequentially administered to the Trial and Sample Groups during the month of January, 1966.

The Preliminary Test consisted of four pages, each containing five or six items separated by a wavy line as shown in the example below. The greatest single difficulty encountered by the children was their inability to move from one item to another. The directions included with each of the sample items from the Preliminary Test were read orally by the teacher to the children.



With your red crayon, color the bar on this graph which shows the highest temperature. With your green crayon, color the bar on this graph which shows the lowest temperature.

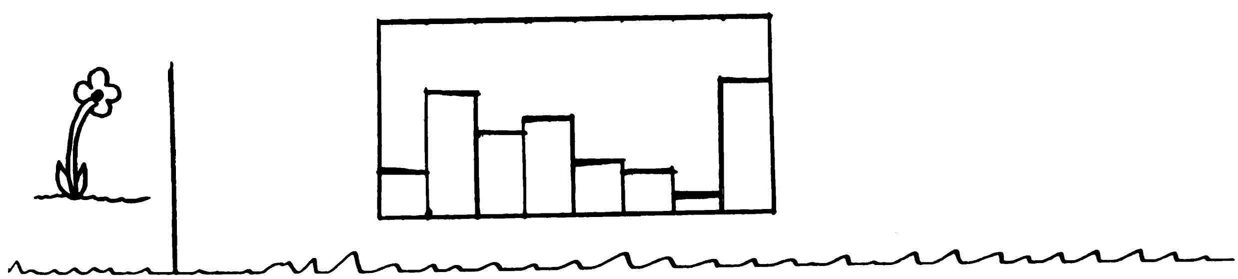


Color the longest line blue.

In order to eliminate the difficulty from the Preliminary Test prior to using it with kindergarten children, each item was preceeded by a picture of some object which was assumed to be known by all kindergarten children. The directions were altered as shown by the example and read orally by the teacher to the children.

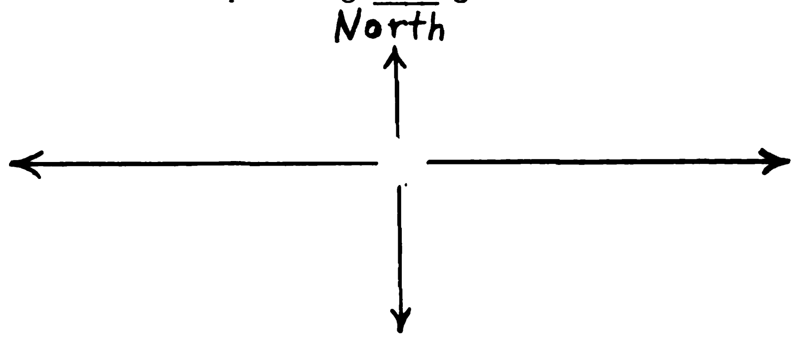
Test: Data Treatment.

Question No. 1. Put your finger on the picture of the flower. Next to the picture of the flower is a graph of the temperature made by the children in Lincoln School. Look carefully at the bar graph and color the bar which shows the highest temperature red. Look carefully at the bar graph and color the bar which shows the lowest temperature green.

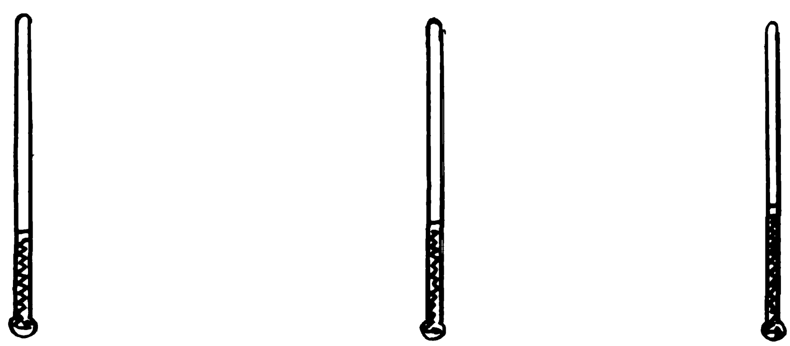


The Skills Test which was used as the pre-test and the post-test for the Sample Group and the post-test for the Trial Group was developed by the writer after the Preliminary Test had been administered to the first grade pupils. The items on the Skills Test were placed one to a page. For clarity and ease of administration, each page of the Skills Test differed in color from the previous page. Two items from the Skills Test which appears in Appendix D are illustrated. The directions which accompany each of the sample items from the Skills Test were read orally by the teacher to the children.

Item 4. Directions: Turn to the blue page. The top of this page is labeled NORTH. There are four arrows shown on this blue page. Color the arrow which is pointing west green.



Item 5. Turn to the yellow page. This page shows three pictures of thermometers. Look carefully at these thermometers and color the one which you think has been in the sun the longest period of time blue.



Other evaluations. In the discussion of the lessons presented previously in this chapter, mention was made of the individual and group appraisal activities which formed an integral part of each lesson. These activities were included to give the teacher immediate assessment of the learnings of children at the conclusion of each lesson. They provided evidence as to whether or not the specific objectives of the lessons had been achieved.

Individual appraisal. The behavioral objectives for each lesson specified the performance desired of the children as the result of

participating in the activities prescribed in each lesson. Since it was impossible from the standpoint of time to give each child an individual performance test, teachers were requested to select pupils randomly for the individual appraisal activities specified in each of the lessons. The number of pupils tested with each individual appraisal was left to the discretion of the teacher.

The administration of the individual appraisal items in each lesson was the responsibility of the teacher. Decisions regarding the correctness or incorrectness of a response was left to the discretion of the teacher. The Individual Appraisal Data Sheet which follows was used by the teachers to record responses of the children.

TEACHING SCIENCE IN THE KINDERGARTEN ETSK 66

Individual Appraisal Data Sheet

Exercise Title: ______________________________ Teacher: ______________

	Student Name	Yes No
Appraisal 1	___________________________	__________
Appraisal 2	___________________________	__________
Appraisal 3	___________________________	__________
Appraisal 4	___________________________	__________
Appraisal 5	___________________________	__________

Lesson 5, which is concerned with measurement, contains the following individual appraisal. Ask three pupils to bring you their red crayons. Ask one of the children which of the crayons is the longest. Ask another child which of the crayons is the shortest. Ask another child if two of these crayons are the same length.

Group appraisal. The content objectives for each lesson

specified the facts, principles, and generalizations children should know as the result of a specific lesson. Evidence concerning the presence or absence of a concept was gained by the appropriate group appraisal activity for all children. The materials for each of the group appraisals were furnished to the teachers by the writer.

Lesson 5, which deals with measurement contains one of the group appraisals. The specific directions for this group appraisal follows. Give each child an evelope which contains five strips of various lengths and color of construction paper. Distribute the mimeographed sheet of paper labeled Measurement 3. Ask the children to glue the various strips of colored paper to this sheet so that the longest strip of paper is on their right and the shortest strip of paper is on their left.

Feedback. Evaluation of the lessons from the standpoint of teacher judgments was accomplished through the use of a feedback form designed by the writer. This feedback form was patterned after the AAAS[10] form. The primary purpose of the feedback form was to gain information which might be of value to the writer in refining the lessons. The information gained through an analysis of the feedback forms completed by the Trial Group teachers was used in revising and re-writing the lessons prior to their use by the Sample Group teachers.

Specific instructions for completing the feedback form were included in the introduction to the materials which was furnished to all teachers participating in the study. The feedback form used by all

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[10] Commission on Science Education. Science--A Process Approach. Commentary for Teachers. Washington: American Association for the Advancement of Science, Miscellaneous Publication 64-16, 1964. p. 80.

teachers participating in the study is included at the end of the lessons in Appendices A and B.

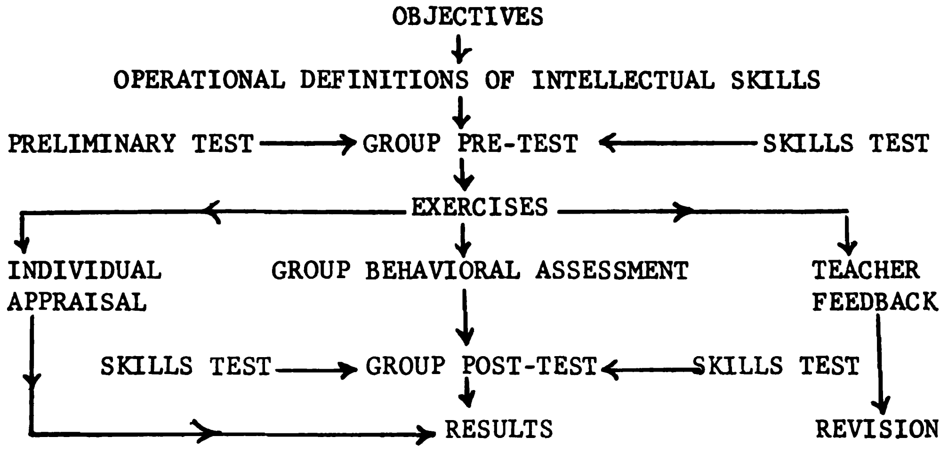
Implementation. During the second week of January, 1966 a complete set of materials was given to the Trial Group teachers. This complete set of materials included the lessons, group tests to be administered, and packaged science materials called for in the lessons.

An individual conference was held with each of the teachers after they had sufficient time to review the lessons. The conference was primarily concerned with answering any questions they might have relative to the lessons, the evaluation procedures, and the feedback instrument.

During the second week of April, 1966 the revised materials were given to the Sample Group teachers. An individual conference was held with each of the teachers to answer any questions they might have relative to the lessons, the evaluation procedure, and the feedback instrument.

The writer was available for consultation with the participating teachers during the afternoons of Monday, Tuesday, Thursday, and Friday. Conferences could be set up on any of these afternoons at the convenience of the classroom teacher.

The total evaluation strategy. A major concern of this study was the construction of evaluation instruments which would assess the growth of intellectual skills in kindergarten children. The following chart summarizes the procedures used in evaluating the kindergarten children and the materials produced in this study.



The testing procedures. All testing was under the direct supervision of the classroom teacher. Directions and general comments pertaining to the administration of the tests were furnished to the classroom teachers with the tests. Scoring and tabulation of the responses of both the Preliminary and the Skills Test was completed by a graduate assistant in chemistry working for the writer.

Individual testing through the use of the individual appraisal activities was completed at the conclusion of each lesson. Scoring of the individual tests was the responsibility of the classroom teacher. Results of these tests were recorded on the Individual Appraisal Data Sheet furnished for each lesson.

Group testing was completed by using the group appraisal activities specified in some of the lessons. The writer assumed the responsibility of scoring these group tests.

The testing schedule. Children in the Trial and Sample Groups were tested with the Preliminary Test during the month of January, 1966. Teachers were instructed to administer the test on four consecutive days, using one page of the test each day. No time limit was placed on each part of the test.

Children in the Sample Group were also tested during the month of January with the Skills Test. This test was administered on two consecutive days. On the first day, items one through fifteen were used. On the second day, the remaining twelve items were used. Again, no time limit was placed on the test.

Children in both the Trial and Sample Group were post-tested with the Skills Test during the third week of May, 1966. The test was administered by the classroom teachers in the manner described in the previous paragraph.

Summary. In this chapter, a detailed description has been presented of the children, teachers, and schools participating in the study. The procedures and techniques used by the writer in developing and revising the instructional materials have been described. A discussion of the tests used in the study, the testing procedures and the testing schedule followed is also included in this chapter.

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CHAPTER IV

EVALUATION AND RESULTS

The purposes of this study were to construct lessons in science designed to teach selected intellectual skills to kindergarten children; to develop group non-reading tests which would measure the growth of the intellectual skills of observation, classification, data treatment and measurement in kindergarten children, and to ascertain the achievement of kindergarten children in selected Normal, Illinois Elementary Schools who used the lessons written for the purposes of this study.

Hypotheses to be tested. Data relevant to the following hypotheses were based on the scores made by pupils on the non-reading Preliminary and Skills Tests designed by the writer and the Metropolitan Reading Readiness Test, Form R. A hypothesis was rejected when the value of a t-test indicated that the results obtained could occur by chance alone no more than five times in one hundred. The following null hypotheses were tested.

1. There will be no difference between the mean scores of the children in the Trial and Sample Groups on the Preliminary Test.

(H_{01}: $M_{sg} = M_{tg}$)*

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*In each of the null hypotheses stated, M symbolizes the mean; 1 symbolizes the pre-test; 2 symbolizes the post-test; sg symbolizes the sample group; tg symbolizes the trial group; and 01, 02, 03 symbolizes each respective hypothesis.

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2. There will be no difference between the means of the pre- and post-test scores made by children in the Sample Group on the Skills Test. (H_{02}: $M_{x1} = M_{x2}$)

3. There will be no difference between the mean scores of the children in the Trial and Sample Groups on the Skills Test. (H_{03}: $MST_{sg} = MST_{tg}$)

4. There will be no difference between the means of the pre- and post-test scores made by children in the Sample Group on those items in the Skills Test which measure observation. (H_{04}: $M_{01} = M_{02}$)

5. There will be no difference between the means of the pre- and post-test scores made by children in the Sample Group on those items in the Skills Test which measure classification. (H_{05}: $M_{c1} = M_{c2}$)

6. There will be no difference between the means of the pre- and post-test scores made by children in the Sample Group on those items in the Skills Test which measure data treatment. (H_{06}: $M_{dt1} = M_{dt2}$)

7. There will be no difference between the means of the pre- and post-test scores made by children in the Sample Group on those items in the Skills Test which assess measurement. (H_{07}:$M_{m1} = M_{m2}$)

8. There will be no difference between the mean scores made by children in the Sample and Trial Group on the Metropolitan Reading Readiness Test, Form R. (H_{08}: $MMRR_{sg} = MMRR_{tg}$)

9. There will be no difference between the mean scores made by children in the Sample Group and children not involved in this study on the Metropolitan Reading Readiness Test, Form R. (H_{09}: $MMRR_{sg} = MMRR_{p}$)

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10. There will be no difference between the mean scores made by the children in the Trial Group and children not involved in this study on the Metropolitan Reading Readiness Test, Form R. (H_{010}: $MMRR_{tg} = MMRR_{p}$)

Preliminary test data. In Chapter III, it was pointed out that the writer developed and administered a group non-reading test to fifty first grade pupils during the month of October, 1965. The primary purpose for using this test with first graders was to gain some insights into potential problems which might arise in the administration of group non-reading tests to kindergarten children.

In administering this test to first grade children, the writer noted that some children had difficulty with words which were assumed to be known by first grade children. As an example, some first grade children did not know the meaning of the word "feature", or "characteristic." During an individual testing period with one of the children, the word "part" was substituted for feature" or "characteristic" and the child correctly answered an item which he had previously missed.

In light of the knowledge gained through the administration of this test and suggestions for improvement made by the first grade teachers who observed the testing, several minor modifications were made in the test items. The revised test was subsequentially administered to both the Trial and Sample Groups during the month of January, 1966. The number of correct responses made by children in the Trial and Sample Groups on the Preliminary Test are shown in Table 1.

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TABLE I

PRELIMINARY TEST SCORES OF CHILDREN IN
THE TRIAL AND SAMPLE GROUPS

Test	1[a]	2	3	4	5	Mean
Observation						
Trial Group	80/23[b]	48	16	24	26	2.71
Sample Group	40/12	24	8	12	13	2.72
Classification						
Trial Group	74	21	19	60	--	2.18
Sample Group	37	10	9	32	--	2.20
Measurement						
Trial Group	74	72	74	70	24	3.93
Sample Group	36	32	38	35	14	3.88
Data Treatment						
Trial Group	64/65[c]	70	16	44	52	3.88
Sample Group	33/38	33	8	23	27	4.05

[a]These numbers refer to the item number on the Preliminary Test in Appendix C.

[b]Item No. 1 on the Observation test has two parts.

[c]Item No. 1 on the Data Treatment test has two parts.

Using a procedure suggested by Edwards[1] for comparing the means of independent groups, the writer calculated a t-ratio. The data presented in Table II on page 75 was used to test hypothesis one. (H_{01}: $M_{sg} = M_{tg}$)

On the basis of the data presented in Table II, one could infer that there was no difference between the science abilities of the children in the Sample and Trial Groups as measured by the Preliminary Test.

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[1]Allen L. Edwards. Statistical Methods for Behavioral Sciences. Chicago: Holt, Rinehart and Winston, 1964. p. 253.

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TABLE II

DIFFERENCE BETWEEN MEANS OF TRIAL AND SAMPLE GROUPS ON PRELIMINARY TEST

	Trial Group		Sample Group
Number of children	80		40
Sum of raw scores	1016		514
Sum of squared raw scores	60348		15400
Mean	12.7		12.85
Mean difference		.15	
Standard error		4.22	
t-value		.00365	
Significance level		not significant	

Skills test data. The Skills Test constructed by the writer was used to gather data related to hypotheses 2, 3, 4, 5, 6, and 7 of this study. The reliability of the test was calculated by the method of rational equivalence, using Froelich's formula as described by Garrett.[2] This calculation gave a reliability of .26. This low reliability coefficient was to be expected, for according to Ebel[3] a test with less than thirty items cannot be expected to have a reliability coefficient greater than .50.

The Skills Test was designed to measure the growth of the intellectual skills of observation, classification, data treatment, and measurement in children. The items on the test were constructed on the basis of the operational definitions presented for the intellectual skills in Chapter III, and on the basis of knowledge gained through the administration of the Preliminary Test to first grade children. Each

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[2] Henry E. Garrett. Statistics in Psychology and Education. New York: Longmans, Green and Co., 1953. p. 336.

[3] Robert Ebel. Measuring Educational Achievement. Englewood Cliffs: Prentice Hall, 1965. p. 337.

of the items on the Skills Test assessed an ability considered to be a part of one of the intellectual skills.

The intellectual skill of observation was measured by items 1, 2, 3, 4, 5, 9, 13, 14, and 22.* One of the abilities considered a part of observation is the ability to compare size. Item 1 asks children to select the largest circle from an assortment of various sized circles. The information shown in Table III reveals that all children tested in the Sample Group answered this item correctly on the pre- and post-test.

The intellectual skill of classification was measured by items 10, 11, 18, 20, 24, and 25.* One of the abilities considered to be a part of the intellectual skill of classification is the ability to recognize common features among a group of objects. Item 24 asks the child to circle the common feature possessed by four objects in an assortment of seven objects. Data presented in Table III shows that four children correctly answered this item on the pre-test and twelve children answered it correctly on the post-test.

Assessment of the intellectual skill of measurement was determined by items 7, 8, 16, 21, and 27.* For the purposes of this study one of the competencies taught for was the ability to specify the length of an object as so many times an arbitrary unit. Item 27 asks the child to determine the length of a line using two different arbitrary units. According to Table III, fourteen children answered this item correctly on the pre-test and eighteen children answered it correctly on the post-test.

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*These numbers refer to the item number on the Skills Test in Appendix D.

TABLE III

NUMBER OF CORRECT RESPONSES MADE BY CHILDREN IN THE SAMPLE GROUP ON THE SKILLS TEST

Item Number	Pre-Test	Post-Test	Item Number	Pre-Test	Post-Test
1	40	40	14	24	15
2	36	37	15	9	25
3	8	6	16	28	39
4	17	37	17	8	21
5	31	36	18	30	37
6	19	33	19	20	20
7	2	21	20	15	13
8	16	23	21	26	24
9	35	35	22	8	26
10	16	22	23	25	38
11	23	20	24	4	12
12	10	18	25	3	27
13	19	28	26	19	21
			27	14	18

The intellectual skill of data treatment has been operationally defined as consisting of the abilities to predict from both a line and a bar graph, to recognize trends in data, to recognize highs and lows on both a line and a bar graph, and to record information on a line or bar graph. Items 6, 12, 15, 17, 19, 23, and 26* on the Skills Test specifically assess these competencies. Item 17 tests for the ability

*These numbers refer to the item number on the Skills Test in Appendix D.

to predict from a bar graph. Information contained in Table III reveals that eight children could predict from a bar graph on the pre-test and twenty-one children could predict from a bar graph on the post-test.

All responses on the Skills Test were scored on a binary scale, 1 for correct, and 0 for incorrect. The resulting raw scores were recorded for each child. The total number of correct responses constitutes the score on the pre- and post-test.

The children in the Sample Group were pre- and post-tested with the Skills Test. The raw scores of these children are shown in Table IV which appears in Appendix F. Examination of the information contained in this table shows that some children achieved at a lower level on the post-test than their level of achievement on the pre-test. As an example, student number nine scored lower on classification items on the post-test than he scored on these items on the pre-test. Examination of the last column in Table IV, which shows pre- and post-test totals, shows that two students did poorer on the post-test than on the pre-test, two students made no gain, and thirty-six students made gains ranging from 1 to 10.

After studying science as prescribed in the instructional materials produced by the writer, the children in the Trial and Sample Groups were tested with the Skills Test. The data relative to the scores of the Trial and Sample Groups is presented in Table V.

To test hypotheses 4, 5, 6, and 7, the raw scores of the children in the Sample Group which appear in Table IV were used. The information appearing in columns X_1 and X_2 was used by the writer to calculate a t-ratio by the method described in Garrett.[4] This t-ratio analyzes the difference that exists between correlated means. The data presented in Table VI shows that the mean gain of the children in the Sample Group on the Skills Test exceeds the point of rejection.

TABLE V

DIFFERENCE BETWEEN MEANS OF TRIAL AND SAMPLE GROUP CHILDREN ON THE SKILLS TEST

	Trial Group		Sample Group
Number of children	80		40
Sum of raw scores	1303		702
Sum of squared raw scores	72079		12530
Mean	16.2		17.5
Mean difference		1.3	
Standard error		4.4	
t-value		.32	
Significance level		not significant	

TABLE VI

DIFFERENCE BETWEEN MEANS OF PRE- AND POST-TEST SCORES MADE BY CHILDREN IN THE SAMPLE GROUP ON THE SKILLS TEST

	Pre-Test		Post-Test
Number of children	40		40
Mean	12.63		17.55
Standard Deviation	3.15		2.29
Standard Error	.49		.36
Difference between means		4.92	
Correlation between tests		.22	
Standard Error of Difference		.54	
t-ratio		9.07	
Significance level		.001	

In order to test for the significance of the growth of the respective intellectual skills, the raw scores of the children in the

[4] Garrett, _op_. _cit_., p. 227.

Sample Group on those items measuring classification, observation, measurement, and data treatment on the pre- and post-test were used. The data presented in Table VII shows that the t-ratio calculated for each of the intellectual skills exceeds the value which could have been due to chance alone.

TABLE VII

SAMPLE GROUP DIFFERENCE BETWEEN MEANS OF PRE- AND POST-TEST ON ITEMS MEASURING SKILLS

Skill	Mean Difference	SD_d	SE_{md}	t	Sig. Level
Observation	0.85	1.54	.244	3.54	.001
Classification	1.05	1.21	.191	5.40	.001
Measurement	1.05	1.24	.196	5.35	.001
Data Treatment	2.075	1.61	.255	8.10	.001

The series of lessons written for this study were designed to teach kindergarten children selected intellectual skills. Data presented in this study supports the fact that learning experiences can be structured which teach children these selected skills. However, one could ask if the skills developed are really separate, or do they represent a single skill which is developed by children as a result of the lessons?

In order to secure information relative to this question, the writer calculated correlation coefficients for all possible combinations of the selected skills using a method suggested by Garrett.[5] These correlation coefficients are shown in Table VIII.

[5] Garrett, *op. cit.*, pp. 142-43.

TABLE VIII

CORRELATION COEFFICIENTS BETWEEN SELECTED INTELLECTUAL SKILLS BASED UPON SKILLS TEST SCORES OF CHILDREN IN THE SAMPLE GROUP

Skills	Correlation Coefficient	Significance
Classification/measurement	.130	not significant
Classification/observation	.014	not significant
Classification/data treatment	.236	not significant
Data Treatment/observation	.280	not significant
Measurement/observation	.118	not significant
Measurement/data treatment	.117	not significant

From these correlation coefficients, one might infer that the intellectual skills which were taught to children in this study are separate and independent. The data show that the intellectual skills of data treatment and observation are more closely related than any of the other skills.

Individual appraisal. Each lesson contained individual appraisal activities designed to give the teacher immediate evaluation of the stated behavioral objectives of the lessons. The individual appraisal activities specified that children should be able to perform, demonstrate, show or select objects and/or events related to a given question. The information reported by teachers in the Sample Group who assumed the responsibility of determining the correctness or incorrectness of a response is shown in Table IX. This table represents a summary of the Individual Appraisal Data sheets completed by the teachers.

TABLE IX

INDIVIDUAL APPRAISAL RESULTS OF CHILDREN IN THE SAMPLE GROUP

	1[a]	2	3	4	5	6	7
Direction							
Number tested	2	2	2	2	2	-	-
Number correct	2	2	2	2	2	-	-
Temperature							
Number tested	18	40	20	-	-	-	-
Number correct	18	40	20	-	-	-	-
Measurement							
Number tested	4	4	4	4	4	-	-
Number correct	4	4	4	4	4	-	-
Observation							
Number tested	40	40	40	40	46	2	4
Number correct	40	40	40	40	6	2	4
Classification							
Number tested	2	2	2	2	40	-	-
Number correct	2	2	2	2	40	-	-
Weather							
Number tested	40	40	40	40	40	-	-
Number correct	30	32	40	40	40	-	-

[a]These numbers refer to the number of the Individual Appraisal Item categories listed in Appendix E.

Group appraisal. Four of the lessons specified appraisal activities for all children. Table X shows the percentage of correct responses to each of the questions on these group appraisals.

The group appraisal activity for Measurement 3 directs children to glue strips of colored paper in order of their increasing length from left to right on a sheet of ordinary paper. Six of the children placed the strips in the proper order, but reversed the directions. One child placed the strips of paper in increasing order with the shortest at the top of the paper and the longest at the bottom.

Thirty-one of the children correctly completed the task.

TABLE X

PERCENTAGE OF CORRECT RESPONSES BY CHILDREN IN THE SAMPLE GROUP TO GROUP APPRAISALS

Lesson	1[a]	2	3	4
Observation 1	100	85	90	82.5
Measurement 3	77.5	--	--	--
Measurement 4	45	75	50	--
Direction	75	77.5	82.5	--

[a]The numbers refer to the number of the item on the group appraisal activities found in the lessons in Appendices A and B.

<u>Feedback information</u>. The Trial Group teachers were requested to furnish information about each of the lessons on the feedback form designed by the writer. This information was used by the writer in revising the lessons prior to their use by the Sample Group teachers. A summary of the specific information reported on each feedback form follows. The comments relative to the intellectual skills of observation, classification, and measurement are presented.

<u>Trial Group Feedback</u>: <u>Observation</u>.

<u>Activities</u>: Teachers responded that all activities proposed were appropriate for inclusion in the lessons, except for the activity contained in Observation 1 which directs pupils to look at their neighbor's clothing for the purpose of color identification.

Suggested activities for addition to those specified in the lessons, included adding other objects to be observed, and activities which would help children understand what a circle is and how it is formed.

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All comments from the teachers indicated that they would like to see this series of lessons included in a sequential science program for kindergarten children.

Content: The teachers felt that the content was logically organized and appropriate for kindergarten children. They suggested adding the words big, little, to the vocabulary and that definitions of luster and brittle should be added to the rationale.

They estimated that over ninety percent of the children developed an understanding of the concepts in the series of lessons designed to teach the skill of observation.

Comments on written material: Both teachers felt that the written material was either excellent, or appropriate with the changes noted. They requested that more information be added to the rationale, and that other suggestions should be made which would help the teacher originate or start the lesson.

Reaction of the class: Teacher evaluations of class reaction to the instructional materials show that children were either fascinated or engaged in active conversation with other children relative to the activities. The attention span of the children was abnormally long for activities of this type. The questions asked by the children relative to the lessons ranged from few questions to a large number of questions. The teachers reported that the lessons caused children to bring related items from home. The teachers also reported that the children were able to use the new words in other situations, could remember the materials of previous lessons and used the skills developed in other situations.

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<u>Classification</u>:

<u>Activities</u>: Teachers responded that the activities included in the lessons designed to teach the skill of Classification were appropriate for kindergarten children and none should be removed from the exercises. They requested further activities to develop the concept of solids, liquids, and gases. All comments from the teachers indicated that they would like to see this series of lessons included in a sequential science program for kindergarten youngsters.

<u>Comments on written material</u>: The criticisms received on the written materials were favorable. Both teachers rated the individual sections of the lessons as acceptable, or excellent. Once again, the request was made for more information to be included in the rationale.

<u>Reaction of the class</u>: Teacher evaluations of class reaction to the lessons shows that the children engaged in active conversation with other children about the activities. The attention span of the children was average and a large number of questions were asked about the lessons. The teachers felt that the lessons caused children to bring related items from home, that children could remember concepts and skills from other lessons, and used the skills developed by this series in other situations.

<u>Measurement</u>:

<u>Activities</u>: Teachers commented that there were sufficient activities to result in concept formation in the children. They recommended that this series of lessons on measurement be included in the educational program for kindergarten children.

<u>Content</u>: A review of the comments concerning the content shows that the lessons on measurement were appropriate for kindergarten

children and the content had been logically developed. One teacher commented that children needed to know how to count prior to Measurement 4. Teachers estimated that over 90% of the children mastered the concepts in the lessons.

Comments on written materials: Teachers rated the exercise sections as acceptable. Their comments indicated that more information should be included in the rationale.

Reaction of the class: Teacher judgments of class reactions to the instructional materials show that the children were fascinated with the activities. The attention span of the children did not exceed the normal attention span, and an average number of questions were asked. Teachers commented that the lessons caused children to be able to use the skills and concepts developed in other situations.

In light of these recommendations from the Trial Group teachers, the lessons were re-written prior to their use by the Sample Group teachers.

Sample Group Feedback: Some of the anecdotal notes made by the Sample Group teachers are included here to illustrate the high degree of acceptance of the lessons by these kindergarten teachers.

Measurement 3: Children did not always note that the paper should be pasted evenly at the bottom, although they were careful to place one paper on the top of the other before pasting to see which was longer. Every child could tell us which strip was longest or shortest, but when he demonstrated his knowledge by pasting the paper he seemed to think that if one piece was higher at the top, the

bottom didn't matter.

<u>Classification 4</u>. I'm happy that you have seen opportunities where children can see their own ideas expressed on the chalk board and have them taken advantage of.

<u>Observation 1</u>. It was interesting and quite revealing that each student's sense of touch was different from another's--what felt smooth to some felt rough to others.

<u>Individual Appraisal--Observation 4</u>. All children were able to complete the appraisal items successfully. What a wonderful feeling this was!

<u>School test scores</u>. During the latter part of May, the Metropolitan Reading Readiness Test, Form R was administered to all children in the elementary schools in Normal, Illinois. Table XI shows the percentile rankings made by the children in the Sample Group, the Trial Group, and the children in other classes in Normal Illinois Public Schools who did not use the science lessons constructed by the writer.

To test hypotheses 8, 9, and 10, the writer secured the raw scores made by the 375 children on the Metropolitan Reading Readiness Test, Form R. These scores came from the records made by teachers of the Trial and Sample Groups and seven other kindergarten teachers in the Normal Illinois Public School system. As shown in Table XII, the mean score of the children in the Trial Group was 70.8, as compared to a mean score of 89.3 made by children in the Sample Group. The mean score of other kindergarten children who did not use the instructional materials prepared in this study was 59.5. In order to determine whether or not these differences were significant, the writer calculated

TABLE XI

PERCENTILE RANKINGS ON METROPOLITAN READING READINESS TEST

Percentile	Sample Group	Trial Group	Other Classes
95-99	25	1	10
90-94	7	5	10
85-89	2	10	11
80-84	1	13	13
75-79	1	9	26
70-74	1	11	16
65-69	-	7	18
60-64	-	10	26
55-59	-	4	18
50-54	-	2	27
45-49	-	4	22
40-44	-	2	15
35-39	-	1	12
30-34	3	1	12
25-29	-	-	8
20-24	-	-	7
15-19	-	-	1
10-14	-	-	1
5-9	-	-	1
Totals	40	80	255

TABLE XII

DIFFERENCE BETWEEN MEANS OF TRIAL, SAMPLE AND OTHER CLASSES ON METROPOLITAN READING READINESS TEST

	Trial Group (x_1)	Sample Group (x_2)	Other Classes (x_3)
Number of children	80	40	255
Sum of raw scores	5613	3573	15166
Sum of squared raw scores	42143	321820	1005108
Mean	70.8	89.3	59.5
Mean difference	$x_2-x_1 = 18.5$	$x_2-x_3 = 29.8$	$x_1-x_3 = 11.3$
Standard error	9.82	3.29	8.024
t-value	1.88	9	1.37
Significance level	not significant	.001	not significant
Hypothesis	8	9	10

t-values using the method suggested in Edwards.[6] The t-value calculated for the mean difference of 18.5 existing between the Trial Group Scores and the Sample Group scores was 1.88. This value is not significant at the .05 level. It is however, close to the value needed for rejection of the hypothesis of no difference. The t-value calculated for the mean difference of 29.8 existing between the Sample Group and other kindergarten children's scores is 9. This value is significant at the .001 level. The t-value of 1.37 calculated for the mean difference of 11.33 existing between the mean scores made by children in the Trial Group and other kindergarten children is not significant.

Summary. The evaluation of this study indicates that the methods and procedures used were effective in: (1) developing selected intellectual skills in kindergarten children, (2) meeting the objectives of the study, (3) evaluating skills possessed by kindergarten children through non-reading testing techniques, (4) teaching kindergarten children selected concepts, and (5) demonstrating a procedure for successfully refining a series of science lessons for kindergarten children.

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[6] Edwards, *loc*. *cit*.

CHAPTER V

CONCLUSIONS

The conclusions in this chapter are based upon the data presented in Chapter IV. The implications of this study for curriculum workers, science educators, and teachers are based upon the findings of the various procedures and techniques used. Problems for further investigation have grown out of questions raised by the study and fragmentary pieces of evidence which suggest relationships that may exist between some of the variables investigated in this study and other worthwhile skills and abilities. The recommendations presented are based upon data resulting from the study, feedback and comments of the participating teachers.

The data presented in Chapter IV supports the following conclusions:

1. There were no significant differences in the skills and abilities of the children in the Trial and Sample Group as measured by the Preliminary Test.

2. The instructional materials used in this study were effective in teaching children in the Sample Group the intellectual skills selected for the purposes of this study.

3. There were no significant differences in the skills and abilities of the children in the Trial and Sample Group as measured by the Skills Test. From this conclusion, one might infer that the

instructional materials were also effective in teaching children in the Trial Group the intellectual skills taught for in this study.

4. The instructional materials written for the purposes of this study were effective in teaching children in the Sample Group the intellectual skill of observation.

5. The instructional materials used in this study were effective in teaching children in the Sample Group the intellectual skill of classification.

6. The instructional materials used in this study were effective in teaching children in the Sample Group the intellectual skill of data treatment.

7. The instructional materials used in this study were effective in teaching children in the Sample Group the intellectual skill of measurement.

8. The instructional materials written for the purposes of this study were effective in increasing the reading readiness abilities of the children involved in the study.

9. The intellectual skills of observation, classification, data treatment, and measurement are separate and distinct skills as inferred from correlation coefficients.

10. On the basis of teacher reactions, it is concluded that the non-reading tests constructed by the writer represents a unique method of group testing appropriate for the primary grade child.

11. On the basis of the results of this study, it is concluded that the procedures used by the writer in developing, refining, and testing the instructional materials used in this study can be used with success by curriculum workers, science educators, and teachers

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in curriculum revision and action-research.

Implications for curriculum development. Some of the knowledge gained through the pre-tests administered to kindergarten children in January, 1966 has implications for curriculum development. As an example, all children tested in the Sample Group knew which circle in an assortment of five circles was the largest. Over ninety percent of the children tested could select the longest line, could select the tallest snowman, and could select the largest rectangle. This evidence suggests that we may be wasting a great deal of children's time in the early primary grades by presenting them concepts and skills which they already possess.

No specific lessons were written to teach the skill of data treatment. The simple activity of having different children read and record the temperature daily on a bar-graph caused growth of this skill in all children. This observation implies that daily activities designed to develop a skill or concept will facilitate acquisition of the skill or concept.

Implications for science educators. The relative success of the instructional materials in teaching kindergarten children the selected intellectual skills suggests that lessons could be designed to teach children other worthwhile skills. By using a wider variety of content, many other science lessons could be written which might help the kindergarten child develop some of the skills which are considered essential for later success in school. The enthusiasm of the teachers and children who participated in this study may provide sufficient evidence for including science as an integral part of the kindergarten program.

The data of this study show that the kindergarten child can be taught to predict, interpret, record, group on the basis of a variety of criteria, and recognize similarities and differences. On the basis of this information, it would appear that a planned sequential science program could be developed for the kindergarten.

Implications for the classroom teacher. The outcomes of this study have particular relevance to the classroom teacher from the standpoint of its suggestions for evaluation techniques with the non-reader. The techniques used by the writer have been tested and have been shown to be an effective means of assessing concept and skill development in the kindergarten age child.

Some of the activities specified in the lessons used in this study are activities which exist in the traditional kindergarten program. The difference, however, is that the activities specified in the lessons are used on a planned sequential basis rather than on an incidental basis. For example, many kindergarten teachers use a ribbon or zipper thermometer, but very few kindergarten teachers ask children to keep a record of the temperature from day to day. The results of this study have shown that this activity results in the formation of the skill of data treatment. Also, many kindergarten teachers provide children with activities calling for the use of the senses. But far too few teachers associate the use of the senses with observation. Many kindergarten teachers place much emphasis upon children recognizing similarities and differences, but seldom do they carry this activity far enough to emphasize that the recognition of similarities and differences is one of the first steps in classification.

Problems for further investigation. The data gathered in this study, evaluations and comments of the participating teachers, and the enthusiastic acceptance by teachers of the lessons constructed by the writer suggest other areas which need investigation.

The findings in this study tend to indicate that schools may be wasting a considerable amount of student time in the elementary grades by presenting them concepts which they already know. More research is needed to provide answers to the question of What are the concepts and skills possessed by the entering kindergarten child?

The lack of difficulty encountered by the children who took the group non-reading tests used in this study suggest that similar tests could be devised which would evaluate other areas of the curriculum. Further research is needed to develop and refine group non-reading tests which evaluate skill and concept development in primary grade children.

Research which examines the relationship between intellectual ability of the child and skill development is needed. Specifically, is skill development a function of intellectual ability?

Data have been presented which tends to indicate that there may exist a relationship between the skills taught to children by these lessons and reading readiness. Further research is needed to clarify the relationship which may exist between reading readiness and intellectual skill development in young children.

Recommendations resulting from this study. The following recommendations are based on an interpretation of the data presented in Chapter IV.

It is recommended that schools provide science facilities in the primary grades so that individual and group experimentation will be possible.

If, educators feel that there are intellectual skills worthy of development in the kindergarten child, then procedures and techniques for teaching these skills similar to those used in this study should be implemented into the existing kindergarten program.

It is recommended that teachers capitalize upon the many opportunities available for having children record, interpret, and predict the results of experimental and environmental phenomena.

It is recommended that science activities become an integral part of the kindergarten program on a planned basis.

It is recommended that testing specialists consider the need for non-reading tests which evaluate the outcomes of primary grade science in achieving such objectives as problem solving, critical thinking, and the development of scientific attitudes.

It is recommended that the instructional program of all children be based upon first hand knowledge of the competencies and concepts possessed by the child as he enters school. This can be accomplished by placing more emphasis upon evaluative techniques which determine the abilities and skills possessed by the child when he enters school.

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APPENDICES

APPENDIX A

TRIAL GROUP LESSONS

TEACHING SCIENCE IN THE KINDERGARTEN

an Experimental Project

by

Thomas F. Edwards

TEACHING SCIENCE IN THE KINDERGARTEN

A Commentary.

The exercises in this experimental program are an outgrowth of a pilot study conducted by the writer with pupils in the kindergarten classes of Thomas Metcalf Elementary School during the academic year 1962-63. The exercises have been re-written and are currently being used in selected kindergarten classrooms in McLean County.

One of the unique features of these exercises is that some of them have already been used by kindergarten children. The revised format represents the combined judgments of those teachers who gave of their time to try the exercises and personal observations of the author who spent much time as an observer. Some of the exercises will undoubtedly fail and need to be re-written, or simply scrapped. Others, which succeed may eventually become a part of a sequential program in science for kindergarten children.

The results which will be gained by your use of these exercises will be analyzed and appropriate revisions will be made in the exercises. The resulting exercises should then be of such nature that kindergarten teachers throughout the state may have available tried and tested instructional materials appropriate for teaching science to kindergarten youngsters.

It is suggested that you read rather thoroughly the "Introduction," "Statement of Objectives," and Exercise Format, before you start using the exercises. Prior to any evaluation of the material, you should study rather carefully the "Appraisal Scheme."

It is my sincere hope that through Teaching Science in the Kindergarten, your children will have rewarding experiences in science. I hope that as part of the research team, you will derive much satisfaction in using these materials and gathering data which may help shed some light on the problem of early school science experiences appropriate for kindergarten children.

INTRODUCTION

During the past century, there has been an ever expanding awareness on the part of the professional educator as to the importance of the learning experiences provided by the schools for the very young child. Teachers have become more keen as to the importance of early school experiences on future learning.

In the field of science, since the late 1950's much emphasis has been placed upon providing experiences for children which would familiarize them with scientific content and develop certain processes which are identifiable in the practicing scientist.

The series of lessons which comprize this experimental material are designed to promote concept formation and develop selected skills and abilities in the child.

The concepts chosen for this experimental material are those concepts which form a base for further understandings in science. They form part of the foundation upon which later learnings in science may be built.

The skills which this experimental material will attempt to develop in children are some of those skills which children of the primary grade levels would probably develop over a longer period of time simply as a result of normal growth and experience.

However, this experimental material is designed to set a learning environment which is directly conducive to the development of the selected skills. The experiences which are presented in this experimental material are designed to help the child do a better job of observing and classifying the objects and events in his environment.

In designing the experiences which follow, the author assumes at the very outset that a child's education begins long before he ever enters the classroom. The experiences are designed to give the child direction in some of the processes which he uses in interpreting the complex environment in which he lives.

TEACHING SCIENCE IN THE KINDERGARTEN

A SERIES OF SCIENCE EXPERIENCES FOR CHILDREN

Before you begin to use the experimental materials which follow, it might be fruitful to discuss the intent which the writer has in devising the experiences.

The literature supports the contention that we learn best from actual experiences. Any teacher that has ever watched a student for the first time view an amoeba or a paramecium, or look at a drop of pond water through a microscope can readily attest to the fact that there is nothing which can substitute for an actual experience in a learning situation.

The author is of the opinion that kindergarten children, and for that matter, most primary grade children should be provided with a wide variety of experiences which are designed to help them discover some of the processes, principles, and facts concerning the objects and events of their immediate environment.

Therefore, in using this experimental material, it is your task to help the child through any pitfalls which may occur in a particular exercise. It is your responsibility to help the child experience the thrill of discovery.

In short, it is the task of the primary grade teacher to structure in the classroom a series of exercises which will lead directly to the development of a given process, principle, or fact.

The following guidelines which were used by the writer in devising and revising the exercises in this experimental material should further help you in your planning as you begin to use this material.

1. The learning of the processes of science (its methods) should accompany the learning of its products (facts). All science is built with facts. A student must learn the method by which facts are discovered and organized as he develops an understanding of the facts.

2. Students must be taught to collect data from an experimental or an environmental situation. The collecting of data is an important part of all of our lives. We collect data in shopping for a new pair of shoes, in buying a new car, or even in deciding which political candidate to vote for. In any systematic study of science, the student must be given the opportunity to collect data relevant to experimental and/or environmental phenomena. In collecting data, the student learns that thoughtful, thorough observations are necessary before meaning can be given to the data. He learns the difference between "looking" and seeing and between "hearing" and listening. Many environmental phenomena take on new meaning to the person who has

been trained early in his life to observe what is taking place around him. Science experiences in the primary grades should provide an excellent beginning in the development of these skills.

3. Students must be taught to evaluate the data which are collected. The ability to evaluate data is something that the scientist and the non-scientist alike must be able to do efficiently if they are to achieve the goals they have set for their personal lives. The ability to look at data and recognize trends and relationships is of paramount importance in the complex society in which we live today. Science experiences in the primary grades should provide an opportunity for pupils to examine data and search for relationships and trends.

The great scientist, Poincare, once made a statement that characterizes the task of the present day science teacher. He said: "Science is built up with facts as a house is with stones, but a collection of facts is no more a science than a heap of stones is a house." The task of the science teacher today is to determine how the many scientific facts which are known today can be organized and presented to students in such a manner that they can see the house rather than the heap of stones.

OBJECTIVES

The lessons which are included in the instructional materials to be used in this program were designed to provide a series of learning experiences which would help children develop the ability to:

1. Classify objects in various ways--size, shape, color, texture, and odor.

2. Arrange objects in ordered series according to their positions along each of a number of dimensions, such as size, color, smoothness, and roughness.

3. Observe and describe similarities and differences in objects according to the presence or absence of certain characteristics, or the degree to which the objects represent certain characteristics such as hardness, elasticity, luster, smoothness, and roughness.

4. Notice and describe changes in various objects in such characteristics as size, shape, color, and position.

5. Notice and describe changes in relationships of objects as to distance and direction.

EXERCISE FORMAT

It is suggested that you have an exercise from Teaching Science in the Kindergarten before you as you read this section. If possible, actually perform one or more of the suggested activities and appraisals of the exercise. This should help you gain a clearer notion of the organization of the exercises.

Exercise Title. Each exercise is designated by an appropriate title. Throughout the exercise, the process or content suggested by the title should be emphasized. The processes stressed in this experimental material are described in another section of this commentary.

Objectives. The objectives in the particular exercise are of two kinds. One set of objectives (behavioral) is concerned with what a child should be able to do as a result of a particular learning experience. The second set of objectives, (content) is concerned with what a child should know as a result of the particular learning experience.

A child may learn many things from a given exercise, but it is of prime importance that the child acquire the abilities and content stated in the objectives.

Rationale. In this section, the importance of the exercises in the total structured program is stressed. The rationale may vary from one exercise to another according to what the author believes would be most helpful to the teacher in establishing the intent and purpose of the particular exercise. Usually, there are explanatory statements concerning the content and the importance of the particular process in science. Where deemed necessary, the rationale will include background information for the teacher.

Vocabulary. New words or special phrases which are introduced as a part of each exercise are listed here. In general, the child must be taught to recognize and use these words in order to make the responses called for in the appraisal activities.

Materials. All materials necessary for the completion of a particular exercise are included in this section. With each exercise, there is provided a set of materials in sufficient quantities for all activities called for. Prior to teaching a given exercise, you should check the materials to make certain that they are all there.

Procedure. Each procedure begins with a note to the teacher. This is simply some suggestions which should help you originate the problem. You are encouraged to use all these suggestions.

Each procedure contains a set of numbered activities which should help children develop a particular skill and or concept. It is essential that you follow these suggestions explicitly.

Generally, the activities are organized in such a manner that they proceed from the simple to the complex. Where alternative suggestions are made, simply use your own judgment. If you have any suggestions about the activities or can suggest alternative activities, be sure to include these in your feedback form.

Appraisal. This series of activities represents the final examination of a particular exercise. It is essential that you follow these suggestions explicitly.

Some of the appraisal activities are for individual pupils. Care should be taken to record responses made by the individual pupils on the Individual Appraisal Data Sheet provided for each lesson. You are encouraged to randomly select children for these individual appraisal activities.

Some of the lessons contain a group appraisal activity for all children. Be sure and devise some means of identifying individual papers.

APPRAISAL SCHEME

In view of the fact that most kindergarten pupils cannot write, evaluation of this experimental material must be of a non-reading nature. As used in this study, evaluation is simply the assessment of the presence or absence of specific human capabilities.

All evaluation should arise from the objectives of a particular lesson or series of lessons. Since the writer is concerned with both concept development and skill development in young children, there must be two kinds of evaluation.

The behavioral objectives for each exercise specify the performance desired of children. Since it is impossible from the standpoint of time to give each child an individual performance test, you are encouraged to select pupils randomly for the individual appraisal activities suggested in each lesson.

The content objectives for each exercise specify the content which children should know. Evidence concerning the presence or absence of the content of a particular exercise will be gained by the appropriate Group Appraisal activity for all children.

Prior to teaching any of the lessons contained in the instructional materials, administer the Preliminary Test to the children.

PROCESSES

The exercises in this experimental material are designed to facilitate the development of selected intellectual skills in kindergarten youngsters. An intellectual skill is defined as an organized mode of operation and a generalized technique for dealing with materials and problems.

One of the fundamental processes in science is observation. For the purposes of this study, observation is defined as an intellectual skill which requires the utilization of the senses to identify and collect data concerning environmental phenomena.

Classification is a primary method or process in science. It is more of an intellectual activity than a physical activity. It is an intellectual skill which includes the ordering of data, the establishment of categories, the seeking of relationships between categories, and the search for unifying characteristics of a phenomena.

One of the activities carried on by all scientists is the collection and analysis of data. Data Treatment is an intellectual skill which requires children to collect, record, and interpret information relative to environmental and experimental phenomena.

Measurement is a fundamental process in science which allows the scientist to increase the precision of experimentation. Measurement is an intellectual skill which includes the ordering of objects with reference to height and length, specifying the length of an object as so many times some arbitrary unit, and measuring the length of an object using a ruler.

DIRECTIONS FOR COMPLETING THE FEEDBACK FORM

The feedback form is designed to provide the writer with immediate information as to the success or failure of each individual lesson. The information that you provide can make a contribution to the overall evaluation of the entire project. For this reason, some suggestions as to the kinds of information appropriate for each section of the feedback form follow.

Sections one and two are self-explanatory. Simply provide the information called for.

In section three, do not hesitate to be critical. Make the suggestions which you feel appropriate from the standpoint of teaching the lesson to your children. If there are specific activities which you think would do a better job than those proposed in the lesson, do not hesitate to suggest them.

Section four is very important. The writer's ideas are based upon working with kindergarten children for only a short period of time, and judgments concerning logical development of content, prior concept needs, and appropriateness of the lesson may be way out of line. You can help by providing your careful appraisal of each item included in section four.

Section five asks you to comment on each individual section of the lesson. For each part of the lesson, please write (include enough information to be helpful to the writer for subsequent revision) any comment, criticism, or suggestion for change which you feel is warranted as a result of teaching the lesson. You are encouraged to contribute novel ideas which may be useful in teaching science to kindergarten children.

In section six, make your best estimate of the reactions of your class to the lesson. If none of the categories suggested are appropriate, feel free to add others.

In section seven, add any interesting event, outcome, or comment which you feel would help the writer in refining the lessons.

ETSKA 66 Lesson 1

DIRECTION

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. point to a given direction.
2. walk in a given direction, and then turn the proper direction when told to do so.

Content: Upon completion of this exercise, children should know:

the names of the directions.

RATIONALE:

One of the fundamental concepts which should be developed as a result of early school experiences is the concept of direction.

VOCABULARY: West, east, north, south, left, right.

MATERIALS: crayons.

PROCEDURE:

Teacher: Walk around the room and point the directions out to the children. You may repeat this several times if you feel it is necessary.

1. Have all children stand up and face the west.

2. Have all children extend their right hand. Ask what direction is pointing toward.

3. Have only the boys remain standing. Have them extend their left hand. Ask what direction it is pointing toward.

4. Ask all children to be seated and simply look around the room and see if they can point toward the directions as you call them out.

APPRAISAL:

1. Ask one child to tell you the direction that is behind him.

2. Ask another child to tell you the direction that is to his left.

3. Ask another child to tell you the direction that is to his right.

4. Ask a girl to stand up and face the east. Have her walk toward the east and then turn and walk toward the south.

5. Ask a boy to stand up and walk toward the south. Ask him to now walk toward the north.

GROUP APPRAISAL: Red, blue, and green crayons needed.

Give the children the mimeographed map which is marked "Directions." Point out to them that the top of the map is labeled NORTH. Have them look at the lines on this page and listen carefully while you read a very short story about these lines.

Barbara stood up and faced the front of the classroom. (This is North.) She turned to her left and walked 4 steps, then turned to her left again and took 5 steps, and then turned to her left again and took 6 steps. The large X shows where Barbara started, and the lines show the paths she took.

Look carefully at the picture and color the path she took to go east green. Color the path she took to go south blue, and the path she took to go west red.

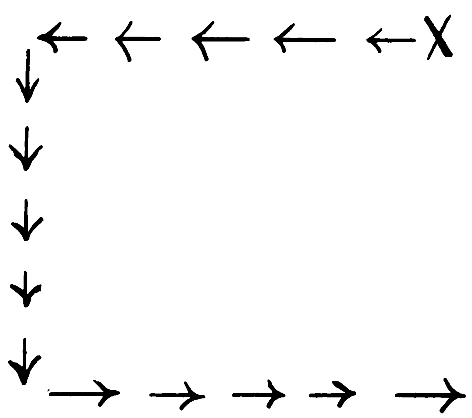
ETSK 66

name

Date: room:

DIRECTIONS

NORTH



ETSKA 66 Lesson 2

TEMPERATURE

OBJECTIVES:

Behavioral: Upon completion of this lesson, children should be able to:

1. Discriminate between hot and cold water by using a thermometer.
2. Predict what will happen to a thermometer when it is placed in hot or cold water.
3. Read a thermometer. (Approximate the temperature.)

Content: Upon completion of this lesson, children should know:

1. That a thermometer is used to measure temperature.
2. That a thermometer will show a higher reading in hot water than it will show in cold water.
3. That a thermometer will show a lower reading outside than it will show inside. (winter)

RATIONALE:

Since one of the customary activities of primary grade instruction in science is the observation of the temperature on a daily basis, it is therefore appropriate that provisions be made to give the child experiences with the thermometer.

VOCABULARY: thermometer, temperature

MATERIALS: large coca cola thermometer, 4 small thermometers, ribbon thermometer.

PROCEDURE:

Teacher: Show children the large coca cola thermometer which has been provided for you. Ask them if they know what it is.

1. Place one of the thermometers in the ice box, or in a glass containing ice cubes, and the other thermometer in a glass of hot water. Have children notice the difference in the readings.

2. Place one of the thermometers in a glass of warm water. (not hot) Place one of the thermometers in ordinary tap water. Have children notice the differences in readings of the two thermometers.

3. Have one child take the temperature reading inside the room. Place this reading on the blackboard. Then have him go outside and take the temperature reading. Compare the readings.

APPRAISAL:

1. Place a glass of hot water and a glass of cold water on your desk. Have a child feel each of the glasses and tell you which is hot and which is cold. Place the thermometer in the cold water and have him predict what will happen to the thermometer when you place it in the hot water. (You may repeat this activity with several children by simply varying which glass you place the thermometer in first.)

2. Have a child manipulate the ribbon thermometer so that it approximates the inside room temperature.

3. Ask a child to predict what will happen if they were to take a thermometer outside. Allow him to verify his answer.

ETSKA 66 Lesson 3

MEASUREMENT 1.

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. order objects according to increasing and decreasing height.
2. demonstrate that one object is as tall as another by placing them side by side.

Content: Upon completion of this exercise, children should know:

the meanings of the words in the vocabulary list.

RATIONALE:

It has often been stated that if anything exists, it can be measured in some way. Measurements enable the scientist to quantify their observations and gain precision in their experimental work. All measurement is approximate and is usually concerned with questions of "how much." In order that people may comprehend questions of how much, arbitrary units have been agreed upon to specify a given quantity.

VOCABULARY: taller, shorter, the same as.

MATERIALS: no specific materials are needed for this exercise.

PROCEDURE:

Teacher: This particular exercise is designed to help children see relationships between various heights.

1. Have children stand next to the blackboard and place a chalk mark directly over their head.

2. Have children return to their seat. Ask--who is the tallest?

3. Who is the shortest?

4. Which children are the same height?

APPRAISAL:

1. Place colored strips of paper on the flannel board in vertical positions. Ask one child to pick out the tallest strip of paper.

2. Ask another child to pick out the shortest strip of paper.

3. Ask a third child to pick out 2 strips of paper which are the same height.

ETSKA 66 Lesson 4

MEASUREMENT 2

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. order objects according to increasing and decreasing height.
2. demonstrate that one object is as tall as another by placing them side by side.

Content: Upon completion of this exercise, children should know:

the meaning of the words in the vocabulary list.

RATIONALE:

The ability to measure is a fundamental ability which should be developed in the kindergarten child through appropriate exercises. This particular exercise is concerned primarily with nominal and ordinal measurement. It is designed to give the child practice in comparing heights. It is further designed to introduce the child to the broad concept of graphing.

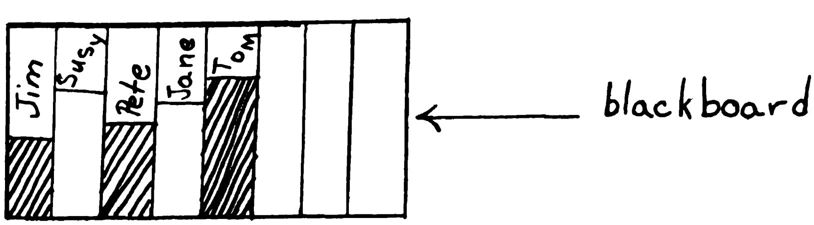
VOCABULARY: taller, shorter, the same as, graph.

MATERIALS: No specific materials are needed for this exercise.

PROCEDURE:

Teacher: Tell the children that you are concerned with trying to find out who is the tallest and who is the shortest in the room. Ask if they have any ideas.

Divide the blackboard into sections so that you have one space to represent the height of each child. Tell the children that you are going to have them help you make something called a graph. Ask if anyone has an idea of what a graph is. See sketch below.



1. Have a child stand next to the blackboard under his name. Draw a line or mark directly over his head. Tell him that he is this tall. Allow the child to color in with chalk the bar which represents his height. (Use a different color of chalk for boys and girls.)

2. Continue until you have worked with all children. Try not to choose children in either increasing or decreasing height.

APPRAISAL:

1. Ask a given child to pick the bar on the graph which shows the tallest boy. The tallest girl.

2. Ask a given child to pick the bar on the graph which shows the shortest boy. The shortest girl.

3. Ask a given child to choose from the graph two bars which show children who are most nearly the same height.

4. For all children: Look at the graph and see if you can find out whether there are more tall boys or girls.

ETSKA 66 Lesson 5

MEASUREMENT 3

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. arrange objects in decreasing and or increasing order of length.
2. demonstrate that one object is as long as, or as short as, another object by placing the objects side by side.

Content: Upon completion of this exercise, children should know that:

length is the distance from one point to another.

RATIONALE:

Length may be defined rather arbitrarily as the distance from one point to another.

VOCABULARY: longest, shortest, length.

MATERIALS: various lengths and colors of construction paper, paste, paper.

PROCEDURE:

1. Have children look carefully at their hands. Which of their fingers is the longest? Hold that finger up. Look again. Which is the shortest? Hold that finger up.

2. Place on the flannel board various strips of colored construction paper in a random fashion. Ask children if they could help you arrange the strips so that the longest strip is at the top of the flannel board and the shortest strip is at the bottom of the board.

3. Ask three children to help you. Mark a spot on the floor with chalk. Start one child at the chalk mark and have him take four steps. (Help them count if it is necessary.) Mark the spot where the child stopped. Repeat with the other two children.

4. Ask the class which child took the longest steps. Which child took the shortest steps? How do you know?

APPRAISAL:

1. Ask three pupils to bring you their red crayon. Ask one of the pupils which crayon is the <u>longest</u>. Ask another child which crayon is the <u>shortest</u>. Ask the other child if there are two crayons

the same length.

2. Draw three lines on the blackboard. Ask one child to choose the longest line.

3. Ask another child to choose the shortest line.

GROUP APPRAISAL:

Give each child an envelope which contains 5 strips of various lengths and color of construction paper. Distribute the mimeographed sheet of paper labeled Measurement 3. Ask the children to glue the various strips of colored paper to this sheet so that the longest strip of paper is on their right and the shortest strip of paper is on their left.

ETSK 66

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name

MEASUREMENT 3 Date:____________________room:_____

ETSKA 66 Lesson 6

MEASUREMENT 4

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. specify the length of some object as so many units.
2. measure the objects using different units.

Content: Upon completion of this exercise, children should know:

that fundamental units of measurements are arbitrarily agreed upon.

RATIONALE:

The general concern of this lesson is to introduce pupils to the notion of units of length.

VOCABULARY: length, width, inches, feet.

MATERIALS: 1 bundle of strips of colored paper of various lengths per child, rulers, 3" x 5" cards.

PROCEDURE:

1. Pass out the 3" x 5" cards. Ask children to measure how many times longer the card is than the red strip of paper that they have.

2. Pass out the rulers. Have children look at their rulers. Have the children hold their hands one foot apart by placing a ruler between their hands. (You may have to show them how to do this.)

3. Instruct the children to find a strip of colored paper that is two inches long. (Your help will be needed here.)

APPRAISAL:

1. Have one child measure the length of an eraser using a set of colored strips. (To do this correctly, he must choose colored strips which are the same length.)

2. Have another child measure the length of a pencil using the same set of colored strips.

3. Have another child measure the length of his hand by using the same set of colored strips.

GROUP APPRAISAL:

Distribute the mimeographed sheet labeled Measurement 4. Children will need a blue and a red crayon and their rulers.

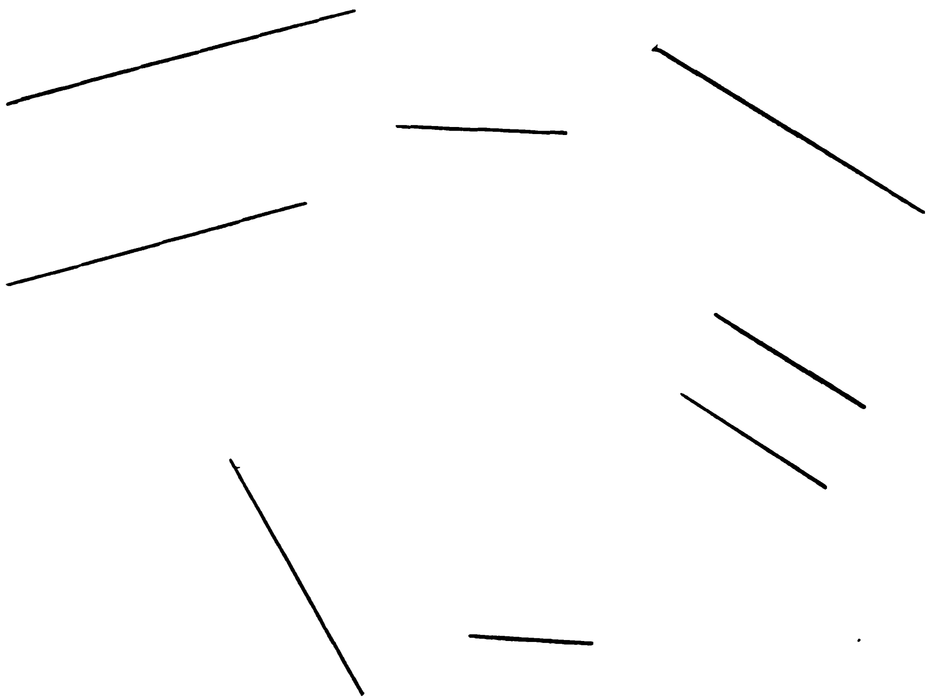
a. color the longest line blue.
b. color the lines which are the same length red.
c. with your crayon, draw a line which is approximately 1 inch long.

ETSK 66

____
name

MEASUREMENT 4

Date:________________room:_______



ETSKA 66 Lesson 7

OBSERVATION 1. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. identify the colors of some sample objects.
2. identify the texture of some objects.
3. identify the difference in size of some objects.

Content: Upon completion of this exercise, children should know:

1. objects are different as to color, texture, size, and shape.
2. the names of the various colors.

RATIONALE:

As preparation for later exercises in science, children should develop the ability to utilize the senses as a means of gaining information relative to objects and their properties. The suggestions which follow should cause the child to begin development of skills which will enable him to make accurate descriptions of objects and environmental phenomena.

VOCABULARY: red, blue, green, yellow, black, white, smooth, rough, hard, soft, bigger-than, smaller-tahn, larger, smaller, largest, smallest, observation, observe, circle, square.

MATERIALS: 8 circles of construction paper of various sizes and colors, 8 squares of sandpaper and aluminum foil of varying sizes, 1 circle for each color in the vocabulary list.

PROCEDURE:

1. Have all pupils who have something red on stand up. Repeat this activity for each of the colors on the vocabulary list. Ask children to note how the various colors are different.

2. Have children examine their own clothing and find a piece of clothing which is smooth and one which is rough.

3. Have children examine their own clothing and find something which is hard and something which is soft.

4. Ask children to examine their neighbors clothing and see how it is different from their own.

APPRAISAL:

1. Display the 8 circles of construction paper of various sizes

and colors on the bulletin or felt board. Ask one child at a time to select a given color--red, green, blue, etc.

2. Using the same 8 circles, ask a child to pick the smallest red circle. Repeat with another child and ask for the largest red circle. Repeat with another child and ask for the smallest black circle.

GROUP APPRAISAL:

Pass out the mimeographed sheet labeled Observation 1. Have the children color the ball green, the sweater red, the largest fish blue, and the smallest fish yellow.

ETSK 66 OBSERVATION 1

Name________________

Date________________

ETSKA 66 Lesson 8

OBSERVATION 2. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. identify the shape of objects.
2. identify the texture of objects.

Content: Upon completion of this exercise, children should know:

1. the difference between round and square objects.
2. the difference between smooth and rough objects.

RATIONALE:

As preparation for later exercises in science, children should develop the ability to use the sense of touch as a means of gaining information relative to objects and their properties.

VOCABULARY: round, smooth, rough, square, texture.

MATERIALS: styrofoam balls, marbles, 1" x 1" wooden blocks, blindfolds.

PROCEDURE: Tell the children you want them to make some observations today without using their eyes. You have some blindfolds for them and you want them to find out all they can about some objects without using their eyes.

1. Pass out the blindfolds. Have each child put their blindfold on and check that they cannot see.

2. Walk around the room and give each child the envelope which contains 1 marble, 1 styrofoam ball, and the 1" x 1" block.

3. Have the children open the envelope and examine the objects.

4. Ask <u>all</u> children to hold up the <u>rough</u> <u>round</u> ball.

5. Ask <u>all</u> children to hold up the <u>square</u>.

6. Remove the blindfolds and repeat items #4 and 5.

APPRAISAL:

1. Choose one child and have him reach into a sack and choose the <u>rough</u> <u>round</u> ball.

2. Repeat with another child and ask for the <u>square</u>.

ETSKA 66 Lesson 9

OBSERVATION 3. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

identify certain objects by their particular odor.

Content: Upon completion of this exercise, children should know:

that some objects can be identified by their particular odor.

RATIONALE:

The sense of smell is probably the sense least thought of as a means of making observations. The odor characteristic of a given object, or event may be sufficient for the identification of the object or event. For this reason, the science experiences provided for kindergarten children should make provisions for experiences which call for the utilization of the sense of smell.

VOCABULARY: odor.

MATERIALS: Cubes of onion, chewing gum, paper towels, styrofoam, or foam rubber cubes.

PROCEDURE:

Divide the class into three groups. Give to each group one of the sacks containing the cubes of either onion, chewing gum, or styrofoam.

1. Ask the children to try to find out what is in the wrapped cubes without tearing open the outer covering of paper.

2. Call for their observations.

APPRAISAL:

1. Display the 4 vials of clear liquids. Choose a child and have him pick out one vial that contains a liquid different from the other ones.

2. Repeat with another child. Same instructions.

ETSKA 66 Lesson 10

OBSERVATION 4. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. recognize the general properties of matter.
2. demonstrate the property of impenetrability.

Content: Upon completion of this exercise, children should know the following general properties of matters:

1. Matter takes up space.
2. Matter has weight.

RATIONALE:

This exercise is designed to further develop a childs ability to observe. In examining materials which are familiar, children can be encouraged to look for relationships which may exist among objects.

VOCABULARY: space, weight.

MATERIALS: chalk, rubber bands, pieces of aluminum foil, string, sugar cubes, modeling clay.

PROCEDURE:

For this particular lesson, children should examine the set of objects in order to find information relative to the following features of the objects.

a. color
b. texture
c. hardness or softness
d. shape

Children should be encouraged to examine the materials carefully to determine the properties common to <u>all</u> objects.

Call for the observations of children relative to the above features.

APPRAISAL:

1. Have a child demonstrate to the class that matter takes up space.

2. Have children examine a set of materials and tell the class the properties which the materials have in common. (use at least three different children.)

ETSKA 66 Lesson 11

OBSERVATION 5. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. demonstrate to classmates some of the specific properties of matter.
2. by examination, determine specific properties of matter.

Contents: Upon completion of this exercise, children should know and be able to identify objects which:

1. have a luster.
2. are brittle.
3. are elastic.
4. are hard.

RATIONALE:

Students should recognize rather early on the educational continuum that special properties of matter refer to those properties of matter which are unique for a given object or set of objects. They should recognize that the special properties of matter ultimately determine its utility.

VOCABULARY: luster, brittle, elastic, hard.

MATERIALS: chalk, rubber bands, pieces of aluminum foil, string, sugar cubes, modeling clay.

PROCEDURE:

1. Ask children to examine the objects and determine:

   a. which object is easiest to break.
   b. which object is the shiniest.
   c. which object is the hardest.
   d. which object is the easiest to stretch.
   e. which object is easiest to change its shape.

APPRAISAL:

Display an assortment of objects which are familiar to the children.

1. Ask a child to choose from the assortment the object which is the shiniest. (Has the most luster.)

2. Ask another child to choose from the assortment the object which is the most brittle.

3. Ask another child to choose from the assortment the object which is the most elastic.

ETSKA 66 Lesson 12

CLASSIFICATION 1. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. group objects on the basis of similarities.
2. establish groups on the basis of differences.
3. sort solids from a group of objects.

Content: Upon completion of this exercise, children should know that:

1. solids have a definite shape.
2. solids have a definite size.
3. solids have weight.

RATIONALE:

Classification is an intellectual skill which includes the ordering of date, the establishment of categories, the seeking of relationships between categories, and the search for unifying characteristics of a phenomena. It is an intellectual activity rather than a manipulative activity.

VOCABULARY: Classification, group, similarities, differences, solid.

MATERIALS: pencils, chalk, crayon, paper, rock, twig, small pieces of wire, string.

PROCEDURE:

1. Pass out the assortment of objects to children with instructions that they are to examine the objects and place them into two groups. (Allow about 5-10 minutes for this activity.)

2. Discussion. Ask for the why of several different groups. Who is right?

3. Ask children to look at the objects in the two groups that they have formed and find out how all the objects are alike. Make a list of these similarities on the board.

APPRAISAL:

1. Show a child a group of paper cutouts (all circles) which differ in size and color. Ask the child to tell the class why these cutouts form a group.

2. Have another child group the cutouts in a different way. (color.)

3. Ask another child if he can group the cutouts in still a different way.

4. Have a child select from the classroom two solids.

5. Show an assortment of solids and have a child tell the class how the assortment is alike. Correct answers include all responses which are expressions of size, shape, weight.

ETSKA 66 Lesson 13

CLASSIFICATION 2. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. group objects on the basis of similarities.
2. group objects on the basis of differences.
3. select liquids from a group of objects.

Content: Upon completion of this exercise, children should know that:

1. liquids have weight.
2. liquids occupy space.
3. liquids take the shape of the container they are in.

RATIONALE:

In this particular lesson, attention should be paid to having children find out all the things about liquids which are alike.

VOCABULARY: liquid

MATERIALS: Two different colored liquids, (kool aid works well) and dixie cups.

PROCEDURE:

Divide the class in two groups. Give 1 group the purple liquid, and the other group the orange liquid.

1. Ask them to examine the liquid and find out all they can about it.

2. Have the groups trade cups of liquids and examine the different liquids and find out all they can about this liquid.

3. Tilt cup and notice shape of liquid.

4. Discuss findings.

APPRAISAL:

1. Show vials of colored liquids. Ask a child how these liquids are alike.

2. Show assortment of pictures. Have a child choose a picture which shows a liquid.

ETSKA 66 Lesson 14

CLASSIFICATION 3. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. recognize gases in motion.
2. demonstrate gases in motion.

Content: Upon completion of this exercise, children should know that:

1. a gas has no definite shape.
2. a gas takes up space.
3. a gas has weight.

RATIONALE:

In this particular lesson, children will be asked to make statements about something which they cannot see--a gas. Previous lessons have been concerned with solids and liquids. The gas that will be used in this lesson is air.

VOCABULARY: gas, air.

MATERIALS: dixie cups, straws, 3" x 5" cards, balloons.

PROCEDURE:

1. Have children place their hands a few inches in front of their mouth and blow their breath on their hands.

2. Have children wave a 3" x 5" card back and forth in front of their face.

3. Give each child a dixie cup which is about 1/3 filled with water and a straw. Have them blow through the straw into the water.

4. Ask the following questions.

   a. Can you see a gas?
   b. Can you feel a gas?

5. <u>A demonstration</u>.

Display two balloons of the same size. Have two of the children blow up the balloons. Tie them. Ask--what did you put into the balloons? Ask--do the balloons weigh more now than they did before you blew them up? Ask--how can we find out? Try this. (See sketch.)

Balance the two balloons on a straw. Relate this balancing to the teeter-totter or see-saw experiences which children have on the playground. Ask--what would happen if I were to break one of the balloons. (Note--here you are asking for speculative thinking. When you ask a child to do speculative thinking, don't be too harsh if some suggestions are "way-out." Be concerned about the kind of thinking children do after they have participated in a learning experience related to a given concept.) List the ideas presented by the children on the blackboard.

Allow one of the children to break the balloon with a pin. Call for the observations of the class.

Ask--what does this show us about air?

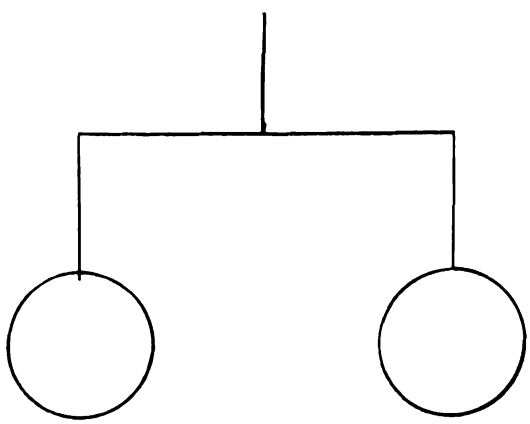
APPRAISAL:

1. Ask a child to demonstrate to the class a gas in motion.

2. Ask a child to look out of the window and tell the class whether or not air is in motion.

3. Display a paper airplane on the desk and ask a child to move the airplane without touching it.

SKETCH



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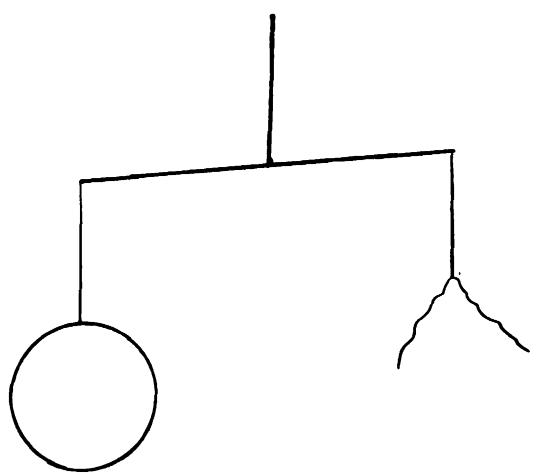


After

ETSKA 66 Lesson 15

CLASSIFICATION 4. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. group objects on the basis of similarities.
2. establish groups on the basis of differences.
3. sort solids and liquids into two distinct groups.

Content: No new content for this particular exercise.

RATIONALE:

This particular exercise is designed to give children practice in classification and reinforce ideas gained through the previous lessons dealing with solids, liquids, and gases.

VOCABULARY: No new words.

MATERIALS: Rocks, twigs, crayons, pencils, water, kool aid, assortments of pictures showing solids and liquids.

PROCEDURE:

Teacher: Have children get 1 sample of each of the materials from a supply desk.

1. Ask them to group all of these materials into two separate groups.

2. Ask for the names of these two groups. Put these names on the blackboard.

3. Ask children what other materials they could find which would fit into these groups.

APPRAISAL:

1. Simply make a random check of three pupils as to their performance on procedure #2.

2. Display pictures and have two different children identify a solid, and a liquid by touching the correct picture.

TEACHING SCIENCE IN THE KINDERGARTEN

WEATHER:

A series of planned experiences which should help kindergarten youngsters more fully understand some of the daily weather changes. In the study of weather, the obvious resource is the weather itself. Look upon this series of lessons as a year long unit.

You are encouraged to use the particular exercises on the day the appropriate phenomena occurs. An exercise appropriate for each of the weather phenomena follows this brief introduction.

A systematic study of the weather affords a daily opportunity for pupils to collect and record information. As a part of this study of weather, the following information should be collected and recorded each day.

Temperature
Direction of wind
Amount of precipitation
Kind of precipitation
Speed of wind
Kind of clouds.

As you pursue this study of weather with your students, you may find some of the following books quite interesting.

Fisher, Aileen Lucia. I Like Weather. Thomas Y. Crowell, 1963. (The seasons of the year are described in rhyme with colorful illustrations.)

Hoban, Russell, and Hoban, Lillian. Some Snow Said Hello. Harper and Row, Publishers, 1963. (Offers background information for children about snow and suggests some vicarious experiences with snow.)

Zolotow, Charlotte. The Storm Book. Harper and Row, Publishers, 1952. (The progress of a storm is followed from beginning to end.)

ETSKA. Weather

Introduction:

As you guide your pupils in a systematic study of the weather, you have the responsibility of showing them how to collect and record information relative to weather phenomena. By showing them how to collect information about the weather, it is hoped that you will instill in them some concern for handling, treatment, and compilation of data.

With all weather incidents, please make certain that children collect and record the following pieces of information.

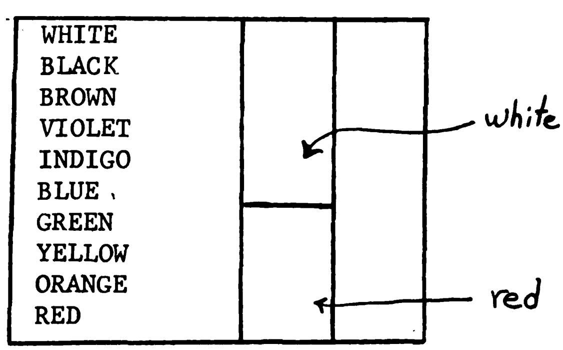
1. Temperature--thermometer--see note #1.
2. Wind direction--wind vane--see note #2.
3. Amount of precipitation--rain gauge--see note #3.
4. Kind of precipitation.
5. Speed of wind--Beauford Scale--see note #4.
6. Kinds of clouds.--see note #5.

NOTE #1. <u>Temperature</u>.

In having children record temperature, it is suggested that you construct a large model of a thermometer by using the suggestion which follows.

<u>Ribbon Thermometer</u>:

Secure a large piece of poster paper, or heavy cardboard. Cut out a one inch slit near the top and the bottom of this poster paper. Glue together the ends of one red and one white ribbon. Place the white end of the ribbon in the top slit and the red end of the ribbon in the bottom slit. Carefully color a scale along one side of the ribbon. By looking outside the window at the thermometer which is also color coded, the children can now manipulate the ribbon to a mark which closely approximates the true temperature. See sketch.



RIBBON THERMOMETER

NOTE #2. Wind Direction. As you guide children in their attempts to determine wind direction, you may use the wind vane which has been provided with the materials accompanying this exercise, or you may simply have children observe the direction of cloud movement or smoke drift. It is suggested that you have children learn to tell wind direction by both methods.

NOTE #3. Amount of Precipitation. Rain Gauge. You should construct a simple rain gauge by securing a glass jar with rather straight sides and glue to the inside of this jar a plastic ruler. Make certain that the plastic ruler touches the bottom of the jar, and check to see that the length units start at the end of the ruler.

After each rain, have children look at the rain gauge to see how much it has rained during the storm. Empty the rain gauge after each reading.

NOTE #4. Speed of wind. Beaufort Scale.

Use the common Beaufort Scale and U.S. Weather Bureau terminology. In order to establish the speeds, use the suggested criteria below. Concentrate on the columns starred.

TABLE OF COMPARATIVE WIND-VELOCITY TERMINOLOGY

Beaufort Force	Velocity m.p.h.	U.S. Weather Bureau Term *	Specifications for use on fixed objects *
0	1	Light	Smoke rises vertically--no leaf motion
1	1-3	Light	Direction of wind shown by smoke drift
2	4-6	Light	Wind felt on face; leaves rustle
3	7-10	Gentle	Leaves and small twigs in constant motion
4	11-16	Moderate	Raises dust and loose paper--small branches are moved
5	17-21	Fresh	Small trees in leaf begin to sway
6	22-27	Strong	Large branches in motion
7	28-33	Strong	Whole trees in motion; hard to walk against the wind
8	34-40	Gale	Breaks twigs off trees
9	41-47	Gale	Slight damages occur
10	48-55	Whole Gale	Trees uprooted
11	56-65	Whole Gale	Wide spread damage
12	Above 65	Hurricane Tornado	Maximum wind damage

NOTE #5. Kinds of clouds. To help children learn some cloud patterns, construct several "mock-ups" using cotton or cut out patterns for the cloud types. Also use the enclosed pictures. Label with the appropriate titles.

Concentrate on the following three types of clouds.

a. cirrus--feathery
b. cumulus--cotton ball like
c. stratus--layer like

ETSKA 66 Lesson 16

Weather Topic: Frost

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. tell or show where frost might be formed.

Content: Upon completion of this exercise, children should know:

1. that frost is water vapor which has condensed on an object whose temperature is below freezing.

RATIONALE:

Frost is one of the weather phenomena which fascinates children. However, far too many children grow into maturity with an erroneous concept of frost. Further, too much emphasis is placed on "Jack Frost," and little attention is given to the variables which produce frost. In this particular exercise, care should be taken to emphasize the words vapor and freezing.

In view of the fact that one cannot see a vapor, this particular word may be difficult to teach to children. However, the following suggestion has proven helpful in teaching the meaning of the word vapor. Place a few very small crystals of camphor in each child's hand. Tell them what the crystals are. Have them smell the crystals. Have them watch the crystals. After they have evaporated, have them smell their hands again. The odor is due to the <u>vapor</u> of the camphor crystals.

VOCABULARY: vapor, frost, freezing.

MATERIALS: camphor crystals.

PROCEDURE:

Teachers: Be sure to guide children to an understanding of the word vapor.

1. Have children examine some frost where it is found or formed.

2. Ask children to find as many places as possible where frost is formed.

3. Have children collect some samples of frost and examine it.

4. Have children note cloud formations and conditions which accompany frost.

APPRAISAL:

1. Ask a child to show you where frost may be found. Repeat with other children.

2. Display a piece of cotton which has had a few drops of perfume placed upon it. Ask a child to explain how he is able to determine the odor.

3. Moisten a spot on the blackboard and have children watch the evaporation. You may even tell them that the water is evaporating. Ask a child why they can no longer see the water after it has evaporated. (You are looking for a response which includes the notion that the water on the board has turned to a vapor.)

ETSKA 66 Lesson 17

Weather Topic: Rain

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. recognize the kinds of clouds present on a rainy day.
2. indicate the direction of movement of clouds.
3. measure the amount of rain which falls during a given rain.

Content: Upon completion of this exercise, children should know:

1. Water comes out of the air as rain.
2. Rain falls from the clouds.
3. The name of the clouds present when it rains.

RATIONALE:

It is essential that pupils learn at an early age the importance of gathering data and keeping records. The systematic study of weather affords pupils the opportunity to gather data and keep records about environmental phenomena.

VOCABULARY: rain, rain gauge, condensed, clouds, stratus, cumulus, cirrus.

MATERIALS: No new materials are needed for this exercise.

PROCEDURE:

Teacher: On the first day that it rains, display the pictures of the various types of clouds on the bulletin board. Make sure that the proper name of these clouds are pointed out to the children.

1. Have children observe the rain, the clouds, and record as accurately as possible the temperature. Allow ample time for them to do some thinking about these tasks.

2. Have children observe the direction the rain is coming <u>from</u>. (The direction of movement of clouds.)

3. If it stops raining for a short period of time, have children examine the rain gauge in order to determine how much rain has fallen.

APPRAISAL:

1. Display the pictures of the three basic kinds of clouds. Ask a pupil to go to the bulletin board and choose the kind of cloud which is present today. If he is correct, tell him and the rest of the class so.

2. Choose a pupil and have him manipulate the ribbon thermometer so that it approximates the outside temperature.

3. Select a pupil and have him tell the direction from which the clouds are coming.

4. Select another pupil and have him tell the direction in which the clouds are moving.

ETSKA 66 Lesson 18

Weather Topic: Snow.

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. recognize the kinds of clouds present on a day when it snows.
2. indicate the direction of movement of the clouds.
3. measure the amount of snow that falls during a given storm.

Content: Upon completion of this exercise, children should know that snow:

1. is frozen water vapor.
2. flakes vary in size.

RATIONALE:

Each year children look forward with eagerness to the occurrence of the first snow. Careful examination of snow flakes offer children an opportunity to appreciate more fully the beauty of snow. This particular exercise is designed to acquaint children with the size, shape, and method of formation of snow.

VOCABULARY: Snow

MATERIALS: snow, jar, plastic ruler, thermometer.

PROCEDURE:

Teacher: If the lesson dealing with frost has not been taught prior to this lesson, consult the rationale of the frost lesson for some suggestions about teaching the word vapor.

1. Have children collect some snow flakes on black paper and examine their shapes.

2. Collect several jars full of snow. Have children note that the jars are full. Allow the snow to melt. Have the children measure the amount of water formed when the snow melts.

3. Take the temperature of the snow outside and compare this temperature with the temperature of the air.

4. Have children notice the kind of day that produced the snow. Ask what kind of day preceeded the snow. (It might be well here to look at the information which you have collected and recorded on the weather chart.)

APPRAISAL:

1. Have a child select from the series of cloud pictures the kinds of clouds present when it snows.

2. Have a child show the direction from which the snow is coming.

3. Have a child indicate the approximate amount of water which would be formed when a jar of snow melts.

APPENDIX B

SAMPLE GROUP LESSONS

TEACHING SCIENCE IN THE KINDERGARTEN

an Experimental Project

by

Thomas Edwards

 PROJECT 65-6

TEACHING SCIENCE IN THE KINDERGARTEN

A Commentary.

The exercises in this experimental program are an outgrowth of a pilot study conducted by the writer with pupils in the kindergarten classes of Thomas Metcalf Elementary School during the academic year 1962-63. The exercises have been re-written and are currently being used in selected kindergarten classrooms in McLean County.

One of the unique features of these exercises is that some of them have already been used by kindergarten children. The revised format represents the combined judgments of those teachers who gave of their time to try the exercises and personal observations of the author who spent much time as an observer. Some of the exercises will undoubtedly fail and need to be re-written, or simply scrapped. Others, which succeed may eventually become a part of a sequential program in science for kindergarten children.

The results which will be gained by your use of these exercises will be analyzed and appropriate revisions will be made in the exercises. The resulting exercises should then be of such nature that kindergarten teachers throughout the state may have available tried and tested instructional materials appropriate for teaching science to kindergarten youngsters.

It is suggested that you read rather thoroughly the "Introduction," "Statement of Objectives," and Exercise Format, before you start using the exercises. Prior to any evaluation of the material, you should study rather carefully the "Appraisal Scheme."

It is my sincere hope that through Teaching Science in the Kindergarten, your children will have rewarding experiences in science. I hope that as part of the research team, you will derive much satisfaction in using these materials and gathering data which may help shed some light on the problem of early school science experiences appropriate for kindergarten children.

INTRODUCTION

During the past century, there has been an ever expanding awareness on the part of the professional educator as to the importance of the learning experiences provided by the schools for the very young child. Teachers have become more keen as to the importance of early school experiences on future learning.

In the field of science, since the late 1950's much emphasis has been placed upon providing experiences for children which would familiarize them with scientific content and develop certain processes which are identifiable in the practicing scientist.

The series of lessons which comprize this experimental material are designed to promote concept formation and develop selected skills and abilities in the child.

The concepts chosen for this experimental material are those concepts which form a base for further understandings in science. They form part of the foundation upon which later learnings in science may be built.

The skills which this experimental material will attempt to develop in children are some of those skills which children of the primary grade levels would probably develop over a longer period of time simply as a result of normal growth and experience.

However, this experimental material is designed to set a learning environment which is directly conducive to the development of the selected skills. The experiences which are presented in this experimental material are designed to help the child do a better job of observing and classifying the objects and events in his environment.

In designing the experiences which follow, the author assumes at the very outset that a child's education begins long before he ever enters the classroom. The experiences are designed to build upon the vast background of unordered science information which the child has when he enters school. They are further designed to give the child direction in some of the processes which he uses in interpreting the complex environment in which he lives.

TEACHING SCIENCE IN THE KINDERGARTEN

A SERIES OF DIRECTED DISCOVERY EXPERIENCES FOR CHILDREN

Before you begin to use the experimental materials which follow, it might be fruitful to discuss the intent which the writer had in devising the experiences.

The literature supports the contention that we learn best from actual experiences. Any teacher that has ever watched a student for the first time view an amoeba or a paramecium, or look at a drop of pond water through a microscope can readily attest to the fact that there is nothing which can substitute for an actual experience in a learning situation.

The author is of the opinion that kindergarten children, and for that matter, most primary grade children are not mature enough to simply be provided with a series of experiences in which the hope is for the child to discover a given principle, process, or fact. Rather, it is the job of the primary grade teacher to guide, direct, and organize experiences in such a manner that her pupils can be led to the given principle, fact, or process.

In short, it is the task of the primary grade teacher to structure in the classroom a series of exercises which will lead directly to the development of a given process, principle, or fact. It is the job of the primary grade teacher to direct the learning experiences of the child.

Therefore, in using this experimental material it is your task to show, demonstrate, and guide the development of the particular concept or skill called for in the lesson that you are using.

The following guidelines which were used by the writer in developing and revising the exercises in this experimental material should further help you in your planning as you begin to use these instructional materials.

1. The learning of the processes of science (its methods) should take precedence over learning its products (facts).

   All science is built with facts. A student must first learn the methods by which these facts are discovered and organized before he can fully understand them, or what is more important, be able to discover new facts for himself.

2. Students should be taught to collect data from an experimental or an environmental situation.

   The collecting of data is an important part of all of our lives. We collect data in shopping for a new pair of shoes, in buying a new car, or even in deciding which political candidate to vote for. In any systematic study of science, the student should be given the opportunity to collect data relevant to experimental and or environmental phenomena. In collecting data, the student learns that thoughtful thorough observations are necessary before meaning can be given to data. He learns the difference between "seeing" and "looking" and between hearing and "listening." Many environmental phenomena take on new meaning to the person who has been trained early in his life to observe what is taking place around him. Science experiences in the primary grades should provide an excellent beginning in the development of these skills.

3. Students should be taught to evaluate the data which are collected.

The ability to evaluate data is something that scientist and non-scientist alike must be able to do efficiently if they are to achieve the goals they have set for their personal lives. The ability to look at data and recognize trends and relationships is of paramount importance in the complex society in which we live today. Science experiences in the primary grades should provide an opportunity for pupils to examine data and search for relationships and trends.

The great scientist, Poincare, once made a statement that characterizes the task of the present day science teacher. He said that . . . science is built up with facts as a house is built with stones, but a collection of facts is no more a science than a heap of stones is a house. The task of the science teacher today is to determine how the many facts which are known today can be organized and presented to students in such a manner that they can see the house rather than the heap of stones.

OBJECTIVES

The lessons which are included in the instructional materials to be used in this program were designed to provide a series of learning experiences which would help children develop the ability to:

1. Classify objects in various ways--size, shape, color, texture, and odor.

2. Arrange objects in ordered series according to their positions along each of a number of dimensions, such as size, color, smoothness, and roughness.

3. Observe and describe similarities and differences in objects according to the presence or absence of certain characteristics, or the degree to which the objects represent certain characteristics such as hardness, elasticity, luster, smoothness, and roughness.

4. Notice and describe changes in various objects in such characteristics as size, shape, color, and position.

5. Notice and describe changes in relationships of objects as to distance and direction.

EXERCISE FORMAT

It is suggested that you have an exercise from Teaching Science in the Kindergarten before you as you read this section. If possible, actually perform one or more of the suggested activities and appraisals of the exercise. This should help you gain a clearer notion of the organization of the exercises.

Exercise Title. Each exercise is designated by an appropriate title. Throughout the exercise, the process or content suggested by the title should be emphasized. The process stressed in this experimental material is described in another section of this commentary.

Objectives. The objectives in the particular exercise are of two kinds. One set of objectives (behavioral) is concerned with what a child should be able to do as a result of a particular learning experience. The second set of objectives, (content) is concerned with what a child should know as a result of the particular learning experience.

A child may learn many things from a given exercise, but it is of prime importance that the child acquire the abilities and content stated in the objectives.

Rationale. In this section, the importance of the exercise in the total structured program is stressed. The rationale may vary from one exercise to another according to what the author believes would be most helpful to the teacher in establishing the intent and purpose of the particular exercise. Usually, there are explanatory statements concerning the content and the importance of the particular process in science. Where deemed necessary, the rationale will include background information for the teacher.

Vocabulary. New words or special phrases which are introduced as a part of each exercise are listed here. In general, the child must be taught to recognize and use these words in order to make the responses called for in the appraisal activities.

Materials. All materials necessary for the completion of a particular exercise are included in this section. With each exercise, there is provided a set of materials in sufficient quantities for all activities called for. Prior to teaching a given exercise, you should check the materials to make certain that they are all there.

Procedure. Each procedure begins with a note to the teacher. This is simply some suggestions which should help you originate the problem. You are encouraged to use all these suggestions.

Each procedure contains a set of numbered activities which should help children develop a particular skill and or concept. It is essential that you follow these suggestions explicitly.

Generally, the activities are organized in such a manner that they proceed from the simple to the complex. Where alternative suggestions are made, simply use your own judgement. If you have any suggestions about the activities or can suggest alternative activities, be sure to include these in your feedback form.

Appraisal. This series of activities represents the final examination of a particular exercise. It is essential that you follow these suggestions explicitly.

Some of the appraisal activities are for individual pupils. Care should be taken to record responses made by the individual pupils on the Individual Appraisal Data Sheet provided for each lesson. You are encouraged to randomly select children for these individual appraisal activities.

Some of the lessons contain a group appraisal activity for all children. Be sure and devise some means of identifying individual papers.

APPRAISAL SCHEME

In view of the fact that most kindergarten pupils cannot write, evaluation of this experimental material must be of a non-reading nature. As used in this study, evaluation is simply the assessment of the presence or absence of specific human capabilities.

All evaluation should arise from the objectives of a particular lesson or series of lessons. Since the writer is concerned with both concept development and skill development in young children, there must be two kinds of evaluation.

The behavioral objectives for each exercise specify the performance desired of children. Since it is impossible from the standpoint of time to give each child an individual performance test, you are encouraged to randomly select pupils for the individual appraisal activities suggested in each lesson.

The content objectives for each exercise specify the content which children should know. Evidence concerning the presence or absence of the content of a particular exercise will be gained by the appropriate Group Appraisal activity for all children.

Prior to teaching any of the lessons contained in the instructional materials, administer the Preliminary Test and the Skills Test to the children.

PROCESSES

The exercises in this experimental material are designed to facilitate the development of selected intellectual skills in kindergarten youngsters. An intellectual skill is defined as an organized mode of operation and a generalized technique for dealing with materials and problems.

One of the fundamental processes in science is observation. For the purposes of this study, observation is defined as an intellectual skill which requires the utilization of the senses to identify and collect data concerning environmental phenomena.

Classification is a primary method or process in science. It is more of an intellectual activity than a physical activity. It is an intellectual skill which includes the ordering of data, the establishment of categories, the seeking of relationships between categories, and the search for unifying characteristics of a phenomena.

One of the activities carried on by all scientists is the collection and analysis of data. Data Treatment is an intellectual skill which requires children to collect, record, and interpret information relative to environmental and experimental phenomena.

Measurement is a fundamental process in science which allows the scientist to increase the precision of experimentation. Measurement is an intellectual skill which includes the ordering of objects with reference to height and length, specifying the length of an object as so many times some arbitrary unit, and measuring the length of an object using a ruler.

DIRECTIONS FOR COMPLETING THE FEEDBACK FORM

The feedback form is designed to provide the writer with immediate information as to the success or failure of each individual lesson. The information that you provide can make a contribution to the overall evaluation of the entire project. For this reason, some suggestions as to the kinds of information appropriate for each section of the feedback form follow.

Sections one and two are self-explanatory. Simply provide the information called for.

In section three, do not hesitate to be critical. Make the suggestions which you feel appropriate from the standpoint of teaching the lesson to your children. If there are specific activities which you think would do a better job than those proposed in the lesson, do not hesitate to suggest them.

Section four is very important. The writer's ideas are based upon working with kindergarten children for only a short period of time, and judgments concerning logical development of content, prior concept needs, and appropriateness of the lesson may be way out of line. You can help by providing your careful appraisal of each item included in section four.

Section five asks you to comment on each individual section of the lesson. For each part of the lesson, please write (include enough information to be helpful to the writer for subsequent revision) any comment, criticism, or suggestion for change which you feel is warranted as a result of teaching the lesson. You are encouraged to contribute novel ideas which may be useful in teaching science to kindergarten children.

In section six, make your best estimate of the reactions of your class to the lesson. If none of the categories suggested are appropriate, feel free to add others.

In section seven, add any interesting event, outcome, or comment which you feel would help the writer in refining the lessons.

ETSK 66 Lesson 1

DIRECTION

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. point in a given direction.
2. walk in a given direction, and then the proper direction when told to do so.

Content: Upon completion of this exercise, children should know:

the names of the directions.

RATIONALE:

One of the fundamental concepts which should be developed as a result of early school experiences is the concept of direction. This concept is necessary for understanding of simple maps, and must be developed prior to any formalized discussion of weather, the seasons, astronomy, etc.

VOCABULARY: West, east, north, south, left, right, in-front of, behind.

MATERIALS: crayons.

PROCEDURE:

Teacher: Prior to this exercise, place the names of the directions (north, south, east, and west) on the four walls of the classroom. Make these names large enough to be seen clearly by all children. Walk around the room and point these directions out to the children. At the completion of the following activities, remove the words north, south, east, and west from the walls.

1. Have <u>all</u> children stand up and face the <u>east</u>.

2. Have <u>all</u> children extend their <u>right</u> hand. Ask what direction it is pointing <u>toward</u>.

3. Have only the boys remain standing. Have them extend their <u>left</u> hand. Ask what direction it is pointing <u>toward</u>.

4. Ask all children to be seated and simply look around the room to get acquainted with the directions. Give the children some time to think about and study the directions.

APPRAISAL

1. Ask one child to tell you the direction that is <u>behind</u> him.

2. Ask another child to tell you the direction that is to his left.

3. Ask a third child to tell you the direction that is to his right.

4. Ask a girl to stand up and face the east. Have her walk toward the east and turn and walk toward the south.

5. Ask a boy to stand up and walk toward the south. Ask him to now walk toward the north.

GROUP APPRAISAL: Children will need their red, blue, and green crayons.

Give the children the mimeographed map which is marked "Directions." Point out to them that the top of the map is labeled NORTH. Have them look at the lines on this page and listen carefully while you read to them a story about these lines.

Barbara stood up and faced the front of the classroom. This is north. She turned to her left and walked 4 steps, then turned to her left again and took 5 steps, and then turned to her left again and took 6 steps. The large X shows where Barbara started and the lines on this page show the paths she took.

Look carefully at the map and color the path she took to go east green. Color the path she took to go south blue, and the path she took to go west red.

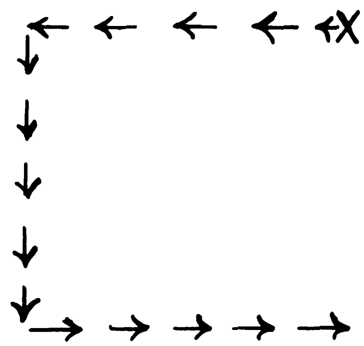
ETSK 66

____
name

Date:________________room:_________

DIRECTIONS

NORTH



ETSKL 66 Lesson 2

TEMPERATURE

OBJECTIVES:

Behavioral: Upon completion of this lesson, children should be able to:

1. Discriminate between hot and cold water by using a thermometer.
2. Predict what will happen to a thermometer when it is placed in hot or cold water.
3. Read a thermometer. (approximate the temperature.)

Content: Upon completion of this lesson, children should know:

1. That a thermometer is used to measure temperature.
2. That a thermometer will show a higher reading in hot water than it will show in cold water.
3. That a thermometer will show a lower reading outside than it will show inside. (winter)

RATIONALE:

Very early in the educational experiences of children, activities should be provided which will familiarize the child with a thermometer. Through non-school experiences, he has probably already acquired some crude knowledge of hot, and cold. He may have had the experience of having a doctor or his mother take his temperature.

Since one of the customary activities of primary grade instruction in science is the observation of the temperature on a daily basis, it is therefore appropriate that provisions be made to give the child experiences with the thermometer.

VOCABULARY: thermometer, temperature, hot, cold.

MATERIALS: large coca-cola thermometer, 4 small thermometers, ribbon thermometer.

PROCEDURE:

Teacher: Show the children the large coca-cola thermometer which has been provided for you. Ask them if they know what it is. What can it show us? Show the other thermometers and discuss their uses.

1. Place one of the thermometers in the ice box, or in a glass containing ice cubes, and the other thermometer in a glass of hot water. Have children notice the difference in readings.

2. Place one of the thermometers in a glass of warm water. (not

hot.) Place one of the thermometers in ordinary tap water. Have children notice the differences in readings of the two thermometers.

3. Have one child take the temperature reading inside the room. Place this reading on the blackboard. Then have him go outside and take the temperature reading. Compare the readings.

APPRAISAL:

1. Place a glass of hot water and a glass of cold water on your desk. Have a child feel each of the glasses and tell you which is hot and which is cold. Place the thermometer in the cold water and have him predict what will happen to the thermometer when you place it in the hot water. (You may repeat this activity with several children by simply varying which glass you place the thermometer in first.)

2. Have a child manipulate the ribbon thermometer so that it approximates the inside room temperature.

3. Ask a child to predict what will happen if they were to take a thermometer outside. Allow him to verify his answer.

ETSKL 66 Lesson 3

MEASUREMENT 1

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. order objects according to increasing and decreasing height.
2. demonstrate that one object is as tall as another by placing them side by side.

Content: Upon completion of this exercise, children should know:

the meanings of the words in the vocabulary list.

RATIONALE:

It has often been stated that if anything exists, it can be measured in some way. Measurements enable the scientist to quantify their observations and gain precision in their experimental work. All measurement is approximate and is usually concerned with questions of "how much." In order that people may comprehend questions of how much, arbitrary units have been agreed upon to specify a given quantity.

The ability to measure is a fundamental ability which should be developed in the kindergarten child through appropriate exercises. This particular exercise is concerned primarily with nominal and ordinal measurement.

Nominal measurement simply involves gross statements which describe objects--such as taller than, and shorter than.

Ordinal measurement is more precise in that the child must compare tallness, or shortness, and place respective measurements in decreasing or increasing sequential order.

VOCABULARY: taller, shorter, the same as.

MATERIALS: no specific materials are needed for this exercise.

PROCEDURE:

Teacher: This particular exercise is designed to help children see relationships between various heights. During this exercise, you should be concerned simply with the notions of "taller" and "shorter." Don't get involved with questions of "how much." This will be developed in later exercises.

Tell the children that you are concerned with trying to find out who is the tallest and who is the shortest in the room. Ask if they have any ideas.

1. Simply have children stand next to the blackboard and place a chalk mark directly over their head. (You might put the child's name above each chalk mark.)

2. Have children return to their seat. Ask--who is the tallest?

3. Who is the shortest?

4. Which children are the same height?

APPRAISAL:

1. Place colored strips of paper on the flannel board in vertical positions. Ask one child to pick out the tallest strip of paper.

2. Ask another child to pick out the shortest strip of paper.

3. Ask a third child to pick out 2 strips of paper which are the same height.

ETSKL 66 Lesson 4

MEASUREMENT 2

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. order objects according to increasing and decreasing height.
2. demonstrate that one object is as tall as another by placing them side by side.

Content: Upon completion of this exercise, children should know:

the meanings of the words in the vocabulary list.

RATIONALE:

See Measurement 1.

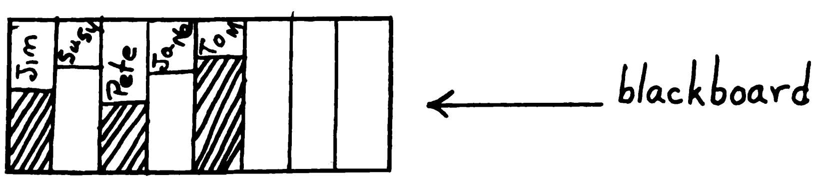
VOCABULARY: taller shorter, the same as, graph.

MATERIALS: no specific materials are needed for this exercise.

PROCEDURE:

Teacher: Parts 1 and 2 of the procedure are a repeat of the procedure of Measurement 1.

Divide the blackboard into sections so that you have one space for each child. Tell the children that you are going to have them help you make something called a graph. Ask if anyone has an idea of what a graph is. (See sketch below.)



1. Have a child stand next to the blackboard under his name. Draw a line directly over his head. Tell them that he or she is this tall. Allow the child to color in with chalk the bar which represents his height. (Use a different colored chalk for boys and girls.)

2. Continue until you have worked with all children. Try not to choose children in either increasing or decreasing height.

3. Discuss the graph. Indicate that we have made a record, called a graph which shows how tall each of the members of the class are. Mention that we cannot give an accurate description of each class

member's height in feet or inches, but that we can compare the heights of all class members, and we can by looking at the graph find out who is the tallest and who is the shortest.

APPRAISAL:

1. Ask a given child to pick the bar on the graph which shows the tallest boy. The tallest girl.

2. Ask a given child to pick the bar on the graph which shows the shortest boy. The shortest girl.

3. Ask a given child to choose from the graph two bars which show children who are most nearly the same height.

4. For all children: Look at the graph and see if you can find out whether there are more tall boys or girls.

ETSKL 66 Lesson 5

MEASUREMENT 3

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. arrange objects in decreasing and or increasing order of length.
2. demonstrate that one object is as long as, or as short as, another object by placing the objects side by side.

Content: Upon completion of this exercise, children should know:

length is the distance from one point to another.

RATIONALE:

Length may be defined rather arbitrarily as the distance from one point to another. This particular exercise is designed to develop in the child the concept of longest and shortest. Again in this exercise, little attention should be paid to questions of "how much."

VOCABULARY: longest, shortest, length.

MATERIALS: various lengths and colors of construction paper, paste, paper.

PROCEDURE:

1. Have children look carefully at their hands. Which of their fingers is the longest? Hold that finger up. Look again. Which is the shortest? Hold that finger up.

2. Place on the flannel board various strips of colored construction paper in a random fashion. Ask children if they could help you arrange the strips in some manner so that the longest strip is at the top of the flannel board and the shortest strip is at the bottom of the board.

3. Ask three children to help you. Mark a spot on the floor with chalk. Start one child at the chalk mark and have his take four steps. (Help them count if this is necessary.) Mark the spot where the child stopped. Repeat this procedure with the other two children.

4. Ask the class which child took the longest steps. Which child took the shortest steps? How do we know?

APPRAISAL:

1. Ask three pupils to bring you their red crayon. Ask one of

the pupils which crayon is the longest. Ask another child which crayon is the shortest. Ask the other child if there are two crayons that are the same length.

2. Draw three lines on the blackboard. Ask one child to choose the longest line.

3. Ask another child to choose the shortest line.

GROUP APPRAISAL

Give each child an envelope which contains five strips of various lengths and colors of construction paper. Pass out the mimeographed sheet of paper labeled Measurement 3. Ask the children to glue the various strips of colored paper to this sheet so that the longest strip of paper is on their right and the shortest strip is on their left.

ETSK 66

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name

Date:__________________room:_______

MEASUREMENT 3

ETSKL 66 Lesson 6

MEASUREMENT 4

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. specify the length of some object as so many units.
2. measure objects using different units.

Content: Upon completion of this exercise, children should know:

that fundamental units of measurements are arbitrarily agreeed upon.

RATIONALE:

The general concern of this lesson is to introduce pupils to the notion of units of length. In beginning to grasp the notion of units, many pupils will undoubtedly be unable to attach statements concerning "how much" or "how many times" greater one length is than another. This inability to quantitatively express ideas of "how much" or "how many times" is due to their lack of number knowledge.

VOCABULARY: length, width, inches, feet.

MATERIALS: 1 bundle of strips of colored paper of various lengths for each child, rulers, 3" x 5" cards.

PROCEDURE:

Teacher: Demonstration. Show children how to measure the length of the feltboard or blackboard by placing colored strips of paper end to end. You should point out to children that each of the colored strips of paper are the same length. We could call the length of one of the strips of paper a unit. Try to get across to children "how many" or "how long" by two methods:

a) count the strips--"The board is three units long."
b) grasp the units needed in one hand and comment that the board is--"This many units long."

1. Pass out the 3" x 5" cards. Ask children to measure how many times longer the card is than the red strip of paper that they have.

2. Compare answers.

3. Pass out the rulers. Have children look at their rulers. Hold a ruler between your hands. The distance between my two hands is one foot. Have children hold their hands one foot apart by placing a ruler between their hands.

4. Let's look closer. Using your ruler, show children where the one inch mark is. Have them compare the red strip of paper with the one inch mark. Instruct them to find a strip of colored paper that is two inches long.

APPRAISAL:

1. Have one child measure the length of an eraser using a set of colored strips. (To do this correctly, he must choose colored strips which are the same length.)

2. Have another child measure the length of a pencil using the same set of colored strips.

3. Have another child measure the length of his hand by using the same set of colored strips.

GROUP APPRAISAL:

Pass out the mimeographed sheet labeled Measurement 4. Children will need a red, a blue crayon, and their rulers.

a. Color the longest line <u>blue</u>.

b. Color the two lines which are the same length <u>red</u>.

c. With one of your crayons, draw a line which is approximately 1 inch long.

ETSK 66

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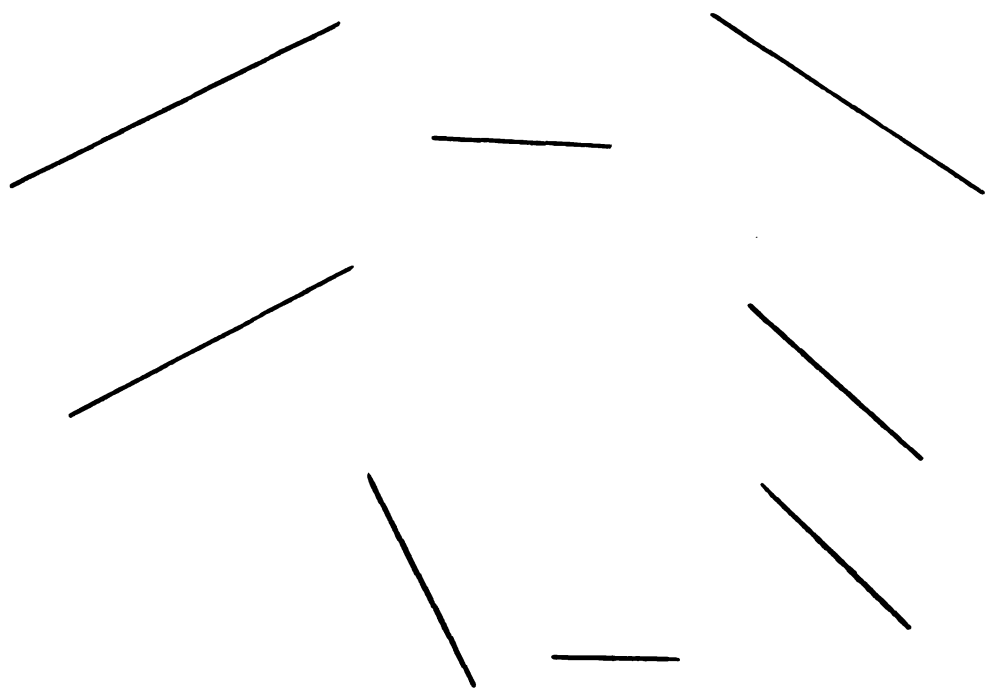
name

MEASUREMENT 4

Date:_______________ room:________



ETSKL 66 Lesson 7

OBSERVATION 1. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. Identify the colors of some sample objects.
2. Identify the texture of some objects.
3. Identify the difference in size of some objects.

Content: Upon completion of this exercise, children should know:

1. Objects are different as to color, texture, size, and shape.
2. The names of the various colors.

RATIONALE:

As preparation for later exercises in science, children should develop the ability to utilize the senses as a means of gaining information relative to objects and their properties. The suggestions which follow should cause the child to begin development of skills which will enable him to make accurate descriptions of objects and environmental phenomena.

VOCABULARY: red, blue, green, yellow, black, white, smooth, rough, hard, soft, bigger-than, smaller-than, larger, smaller, largest, smallest, observation, observe, circle, square.

MATERIALS: Ordinary clothing which the children are wearing, 8 circles of construction paper of various colors and sizes, 8 squares of sandpaper and aluminum foil of varying sizes, one circle of each color of construction paper available for the bulletin board, names of the six colors used in this exercise.

PROCEDURE:

Teacher: Explain or tell the pupils that we are beginning today a series of lessons dealing with science. As we study science, you will need to observe very carefully. Ask children how they observe. After some discussion, display the chart on the bulletin board. Point out all the ways we observe--we look, we listen, we feel, we smell, and we can even taste. Stress the rather simple notion that statements which describe what happens are observations.

1. Pick a child who has a red skirt or sweater or dress on. Ask for the color. Choose another child who is wearing something red. Ask if the colors of red are the same. Continue this general line of questioning until you have called attention to those colors in the vocabulary list.

2. Point to your own dress. Ask children what color it is. Ask if there is another dress in the room which is the same color as yours. If there is, have this girl come to the front of the room and stand next to you. Now, ask the class how the little girl's dress is different from yours. How is it like yours?

3. Choose two boys from the class who have the same color of trousers, but differ noticeably in size. Have them come to the front of the room. Ask the children how the boys' trousers are different. How are they alike?

4. Have the children feel two different pieces of their clothing, such as their dress and their socks or shoes. Ask for their observations. (Probe, guide the discussion until you have elicited from the children words such as rough, smooth, hard, soft, etc.)

APPRAISAL:

1. Display the 8 circles of construction paper of various sizes and colors on the bulletin or felt board. Ask one child at a time to select a given color--red, green, blue, etc.

2. Using the same 8 circles ask a child to pick the smallest red circle. Repeat with another child and ask for the largest red circle. Repeat with another child and ask for the smallest black circle.

3. Remove the circles from the felt or bulletin board and place the squares on the bulletin board. Ask a child to choose the largest rough square. Ask another child to choose the smallest smooth square.

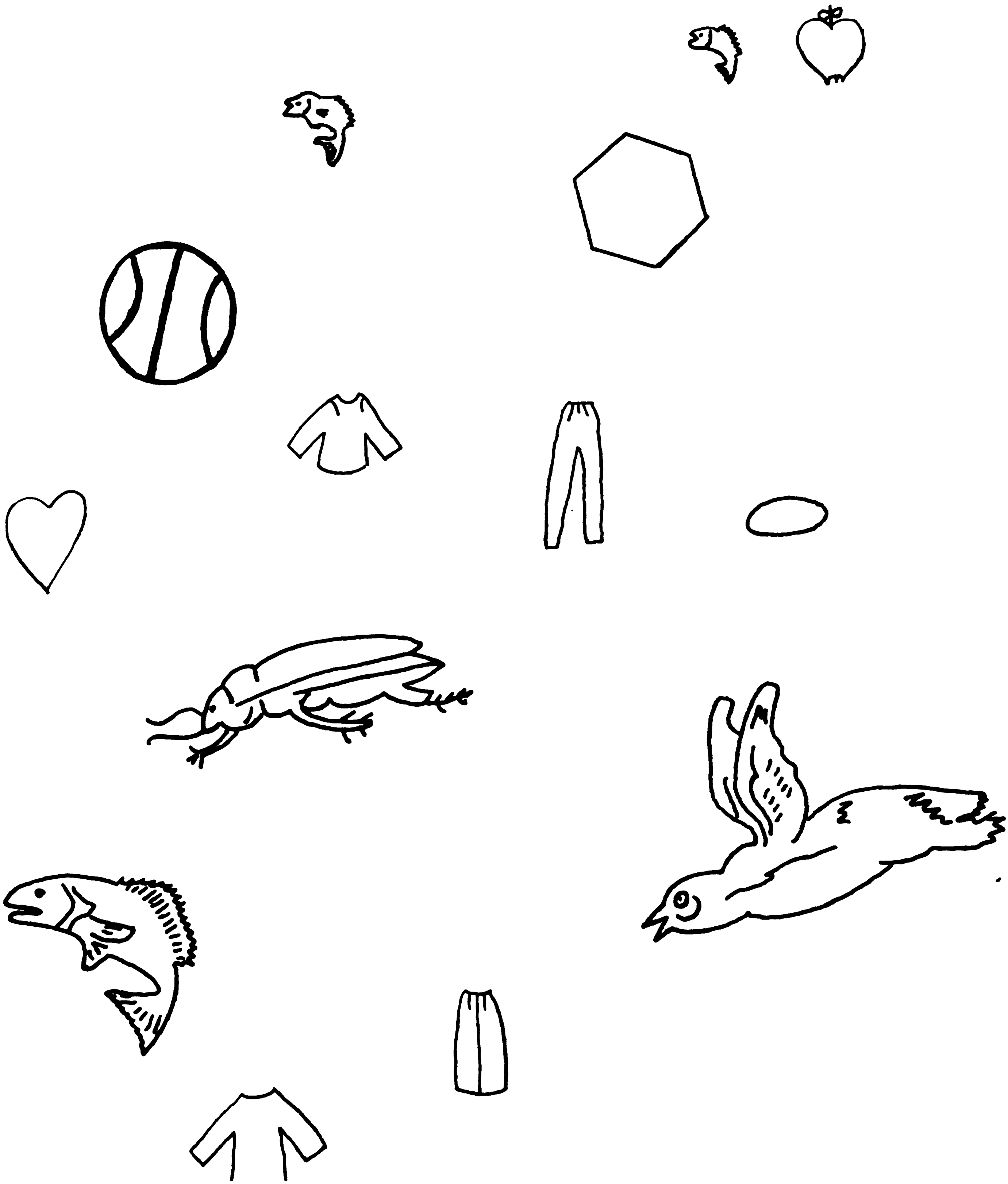
4. For class discussion: Ask children to look carefully at all the squares. How are they all alike? How do they differ?

FOR ALL PUPILS:

5. Pass out the mimeographed sheet. Have the children color the ball green. Have them color the sweater red. Have them color the largest fish green. Have them color the smallest fish yellow.

ETSK 66 OBSERVATION 1 NAME ____________________

DATE ____________________



ETSKL 66 Lesson 8

OBSERVATION 2. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. Identify the shape of objects.
2. Identify the texture of objects.

Content: Upon completion of this exercise, children should know:

1. The difference between round and square objects.
2. The difference between smooth and rough objects.

RATIONALE:

As preparation for later exercises in science, a child should develop the ability to use the sense of touch as a means of gaining information relative to objects and their properties.

VOCABULARY: round, smooth, rough, square, texture.

MATERIALS: styrofoam balls, marbles, 1" x 1" wooden blocks, blindfolds.

PROCEDURE:

Teacher: As you begin this exercise, your role will be to demonstrate (show) to children how observations can be made without using the eyes. Utilize the chart which was used in Observation 1. Point out to children that we are going to make some observations today by using our sense of touch--we feel.

Put on one of the blindfolds and have a child bring you an object. Describe it to the class as thoroughly as possible. Include in your description words which call attention to the shape and texture. Ask another child to bring you another object and go through the same procedure again.

For Children:

1. Distribute the blindfolds. Have each child put their blindfold on and check that they cannot see.

2. Walk around the room and give each child the envelope which contains 1 marble, 1 styrofoam ball, and the 1" x 1" block.

3. Have the children open the envelope and examine the objects.

4. Ask all children to hold up the <u>rough</u> <u>round</u> ball.

5. Ask all children to hold up the square.

6. Remove the blindfolds and repeat items # 4 and 5.

APPRAISAL:

1. Choose one child and have him reach into a sack and choose the rough round ball.

2. Repeat with another child and ask for the square.

ETSKL 66 Lesson 9

OBSERVATION 3. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

identify certain objects by their particular odor.

Content: Upon completion of this exercise, children should know:

that some objects can be identified by their particular odor.

RATIONALE:

The sense of smell is probably the sense least thought of as a means of making observations. The odor characteristic of a given object, or event may be sufficient for the identification of the object or event. For this reason, the science experiences provided for kindergarten children should make provisions for experiences which call for the utilization of the sense of smell.

VOCABULARY: odor.

MATERIALS: Cubes of onion, chewing gum, styrofoam or foam rubber cubes.

PROCEDURE:

Teacher: Remind children of the "ways we find out"--look, touch, hear, smell, and some times we even taste things. Today we are going to help you find out more about some things you should do when you make observations.

Divide the class into three groups. Give to each group one of the sacks containing the cubes of either onion, chewing gum, or styrofoam.

1. Ask the children to try to find out what is in the wrapped cubes without tearing open the outer covering of paper.

2. Call for their observations.

NOTE** One of the groups will be attempting to find an odor where there is none.

APPRAISAL:

1. Display the 4 vials of clear liquids. Choose a child and have him pick out one vial that contains a liquid different from the other ones.

2. Repeat with another child. Same instructions.

ETSKL 66 Lesson 10

OBSERVATION 4. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. recognize the general properties of matter.
2. demonstrate the property of impenetrability.

Content: Upon completion of this exercise, children should know the following general properties of all matter:

1. All matter takes up space.
2. All matter has weight.

RATIONALE:

This exercise is designed to develop further a child's ability to observe. In examining materials which are familiar, children can be encouraged to look for relationships which may exist among objects.

VOCABULARY: space, weight.

MATERIALS: chalk, rubber bands, pieces of aluminum foil, string, sugar cubes, modeling clay.

PROCEDURE:

Teacher: In this particular lesson, you should be concerned with gross general properties of <u>all</u> matter. It might be wise to introduce the notion of <u>general properties</u> of matter in the following manner.

Refer to the common--general--features of <u>all</u> boys or <u>all</u> girls--hair, arms, legs, eyes, ears, nose, feet, etc.

For this particular lesson, children should examine the set of objects in order to find information relative to the following features of the objects.

a. color
b. texture
c. hardness or softness
d. shape

Children should be encouraged to examine the materials carefully to determine the properties common to <u>all</u>.

Call for the observations of children relative to the above features.

APPRAISAL:

1. Have a child demonstrate to the class that matter takes up space.

2. Have children examine a set of materials and tell the class <u>all</u> the properties of the materials which are common.

ETSKL 66 Lesson 11

OBSERVATION 5. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. demonstrate to classmates some of the specific properties of matter.
2. by examination, determine specific properties of matter.

Content: Upon completion of this exercise, children should know and be able to identify objects which:

1. have a luster.
2. are brittle.
3. are elastic.
4. are hard.

RATIONALE:

This particular lesson is designed to sharpen the pupils' observational powers. In this exercise, he will be asked to look beyond the simple gross features or properties of a given piece of matter.

Students should recognize rather early on the educational continuum that the special properties of matter refer to those properties of matter which are unique for a given object or set of objects. They should recognize that the special properties of matter ultimately determine its utility.

VOCABULARY: luster, brittle, elastic, hard.

MATERIALS: chalk, rubber bands, pieces of aluminum foil, string, sugar cubes, modeling clay.

PROCEDURE:

Teacher: As in the past lesson, you should start by comparing two boys or two girls. Recall for the class the general properties of both. Then ask the class how we can tell one student from another. They will probably contribute such ideas as color of hair, color of eyes, presence or absence of freckles, etc.

Explain or tell the class that these features are special features and that every object has features or properties which are unique for that object or material.

1. Ask children to examine the objects and determine:
   a. which object is easiest to break
   b. which object is the shiniest

c. which object is the hardest
d. which object is the easiest to stretch
e. which object is easiest to change its shape.

APPRAISAL:

Display an assortment of objects which are familiar to the children.

1. Ask a child to choose from the assortment the object which is the shiniest. (Has the most luster.)

2. Ask another child to choose from the assortment the object which is the most brittle.

3. Ask another child to choose from the assortment the object which is most elastic.

ETSKL 66 Lesson 12

CLASSIFICATION 1. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. group objects on the basis of similarities.
2. establish groups on the basis of differences.
3. sort solids from a group of objects.

Content: Upon completion of this exercise, children should know that:

1. solids have a definite shape.
2. solids have a definite size.
3. solids have weight.

RATIONALE:

Classification is an intellectual skill which includes the ordering of data, the establishment of categories, the seeking of relationships between categories and the search for unifying characteristics of a phenomena. It is an intellectual activity rather than a manipulative activity.

In this particular lesson, children will be asked to classify an assortment of objects into two discrete groups. There is no one correct answer. The important thing for children to realize as a result of this particular lesson is that all classification is arbitrary and "man-made."

Particular attention should be given to those properties of solids which cause children to place them in a related group. Your particular role in this exercise is to cause children to look at many properties of the solids and then establish two groups.

VOCABULARY: classification, group, similarities, differences, solid.

MATERIALS: pencils, chalk, crayon, paper, rock, twig, small pieces of wire, string.

PROCEDURE:

Teacher: Illustrate classification to the class using the simple notion of boys and girls. This is a means of grouping which is already familiar to children and should present no problems. You should point out to the class the common features of the group (similarities), and also the features of the group which are different. Use such ideas as weight, height, color of hair, length of hair, etc.

1. Pass out the assortment of objects to children with instructions that they are to examine the objects and place them into two groups. (Allow about 5-10 minutes for this activity.)

2. Discussion. Ask for the why of several different groups. Who is right?

3. Ask children to look at the objects in the two groups that they have formed and find out how all the objects are alike. Make a list of these similarities on the board.

APPRAISAL:

1. Show a child a group of paper cutouts (all circles) which differ in size and color. Ask the child to tell the class why these cutouts form a group.

2. Have another child group the cutouts in a different way. (color)

3. Ask another child if he can group the cutouts in still a different way. (size.)

4. Have a child select from the classroom two solids.

5. Show an assortment of solids and have a child tell the class how the assortment is alike. (Correct answers include all responses which are expression of size, shape, weight.)

ETSKL 66 Lesson 13

CLASSIFICATION 2. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. group objects on the basis of similarities.
2. group objects on the basis of differences.
3. select liquids from a group of objects.

Content: Upon completion of this exercise, children should know that:

1. liquids have weight.
2. liquids occupy space.
3. liquids take the shape of the container they are in.

RATIONALE:

In this particular lesson, children will be asked to examine rather carefully two liquids. They should be looking at the liquids in a manner which would allow them to find out all they can about the liquids. Particular attention should be paid to having children find out all the things about the liquids which are similar.

VOCABULARY: liquid.

MATERIALS: two different colored liquids, (kool-aid works well) and dixie cups.

PROCEDURE:

Teacher: Start by showing the children the two glass containers of liquid. Direct discussion until the children have verbalized the word liquid. If they do not verbalize the word liquid, tell them the word. Stress that today, we are going to study the substances in these two containers--liquids. It might be well to demonstrate to the children that liquids take the shape of the container they are in.

Divide the class in two groups. Give 1 group the purple liquid, and the other group the orange liquid.

1. Ask them to examine the liquid and find out all they can about it.

2. Have the groups trade cups of liquids and examine the different liquid and find out all they can about this liquid.

3. Discuss findings.

APPRAISAL:

1. Show vials of colored liquids. Ask a child how these liquids are alike.

2. Show assortment of pictures. Have a child choose a picture which shows liquids.

ETSKL 66 Lesson 14

CLASSIFICATION 3. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. recognize gases in motion.
2. demonstrate gases in motion.

Content: Upon completion of this exercise, children should know that:

1. a gas has no definite shape.
2. a gas takes up space.
3. a gas has weight.

RATIONALE:

In this particular lesson, children will be asked to talk about and make statements about something which they cannot see--a gas. Generally speaking, it is quite difficult for children of this age to conceptualize phenomenon which they cannot see.

However, it is felt that if children concentrate upon simple phenomena with which they are familiar, concept formation can take place. The particular gas that will be used in this exercise is air.

VOCABULARY: gas, air.

MATERIALS: dixie cups, straws, 3" x 5" cards, balloons.

PROCEDURE:

Teacher: Your role in this particular lesson will be merely that of director of activities. When necessary, it will be your task to draw from children verbalizations regarding air.

1. Have children place their hands a few inches in front of their mouth and blow their breath on their hands. Ask
   a. can you feel anything?
   b. can you see anything?

2. Have children wave a 3" x 5" card back and forth in front of their face. Ask
   a. can you feel anything?
   b. can you see anything?

3. Give each child a dixie cup which is about 1/3 filled with water and a straw. Have them first to simply blow through the straw

on to their hands. Ask

a. can you feel anything?
b. can you see anything?

4. Now have the children gently blow through the straw into the glass of water and watch what happens. Ask

a. can you see anything?
b. what causes the bubbles in the water?

5. <u>A demonstration</u>

Display two balloons of the same size. Have two of the children blow up the balloons. Tie them. Ask--what did you put into the balloons? Ask--do the balloons weigh more now than they did before you blew them up? Ask--How can we find out? Try this. (See sketch.) Balance the two balloons on a straw. Relate this balancing to the teeter-totter or see-saw experiences which children have on the playground. Ask--What would happen if I were to break one of the balloons? (Note--here you are asking for speculative thinking. When you ask a child to do speculative thinking, don't be too harsh if some suggestions are "way-out." Be concerned about the kind of thinking children do <u>after</u> they have participated in a learning experience related to a given concept.) List the ideas presented by the children on the blackboard.

Allow one of the children to break the balloon with a pin. Call for the observations of the class.

Ask--What does this show us about air?

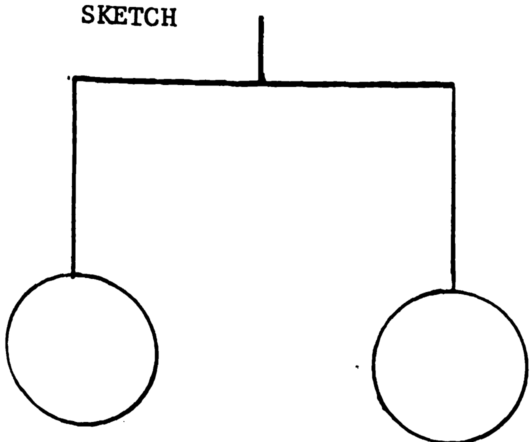
APPRAISAL:

1. Ask a child to demonstrate to the class a gas in motion.

2. Ask a child to look out of the window and tell the class whether or not air is in motion.

3. Display a paper airplane on the desk and ask a child to move the airplane without touching it.

SKETCH



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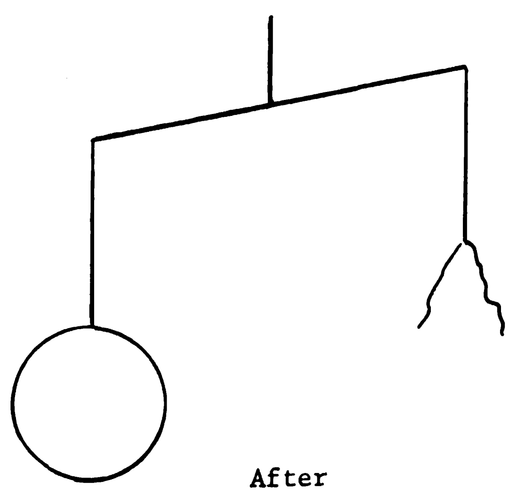


After

ETSKL 66 Lesson 15

CLASSIFICATION 4. Nature of Matter

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. group objects on the basis of similarities.
2. establish groups on the basis of differences.
3. sort solids and liquids into two distinct groups.

Content: No new content for this particular exercise.

RATIONALE:

This particular exercise is designed to give children practice in classification and reinforce ideas gained through the previous lessons dealing with solids, liquids, and gases.

VOCABULARY: No new words.

MATERIALS: Rocks, twigs, crayons, pencils, water, kool-aid, assortments of pictures showing solids and liquids.

PROCEDURE:

Teacher: Have children get 1 sample of each of the materials from a supply desk.

1. Ask them to group all of these materials into two separate groups.

2. Ask for the names of these two groups. Put these names on the blackboard.

3. Ask children what other materials they could find which would fit into these groups.

APPRAISAL:

1. Simply make a random check of three pupils as to their performance on procedure # 2.

2. Display pictures and have two different children identify a solid and a liquid by touching the correct picture.

TEACHING SCIENCE IN THE KINDERGARTEN

WEATHER:

A series of planned experiences which should help kindergarten youngsters more fully understand some of the daily weather changes. In the study of weather, the obvious resource is the weather itself. Look upon this series of lessons as a year long unit.

You are encouraged to use the particular exercises on the day the appropriate phenomena occurs. An exercise appropriate for each of the weather phenomena follows this brief introduction.

A systematic study of the weather affords a daily opportunity for pupils to collect and record information. As a part of this study of weather, the following information should be collected and recorded each day.

Temperature
Direction of wind
Amount of precipitation
Kind of precipitation
Speed of wind
Kind of clouds

As you pursue this study of weather with your students, you may find some of the following books quite interesting.

Fisher, Aileen Lucia. I Like Weather. Thomas Y. Crowell, 1963. (The seasons of the year are described in rhyme with colorful illustrations.)

Hoban, Russell, and Hoban, Lillian. Some Snow Said Hello. Harper and Row, Publishers, 1963. (Offers background information for children about snow and suggests some vicarious experiences with snow.)

Zolotow, Charlotte. The Storm Book. Harper and Row, Publishers, 1952. (The progress of a storm is followed from beginning to end.)

Introduction:

As you guide your pupils in a systematic study of the weather, you have the responsibility of showing them how to collect and record information relative to weather phenomena. By showing them how to collect information about the weather, it is hoped that you will instill in them some concern for handling, treatment, and compilation of data.

With all weather incidents, please make certain ther children collect the following pieces of information.

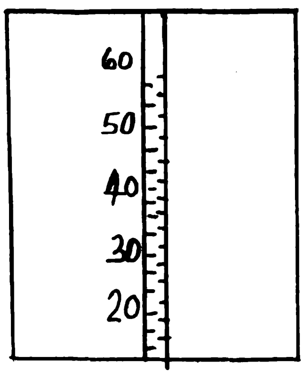
1. Temperature--thermometer--see note # 1.
2. Wind direction--wind vane--see note # 2.

3. Amount of precipitation--rain gauge--see note # 3.
4. Kind of precipitation.
5. Speed of wind--Beaufort Scale--see note # 4.
6. Kinds of clouds. See note # 5.

NOTE # 1. Temperature. In having children record the temperature, it is suggested that you construct a large model of a thermometer by using one of the following suggestions.

Zipper Thermometer. Secure a large (approximately 18 inches long) zipper. Attach it to a piece of poster paper, or heavy cardboard. Glue a scale which will approximate the temperature range during the month along the side of the zipper. By looking outside the window at the thermometer, the children can manipulate the zipper to a temperature which closely approximates the true temperature. See sketch a.

Ribbon Thermometer: Secure a large piece of poster paper, or heavy cardboard. Cut out a one inch slit near the top and the bottom of this poster paper. Glue together the ends of one red and one white ribbon. Place the white end of the ribbon in the top slit and the red end of the ribbon in the bottom slit. Carefully mark a scale along one side of the ribbon. By looking outside the window at the thermometer, the children can now manipulate the ribbon to a mark which closely approximates the true temperature. See sketch b.



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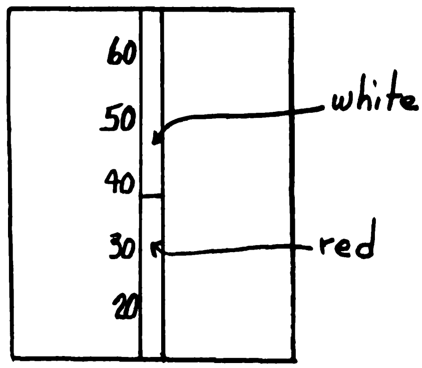

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NOTE # 2. Wind Direction. As you guide children in their attempts to determine wind direction, you may use the wind vane which has been provided with the materials accompanying this exercise, or you may simply have children observe the direction of cloud movement or smoke drift. It is suggested that you have children learn to tell wind direction by both methods.

NOTE # 3. Amount of Precipitation. Rain Gauge. You should construct a simple rain gauge by securing a glass jar with rather straight sides and glue to the inside of this jar a plastic ruler.

Make certain that the plastic ruler touches the bottom of the jar and check to see that the length units start at the end of the ruler.

After each rain, have children look at the rain gauge to see how much it has rained during the storm. Empty the rain gauge after each reading.

NOTE # 4. Speed of wind. Beaufort Scale.

Use the common Beaufort Scale and U. S. Weather Bureau terminology. In order to establish the speeds, use the suggested criteria below. Concentrate on the columns starred.

TABLE OF COMPARATIVE WIND VELOCITY TERMINOLOGY

Beaufort Force	Velocity m.p.h.	U.S. Weather Bureau Term *	Specifications for use on fixed objects. *
0	1	Light	Smoke rises vertically--no leaf motion
1	1-3	Light	Direction of wind shown by smoke drift
2	4-6	Light	Wind felt on face; leaves rustle
3	7-10	Gentle	Leaves and small twigs in constant motion
4	11-16	Moderate	Raises dust and loose paper--small branches are moved
5	17-21	Fresh	Small trees in leaf begin to sway
6	22-27	Strong	Large branches in motion
7	28-33	Strong	Whole trees in motion; hard to walk against the wind
8	34-40	Gale	Breaks twigs off trees
9	41-47	Gale	Slight damages occur
10	48-55	Whole Gale	Trees uprooted
11	56-65	Whole Gale	Wide spread damage
12	Above 65	Hurricane Tornado	Maximum wind damage

NOTE # 5. Kinds of clouds. To help children learn some cloud patterns, construct several "mock-ups" using cotton or cut out patterns for the cloud types. Also use the enclosed pictures. Label with the appropriate titles.

Concentrate on the following three types of clouds.

a. cirrus--feathery
b. cumulus--cotton ball-like
c. stratus--layer-like

ETSKL 66 Lesson 16

WEATHER Topic: Frost

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. tell or show where frost might be formed.
2. draw some frost crystals.

Content: Upon completion of this exercise, children should know:

1. that frost is water vapor which has condensed on an object whose temperature is below freezing.

RATIONALE:

Frost is one of the weather phenomena which fascinates children. However, far too many children grow into maturity with an erroneous concept of frost. Further, too much emphasis is placed on "Jack Frost," and little attention is given to the variables which produce frost. In this particular exercise, care should be taken to emphasize the words vapor and freezing.

In view of the fact that one cannot see a vapor, this particular word is difficult to teach to children. However, the following suggestion has proved helpful in teaching the meaning of this word. Place a few very small crystals of camphor in each child's hand. Tell them what the crystals are. Have them smell the crystals. Have them watch the crystals. After they have evaporated, have them smell their hands again. The odor is due to the vapor of the camphor crystals.

VOCABULARY: vapor, frost, freezing, evaporate.

MATERIALS: camphor crystals, hand lens.

PROCEDURE:

Teacher: Be sure to guide children to understanding of the word "vapor."

1. Have children examine some frost where it is formed with their hand lens.

2. Ask children to find as many places as possible where frost can be formed.

3. Have children collect some samples of frost and examine it with their hand lens.

4. Have children note cloud formations and conditions which accompany frost.

APPRAISAL:

1. Ask a child to show you where frost may be found. Repeat with other children.

2. Display a piece of cotton which has had a few drops of perfume placed upon it. Ask a child to explain how he is able to determine the odor.

3. Moisten a spot on the blackboard and have children watch the evaporation. You may even tell them that the water is evaporating. Ask a child why they can no longer see the water after it has evaporated. (You are looking for a response which includes the notion that the water on the board has turned to a vapor.)

ETSKL 66 Lesson 17

OBSERVATION Weather Topic: Rain

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. recognize the kinds of clouds present on a rainy day.
2. indicate the direction of movement of clouds.
3. measure the amount of rain which falls during a given rain.

Content: Upon completion of this exercise, children should know:

1. Water comes out of the air as rain.
2. Rain falls from the clouds.
3. The name of the clouds present when it rains.

RATIONALE:

It is essential that pupils learn at an early age the importance of gathering data and keeping records. The systematic study of weather affords pupils the opportunity to gather data and keep records about environmental phenomena.

VOCABULARY: rain, rain gauge, condensed, clouds, stratus, cumulus, cirrus.

MATERIALS: No new materials are needed for this exercise.

PROCEDURE:

Teacher: On the first day that it rains, display the pictures of the various types of clouds on the bulletin board. Make sure that the proper name of these clouds are pointed out to the children.

1. Have children observe the rain, the clouds, and record as accurately as possible the temperature. Allow ample time for them to do some thinking about these tasks.

2. Have children observe the direction the rain is coming from. (The direction of movement of clouds.)

3. If it stops raining for a short period of time, have children examine the rain gauge in order to determine how much rain has fallen.

APPRAISAL:

1. Display the pictures of the three basic kinds of clouds. Ask a pupil to go to the bulletin board and choose the kind of cloud which is present today. If he is correct, tell him and the rest of the class so.

2. Choose a pupil and have him manipulate the ribbon thermometer so that it approximates the outside temperature.

3. Select a pupil and have him tell the direction from which the clouds are coming.

4. Select another pupil and have him tell the direction in which the clouds are moving.

ETSKL 66 Lesson 18

OBSERVATION: Weather Topic: Snow

OBJECTIVES:

Behavioral: Upon completion of this exercise, children should be able to:

1. recognize the kinds of clouds present on a day when it snows.
2. indicate the direction of movement of the clouds.
3. measure the amount of snow that falls during a given storm.

Content: Upon completion of this exercise, children should know that snow:

1. is frozen water vapor.
2. flakes vary in size.

RATIONALE:

Each year children look forward with eagerness to the occurrence of the first snow. Careful examination of snow flakes offers children an opportunity to appreciate more fully the beauty of snow. This particular exercise is designed to acquaint children with the size, shape, and method of formation of snow.

VOCABULARY: snow

MATERIALS: snow, jar, plastic ruler, thermometer.

PROCEDURE:

Teacher: If the lesson dealing with frost has not been taught prior to this lesson, consult the rationale of the frost lesson for some suggestions about teaching the word vapor.

1. Have children collect some snow flakes on black paper and examine their shapes.

2. Collect several jars full of snow. Have children note that the jars are full. Allow the snow to melt. Have the children measure the amount of water formed when the snow melts.

3. Take the temperature of the snow outside and compare this temperature with the temperature of the air.

4. Have children notice the kind of day that produced the snow. Ask what kind of day preceeded the snow. (It might be well here to look at the information which you have collected and recorded on the weather chart.)

APPRAISAL:

1. Have a child select from the series of cloud pictures the kinds of clouds present when it snows.

2. Have a child show the direction from which the snow is coming.

3. Have a child indicate the approximate amount of water which would be formed when a jar of snow melts.

ETSK

FEEDBACK FORM

1. Title of Exercise____________________________ Date of Report_____

   Your Name _____________________________

2. Time Data: Date taught____________ Instructional time: Planning___ Preparing materials____________

3. Activities:

   A. What activities proposed for you and or for the pupils could be omitted from this exercise?

   B. What activities should be added to those proposed for this exercise?

   C. Would you like to see this exercise included in a science program for kindergarten pupils?

4. Content:

   A. Is the content suggested in this particular exercise appropriate for kindergarten pupils?

   B. Has the content been logically developed?

   C. What prior concepts are needed as a basis for this particular lesson?

   D. Estimate the percentage of the class who developed an understanding of the particular concepts in this lesson.

5. Comments on written material:

For each of the exercises, please write (include enough information to be helpful to the writer for subsequent revision) any comment, criticism, or suggestions for change which you feel are warranted as a result of teaching the exercise. You are encouraged to contribute novel ideas which may be useful in teaching science to kindergarten youngsters.

EXERCISE SECTION	CRITICISMS
Behavioral Objectives	______________________________
Content Objectives	______________________________
Rationale	______________________________
Vocabulary	______________________________
Procedure	______________________________
Appraisal	______________________________

6. Reaction of the class:

The writer is concerned with getting your impression as to the reactions of the children to the instructional materials. Please examine the possible responses to the various categories and select the most appropriate description.

INTEREST

Fascinated with the exercise: __________
Little interest in the exercise: __________
Active conversation with other children relative to the activities: ____
Average interest in the exercise: __________
Other: __________

ATTENTION SPAN

Abnormally long attention span: __________
Impatience: __________
Restless: __________
Normal attention span: __________
Other: __________

QUESTIONS ASKED

Few, or no questions asked: __________
Average number of questions asked: __________
Large number of questions asked: __________
Questions asked not related to the exercise: __________
Other: __________

CARRY OVER

Exercise resulted in children bringing related items from home: _______
Children used new words in other situations: __________
Children could remember material of previous exercise: __________
Children used skills developed in other situations: __________
Other: __________

7. Anecdotal notes:

Please add here any interesting events or observations you may recall which may be a result of this particular exercise.

APPENDIX C

PRELIMINARY TEST

The Preliminary Test developed by the writer and used by all children in the study follows. The items on this test were mimeographed and used by the children in the form shown.

TEACHING SCIENCE IN THE KINDERGARTEN

ETSK 66

TESTING

A major obstacle to the evaluation of instructional procedures in science at the kindergarten level has been the lack of instruments to measure growth of pupils toward many of the desired goals of instruction. Existing tests require that the pupil be able to read and write. To meet the need for evaluation instruments appropriate for the kindergarten child, this study has as one of its major aims the development of non-reading group tests which measure concept formation and growth of pupils in their ability to use the intellectual skills of observation, classification, data treatment, and measurement.

Prior to using any of the exercises in this experimental program, administer to all children the non-reading group tests on Observation, Classification, Measurement, and Data Treatment. Use the tests in this order. Make certain that you use exactly the same words that accompany the directions for each test. Key words which should be emphasized are underlined in the questions.

Since we are concerned with measuring pupil growth, it is of prime importance that we know where they are in concept and skill development now. Alternate forms of these tests will be given at the end of the series of lessons designed to develop a concept or skill, or at the end of the school year.

If the children have not yet learned to write their name, make certain that you have some way of identifying their papers.

Past experience with primary grade children has shown that they have not yet learned that it is not fair to copy their answers from some one else's paper. They should be cautioned to keep their eyes on their own paper. Tell them that you want to know what they think the answer to a question is.

When you have completed the testing, please call me at either 452-4009, or 453-2359 and I will pick up the tests and run an analysis. Copies of this analysis will be available for your use if you want it.

If there are specific questions, do not hesitate to call me.

TEACHING SCIENCE IN THE KINDERGARTEN

ETSK 66

OBSERVATION

Directions: Give each child an answer sheet, make sure that each child has a red and a green crayon, and then read the following to the children.

Today, I want to find out what you think the answers to some questions are. Each of you have a sheet of paper with lots of pictures on it--circles, rectangles, grapes, arrows, etc. Listen very carefully to some questions that I would like for you to answer.

Question #1. Place your finger on the picture of the ice cream cone. Find it? Next to the ice cream cone is a circle, two triangles, a rectangle, and an oval. Color the picture that you think is a <u>circle</u> <u>red</u>. Color the picture of the <u>rectangle</u> <u>green</u>.

Question #2. Place your finger on the picture of the pencil. Next to this picture of the pencil, there are pictures of two pieces of wood. Color the <u>rough</u> piece of wood <u>red</u>.

Question #3. Place your finger on the picture of the ball. Next to this picture of the ball, there are pictures of a key, a slice of bread, a glass of water, and a bunch of grapes. Color the picture which shows a <u>liquid</u> <u>green</u>.

Question #4. Place your finger on the picture of the kite. Next to the picture of the kite, there are some arrows and the word <u>NORTH</u>. Color the arrow which you think points <u>east</u> <u>green</u>. Color the arrow which you think points <u>south</u> <u>red</u>.

TEACHING SCIENCE IN THE KINDERGARTEN

ETSK 66

CLASSIFICATION

Directions: Give each child an answer sheet, make sure that each child has a red and a green crayon, and then read the following to the children.

Today I want to find out what you think the answers to some questions are. Each of you has a sheet of paper with pictures of some animals, leaves, bottles and some figures on it. Listen very carefully to some questions that I would like for you to answer.

Question # 1. Put your finger on the picture of the flower. Next to the picture of the flower, there is a picture of some animals. Look carefully at this picture and color the animal that is <u>different</u> from the rest <u>green</u>.

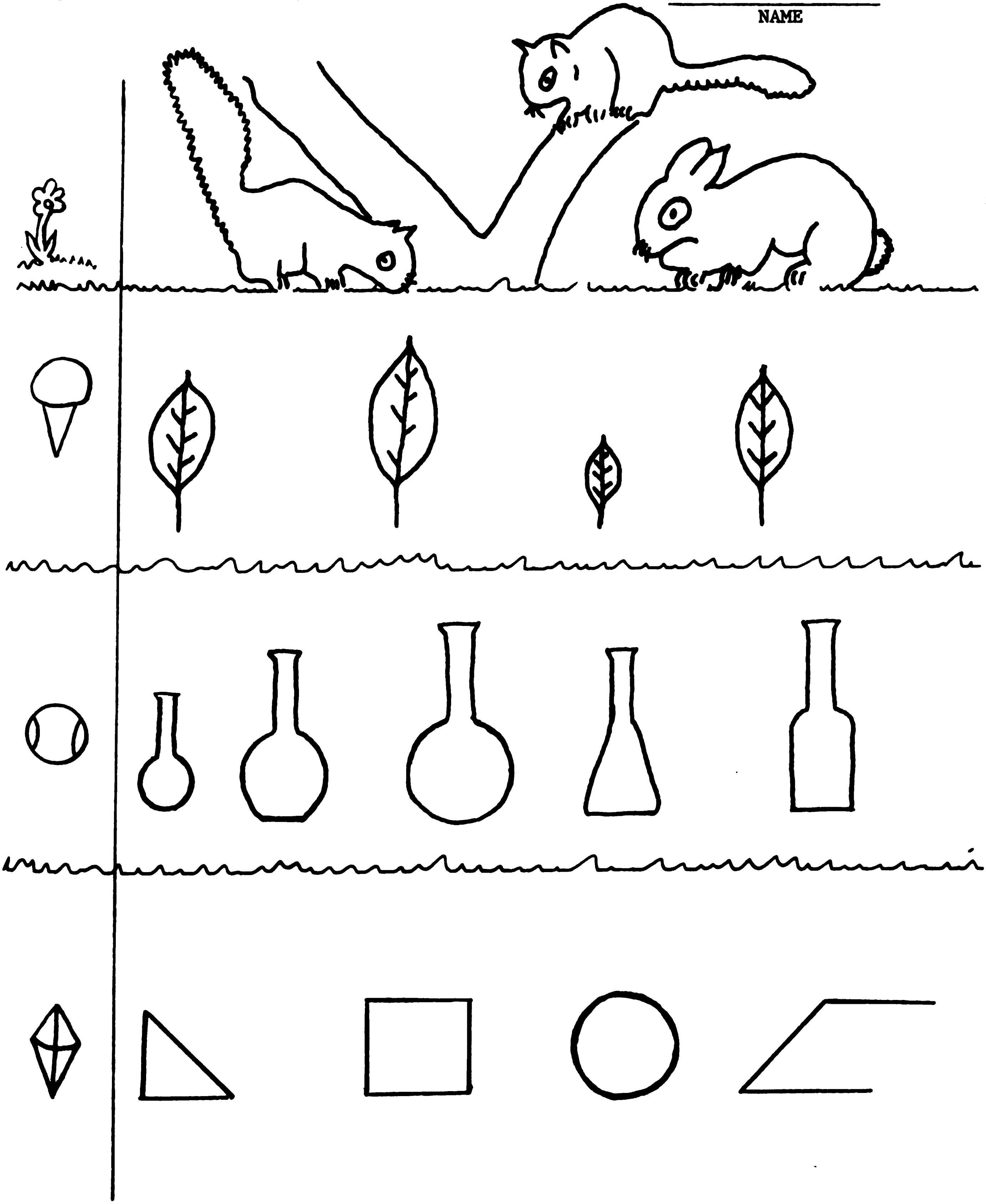
Question # 2. Put your finger on the picture of the ice cream cone. Next to the picture of the ice cream cone, there is a picture of some leaves. They are all different size, but have the same shape. Look carefully at the leaves and color the one that is different in <u>another</u> way <u>green</u>.

Question # 3. Put your finger on the picture of the ball. Next to the picture of the ball there is a picture of five bottles. These bottles are all different in size and shape. Look carefully at the first bottle and see if you can find the part of the first bottle that is the <u>same</u> as all of the rest of the bottles. Color this part <u>red</u>.

Question # 4. Put your finger on the picture of the kite. Next to the picture of the kite, there is a picture which shows a triangle, a square, and a circle. These are all different. Look carefully at these figures and with your <u>red</u> crayon, make the last figure like the other ones in one way.

CLASSIFICATION ETSK 66

NAME



TEACHING SCIENCE IN THE KINDERGARTEN

ETSK 66

MEASUREMENT

Directions: Give each child an answer sheet, make sure that each child has a red and a green crayon, and then read the following to the children.

Today, I want to find out what you think the answers to some questions are. Each of you has a sheet of paper with pictures of balls, snowmen, rectangles and lines on it. Attached to the upper left hand corner of this sheet is a piece of blue paper which is one inch square. You may use this piece of paper if you want to in deciding your answers to the following questions.

Question # 1. Put your finger on the picture of the flower. Next to the picture of the flower, there are two lines. Look carefully at these two lines and color the longest line red.

Question # 2. Put your finger on the picture of the ice cream cone. Next to the picture of the ice cream cone, there are three pictures of balls. Color the biggest ball green.

Question # 3. Put your finger on the picture of the pencil. Next to the picture of the pencil, there is a picture of two snowmen. Color the tallest snowman red.

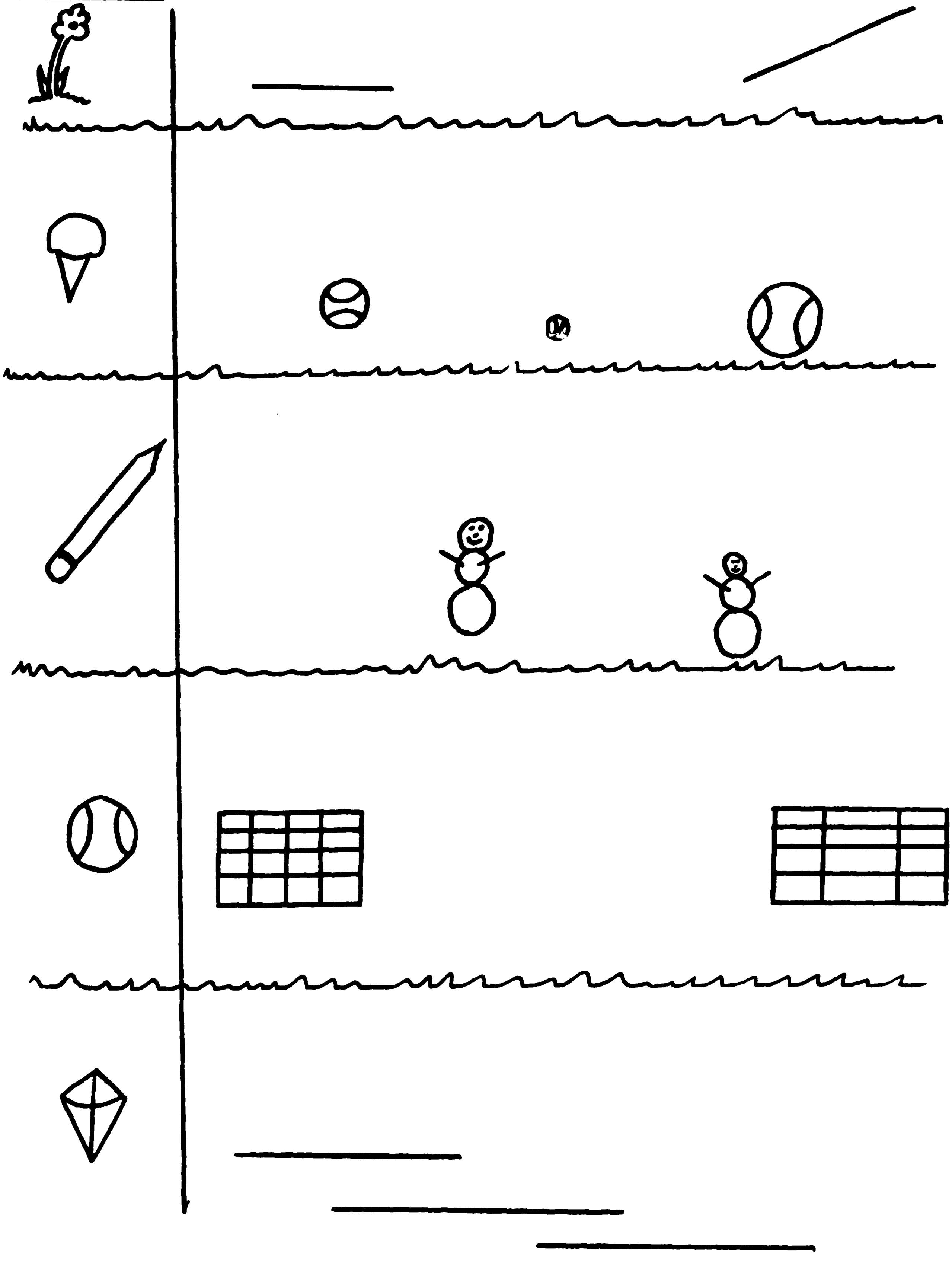
Question # 4. Put your finger on the picture of the ball. Next to the picture of the ball, there are two rectangles. Color the largest rectangle green.

Question # 5. Put your finger on the picture of the kite. Next to the picture of the kite, there are three lines. Color the line which is most nearly two inches long red.

BLUE

MEASUREMENT ETSK 66

NAME



TEACHING SCIENCE IN THE KINDERGARTEN

ETSK 66

DATA TREATMENT

Directions: Give each child an answer sheet, make sure that each child has a red and a green crayon, and then read the following to the children.

Today, I want to find out what you think the answers to some questions are. Each of you have a sheet of paper with several pictures of different kinds of graphs on it. Listen very carefully to some questions that I would like for you to answer.

Question # 1. Put your finger on the picture of the flower. Next to this picture of a flower is a graph of the temperature made by the children in Lincoln School. Look carefully at the bar graph and color the bar which shows the highest temperature red. Look carefully at the bar graph and color the bar which shows the lowest temperature green.

Question # 2. Put your finger on the picture of the ice cream cone. Next to the picture of the ice cream cone is a line graph made by the children in Washington School. This line graph shows the height of all the children in the room. Look carefully at this line graph and draw a red circle around the point on the line graph which shows the child who was the tallest.

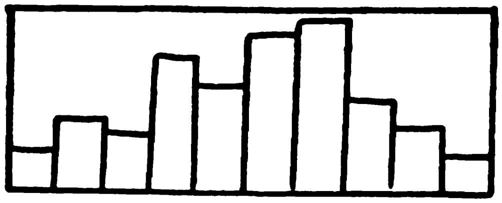
Question # 3. Put your finger on the picture of the pencil. Next to the picture of the pencil is another line graph made by the children in Washington School. This line graph shows the temperature during the past few days. With your green crayon, draw a line which shows what you think the temperature will be during the next few days.

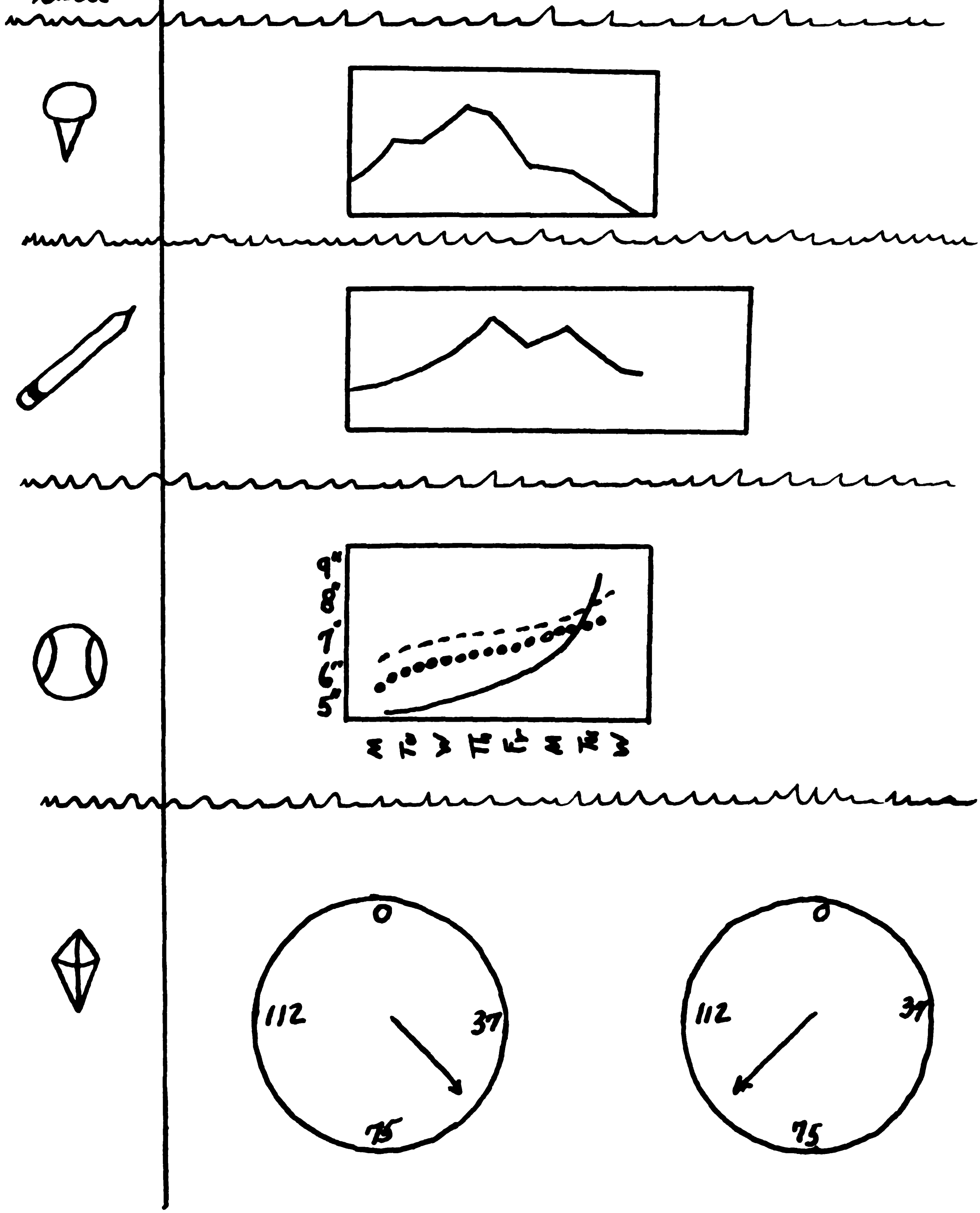
Question # 4. Put your finger on the picture of the ball. Next to the picture of the ball, there is a graph which was made by three science students. Each line represents the height to which their plants grew. With your red crayon, color the line which shows which plant grew the tallest.

Question # 5. Put your finger on the picture of the kite. Next to the picture of the kite, there is a picture showing what a scale registered when two different children got on it to be weighed. Color the scale which shows the highest reading green.

DATA TREATMENT ETSK 66

NAME





APPENDIX D

SKILLS TEST

The Skills Test which was developed by the writer to measure the achievement of the intellectual skills of Observation, Classification, Data Treatment, and Measurement by kindergarten children follows. The directions which were used by the classroom teachers in administering this group non-reading test are included. Due to the unique method of assembling the test, it cannot be shown in the form that it was used by the children in the study.

Each item of the test was placed on a single page, either white, yellow, or blue. The length of each page was either 2-1/2 inches, 3-3/4 inches, or 4-3/4 inches. The pages were placed in consecutive order and stapled in the upper left hand corner.

By using this format, the question which had just been completed was turned over, thus tending to eliminate some of the "cheating" which had occurred on earlier tests. Also, with this format, teachers could check with ease that all children were working on the correct item by simply looking at the color of the page which had been turned over and the color of the page the child was working on.

TEACHING SCIENCE IN THE KINDERGARTEN

ETSK 66

SKILL TEST

General Directions: Children will need their red, their blue, and their green crayons. They should be cautioned about looking on someone elses paper. Give each child one of the test booklets. Have them write (print) their name on the back of the test booklet. Instruct them to listen carefully as you read to them the following questions.

1. A white sheet of paper should be on the top. Look at the pictures on this white sheet of paper and color the largest circle green.

2. Turn to the blue sheet of paper. There are two thermometers shown on this blue sheet of paper. Color the thermometer which shows the highest temperature blue.

3. Turn to the yellow sheet of paper. If you were facing east, your left shoulder would point in which direction. Show by drawing a red arrow pointing in the direction that your left shoulder would point.

4. Turn to the blue sheet of paper. The top of this sheet is labeled "N O R T H". There are four arrows on this sheet of paper. Color the one which is pointing west green.

5. Turn to the yellow sheet of paper. Look at these three thermometers, and color the one which you think has been in the sun the longest period of time blue.

6. Turn to the white sheet of paper. Here is a picture of a graph. Look carefully at this graph. If you think the graph shows an increase in temperature, color the circle green. If you think the graph shows a decrease in temperature, color the circle red.

7. Turn to the yellow sheet of paper. There are no pictures on this page. However, there is a piece of blue paper attached to this page. This piece of blue paper is one inch square. By using this blue square of paper, draw a line with your red crayon which is two inches long.

8. Turn to the white sheet of paper. You may use the little blue square in helping you arrive at an answer to this question. Color the line which is most nearly three inches long blue.

9. Turn to the blue sheet of paper. This page shows four rain gauges. Color the rain gauge which shows the smallest amount of rain red.

10. Turn to the white sheet of paper. There are four pictures of things you might find in the yard or garden. They all differ in size and shape. However one does not belong to the same group as the rest. Color this one green.

11. Turn to the blue sheet of paper. Here are pictures of five toys. Look carefully at these toys and color the one part that is alike in all the toys red.

12. Turn to the yellow sheet of paper. Here is a picture of five thermometers. Below the picture of the five thermometers there is a graph which the pupils in Lincoln School made. They failed to record the temperature shown by one thermometer. With your green crayon, record the temperature on the graph.

13. Turn to the blue sheet of paper. Carefully look at these pictures and color the one which shows the sun shining red.

14. Turn to the yellow sheet of paper. The top part of this paper represents the north. Look carefully at these trees and color the one which shows the wind blowing from the west blue.

15. Turn to the white sheet of paper. Here is a picture of five thermometers. Below the picture of the five thermometers there is a graph which the pupils in Washington School made. You help them by taking your red crayon and recording the temperature shown by the last thermometer.

16. Turn to the yellow sheet of paper. Look at the lines on this yellow sheet of paper and color the longest line green.

17. Turn to the white sheet of paper. This is a bar graph of the temperature for eight days. With your red crayon, complete the graph and show what you think the temperature will be the last two days.

18. Turn to the blue sheet of paper. There are pictures of four leaves. They each differ in size, and shape. One of the leaves does not belong in a group with the rest of the leaves. Look carefully at the pictures and color the leaf that does not belong with the rest blue.

19. Turn to the white sheet of paper. This is a line graph which shows the distance traveled by a ball in given periods of time. With your red crayon, complete the graph to show how far the ball will travel as the time increases.

20. Turn to the blue sheet of paper. Here are pictures of five things one might find on the dinner table--a gum drop, an orange, a piece of watermelon, a glass of kool aid, and a piece of bread. Each of these foods differ in many ways--color, shape, size, and taste. One of these foods is unlike all the rest. Color the one that is different from all the rest green.

21. Turn to the yellow sheet of paper. Here are two pictures of rectangles. Color the shortest one blue.

22. Turn to the blue sheet of paper. Here are shown four containers which could be used to hold liquids. If you filled each one with your favorite soda pop, which one would contain the most soda pop? Color

the one which you think would contain the most soda pop red.

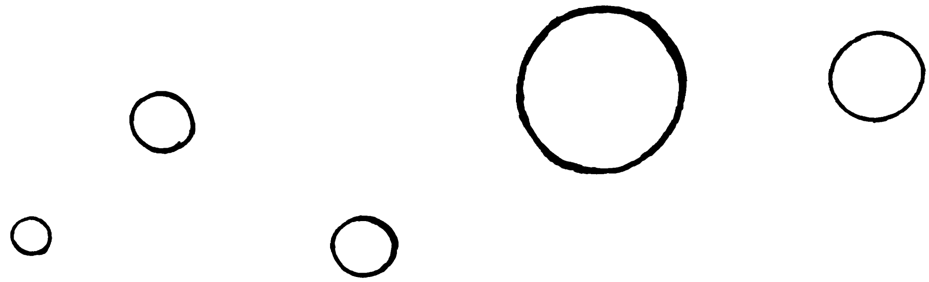
23. Turn to the yellow sheet of paper. This yellow sheet shows three line graphs made by the school nurse showing the number of pupils absent with measles during three different weeks. Color the graph which shows the week in which the most pupils were absent due to measles green.

24. Turn to the white sheet of paper. Some of the pictures have features or parts which are the same. Color the parts or features which are the same blue.

25. Turn to the yellow sheet of paper. Here are some pictures of things one might find in the kitchen. One of the objects could not be used for the same purpose that the rest of the objects could be used for. Color this object red.

26. Turn to the white sheet of paper. This is a picture of a graph showing the temperature during three parts of the year. Color the line which you think shows the summer temperatures green.

27. Turn to the blue sheet of paper. On this sheet, you will find attached a strip of black and a strip of green paper. Tear these strips off. The line in the center of the page is exactly twice as long as one of these strips. If you think it is twice as long as the black strip, color the line red. If you think the line in the center of the page is twice as long as the green strip, color the line green.



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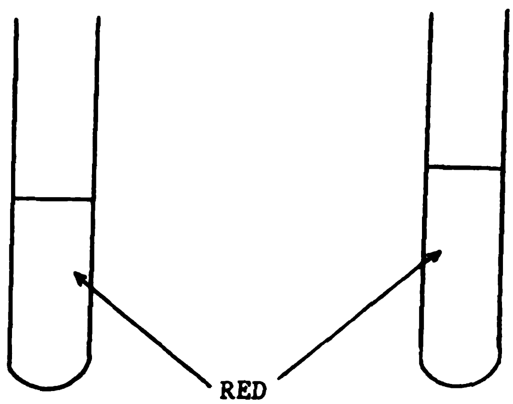

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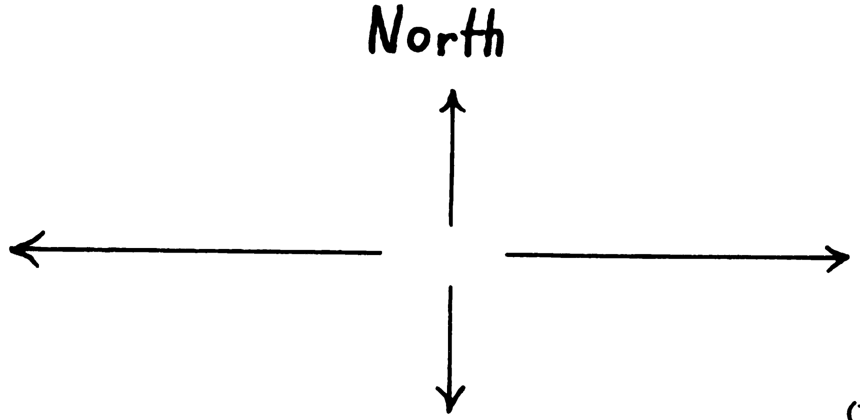

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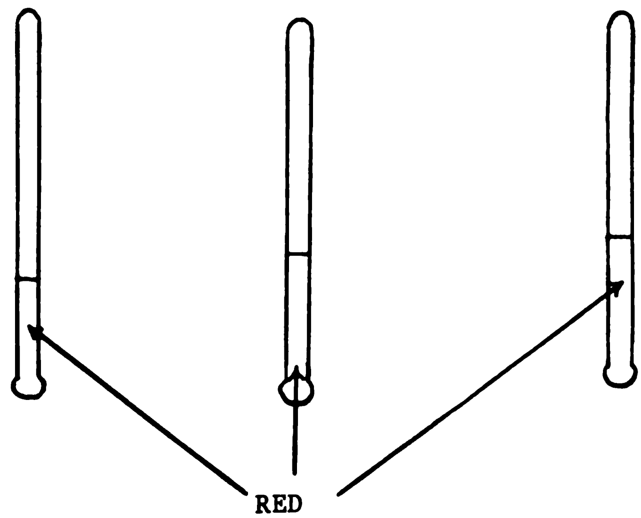

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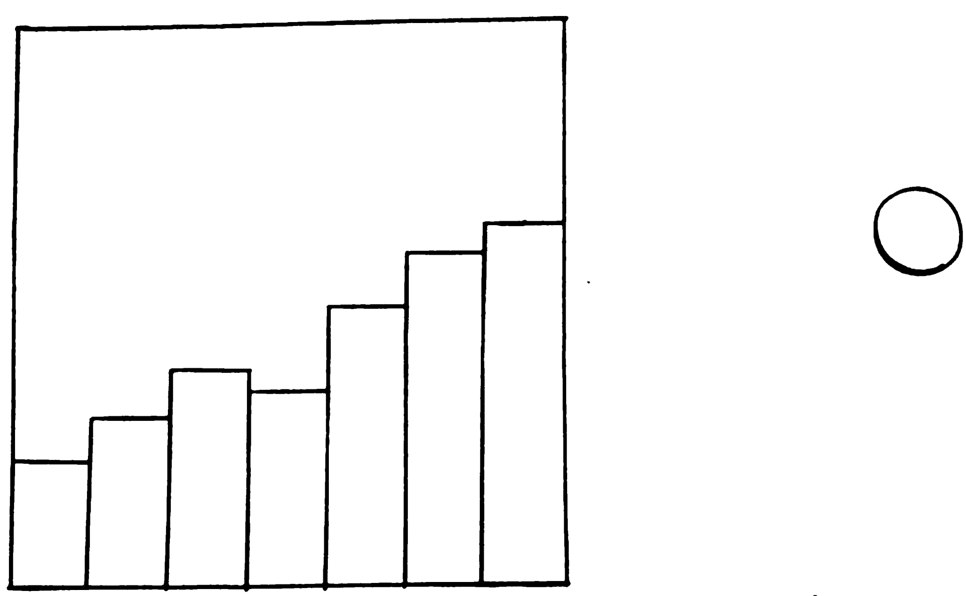

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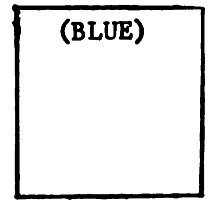

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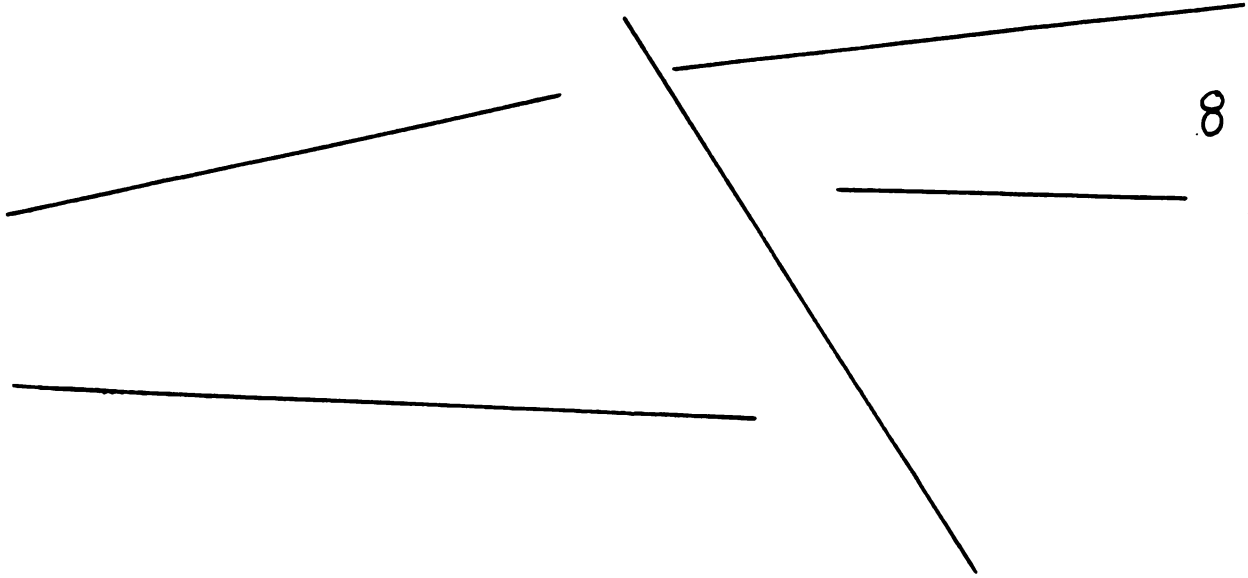

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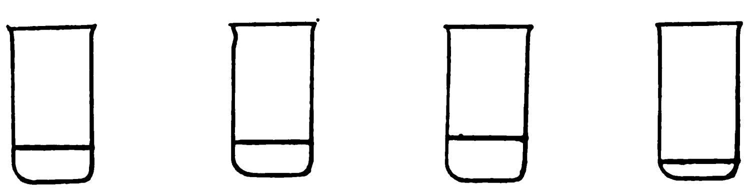

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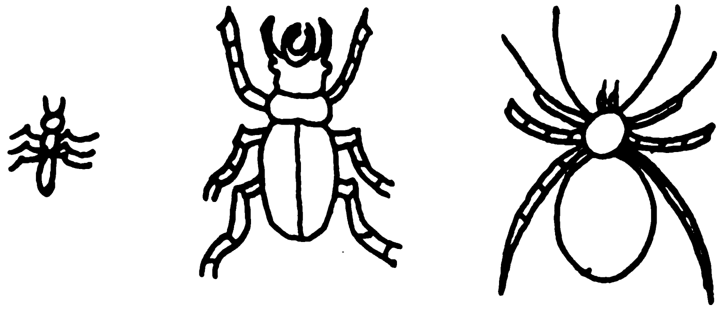

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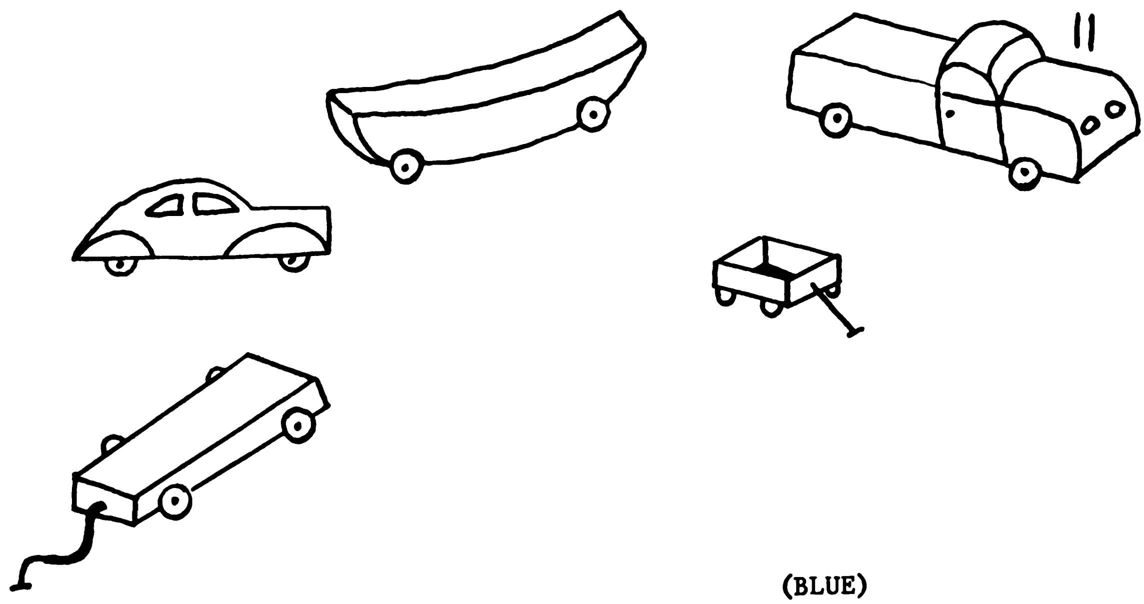

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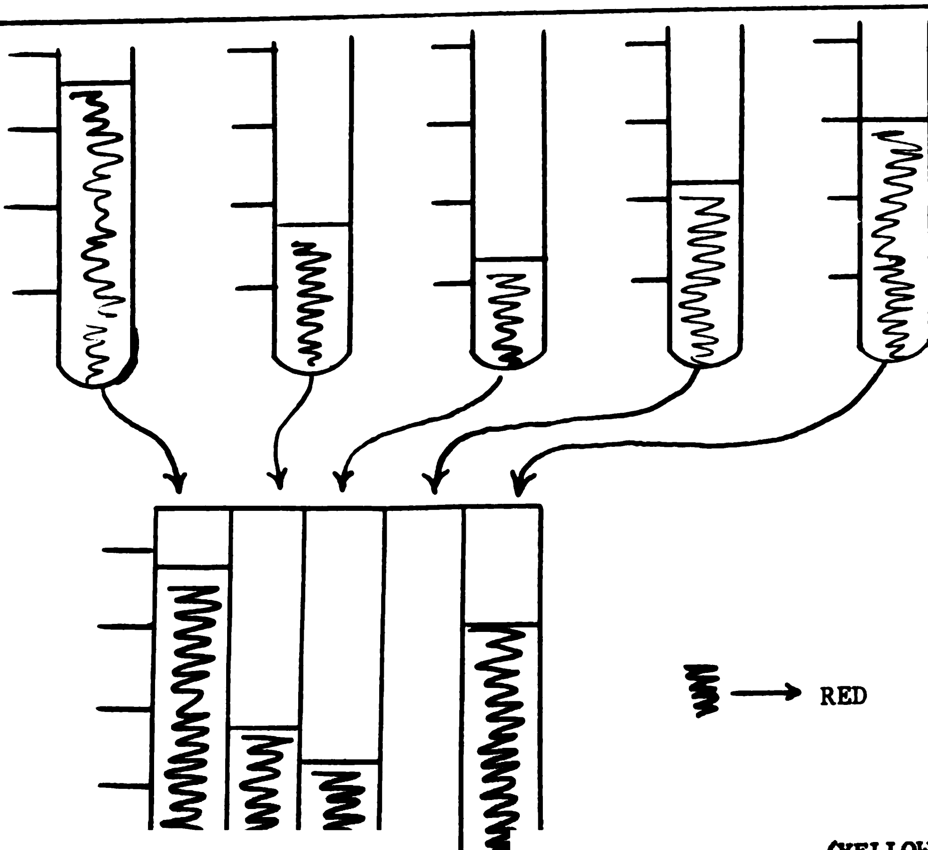

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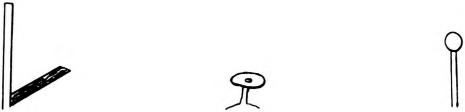

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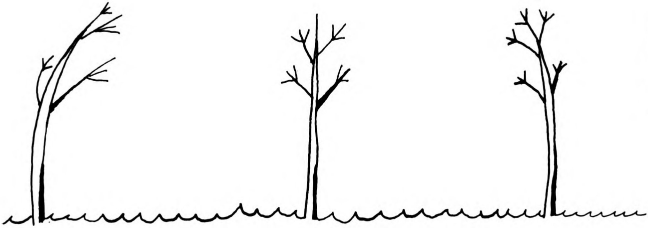

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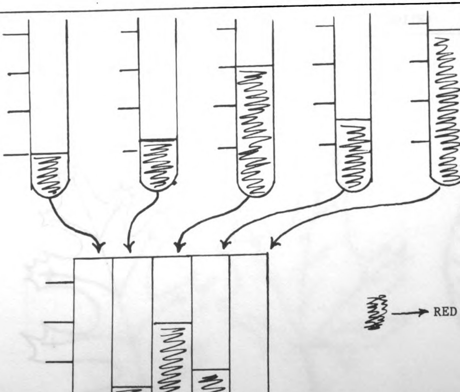

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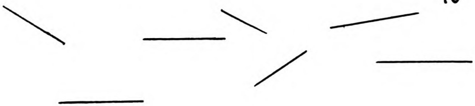

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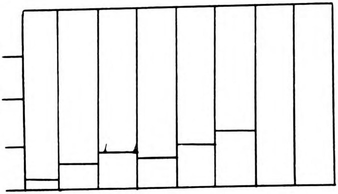

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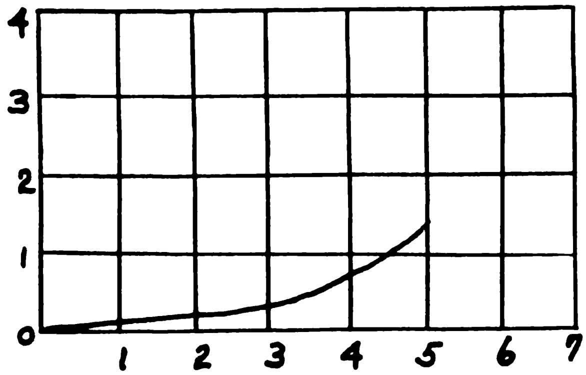

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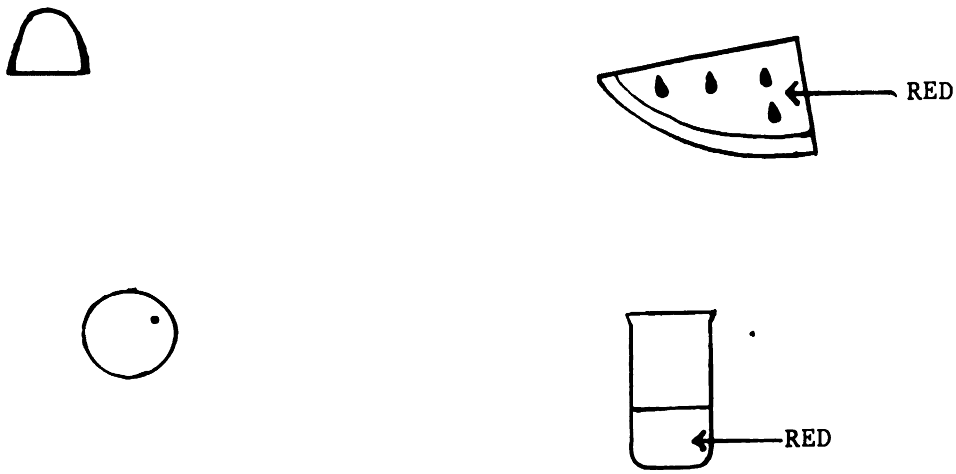
20

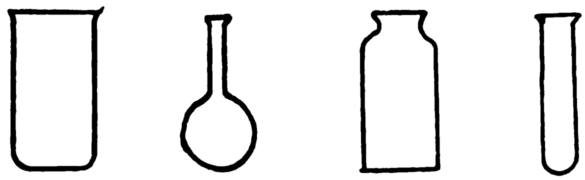


(BLUE)

21

(YELLOW)

22



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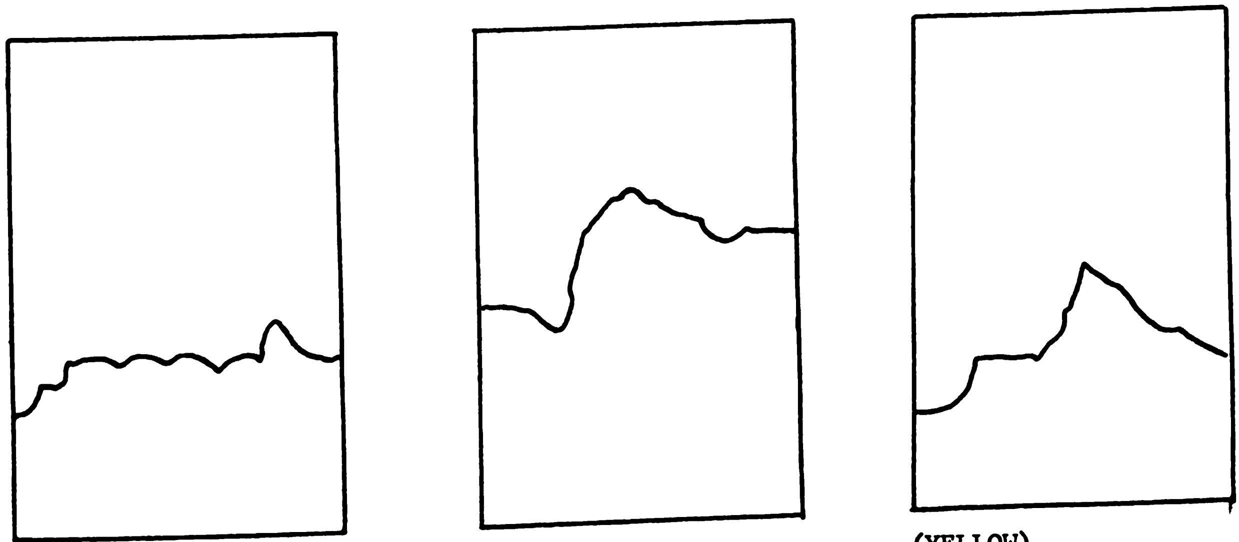
23



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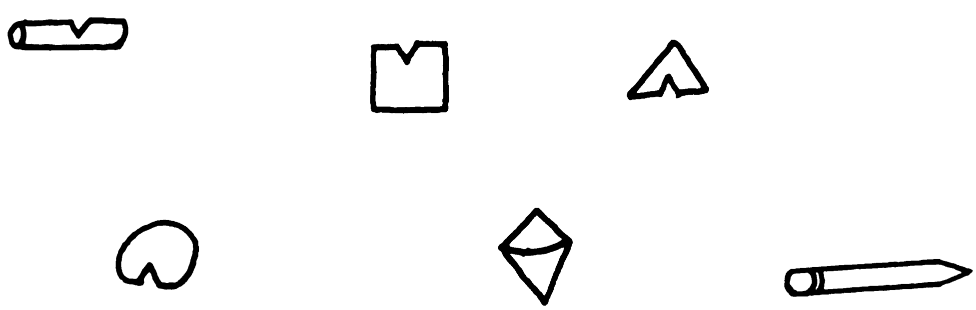
24



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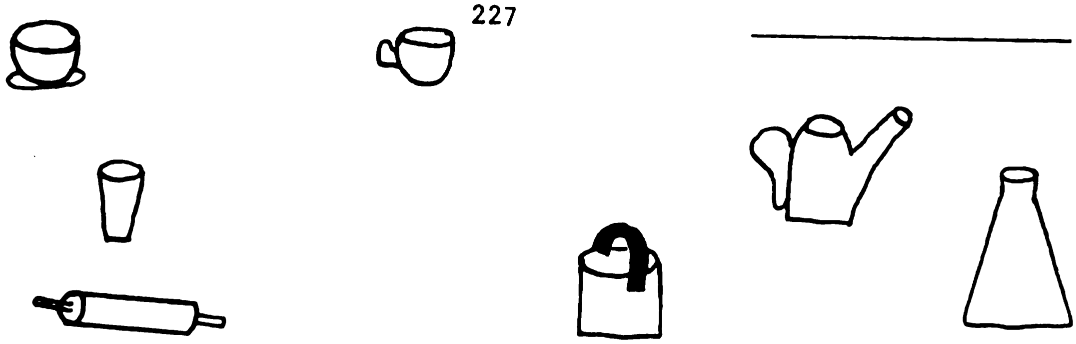
25



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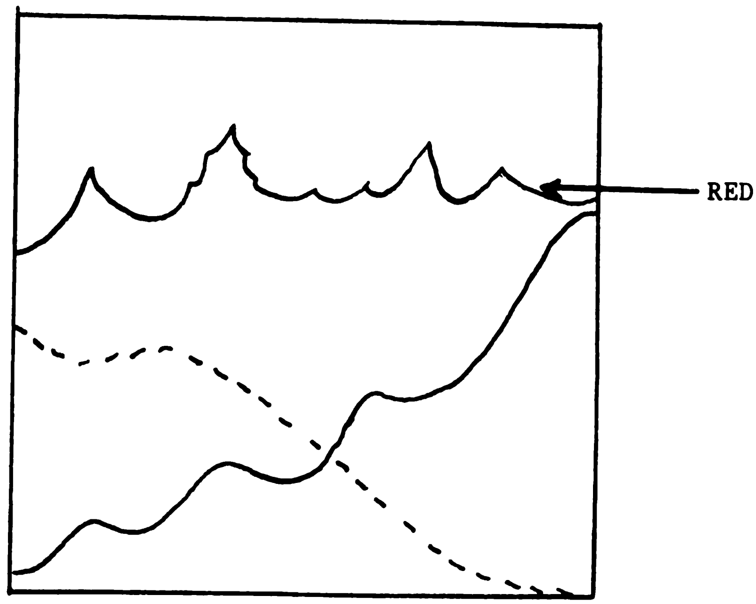
26



(WHITE)

27

GREEN

BLACK

(BLUE)

APPENDIX E

INDIVIDUAL APPRAISALS

The lessons appearing in Appendices A and B contain forty-nine separate Individual Appraisal items. Some of these Individual Appraisals test the same concept or skill, but in a different context. In order to report the results of the individual tests administered by the classroom teachers, the writer carefully analyzed the Individual Appraisal items and drew up the following list.

The numbers appearing in parentheses after each Individual Appraisal indicate the lesson and the specific individual items which are included in the categories made by the writer.

DIRECTION:

1. Tell direction behind. (Lesson 1-1.)
2. Tell direction to left. (Lesson 1-2.)
3. Tell direction to right. (Lesson 1-3.)
4. Walk east, then turn south. (Lesson 1-4.)
5. Walk south, then turn north. (Lesson 1-5.)

TEMPERATURE

1. Predict thermometer changes. (Lesson 2-1.)
2. Manipulate ribbon thermometer. (Lesson 2-2; Lesson 18-2.)
3. Predict temperature. (Lesson 2-3.)

MEASUREMENT

1. Choose tallest object. (Lesson 3-1; Lesson 4-1; Lesson 5-1,2.)

2. Choose smallest object. (Lesson 3-2; Lesson 4-2; Lesson 5-1, 2, 3.)

3. Select objects of even length. (Lesson 3-3; Lesson 4-3.)

4. Determine whether more tall boys or girls from graph. (Lesson 4-4.)

5. Measure length using arbitrary units. (Lesson 5-1, 2, 3.)

OBSERVATION

1. Select a color. (Lesson 7-1.)

2. Select a colored circle. (Lesson 7-2; Lesson 8-1.)

3. Select a rough or smooth square. (Lesson 7-3; Lesson 8-2.)

4. Recognize differences on the basis of odor. (Lesson 9-1, 2.)

5. Demonstrate that matter takes up space. (Lesson 10-1.)

6. Tell common properties of matter. (Lesson 10-2.)

7. Recognize and select objects with special properties, such as luster, brittleness, elasticity, hardness, etc. (Lesson 11-1, 2, 3.)

CLASSIFICATION

1. Group objects on the basis of a single criterion. (Lesson 11-1,2,3.)

2. Recognize solids and or liquids. (Lesson 11-4.)

3. Recognize similarities in solids and liquids. (Lesson 11-5; Lesson 12-1, 2.)

4. Demonstrate a gas in motion. (Lesson 13-1, 2, 3.)

5. Select solids and liquids from pictures. (Lesson 14-1, 2.)

WEATHER

1. Can show where frost would be formed. (Lesson 16-1.)

2. Can identify vapor. (Lesson 16-2, 3.)

3. Match cloud formations with pictures. (Lesson 17-1; Lesson 18-1.)

4. Tell directions clouds are coming from or moving toward. (Lesson 18-3; Lesson 17-2.)

5. Approximate the amount of water formed when snow melts. (Lesson 17-3.)

APPENDIX F

PRE- AND POST-TEST RAW SCORES OF CHILDREN IN SAMPLE GROUP ON SKILLS TEST

TABLE IV

PRE- AND POST-TEST RAW SCORES OF CHILDREN IN SAMPLE GROUP ON SKILLS TEST

S	C_1	C_2	d_c	M_1	M_2	d_m	O_1	O_2	d_o	D_1	D_2	d_d	X_1	X_2	d_x
1	2	4	2	1	4	3	6	7	1	3	4	1	12	19	7
2	2	4	2	0	3	3	5	7	2	3	4	1	10	18	8
3	3	3	0	3	4	1	5	9	4	4	4	0	15	20	5
4	4	3	-1	3	3	0	6	5	-1	3	5	2	16	16	0
5	2	3	1	2	3	1	5	7	2	3	6	3	12	19	7
6	1	3	2	1	3	2	6	7	1	2	5	3	10	18	8
7	1	4	3	2	4	2	6	5	-1	4	5	1	13	18	5
8	1	3	2	1	1	0	6	6	0	2	2	0	10	12	2
9	5	3	-2	0	1	1	6	7	1	1	5	4	12	16	4
10	2	4	2	0	1	1	5	6	1	4	7	3	11	18	7
11	3	2	-1	1	3	2	2	6	4	5	6	1	11	17	6
12	3	4	1	1	3	2	6	6	0	4	6	2	14	19	5
13	4	2	-2	2	4	2	8	7	-1	4	3	-1	18	16	-2
14	2	4	2	3	4	1	6	8	2	3	4	1	14	20	6
15	2	3	1	2	2	0	6	5	-1	2	5	3	12	15	3
16	2	2	0	3	2	-1	7	7	0	1	2	1	13	13	0
17	4	4	0	4	4	0	5	4	-1	3	5	2	16	17	1
18	1	1	0	2	2	0	4	6	2	0	3	3	7	12	5
19	3	5	3	3	4	1	4	7	3	2	6	4	11	21	10
20	2	4	2	3	3	0	7	6	-1	4	5	1	16	18	2
21	2	4	2	2	3	1	4	7	3	2	5	3	10	19	9
22	3	3	0	3	3	0	7	4	-3	3	7	4	16	17	1
23	1	3	2	3	4	1	5	7	2	1	6	5	10	20	10
24	3	3	0	3	1	-2	7	6	-1	4	5	1	17	15	-2
25	3	3	0	2	3	1	6	7	1	4	4	0	15	17	2
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27	2	2	0	3	5	2	5	7	2	1	6	5	11	20	9
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33	2	3	1	3	4	1	5	6	1	2	3	1	12	16	4
34	2	4	2	3	5	2	7	7	0	2	4	2	14	20	6
35	1	3	2	3	3	0	7	6	-1	1	4	3	12	16	4
36	3	3	0	4	5	-1	6	7	1	5	6	1	18	21	3
37	2	3	1	3	4	1	6	6	0	1	3	2	12	16	4
38	2	4	2	1	1	0	6	7	1	2	5	3	11	17	6
39	1	3	2	1	2	1	5	7	2	1	4	3	8	16	8
40	0	2	2	2	3	1	4	6	2	3	5	2	9	16	7
Σ	92	130	38	84	126	42	224	258	34	105	188	83	505	702	197

C_1--Classification pre-test
C_2--Classification post-test
d_c--Difference between C_2 and C_1
M_1--Measurement pre-test
M_2--Measurement post-test
d_m--Difference between M_2 and M_1
O_1--Observation pre-test
O_2--Observation post-test
d_o--Difference between O_2 and O_1
D_1--Data Treatment pre-test
D_2--Data Treatment post-test
d_d--Difference between D_2 and D_1
X_1--Skills Test pre-test total
X_2--Skills Test post-test total
d_x--Difference between X_2 and X_1
Σ --Sum of respective columns
S --Student number