



A study of the gain in science knowledge of four- and five-year-olds in two nursery school environments

by Betty Jean Kurtz Lewis

A Thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of mASTeR of science in Rome Economics

Montana State University

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Abstract:

The purpose of the study was to compare the gain in science knowledge of preschool children in two different learning environments: a university child development center and a day care center located in a rural community in Washington State. The sample consisted of 32 children, 16 from each school, with an age range of 4.5 to 5.5 years. For determining level of science knowledge the areas of odor, shape, and measuring were used. Each child was given a pretest, training activities, and a posttest.

The students from Both schools exhibited a significant gain in science knowledge for all three areas. There was no significant difference in the pretest scores of the two groups of children for the areas of odor and shape. In the area of measuring there was a significant difference with the university child development center children's scores higher than the day care center children's scores. There was no significant difference in the gain on the scores for the areas of odor and shape. The day care center children made a greater gain than the university child development center children on the measuring scores.

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A STUDY OF THE GAIN IN SCIENCE KNOWLEDGE OF FOUR- AND
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by

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A thesis submitted to the Graduate Faculty in partial
fulfillment of the requirements for the degree

of

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in

Home Economics

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ABSTRACT

The purpose of the study was to compare the gain in science knowledge of preschool children in two different learning environments: a university child development center and a day care center located in a rural community in Washington State. The sample consisted of 32 children, 16 from each school, with an age range of 4.5 to 5.5 years. For determining level of science knowledge the areas of odor, shape, and measuring were used. Each child was given a pretest, training activities, and a posttest.

The students from both schools exhibited a significant gain in science knowledge for all three areas. There was no significant difference in the pretest scores of the two groups of children for the areas of odor and shape. In the area of measuring there was a significant difference with the university child development center children's scores higher than the day care center children's scores. There was no significant difference in the gain on the scores for the areas of odor and shape. The day care center children made a greater gain than the university child development center children on the measuring scores.

CHAPTER I

INTRODUCTION

Importance of the Study

One result of the ostensible Russian superiority in certain areas of science has been a critical scrutiny of American educational practices. Sears and Dowley (1963) stated that recent public criticism of the academic achievement of high school graduates has not only led to demands for revision of the elementary school curriculum but also a revision of the nursery school curriculum. One result of this is a growing interest in early cognitive development pioneered by Jean Piaget.

Pines (1967) wrote that a person's achievement in life depends very largely on what he has been helped to learn before the age of four for that is when human intelligence grows most rapidly and the foundations of intellectual curiosity are laid. Representatives of scholarly disciplines interested in learning and cognition are beginning to recognize the importance of a child's experience before his sixth year. This early experience may influence not only his attitudes towards intellectual ideas, but his actual abilities for grasping them (Almy, 1967). Bloom (1964) estimated that the child progresses about 50 per cent of the way in organizing his intellectual processes by the time he is four. Paschal (1967) supported these writers with his observation that it is the first five years of a child's life that are the

most important educationally. According to him it is during these years that a child assumes the basic attitudes toward learning that will be carried with him for the rest of his life.

The increasing awareness during the last 15 years of the importance of early stimulation on later learning was documented by Fowler (1965). He observed that we are witnessing an explosion of interest in cognitive processes and their origins in early development. Operation Head Start and other compensatory programs are examples of how the nation's attention is focused on the significance of the early environment for cognitive development. Cognitive development is one of the recognized problem areas of concern for the coming decades (Association of Administrators of Home Economics, 1970). According to the National Goals and Guidelines for Research in Home Economics, published by this association, "information is urgently needed on how family and community environment can provide the optimum climate for developing cognitive abilities to their fullest potential (p. 20)."

Cognitive development does not come about in a haphazard manner. According to Goldberg, "Children raised in a complex technological world where so much escapes their notice must be helped to cultivate their perceptions and thereby gain a new and richer view of their environment (1970, p. 17)." Hildebrand (1971) said that it is alright to build on spontaneous experiences of children but a program that relies only on this kind of experience will be cheating the children.

For example, Lovell (1962) found that children from a stimulating background were superior in forming fresh concepts to those from a less favorable background.

One result of the emphasis on cognitive development is an increased emphasis upon science in the nursery school. Taylor (1967) quoted a supervisor of science in a large school system to emphasize the importance of early science education: "If the foundations of science are not well laid in the first few years, later attainments are much more difficult (p. 11)."

Up to now, few studies have been completed which describe the best way for a preschool child to develop science concepts on that level other than self-initiated experiences. Because of the current concern to develop an optimal environmental stimulation in preschool education, it is important that such studies be done.

Purpose of the Study

The purpose of this study was to measure and compare the gain in science knowledge of children aged four and one-half to five and one-half in two settings: a university child development center and a day care center. For determining level of science knowledge the areas of odor, shape, and measuring were used. These were considered to be representative of the types of scientific knowledge young children need to develop. The investigator was primarily concerned with

discovering the differences in learning in the two separate learning environments.

Hypotheses to be Tested

The null hypotheses to be applied to the data collected in this study are as follows:

1. There will be no significant difference between pretest and posttest scores of 4.5- to 5.5-year-olds in the science areas of (a) odor, (b) shape, and (c) measuring.
2. There will be no significant difference in science knowledge between 4.5- to 5.5-year-olds in the university child development center and the day care center based upon pretest scores for (a) odor, (b) shape, and (c) measuring.
3. There will be no significant difference in the gain of science knowledge between 4.5- to 5.5-year-olds at the university child development center and the day care center in the areas of (a) odor, (b) shape, and (c) measuring.

For the first hypothesis the difference between pre- and post-test scores for the entire group was compared in each of the three areas by means of Wilcoxon's matched-pairs signed-ranks test. Hypothesis two was tested by using the Median test to compare the pretest scores of the two groups in each of the three areas. Hypothesis three was tested by comparing the difference between the pre- and posttest scores of the

two groups in each of the three areas by means of the Median test.

For all hypotheses the .05 level of significance was used as the criterion for acceptance or rejection.

Definition of Terms

For this study, the following definitions are given to the terms listed:

Directed instruction is a method of preschool instruction where the teacher functions not only as a guide but also as a source of information and materials (Spodek, 1972).

Cognitive development is the gradual growth of mental processes which make it possible for human beings to acquire, store, arrange, and rearrange information (Hess and Croft, 1972).

Limitations of the Study

Certain limitations were placed on this study and are noted as follows:

1. The experimental portion of this study was limited to three weeks and there was no opportunity to test long-term retention.

2. The study was limited to a rural area and therefore, cannot be generalized to a broader population.

3. The measurement of science knowledge was limited to the Competency Measure taken from one science program. This was the only science program available which had been evaluated on a nationwide

scale and had been used in other experimental studies of preschool children.

4. The study was limited in that it covered only three areas of science: odor, shape, and measuring.

5. The selection of contrasting environments was limited to two schools and therefore, the findings could not be as valid as if a number of different schools could have been studied.

6. The study was limited in that the socioeconomic background of the subjects was not statistically analyzed.

CHAPTER II

REVIEW OF LITERATURE

Introduction

The purpose of this review of literature is to give background material on (1) the development of cognitive thought in young children, (2) the modifying effect of the environment on the child's development of cognitive style, and (3) previous research in preschool science education.

Development of Cognitive Thought in Young Children

The development of cognitive thought takes place throughout the life span, beginning with the earliest reflexes of the neonate and continuing to the more complex scientific thought patterns of the adult (Athey and Rubadeau, 1970). This section will review the literature that pertains to the process of cognitive development in young children and the implications this has for preschool science.

The growth of intelligence involves two complimentary processes—assimilation and accommodation (Piaget, 1964). Assimilation is the process by which information is taken into the mental structures, and accommodation is the modification of the thought patterns to adapt to reality (Piaget, 1964). Carlson (1967) suggested that spacing learning activities is an important factor in planning instruction because it takes time to assimilate new information and modify thought patterns.

In addition to spacing, Piaget (1964) wrote that for equilibrium to be achieved at a higher level the child must be mentally active. Unless he is engaged in wrestling with data and transforming it, accommodation will not occur.

Thought processes, according to Hunt (1961), originate through the process of internalizing actions. Stendler (1965) stated that knowledge always involves a mental operation which permits one to transform what one sees in the light of what one already knows but that these mental operations are not all the same at all ages. Almy (1970) saw intelligence not as something fixed by genetic factors at birth but as information processing that emerges as it is nurtured.

Inhelder (1962) stated that logical thought is developed as the result of a process of elaboration. This is based essentially on the child's activity. Two types of activity can be distinguished: first, a logico-mathematical type; and second, a physical type. The former activity is the bringing together, of dissociating, or ordering, of counting, and so on--any activity for which objects are no more than a support. The latter is exploration aimed at extracting information from objects themselves, such as their colors, form, weight, and so on. Thus as the child acts on the external world he elaborates a more and more adequate knowledge of reality (Piaget, 1964). The first type of activity mentioned above, classification and seriation, is, according to Inhelder and Piaget (1964), one of the most critical to develop in that

it is basic to logical thinking. Comparing two objects, wrote Hunt (1961), in terms of some perceptible property is a primitive activity, but ordering a number of objects in terms of such comparison is another matter. Another critical skill is reversibility. Lovell (1961) said that the capacity for reversibility, which is the permanent possibility of returning in thought to one's starting point, is the fundamental skill that underlies all logical thinking.

For Piaget (1964) the child is not born capable of logical thought processes. He views intellectual growth as occurring in periods, stages, and substages, with each subordinate subdivision forming the basis upon which supraordinate stages and periods can be built. The child from the age of four and one-half to five and one-half years, with whom this study is concerned, is placed by Piaget in the stage of preoperational thinking which starts as early as two and lasts until six or seven. The preoperational stage is divided into two substages; the first is called pre-conceptual thinking. This lasts from ages two to four. From ages four to seven the child is in the period of intuitive thinking (Lefrancos, 1972). The stage of intuitive thinking is highlighted by the rudimentary development of logical thought (Chittenden, 1970). Young (1970) agreed with Piaget that the earliest steps of concept development involves the child's sensory impressions of the world and the meaning that he attaches to them. Therefore, for the young child, wrote Russell (1956), concept development must be

considered as taking place in concrete, immediate situations. Mukerji (1965) argued that children cannot move ahead toward abstract structure and reasoning without a broad base of direct encounters from which to abstract and generalize. Early childhood programs, therefore, should be rich and varied in concrete, manipulative, and sensory learning experiences. With this kind of learning experience, children will gradually develop a way to collect and compare important information (Mukerji, 1965). They will find a way to include the elements of disagreement. This will lead them to refine their concepts and make them more correct. The preoperational child has the capacity to discriminate between fine and gross details. But it is putting these observations into a logical system of relating the data that puzzles him (Chittenden, 1970).

Some authors believed that every experience is a learning situation for a young child (Roeper and Sigel, 1966). The learning is unselective, however, since the child is not yet ready to estimate what is relevant. Because of this he is apt to make wrong interpretations. These wrong conceptions may become a part of the child's thinking and stand in the way of further concept formation. In other words, the young child is deeply motivated toward understanding the world but is not yet mentally equipped for it. The solution, the authors continued, is knowledgeable adult guidance. It is for this reason that they believe the young child should be helped toward proper concept formation

through an organized goal-directed approach built on knowledge of how children develop cognitively.

One aspect of the goal-directed nursery school is to provide for the basic development of science concepts by providing the opportunity for new perceptual experiences. It is apparent that the teaching process is involved with guiding the child in his reactions to perceptions (Smith, 1966). The child is helped to make more detailed observations, to think about his old and new store of information and to organize and reorganize his thinking into more useful, easier understood and correct concepts. Another aspect is that questions to the child should be difficult enough to make him think but not out of his reach entirely (Baldwin, 1965). The teacher needs to turn back to the child and allow him to answer questions for himself. This would include pointing out similarities between new phenomenon and those the child already knows. This experience would involve presenting science material that is close to what the child already understands but contains enough new material to require accommodation. Perryman (1964) wrote that those who teach science to the young child must keep in mind that science teaching is best done through the art of asking questions, not supplying answers.

Lovell (1961) cautioned that if one is not careful, he may overestimate the quality of the child's thinking. A child's explanation, wrote Inbody (1963), may be a repetition of adult language and be

unrelated to his understanding of the underlying meanings. Overholt (1965), stated that there is a need for continuous evaluation of the basic concepts. This is because of the possibility that children are being "trained" to answer questions rather than truly understand the concepts involved. Mukerji (1965) added that a single experience, no matter how successful, is not enough to build a reliable concept. A child must make many approaches from many angles over a period of time before a concept has some measure of stability. In addition it can be pointed out that it is fundamental to developmental theory that cognitive growth is not an additive process but a continual reconstruction of the cognitive structures a child already has (Kamii and Radin, 1970).

In summary, the literature indicates that cognitive growth is improved when the stimuli is organized in a goal-directed approach.

Modifying Effect of the Environment on Cognition

The references in the following section are not meant to detract from the time-honored approach to nursery school education which is based on individual unstructured learning. It is to give insight into the possibilities for presenting science through a degree of understanding of how the child can be challenged to develop cognitively. As far back as 1933, Stormes suggested that "by intelligently directing and providing science for children we are contributing to their mental and physical growth (p. 304)."

A thirty-year follow-up study of the effect of early environment on intelligence was reported by Harold Skeels (1966). In this study he compared the intellectual development of babies left in the unstimulating setting of an orphanage with an experimental group of babies transferred to an institution where they were "adopted" by mentally retarded girls and given individual attention. Tests showed that the experimental group had no gross physical handicaps but that their development was seriously retarded with IQs ranging from 35 to 89. No special program of training was planned for the experimental group in their new environment. Thirty years later, final tests for mental development showed IQ change of anywhere from +7 to +58 points. None failed to show some gain. The control group who stayed in the orphanage showed only one child with a gain in IQ (+2 points). The control group scored from 8 to 45 points lower than when originally tested.

Almy (1966) and her associates found a significant difference in a comparison of lower-class children with middle-class children. The better conservation abilities they found in the middle-class group suggested advanced intellectual development due to the more stimulating environmental background of these children.

Piaget and Inhelder (1958) suggested that children in an intellectually stimulating environment might progress from one stage of intellectual development to another more rapidly than would be the

case for other children. In other words, the effect of the environment, not just maturation, plays an important part in the development of learning (see also Ginsberg and Oppen, 1969). Bloom's (1964) research indicated that environmental stimulation may account for as many as twenty IQ points. Fowler (1968) provided further support to the importance of early environmental experience when he writes: "In no instance (where documentation exists) have I found any individual of high ability who did not experience intensive early stimulation as a central component of his development (p. 17)."

Young (1970) said: "David Russell, Jean Piaget, and others who have studied the conceptual development of young children have found evidence showing clearly that the ability to think through problems, to cope with new situations, and to create new ideas is part of an ongoing process that children learn from their environment, and one that starts at a very early age (p. 4)." The life of the young child, wrote Maier (1965), is one of continuous investigation of his environment and the possibilities of his activity within it. This investigation provides learning through perceptions, stated Heffernan (1966), for it is through the child's sensory equipment he perceives his world.

The early years according to Mukerji (1965), is when curiosity impels a child to reach out into his environment; to touch, squeeze, taste, and try to know. It is through this type of activity that he is able to grow intellectually and build his conceptual scheme of the

world. By creating an environment where children can use all their senses, wrote Roche (1964), they develop awareness, alertness, and perceptiveness. Because the young child's interactions with the environment are relatively short-term and undifferentiated, wrote Lichtenberg and Norton (1970), it is not possible to isolate and distinguish cognitive processes from his sensory processes and motor activities. Stendler (1965) reported that as the child acts upon his environment certain elements from his experience are stored in mental structures. These mental structures begin at birth and as the child has fresh experiences with the environment these are incorporated into these structures. Maria Montessori (1967) also felt that the environment becomes a part of the child as he absorbs and takes everything from it, "incarnating" it within himself.

Simply to present a child with a stimulating environment, however, is not enough. Writers such as Fowler (1965), Hunt (1961), and Schermann (1968) emphasized the need for arranging the child's environment in such a way that the child's encounters with it will stimulate his thinking. It is through arranging the environment, wrote Heffernan (1966), that the young child is given an opportunity for developing science concepts as new experiences are opened to him. In this way he is given a chance to observe, ask questions, and discover for himself.

Because of this, Almy (1967) considered there needs to be a change of emphasis in nursery school education. In the early years of nursery school education, emotional and social development received primary emphasis, with self-initiated activity by the child predominating. But today, continued Almy, there needs to be a proper balance between self-initiated activity by the child and adult-prescribed activity.

For more than a generation, much preschool education has been based on the supposition that the psyche of little children could be harmed if systematic attempts were made to help them learn. The child was considered mainly a social being who suddenly acquired cognitive development at age 6 (National School Public Relations Association, 1970, p. 3).

Elkind (1970) cautioned that formal instructional programs are inappropriate at any level of education, including the preschool level. The Association for Supervision and Curriculum Development has concluded that most educators of young children are taking positions somewhere between controlled learning and a total lack of any directed teaching. They are using the interests and motivating forces within children but are still intervening in the child's activities in a variety of ways to facilitate learning (National School Public Relations Association, 1970).

Sonquist, Kamii, and Derman (1970) proposed that what is needed now is a preschool curriculum that could advance cognitive growth. The 1970 statement of principles for day care from the U. S. Department of Health, Education, and Welfare child development office suggested that

the cognitive development aspect of the day care program must go beyond stimulation to include a range of experiences designed to strengthen the development of attention, perserverance, and listening skills. This will also strengthen the more complex intellectual capacities of concept formation. In a comparison of the different preschool curriculum models, Spicker (1971) came to these conclusions: "Curriculum models which stress cognitive or academic skill development produce the largest IQ score increases (p. 635)." Furthermore, "'Traditional' curriculum approaches produce significant intellectual growth only when the programs contain specific short- and long-term goals including language development and are highly structured and well supervised (p. 635)."

Read (1971), Hildebrand (1971), and Todd and Heffernan (1964) in their textbooks for preschool teachers stressed science as an important part of the nursery school curriculum. According to George (1968), for a child to conceptualize he must be exposed to sensory images. Therefore, he believes science for preschoolers should begin with experiences in which the child can manipulate and observe objects in his environment. Almy (1966) agreed that there is no question as to the importance of learning through activity. She goes on to say it is direct experience that is the avenue to knowledge and logical ability. Piaget (1964) enlarged on this by including social interaction as essential for intellectual development when a child is acting on material

things. According to Piaget (1964), an important part of this social interaction is language for it is in social activity that the child learns to use language to express logic. For early childhood education, therefore, activity and language need close association.

Neuman (1972) in an article on "sciencing" for young children emphasized planned activities that will give children as much opportunity as possible for discovering concepts and relationships for themselves. Almy (1966) wrote, however, that "discovering" loses its meaning if a child has to flounder aimlessly for some time before making the discovery. For this reason it is important to arrange the science curriculum so that once a child has had a chance to explore and manipulate, the "discovery" is within his grasp. Piaget (1962) suggested that in teaching the exact sciences instruction is at times well assimilated by the child because it fits into some spontaneous construction he already has and when it does his development is accelerated. But because of this it is possible for instruction to be presented too soon or too late. When this happens the child's development is hindered, or even deflected into barrenness because it does not fit in with the child's spontaneous constructions. This is related to Taylor's statement that in teaching science the teacher should always relate the known in order to increase the existing knowledge of the child (1970). Another reason given by Carmichael (1969) for a planned science program is to make sure the children get a wide variety of science

experiences. She felt that if the science program is based solely on what the children bring to the school or only on their interests, the result would be an overemphasis in some areas and a gap in other areas that go untouched.

Previous Research in Preschool Science

Current emphasis on nursery school education has increased the interest in science programs suitable for children of ages three, four, and five. Zeitler (1972) reported a study of the ability of three-year-old children to develop observational skills using science materials from the Science--A Process Approach program. A pretest was administered individually to the children in October and a posttest in May. In the interim three weeks training took place. A significant difference was found in the means on the posttest-pretest which suggested that observational skills using science materials can be taught to three-year-old children. The greatest increases in observations were noted in the categories of color, hardness, temperature, and texture. None of the children observed odor during the pretest and only 11.1% of the girls and 25% of the boys named odor on the posttest.

In 1969 Zeitler proposed a structured science program for the comparison of the ability of two groups of children ages three, four, and five to perform science tasks. One group was designated as deprived and the other group was representative of a cross section of the

population. The lessons in this program emphasized an awareness and use of the senses. All children in the study were able to perform the tasks that were required, however, "variations in the evaluation results strongly indicate . . . a great difference" between the two groups (Zeitler, 1969, p. 423).

Studies involving university students in developing science programs for three-, four-, and five-year-olds in the university laboratory schools are reported by Bennett (1969, 1970, 1972) at Texas Woman's University, Cohen (1971) at Indiana University, and Bybee (1970) at the University of Northern Colorado. The reports were that teaching science in preschool classes was worthwhile and learning did occur.

Piaget's studies on preoperational thought have many implications for preschool science education. Most important, he has identified through his research, the basic building blocks necessary for the development of higher levels of cognition in children (Piaget, 1965). Based upon his work, a number of researchers have attempted to influence young children's cognitive growth in areas related to science knowledge, such as conservation, through the use of experimental training procedure. Flavell (1963) reviewed the major early experimental studies in this area and concluded that training aimed at accelerating conservation in young children who were clearly nonconservers was not very successful. Later studies, however, such as that by Smedslund (1968), Sigel, Roeper, and Hooper (1966), Beilin, Kagan, and Rabinowitz (1966),

Goldschmid (1970), Wohlwill and Lowe (1962), Gelman (1969), and Beilin and Franklin (1962) have found that conservation skills are trainable when special teaching procedures are used. These procedures are derived "from Piagetian theory (for example, conflict situation), and from traditional learning theory (for example, direct reinforced practice) (Sigel and Hooper, 1968, p. 259)."

The review of literature reveals that there is a possibility of helping young children acquire science knowledge. A goal-directed approach based on the normal cognitive development process is generally regarded as the most effective. This investigation is an attempt to examine and evaluate this concept.

CHAPTER III

DESIGN OF THE STUDY

Goals of Study

The goals of this study were to measure and compare the gain in science knowledge of 4.5- to 5.5-year-old children in two learning environments: a university child development center and a day care center. The areas of odor, shape, and measuring were chosen to determine the level of science knowledge. These three areas were considered to be representative of the types of scientific knowledge young children need to develop.

Selection of Sample

The sample for this study consisted of 32 preschool children with an age range of 4.5 to 5.5 years. Sixteen attended a university child development center and sixteen attended a day care center. All of the children lived in a Washington State community which was sparsely populated (approximately 20,000).

The majority of the children in attendance at both schools was the 4.5- to 5.5-year-old group. Letters describing the study were sent to the parents of all the children in this age range in the two schools (see letter in Appendix). The parents who were willing to have their child participate were asked to give written permission. Those who did not respond within two weeks were contacted by phone. Permission was

received for 17 of the 19 children who met the age requirement in the day care center and all 32 of the eligible university child development children. One of the 17 children in the day care center was disqualified because he attended school only intermittently. The remaining 16 made up the sample from the day care center. These 16 children were matched with 16 children from the university child development center according to age, sex, and race. These 32 made up the entire sample.

Description of Schools

In order to test the concept that learning proceeds best in an enriched environment it was necessary to include in this survey two different learning situations.

The university child development center is a laboratory/demonstration school located on a university campus. The primary emphasis of this type of school is first, supervision of teachers in-training; and second, an exemplary educational program for children from two and one-half or three-years-old up to kindergarten age (Hildebrand, 1971). A secondary purpose is to provide care for children of working mothers.

The day care center is located in one wing of a public elementary school. The first priority of day care centers is to provide full day care for children from infancy up to sixteen years old (two to six years in this particular school) for working mothers. The emphasis is

on keeping the child safe, nourished, and rested. Of secondary emphasis is the provision of an educational program for the children (Hildebrand, 1971).

Selection of Instrument

The instrument used in this study consisted of four exercises of Science--A Process Approach/Part A (American Association for the Advancement of Science (AAAS), 1967). The program is a series of articulated, sequential science exercises. This instrument "has been developed through more than three years of experimentation, tryout, revision, and evaluation on a nationwide scale (AAAS, 1967, p. 3)." The aim of the program is to develop skill in careful and systematic use of the scientific process skills which underlie the discovery and continuing development of scientific knowledge (AAAS, 1967). Part A, the beginning level, consists of 22 exercises organized around eight basic process skills: observing, using space/time relationships, using numbers, measuring, classifying, communicating, predicting, and inferring. Each exercise begins with a statement of objectives, which are "simple statements of what the individual child is expected to be able to do after successful completion of the exercise . . . (AAAS, 1967)."

The exercise consists of a series of "scientific tasks" in which the child is an active participant. At the end of each exercise is a Competency Measure made up of several tasks which test the attainment

of the objectives of the exercise. The tasks are intentionally designed to use content material different from that of the exercises in order to assess the ability of each child to generalize what he has learned. The tests are designed to evaluate observable performances, not recall of memorized facts nor recognition of familiar materials (AAAS, 1967). The Competency Measure tasks were used for the evaluation items on the pre- and posttests for this study. A score sheet (based on the sample in AAAS, 1967, p. 7) was made up by the investigator to check the individual child's observable response on each test. (See Appendix for sample score sheet.)

Science—A Process Approach/Part A was originally designated as kindergarten level but has been used previously with some success on the preschool level by Ayers in 1969 and Zeitler in 1972. Ayers (1969) did a study evaluating the use of this instrument with preschool age children. He found the science materials in this program highly appropriate for children in the five-year-old age group and the more mature four-year-old subjects. Color, odor, shape, and measuring were the four exercises used for this study. These exercises were arbitrarily chosen from the base of the heirarchy chart outlining the eight basic process skills (AAAS, 1967, pp. 11-15). Each is described below, and a complete copy of each exercise is included in the Appendix.

Color

The purpose of this exercise is to develop early the ability to recognize primary and secondary colors, and also to recognize a color as being lighter or darker than the original hue (AAAS Exercise pamphlet, Observing 1: Perception of color, 1967).

Odor

The purpose of this exercise is to extend the child's powers of observation by developing his ability to use his sense of smell to identify and classify odors (AAAS Exercise pamphlet, Observing 1: Perception of odor, 1967).

Shape

The purpose of this exercise is to help the child acquire the ability to identify and name common two-dimensional shapes, both plane shapes and shapes of objects in the environment, when they are in unfamiliar situations (AAAS Exercise pamphlet, Using Space/Time Relationships 1: Recognizing and using shapes, 1967).

Measuring

The purpose of this exercise is to increase the child's ability to measure lengths of two objects. This includes comparative observations such as "longer than" or "shorter than," and using a single standard for matching (AAAS Exercise pamphlet, Measuring 1: Beginning measurement—comparing lengths, 1967).

For the purposes of this study it was necessary to make two changes in the Science--A Process Approach program. These adjustments were as follows:

1. Due to the short-term emphasis of this study, each exercise was covered in a three-day period. The instrument was adjusted so that only those activities considered by the investigator to be most essential to the desired observable gain in science knowledge were included.

2. At the end of each exercise it is suggested that both an Appraisal and a Competency Measure be given for evaluation. Again, because of the short-term emphasis of this study, only the Competency Measure was used for testing.

A pilot study was run with 15 kindergarten and 13 preschool children in a separate community. This study indicated that preschool children could be taught science concepts using Science--A Process Approach/Part A. However, it was found that the exercise on color was too easy. Only two children in the pilot study were not able to make all acceptable responses on the pretest and these were younger than the proposed experimental group. Similar results were found when the color pretest was given to the participants in the full study, and a decision was made to drop this exercise.

Collection of Data

The procedures used at both schools were, as far as possible, identical. The study was conducted in three weekly sessions, with each

of the three exercises being administered by the investigator to each child over three successive days, making a total of nine sessions with each child. Table 1 illustrates the order of procedure followed for each week.

TABLE 1
ORDER OF PROCEDURE FOR EACH WEEK

Order	First Day	Second Day	Third Day
1	Pretest	Training Activities	Training Activities
2			Posttest

The general design of the experiment consisted of (a) a pretest on one of the three exercises; (b) the activity training tasks for the exercise; and (c) following training an identical posttest for the exercise.

The investigator spent a minimum of three hours prior to the experiment at each school to develop familiarity with the children. The investigator did the testing and training. Each day for the duration of the study each subject was approached individually and told, "It is your turn to play a game." The child was taken to an experimental room, which was familiar to him, and sat across from the investigator at a low table. The investigator told the children they were going to play a game, and that when the game was finished they would be

able to see what was in the investigator's mystery box. Both tests and training activity involved the child and were verbalized. Materials, activities, and the exact words used can be found in the Appendix.

Pretest

For each evaluation task the subject was given materials to handle, smell, arrange, or whatever was required. (See Appendix for complete test.) The same words, those underlined in the test, were spoken to each child. As the subjects made a response, the investigator checked the score sheet. Each observable response made by the subject was checked as acceptable or unacceptable. The subject was not made aware of whether the response was acceptable or unacceptable. The test for odor had a possible score of 4; shape had a possible score of 10; and measuring had a possible score of 5.

Training

The two training sessions each week were approximately 10 minutes in length for each child with the subject sitting across the table from the investigator, manipulating the materials as they were handed to him. The training materials were different from those used for testing so the child had to transfer or generalize from the training to the posttest tasks. A detailed outline of the materials used and the words spoken to each subject as the materials were handed to him is included in the Appendix.

Posttest

The posttest was identical to the pretest with the subjects interacting with the testing materials.

Reward

The university child development center children were reward oriented because of the various studies that had been conducted there throughout the school year. Because of this, the following described reward was chosen and used at both schools. It was felt a take-home reward might cause hard feelings because not all of the children in each room were being studied.

The reward used was a mystery box. This was a plain, black box with a slot for a penny. When the penny was put in the slot, a battery operated, green plastic hand came up, opened the lid, and grabbed the penny, taking it back into the box and closing the lid. At the end of each session the subject was given two pennies to put in the slot.

CHAPTER IV

RESULTS AND DISCUSSION

Description of Subjects

The participants in the study included 16 preschool children attending a university child development center (UCDC) and 16 preschool children attending a day care center (DCC). In each group there were eight boys and eight girls. As of May 1, 1973 the subjects ranged in age from 54 to 66 months, a mean of 60 months.

Twenty-eight children were caucasian, two were black, and two were racially mixed. The samples for the two schools were matched for sex, age, and race.

Information concerning the occupation and income of the parents was not gathered since the director of the university school considered this to be an invasion of their privacy. The director from each school, however, was acquainted with the children's backgrounds and indicated that both samples had been drawn from a similar population which consisted mostly of the middle socioeconomic group. Both of the schools were located in a city of approximately 20,000 people in a rural area of Washington State. Table 2 shows the difference in the number of hours of school attendance for the subjects from the two preschool groups. It is noteworthy that the university group attended a mean of only 9.5 hours per week while the day care center children attended a mean of 39.6 hours per week.

TABLE 2

A DESCRIPTION OF WEEKLY SCHOOL ATTENDANCE
FOR SUBJECTS FROM THE UNIVERSITY CHILD DEVELOPMENT CENTER
AND THE DAY CARE CENTER

Number of School Hours per Week	UCDC	DOC
8	10	
12	6	
20		2
27		1
36		2
45		11
Number	16	16
Mean Hours	9.5	39.6

Environmental differences between the schools included the teacher ratio per student. The university child development center had one full-time teacher for every eight children plus numerous teachers in-training. Each quarter the number of teachers in-training varied. The day care center provided one teacher for every ten children, as prescribed by state law.

A difference was also found in the amount and type of education the teachers had. At the university child development center the head teachers had master's degrees in child study. The assistants were finishing master's degrees in child study. The teachers in-training were upper division undergraduate students in child study. At the day care center three of the teachers had baccalaureate degrees, one in child

study and two in anthropology. The other four teachers did not have college degrees. The director had a baccalaureate degree in home economics.

There were no observable differences in the quality and adequacy of the physical building facilities and equipment. Each school had adequate floor space, some outdoor play equipment, child-size furniture, and an assortment of play materials. There was difference observed in the use of the materials. At the university child development center the puzzles, dress-up clothes, blocks, books, music instruments, records, and pets, such as gerbils, white rats, and guinea pigs, were available at all times. At the day care center most of these items were stored out of sight and brought out only occasionally for supervised group activities. There were no pets in the day care center.

Another difference was found in the activities available for the children. At the university child development center the assistant teacher and teachers in-training were required each day to have three to five tables set up with small muscle activities, science experiences, and art media for voluntary use of the children. Any directed teaching was done at these tables on a one-to-one basis or in groups of two or three and was available throughout the school day. At the day care center these kinds of things were not available to the children. However, on days when the weather was too cold for outdoor play, the day care children were all seated in a group either on the floor or at a

long table where they were read to, directed in cutting, pasting, and coloring, or instructed in things like the days of the week or the spelling of their names.

Both directors said that most of the shapes had been directly taught to the children during the school year, some experience with odor had been included, and measuring had not been directly taught at all.

Discussion of Results

Statistical computations were conducted to investigate the following three aspects of the study: (1) the gain in science knowledge in the areas of odor, shape, and measuring for the entire sample of preschool children; (2) the difference in the pretest scores for odor, shape, and measuring between the university child development center children and day care center children; and (3) a comparison of the gain in science knowledge in the areas of odor, shape, and measuring for the two groups. The discussion will examine the results obtained for each of the three areas.

Gain in Science Knowledge for Entire Group of Children

On the pretest, the participants showed a minimum of 3%, 7%, and 23% acceptable responses on the separate tasks in each area, respectively, and a maximum of 97%, 86%, and 57%. On the posttest, however, the minimum acceptable response on the separate tasks was 32%,

57%, and 87%, respectively, and the highest 100%, 100%, and 97%. The smallest amount of gain was usually in those areas where scores were high on the pretest. The greatest amount of gain was shown in identifying a one-dimensional rectangle (57%) and ordering objects from shortest to longest (64%) (Table 3).

TABLE 3
ACCEPTABLE RESPONSES FOR ENTIRE GROUP OF CHILDREN

Areas and Tasks	Pretest		Posttest		Gain
	N	%	N	%	
<u>Odor</u>	31	100	31	100	
States that object has odor	30	97	31	100	3
Identifies lack of odor	1	3	10	32	29
Identifies similar odors	8	26	21	68	42
Identifies different odors	4	13	19	61	48
<u>Shape</u>	28	100	28	100	
Identifies one-dimensional triangle	19	68	25	89	21
Identifies one-dimensional circle	16	57	24	86	29
Identifies one-dimensional square	24	86	28	100	14
Identifies one-dimensional ellipse	14	50	22	79	29
Identifies one-dimensional rectangle	2	7	18	64	57
Identifies two-dimensional square	18	64	26	93	29
Identifies two-dimensional ellipse	16	57	22	79	22
Identifies two-dimensional rectangle	4	14	16	57	43
Identifies two-dimensional triangle	9	32	21	75	43
<u>Measuring</u>	30	100	30	100	
Identifies objects of equal length	17	57	29	97	40
Orders objects from shortest to longest	7	23	26	87	64
Distinguishes that one object is the same length as another object by showing that both are the same length as a third	11	37	27	90	53

Each child received a score in each of the three areas; odor, shape, and measuring. The score was the number of acceptable responses made in that area. The largest net change between the pre- and post-test was in shape. The smallest amount of gain was made in the area of odor (Table 4).

TABLE 4

GAIN IN SCIENCE KNOWLEDGE BY THE ENTIRE GROUP OF CHILDREN
BEFORE AND AFTER TRAINING

Area	Possible Score	Mean Pretest Score	Mean Posttest Score	Net Change
Odor	4	1.39	2.61	+1.22
Shape	10	4.60	7.93	+3.33
Measuring	5	2.10	4.50	+2.40

The Wilcoxon matched-pairs signed-ranks test was used to show the difference between the pre- and posttest scores for each of the three areas. The results showed that the difference between the pre- and posttest scores in all three areas was significant at the .05 level. This would indicate that the training produced a gain in science knowledge.

Difference in Pretest Scores Between the Two Groups of Children

In the area of odor the pretest responses of the two groups were quite similar with the exception of identifying different odors where the UCDC group made a 12% greater number of acceptable responses (Table 5).

TABLE 5

ACCEPTABLE RESPONSES OF EACH GROUP OF CHILDREN ON THE PRETEST

Area and Tasks	Pretest				Pretest
	UCDC		DCC		Difference
	N	%	N	%	%
<u>Odor</u>	16	100	15	100	
States that object has odor	15	96	15	100	4
Identifies lack of odor	1	6		0	6
Identifies similar odors	4	25	4	27	2
Identifies different odors	3	19	1	7	12
<u>Shape</u>	14	100	14	100	
Identifies one-dimensional triangle	9	64	10	71	7
Identifies one-dimensional circle	8	57	8	57	0
Identifies one-dimensional square	12	86	12	86	0
Identifies one-dimensional ellipse	5	36	9	64	28
Identifies one-dimensional rectangle	2	14		0	14
Identifies two-dimensional circle	10	71	8	57	14
Identifies two-dimensional square	9	64	7	50	14
Identifies two-dimensional ellipse	4	29	3	21	8
Identifies two-dimensional rectangle	2	14	2	14	0
Identifies two-dimensional triangle	6	43	3	21	22
<u>Measuring</u>	15	100	15	100	
Identifies objects of equal length	9	60	8	53	7
Orders objects from shortest to longest	6	40	1	7	33
Distinguishes that one object is the same length as another object by showing that both are the same length as a third	8	53	3	20	33

In the area of shape the UCDC subjects had either the same or a greater per cent of acceptable responses on each task with the exception of identifying a one-dimensional triangle and a one-dimensional ellipse. In the area of measuring UCDC had a higher per cent of

acceptable responses on each of the three tasks. The greatest difference between the pretest scores was on the last two measuring tasks where the UCDC acceptable responses were 33% higher than DCC. In the areas of odor and shape the children in both schools had been given some directed instruction while in the area of measuring they had not. In the first two areas they did equally well or nearly as well on the pretests. In the area of measuring where it was totally left up to what they had assimilated from their separate environments, the DCC subjects were markedly behind the UCDC subjects. In their enriched environment the UCDC subjects had apparently been able to extract this information for themselves.

As in the previous section each child was given a score for each of the three areas equal to the number of acceptable responses made in that area. The greater difference in measuring pretest scores

TABLE 6

MEAN PRETEST SCORES FOR THE TWO GROUPS OF CHILDREN

Area	Possible Score	UCDC Mean Pretest Score	DCC Mean Pretest Score	Net Difference
Odor	4	1.44	1.33	.11
Shape	10	4.79	4.43	.36
Measuring	5	2.73	1.47	1.26

is illustrated also with the mean score net difference between the two groups of children (Table 6).

A Median test was used to determine if there was significant difference between the pretest scores of the two groups on each of the three areas. The difference between the pretest scores for each group was not significant on odor or on shape at the .05 level. The pretest measuring scores, however, showed a difference significant at the .05 level (Table 7).

TABLE 7

COMPARISON OF SUBJECTS SCORING BELOW AND ABOVE MEDIAN
ON PRETEST FOR BOTH SCHOOLS

Area	UCDC		DCC		χ^2 Value
	Below median	Above median	Below median	Above median	
Odor	10	6	10	5	.815
Shape	5	9	7	7	.582
Measuring	5	10	11	4	4.820

The critical value of χ^2 at the .05 level of significance with one degree of freedom is 3.84.

The acceptable responses on the measurement test required that the child identify objects of equal length, order objects according to size, and show that an object is the same length as another object by showing that both are the same length as a third. Flavell (1963) observed that measuring ability is orderable into developmental steps.

He concluded that only the more mature child is able to make use of "body-independent" objects as unit measures (p. 200). Inhelder and Piaget (1958) suggested that a stimulating environment might cause a child to advance from one stage of intellectual development to another faster than other children would. The better measuring ability found in the UCDC group as compared to the DCC group would appear to support this idea.

Comparison of Gain in Science Knowledge Between the Two Schools

Table 8 compares the per cent of acceptable pre- and posttest responses and gain made by each of the two groups in the three areas. On ten out of the total seventeen tasks UCDC made the same or a greater per cent of gain. The UCDC group also had a higher per cent of acceptable responses on thirteen out of the total seventeen posttest tasks.

As previously described, subjects received a score for each of the three areas. The UCDC and DCC subjects show comparable net gain between the pre- and posttests in the areas of odor and shape. In the area of measuring the DCC subjects surpassed the UCDC subjects in the net gain made (Table 9).

A multi-celled Median test was used to determine if the difference between the pre- and posttest scores of the two groups was significant at the .05 level. There was no significant difference on pre- and posttest gain for odor and shape between the two groups of subjects

TABLE 8

ACCEPTABLE SCIENCE TEST RESPONSES OF CHILDREN AGE 4.5 TO 5.5

Area and Tasks	Pretest				Posttest				Pre-Post Gain	
	UCDC		DCC		UCDC		DCC		UCDC %	DCC %
	N	%	N	%	N	%	N	%		
<u>Odor</u>	16	100	15	100	16	100	15	100		
States that object has odor	15	96	15	100	16	100	15	100	4	0
Identifies lack of odor	1	6		0	6	38	4	27	32	27
Identifies similar odors	4	25	4	27	10	63	11	73	38	46
Identifies different odors	3	19	1	7	10	63	9	60	44	53
<u>Shape</u>	14	100	14	100	14	100	14	100		
Identifies:										
one-dimensional triangle	9	64	10	71	13	93	12	86	29	15
one-dimensional circle	8	57	8	57	12	86	12	86	29	29
one-dimensional square	12	86	12	86	14	100	14	100	14	14
one-dimensional ellipse	5	36	9	64	10	71	12	86	35	22
one-dimensional rectangle	2	14		0	11	79	7	50	65	50
two-dimensional circle	10	71	8	57	14	100	12	86	29	29
two-dimensional square	9	64	7	50	11	79	11	79	15	29
two-dimensional ellipse	4	29	3	21	11	79	9	64	50	43
two-dimensional rectangle	2	14	2	14	9	64	7	50	50	36
two-dimensional triangle	6	43	3	21	11	79	10	71	36	50
<u>Measuring</u>	15	100	15	100	15	100	15	100		
Identifies objects of equal length	9	60	8	53	14	93	15	100	33	47
Orders objects from shortest to longest	6	40	1	7	14	93	12	80	53	73
Distinguishes that one object is the same length as another object by showing that both are the same length as a third	8	53	3	20	13	87	14	93	34	73

TABLE 9

MEAN PRE- AND POSTTEST SCORES FOR THE TWO GROUPS OF CHILDREN

Area	Possible Score	UCDC	DCC	UCDC	DCC	UCDC Net Gain	DCC Net Gain
		Mean Pretest Score	Mean Pretest Score	Mean Posttest Score	Mean Posttest Score		
Odor	4	1.44	1.33	2.63	2.60	1.19	1.27
Shape	10	4.79	4.43	8.29	7.57	3.50	3.14
Measuring	5	2.73	1.47	4.47	4.53	1.74	3.06

(Table 10). In these two areas where there had been some directed instruction at the two schools, the gain in score was similar. There was a significant difference on measuring. This gain was made by the DCC group. Almy, Chittenden and Miller (1966) found that the private

TABLE 10

COMPARISON OF SUBJECTS SCORING BELOW AND ABOVE MEDIAN ON PRETEST AND POSTTEST FOR BOTH SCHOOLS

Area	UCDC		DCC		X^2 Value of gain
	Pretest Below/Above Median	Posttest Below/Above Median	Pretest Below/Above Median	Posttest Below/Above Median	
Odor	10/6	8/8	10/5	8/7	2.112
Shape	5/9	8/8	7/7	8/6	1.714
Measuring	5/10	3/12	11/4	5/10	10.001

The critical value of X^2 at the .05 level of significance with three degrees of freedom is 7.815.

school subjects in their study made significantly greater progress in gaining conservation ability than the day care center subjects (p. 71). In this study the UCDC group scored high on the pretest. This indicated that the UCDC subject's exposure to a more enriched environment had given them the opportunity to assimilate the experiences necessary for them to score high on this test. The DCC group, on the other hand, scored low on the pretest. It is possible, in view of the above study and the initial high pretest scores, to consider that the tasks in the Competency Measure for this exercise were not inclusive enough to allow for a true measure of the UCDC group's potential gain. The significant gain by the DCC group would also indicate that "an empty cup needs filling."

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to measure and compare the gain in science knowledge of four and one-half- to five and one-half-year-old children in enriched and nonenriched environments to see what affect environment has on learning in children.

Subjects for the investigation were 32 preschool children. Sixteen attended a university child development center and sixteen attended a day care center. The sample from each school was matched according to age, sex, race, and, presumably, home environment.

Collection of the data took place at the two schools. Each child was individually tested and trained by the investigator using three Science---A Process Approach exercises. Score sheets for each child were recorded at the interview.

The results indicated a significant gain in science knowledge in all three areas of odor, shape, and measuring. The difference in the pretest scores and a comparison of the gain in science knowledge between the two schools was found insignificant for odor and shape but was significant for measuring. The results of this test suggested the possibility that environment may be an element in the development of measuring ability, but not the other two areas of odor and shape where the subjects had been given some directed instruction.

Conclusions

From the findings of the study, the following conclusions were drawn:

Hypothesis 1. There will be no significant difference between pretest and posttest scores of 4.5- to 5.5-year-olds in the science areas of (a) odor, (b) shape, and (c) measuring.

When the difference between the pre- and posttests for each child was ranked a t value of 0 was found for each area using the Wilcoxon matched-pairs signed-ranks test. This is significant at the .01 level of confidence. Hypothesis 1a, 1b, and 1c were rejected. This would indicate that a significant gain in science knowledge in the areas of odor, shape, and measuring can be achieved through the use of short-term, one-to-one, directed instruction.

Hypothesis 2. There will be no significant difference in science knowledge between 4.5- to 5.5-year-olds in the university child development center and the day care center based upon pretest scores for (a) odor, (b) shape, and (c) measuring.

The Median test failed to reject Hypothesis 2a and 2b. The pretest scores of each group on odor and shape were found to be similar. Hypothesis 2c was rejected at the .05 level. Measuring pretest scores for the university child development center were significantly higher than for the day care center group. The results of this test would

indicate the possibility that environment may be an element in the development of measuring ability.

Hypothesis 3. There will be no significant difference in the gain of science knowledge between 4.5- to 5.5-year-olds at the university child development center and the day care center in the areas of (a) odor, (b) shape, and (c) measuring. Hypothesis 3a and 3b was held tenable but Hypothesis 3c was rejected at the .05 level. The Median test comparison of the two groups on the pretest-posttest gain on odor and shape failed to show a significant difference. However, the measuring score gain was significantly different with the DCC group making the greatest gain. Because of the high pretest scores it would not have been possible for the UCDC group to make as much gain on this test. It was concluded that a more comprehensive measure of the UCDC group's potential gain in this area was needed.

Recommendations

The present study suggests that children can gain science knowledge using short-term, one-to-one, directed instruction. Testing to compare this method with long-term, large group, non-directed instruction is needed to determine which is the most effective.

Evidence derived from this study suggests the need for a more comprehensive measure of preschool science knowledge. The test instrument provided for this study proved to be somewhat inadequate in that

it did not measure what the child really knew. An instrument is needed that would more fully test the extent of the child's science knowledge.

This study of university child development center children and day care center children in a rural community suggests caution in making generalizations to a larger population. The significant differences found in measuring ability between the two groups would indicate that generalizing to other populations with environmental differences would most likely have varying results.

That there was a significant difference found between the two groups of children in measuring but not in odor or shape would suggest the need to investigate other areas of science than those used in this study.

The significant gain in science knowledge found in this study would indicate that short-term, one-to-one, directed instruction should be considered by preschool teachers as a method of helping children develop the basic science knowledge the review of literature suggested is needed for future mental growth.

Since environment apparently is related to science knowledge gain, there needs to be further study to investigate environmental differences not only in various types of preschools, but also, outside of school, such as home training.

While this study indicated that science concepts can be taught on a short-term basis there needs to be further study to test long-term retention of science knowledge.

APPENDIX

Dear Parent:

For my master's thesis research I am studying the ability of the child to correctly identify color, sound, odor, shape, and size. This will not only be a learning experience for the child but will also be enjoyable. The entire procedure will take from 5 to 10 minutes three days a week for four weeks. Your child will only participate voluntarily and will be free to discontinue the activities at any time.

I have been given permission by the persons in charge of the nursery school to do this research when permission from you has been received. Please fill out the bottom portion of this letter and return it to the Head Teacher. I would like to begin Monday, April 9.

Your cooperation in allowing your child to participate will be greatly appreciated. Please feel free to contact me at the nursery school or call collect (1-529-6076) for additional information.

Sincerely yours,

Jeanne Lewis

_____ has my permission to participate in
(Child's name)
the above described research.

(Parent's name)

Science Observations	Activity-oriented Lessons	Pretest Posttest (the same test for both)
1. Odor Identifies that object has odor Identifies similar and different odors	Day 1 - Pretest Give the child a small piece of colored cloth. Ask him to describe the cloth in as many ways as he can think of—as to size, color, texture, and so forth. Now give the child another piece of cloth of the same size, and texture as before, but of another color. Have this piece of cloth differ from the first piece only in that it contains perfume, so that it has a pronounced odor. After giving the child the second piece of cloth, ask him again to describe the pieces of cloth. He will probably say, "The (blue or red) one has perfume on it or smells nice." Stress the idea that these pieces of cloth look different and are different in odor since one piece has an odor and the other does not. Day 2 - Show the child two clear glasses—one filled with water, the other filled with alcohol. Ask the following questions: <u>Do you think these glasses might have the same liquid in them?</u> <u>What could we do to find out?</u> <u>Can we tell by looking?</u> <u>What can we do?</u> If the child doesn't suggest smelling them—suggest it. Emphasize the importance of keeping the face a safe distance from the glass, here, and only close enough to note whether or not there is an odor. Give the child a chance to smell each of the liquids. Say, <u>No, they are not the same liquids, although they do look alike.</u> Remind the child of the observations he made the day before where the pieces of cloth looked different and smelled different. Now he can see that two things may look the same yet smell different. Show the child two glasses of vinegar, one white and one amber color (ordinary cider vinegar), and repeat the procedure you used above. Say, <u>These liquids smell the same, but do they look the same?</u> After discussion, the child should conclude that appearance does not necessarily tell anything about smells, and vice versa. Use four identical paper bags. Put an orange cut in pieces in one bag, a cut onion in a second, a tablespoon of peanut butter in a third, and squares of plain chocolate bars in the fourth (perhaps give them a piece to eat afterwards). Have the child smell each bag and try to identify the contents. Open the bag just enough so that he can smell the contents without letting him see what is inside. Day 3 - Posttest	Prepare five bottles so that each contains one of the following liquids: (1) clear tap water; (2) tap water colored blue with food coloring; (3) white vinegar; (4) white vinegar colored with red food coloring; and (5) vanilla extract. Give the child these five bottles, with these instructions: <u>Here are some bottles. I want you to smell each bottle. After you have smelled a bottle, take a deep breath and breathe out before you smell the next one.</u> TASK 1: When he has done this, ask, <u>Do the bottles have odors?</u> Give one check in the acceptable column if he says "Yes," or that some of the bottles have odors. Then say, <u>Now put together the bottles that smell alike. You may smell them again if you wish.</u> Put one check in the acceptable column for each correct set which the child constructs. TASK 2: water; blue water. TASK 3: white vinegar; red vinegar. TASK 4: vanilla extract. If the child makes only one of these arrangements, ask, <u>Are there other bottles that smell alike?</u> Be sure that he is satisfied that he has finished his task, but do not help him.

Science Observations	Activity-Oriented Lessons	Pretest Posttest (the same test for both)
II. Shape	Day 1: Pretest	Show each child an array of colored paper shapes which includes these:
Identifies triangle, circle, square, ellipse, and rectangle	Give the child the following cardboard shapes, one at a time, a square, a rectangle, a triangle, a circle, and an ellipse. Have him repeat the name for each shape and run his fingers around the edge of the cardboard shapes so he will become more familiar with it.	
Identifies two-dimensional shapes in objects in his environment	Put tape on the backs of the shapes and have the child fasten it to a chalkboard repeating the names of the shapes as he does so. Have the child draw with chalk around the edge of the cardboard shape; remove the cardboard, and ask him to tell you the name of the shape. Then help the child make this shape in the air with his arms.	TASK 1: Say, <u>Show me the square.</u> Give one check in the acceptable column if he points to the square.
	Day 2: Give the child, one at a time, wire shapes of a square, rectangle, a triangle, a circle, and an ellipse to give him further experience in recognizing and naming them.	TASK 2: Say, <u>Show me the rectangle.</u> Give one check in the acceptable column if he points to either of the rectangles.
	Using shapes cut out in flannel, put one at a time on a flannelboard so the child cannot see it. Make the shape in the air with your arm and ask the child to guess the name of the shape. Turn the board around and look to see if he was right.	TASK 3: Say, <u>Show me the circle.</u> Give one check in the acceptable column if he points to the circle.
	Reverse the procedure with the child putting the shape on the board, having the teacher guess the shape as he makes it with his arms, and then turning the board around to see if the guess was right.	TASK 4: Trace the outline of a triangle in the air with a finger. Say to the child, <u>Name the shape.</u> Put one check in the acceptable column if he calls it a triangle.
	Day 3: Posttest	TASK 5: Trace the outline of the ellipse in the air with a finger. Say to the child, <u>Name the shape.</u> Put one check in the acceptable column if he calls it an ellipse. TASKS 6-10: Place the following collection of objects on a table near the child: coin, bottle cap, small box, ruler, triangular-shaped solid, musical triangle, wooden cube, bowl having an elliptical shape, and a toy tire or wheel.
		Place five sheets of paper on another table. On each piece of paper, draw one of the following shapes: circle, square, ellipse, rectangle, and triangle.
		(6) Say to the child: <u>Put all the objects that are shaped like circles on the paper with the circle on it.</u> Repeat this request for (7) the square, (8) the ellipse, (9) the rectangle, and (10) the triangle.
		At the end of this procedure, the sheets of paper should have these items on them: (6) coin, bottle cap, toy tire; (7) wooden cube; (8) elliptical-shaped bowl; (9) small box, ruler; (10) musical triangle, triangular solid. Give one check for each collection of shapes he gets right. If he puts an inappropriate object on a shape, give one check in the unacceptable column.

Science Observations	Activity-Oriented Lessons	Pretest Posttest (the same test for both)
III. Measuring	Day 1: Pretest	Prepare four sets of crayons. Each set should consist of three crayons that are of equal length. All the sets, however, should be of different lengths. Scramble all of the crayons together so that you have a completely unsorted pile of crayons.
Identifies objects of equal length	Scramble in a single pile three 2-inch dowels, three 4-inch dowels, and three 6-inch dowels. Ask the child to select one dowel from the pile. Then ask him for suggestions of a way to find all the other dowels of the same length as the dowel he is holding. The response wanted here is that the dowels can be matched with the first one. (This suggestion should come from the child, offer suggestions only if he does not suggest a satisfactory procedure.) When a procedure has been established, tell the child to put in one pile all the dowels that match the first one he selected in length. Tell him to put all the dowels that do not match it in another pile. When the child has all the dowels separated into two piles, have him repeat the process by choosing a second dowel from the unsorted pile and again sorting the remainder into two piles.	TASK 1: Say, <u>Sort the crayons into sets in which each crayon is of the same length.</u> If the child succeeds in sorting all of the crayons into sets of equal length, give one check in the acceptable column.
Orders objects by length, from shortest to longest	Prepare a cardboard poster by glueing to it pairs of strips of paper exactly as long as the dowels used above. Point to one of the strips and ask a child to locate another strip which is the same length. In the above lesson, the child was able to match two objects directly. Because the objects being matched here cannot be moved, the child must use a different technique to solve the measurement problem. The child may see the need of a movable "tool" to make the necessary comparisons in this activity. Accept the use of any suitable tool such as the finger, the hand, a pencil, or a dowel. (Have all available) After the child has determined which strips are of equal length, ask him to identify the pairs by making them the same color with a marking pen.	TASK 2: Say, <u>Order the sets of crayons from the shortest to the longest.</u> If he succeeds, give one check in the acceptable column.
Distinguishes that one object is the same length as another object by showing that both are the same length as a third	Day 2: Arrange the dowels into sets that contain one dowel of each length. Ask the child to select from the pile of dowels the one he believes to be the shortest, and to place it on the table. Then have him select the next longer dowel by sight, compare it with the first for length, and place the longer dowel next to the shorter. Have him continue selecting, comparing, and placing the remaining dowels until all are ordered into a sequence from shortest to longest. Accept any arrangement that complies with these directions. Give each child 9 strips of paper cut from a random selection of colored paper. The set will include three strips of different colors, each 7 inches long; two strips of different colors, each 5 inches long; four strips of different colors; each 3 inches long. Ask the child to place all strips of equal lengths into piles. Watch to see if they determine three strips to be of the same length by making two comparisons, rather than three.	TASK 3: Remove all the crayons from the test area. Choose three crayons which are of the same length but different colors. Give the child one of the crayons and hold the others, one in each hand. Give the child one of the two crayons that you are holding. Ask, <u>Is this longer than, shorter than, or the same length as the crayon you are holding?</u> Give one check in the acceptable column if he says they are the same length.
	Day 3: Posttest	TASK 4: Have the child return to you the second crayon you gave him. Give him the crayon which is in your other hand, and ask, <u>Is this crayon longer than, shorter than, or the same length as the crayon you have?</u> Put one check in the acceptable column if the child says they are the same length. TASK 5: Have the child return the third crayon you have given him. Ask, <u>What can you say about the lengths of the two crayons I am holding?</u> Put one check in the acceptable column if the child suggests that the crayons are the same length.

SCIENCE OBSERVATION SCORE SHEET

Child: _____ Pretest _____ Posttest _____

I. Color			IV. Odor		
Task Number	Acceptable Response	Unacceptable Response	Task Number	Acceptable Response	Unacceptable Response
Identifies primary colors			Identifies that object has odor		
Identifies secondary colors			Identifies similar and different odors		
Identifies color likeness					
1			1		
2			2		
3			3		
4			4		
5					
6					
7					
8					
TOTAL SCORE			TOTAL SCORE		

II. Shape			III. Measuring		
Task Number	Acceptable Response	Unacceptable Response	Task Number	Acceptable Response	Unacceptable Response
Identifies triangle, circle, square, ellipse, and rectangle			Identifies objects of equal length		
Identifies two-dimensional shapes in objects in his environment			Orders objects by length, from shortest to longest		
1			Distinguishes that one object is the same length as another object by showing that both are the same length as a third		
2					
3					
4					
5					
6					
7					
8					
9					
10					
TOTAL SCORE			TOTAL SCORE		

COMMENTS:

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A study of the gain
in science knowledge
of four- and five-year
olds ...

[illegible]

B. Barnhart 6/4/50

Figure 1

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Sanders

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cap. 2



College
Place
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[illegible]