RIECHARD, Donald Edward, 1936-
THE ACQUISITION OF SELECTED LIFE-SCIENCE CONCEPTS
BY BEGINNING KINDERGARTEN CHILDREN FROM THREE
DIFFERENT COMMUNITY SETTINGS.

The Ohio State University, Ph.D., 1970
Education, scientific

University Microfilms, A XEROX Company, Ann Arbor, Michigan

© 1971
Donald Edward Riechard

ALL RIGHTS RESERVED

THIS DISSERTATION HAS BEEN MICROFILMED EXACTLY AS RECEIVED
THE ACQUISITION OF SELECTED LIFE-SCIENCE CONCEPTS BY
BEGINNING KINDERGARTEN CHILDREN FROM THREE
DIFFERENT COMMUNITY SETTINGS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

Donald Edward Riechard, A.B., A.M.

* * * * * *

The Ohio State University
1970

Approved by

[Signature]
Adviser
School of Education
ACKNOWLEDGMENTS

To the teachers and supervisors of the schools in which this research was conducted, I am deeply indebted. Among those persons are: Mr. Thomas Barton, Mr. Paul Boyd, Mrs. Jo Ann Bush, Mrs. Marilyn Foreman, Mrs. Lynn Hutter, Mrs. Jeanette Kostohryz, Miss Elaine Leach, Mrs. Maxine Smith, Mrs. Carmen Tubbs, and Mrs. Charlesana Workman.

The following professors are acknowledged for their guidance during my doctoral studies: Professors Herbert L. Coon, Stanley L. Helgeson, Robert W. Howe, Paul R. Klohr, Marlin L. Languis, John S. Richardson (deceased), Clarence E. Taft, Alan M. Voelker, and Arthur L. White.

A special recognition is given Professor Marlin L. Languis, chairman of my research committee. No words can express the sincere thanks which are due him. Not only was Professor Languis a competent and able director of research, he was a warm and understanding friend.

And finally, to my wife Katherine, I express my deepest gratitude. Besides many contributions to the study, itself, she was my constant source of encouragement and inspiration.
VITA

January 16, 1936 . . . Born-Frankford, Missouri

1958 . . . . . . . A.B., The University of Missouri, Columbia, Missouri

1958-1962 . . . . Teacher, Lincoln County School District Number Three, Troy, Missouri

1963 . . . . . . . A.M., West Virginia University, Morgantown, West Virginia

1963-1965 . . . . Supervisor and Teacher, Lincoln County School District Number Three, Troy, Missouri

1965-1966 . . . . Academic Year Institute, The Ohio State University, Columbus, Ohio

1966-1967 . . . . Teacher, Columbus Torah Academy, Columbus, Ohio

1967-1970 . . . . Teaching Associate, Department of Science and Mathematics Education, The Ohio State University, Columbus, Ohio

FIELDS OF STUDY

Major Field: Science Education

Studies in Science Education. Professors John S. Richardson (deceased) and Marlin L. Languis

Studies in Biology. Professor Clarence E. Taft

Studies in Curriculum and Supervision. Professor Paul R. Klohr
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>ii</td>
</tr>
<tr>
<td>VITA</td>
<td>iii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vi</td>
</tr>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>I. THE PROBLEM</td>
<td>1</td>
</tr>
<tr>
<td>Rationale</td>
<td></td>
</tr>
<tr>
<td>Problem Statement</td>
<td></td>
</tr>
<tr>
<td>Hypotheses</td>
<td></td>
</tr>
<tr>
<td>Definition of Terms</td>
<td></td>
</tr>
<tr>
<td>Assumptions, Delimitations, and Limitations</td>
<td></td>
</tr>
<tr>
<td>Chapter Summary</td>
<td></td>
</tr>
<tr>
<td>II. REVIEW OF RELATED RESEARCH</td>
<td>17</td>
</tr>
<tr>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>Studies Related to the Present Investigation</td>
<td></td>
</tr>
<tr>
<td>in a Primary Way</td>
<td></td>
</tr>
<tr>
<td>Studies Related to the Present Investigation</td>
<td></td>
</tr>
<tr>
<td>in a Secondary Way</td>
<td></td>
</tr>
<tr>
<td>Chapter Summary</td>
<td></td>
</tr>
<tr>
<td>III. PROCEDURE</td>
<td>36</td>
</tr>
<tr>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>Hypotheses Tested</td>
<td></td>
</tr>
<tr>
<td>Selection of Participating Schools</td>
<td></td>
</tr>
<tr>
<td>Collection of Socio-Cultural Data</td>
<td></td>
</tr>
<tr>
<td>Sample Selection</td>
<td></td>
</tr>
<tr>
<td>Subject-Investigator Interactions</td>
<td></td>
</tr>
<tr>
<td>Data Analysis</td>
<td></td>
</tr>
<tr>
<td>Chapter Summary</td>
<td></td>
</tr>
</tbody>
</table>
IV. RESULTS AND DISCUSSIONS ........................................ 47

Introduction
Differences in Life-Science Concept Acquisition Test Results among the Three Community Settings
Correlations of Independent Variables with Life-Science Concept Acquisition Test Results
Independent Variables as Predictors of Performance on the Life-Science Concept Acquisition Test
Chapter Summary

V. SUMMARY ......................................................... 90

Conclusions
Implications
Chapter Summary

APPENDIX

A. ........................................................ 104
B. ........................................................ 106
SELECTED BIBLIOGRAPHY ................................. 139
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. L-SCAT Total Score Results: Analysis of Variance</td>
<td>48</td>
</tr>
<tr>
<td>2. L-SCAT Total Score Results: Tests on Differences between Pairs of Means</td>
<td>48</td>
</tr>
<tr>
<td>3. L-SCAT Nonverbal Score Results: Analysis of Variance</td>
<td>50</td>
</tr>
<tr>
<td>4. L-SCAT Nonverbal Score Results: Tests on Differences between Pairs of Means</td>
<td>50</td>
</tr>
<tr>
<td>5. L-SCAT Verbal Score Results: Analysis of Variance</td>
<td>51</td>
</tr>
<tr>
<td>6. L-SCAT Verbal Score Results: Tests on Differences between Pairs of Means</td>
<td>51</td>
</tr>
<tr>
<td>7. Conceptual Theme 1: Analysis of Variance</td>
<td>54</td>
</tr>
<tr>
<td>8. Conceptual Theme 1: Tests on Differences between Pairs of Means</td>
<td>55</td>
</tr>
<tr>
<td>9. Conceptual Theme 2: Analysis of Variance</td>
<td>56</td>
</tr>
<tr>
<td>10. Conceptual Theme 2: Tests on Differences between Pairs of Means</td>
<td>56</td>
</tr>
<tr>
<td>11. Conceptual Theme 3: Analysis of Variance</td>
<td>57</td>
</tr>
<tr>
<td>12. Conceptual Theme 3: Tests on Differences between Pairs of Means</td>
<td>58</td>
</tr>
<tr>
<td>13. Conceptual Theme 4: Analysis of Variance</td>
<td>59</td>
</tr>
<tr>
<td>14. Conceptual Theme 5: Analysis of Variance</td>
<td>60</td>
</tr>
<tr>
<td>15. Conceptual Theme 5: Tests on Differences between Pairs of Means</td>
<td>59</td>
</tr>
<tr>
<td>16. Conceptual Theme 6: Analysis of Variance</td>
<td>60</td>
</tr>
<tr>
<td>Table</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>17. Conceptual Theme 6: Tests on Differences between Pairs of Means</td>
<td>61</td>
</tr>
<tr>
<td>18. Conceptual Theme 7: Analysis of Variance</td>
<td>62</td>
</tr>
<tr>
<td>19. Conceptual Theme 7: Tests on Differences between Pairs of Means</td>
<td>63</td>
</tr>
<tr>
<td>20. Correlations of Independent Variables with L-SCAT Results</td>
<td>68</td>
</tr>
<tr>
<td>21. Thirty Independent Variables as Predictors of Total Performance</td>
<td>73</td>
</tr>
<tr>
<td>22. Thirty Independent Variables as Predictors of Nonverbal Performance</td>
<td>74</td>
</tr>
<tr>
<td>23. Thirty Independent Variables as Predictors of Verbal Performance</td>
<td>75</td>
</tr>
<tr>
<td>24. Twenty-five Independent Variables as Predictors of Total Performance</td>
<td>81</td>
</tr>
<tr>
<td>25. Twenty-five Independent Variables as Predictors of Nonverbal Performance</td>
<td>83</td>
</tr>
<tr>
<td>26. Twenty-five Independent Variables as Predictors of Verbal Performance</td>
<td>84</td>
</tr>
</tbody>
</table>
CHAPTER I

THE PROBLEM

Rationale

Introduction

The present investigation is a study of the acquisition of selected life-science concepts by beginning kindergarten children from three different community settings. The study treats several physical, mental, and socio-cultural variables as they relate to life-science concept acquisition.

The rationale for the study is centered around four basic arguments. The first argument is that a significant amount of a child's cognitive development occurs during the first five years of his life. Further, it is argued that this development is greatly affected by many different intervening variables. The second argument holds that concept acquisition is a very important process of cognitive development and that the process is inseparable from the nature of the scientific enterprise. The third argument builds the case that planners of kindergarten science curricula need to have substantial knowledge of the life-science concepts which different children bring to
kindergarten for the first time. The fourth argument synthesizes the previous three to show that there is a definite need for this present investigation. Each of the arguments is presented below.

**Cognitive Development in Early Childhood**

During the past decade, the evidence has steadily mounted to show that the years in a child's life before age six are of utmost importance in his cognitive development. Bloom's (1964) analysis of over one thousand longitudinal studies reveals the rapidity with which many human characteristics develop in early childhood. Relative to the present investigation, one of his most significant findings is that approximately 50 per cent of the intelligence a person has at age seventeen is already developed by age four (p. 88).

Some years ago, the acceptance of the idea that a child's intelligence was "fixed" at conception made any concern for learning in early childhood seem a relatively fruitless waste of time (Hunt, 1964). This idea of a "fixed intelligence" is no longer tenable. Bloom (1964, p. 71), for example, states that varying environments in early childhood can change the intelligence quotient (I.Q.) by about twenty points. Recent experiments (Krech, 1969) in the chemistry of learning show that rats which had been subjected to an "intellectually enriched" environment have better developed neurological systems than those which had
been "intellectually deprived." There is a definite possibility that similar neurological differences might exist among beginning kindergarten children who have grown up in significantly different environments.

The conclusions drawn from recent findings are straightforward. The growth of a child's intellect is quite rapid during the first five years of his life and the rate and nature of that growth is, in some way, related to the environmental context within which the child lives. How do these conclusions relate to the planning of school programs? J. McV. Hunt (1961, p. 357) states that

... it is the appropriateness of the match between the circumstances that the child encounters as he develops and the nature of his own intellectual organizations at the time of the encounters that appear to determine in very large part his rate of intellectual development.

Therefore, it seems obvious that program planners must determine what and how different circumstances have affected a child's intellectual development by the time he enters school. Then, the planner must find the "proper match" between the child's "intellectual organizations" at that time and the new "circumstances" that can be provided him.

Concept Acquisition and the Nature of Science

The argument above deals with general intellectual development. Psychologists agree that within the general development of the human intellect, concepts play a most significant role. George Thompson (1962, p. 319), for
example, states that concepts are "... the essential modus operandi of the higher mental processes of problem solving, or 'reasoning.'" Gagne (1965, p. 137) writes that "It is difficult to overemphasize the importance of concept learning in formal education. The acquisition of concepts is what makes instruction possible." In a very similar statement, Russell (1956, p. 122) concludes

It seems difficult to overestimate the importance of concepts in any thinking done by children or adults. More than anything else they are the premises, the foundations, and the structural steel of thinking.

This present study deals with science concepts. It is difficult, if not impossible, to consider science as divorced from concept formation. In a sense, science is concept formation! Richardson (1957, p. 2) has stated that "Science is a way of thinking and acting. . . ." He maintains that the printed page of a scientific or technological report, so often considered as science, is "... primarily a record of man's accomplishment." Craig (1956) presents a similar view of the nature of science when he writes that

Science does nothing in and of itself. It is man who does things with science. . . . Science is a product of mankind—mankind is not the product of science. . . .

The view of science presented above by Richardson and Craig is strikingly similar to the reference to concepts by Einstein and Infeld (1938, p. 33) who state that "... concepts are free creations of the mind, and are not, however
it may seem, uniquely determined by the external world."

The case for the importance of concepts in relation to the nature of the scientific enterprise is quite aptly summarized by Voelker (1969) who writes that

Both concept formation and the scientific enterprise are intellectual activities of mankind. The initial step in both processes is to make observations; the origin of thought is concrete experience. . . . Concept formation in the scientific enterprise is a system of organizing knowledge (imposing order) based on observation and experiment. . . . Theories in science are concepts. . . . The processes of concept formation are analogous to the processes of scientific inquiry and discovery, and possession of the concepts represents the knowledge of the theories of science.

The importance of concepts in general cognitive development cannot be denied. It is equally clear that science concepts are basic elements in understanding the scientific enterprise. Further, since science concept development is a form of intellectual activity, there is little doubt that it too is affected by physical, mental, and socio-cultural variables. If science is to be a part of the elementary school program, the conclusions presented in this paragraph cannot be ignored.

Concepts in the Kindergarten Science Curriculum

The statements above place a heavy responsibility on those concerned with science in the kindergarten curriculum. Hurd (1964, p. 11) suggests that

The task of the curriculum-maker is to extract the essence of scientific knowledge and define the significant concepts in terms of their usefulness for understanding the structure of science. This
is a process that begins with the "big picture" of science, not with bits of information, bodies of facts, or concepts in isolation. Thus it is the conceptual schemes and the inquiry processes that provide the framework for curriculum design and for developing courses at each grade level.

The task, however, at the kindergarten level is an especially difficult one. Surely the children have had some experiences related to science. Gerald Craig (1956) has stated that "... the child does not come to school for the first time at zero in science." But how does the curriculum maker know what science the children do bring to school for the first time? Do all children bring the same general level of science concept development? It seems obvious that the curriculum maker cannot decide what the "big picture" is or what conceptual schemes and inquiry processes are most appropriate for the curriculum design without answers to these basic questions.

A logical proposal for planning kindergarten science curricula includes two major steps. The first is to determine or predict what science concepts children with differing physical, mental, and socio-cultural make-ups bring to school for the first time. The second step involves building a framework for curriculum design which is based on information obtained in the first step.

The need for input from the proposed first step in curriculum planning is well established. Almy, et al. (1966, p. 10) write that there is a paramount need for finding out how children from different experiential
backgrounds think **before** receiving formal instruction. Such information is necessary in order to plan science curricula which permit a kindergarten child to build on that which he already possesses. Kranzer (1963) adds strength to this conclusion when he states that

> It does not seem too much to expect that programs can be developed that are in phase with normal growth processes, in contrast to proclivity for imposing various science disciplines because of the importance we attach to them.

The present investigation proposes to shed light on the readiness of different kindergarten children for dealing with selected life-science concepts and conceptual themes. Therefore, it is concerned with what has been referred to above as the first step in curriculum planning. The need for such basic research is emphasized by the National Science Teachers Association (1961, p. 49) when it states that

> The entire area of the science curriculum is one in which basic research is sorely needed. Too little is known about the readiness of students for different concepts. More must be learned about the dependence of readiness on age, on background, and on the type of presentation employed.

**Need for the Present Investigation**

The arguments presented above have established a need for obtaining a great deal of information about kindergarten children's science concept development and background experiences **before** they receive formalized science instruction. Life science is a major component of the school
science curriculum. Research leading to information about life-science concept development among beginning kindergarten children who differ physically, mentally, and socio-culturally has not been done. Therefore, the need for the present investigation is clearly indicated.

**Problem Statement**

The major problem to be investigated in this study is to assess the acquisition of selected life-science concepts by beginning kindergarten children from three different community settings—inner-urban, outer-urban, and rural-farm.

Subproblems to be investigated are:

1. To determine the extent to which the acquisition of selected life-science concepts is related to several physical, mental, and socio-cultural variables.

2. To determine the combinations of the several physical, mental, and socio-cultural variables which are the most useful predictors of the acquisition of selected life-science concepts.

**Hypotheses**

The subjects in this study are beginning kindergarten children from three different community settings—inner-urban, outer-urban, and rural-farm. The hypotheses to be tested are:
H₀ 1. There are no significant differences, at alpha equals .05, among the total scores made on the Life-Science Concept Acquisition Test by the subjects in this study.

H₀ 2. There is no significant correlation, at alpha equals .05, between the total scores made on the Life-Science Concept Acquisition Test by the subjects in this study and any of the following independent variables. The subjects:

x₁ Community settings
x₂ Chronological ages
x₃ Sex
x₄ Language intelligence quotients
x₅ Nonlanguage intelligence quotients
x₆ Total intelligence quotients
x₇ Nursery school attendance
x₈ Head Start attendance
x₉ Possession of pets
x₁₀ Participation in caring for house plants
x₁₁ Participation in caring for a flower garden
x₁₂ Participation in caring for a vegetable garden
x₁₃ Participation in caring for a bird feeder
x₁₄ Participation in caring for animals used for food purposes
x₁₅ Zoo visitation
x₁₆ Farm visitation
x₁₇ Examination by a physician within the past two years
x₁₈ Examination by a dentist within the past two years
x₁₉ Time spent watching television
x₂₀ Time spent with someone reading to them
H_0 3. The relative importance of the independent variables, listed in H_0 2, above, as predictors of a subject's total score performance on the Life-Science Concept Acquisition Test cannot be determined.

**Definition of Terms**

The following terms are defined and/or described to provide an understanding of terminology as it is used in the present investigation. Other terms are defined as they appear in the text.

**Concept.**—There is no precise standard definition of a concept. Concepts are individual possessions and products of one's own mind. This characteristic makes them more than facts, and, thus, makes them undefinable by precise standard definition. For the purposes of this study, Pella's (1966) description of a concept as "... a summary of the essential characteristics of a group of ideas and/or facts that epitomize important common features or factors from
a larger number of ideas" is used.

**Concept Acquisition.**--Synonyms are concept development, concept formation, concept learning and concept attainment. A concept is assumed to have been acquired when the subject can summarize, verbally and/or nonverbally, the essential characteristics of the group of ideas and/or facts that epitomize important common features or factors from a larger number of ideas represented by that concept.

**Conceptual Theme.**--A synonym is conceptual scheme. There is no precise standard definition of conceptual theme. In this study, a conceptual theme is described in accord with Hurd's (1969, p. 77) statement that it is a "... network of concepts related in a systematic way."

**Life-Science Concept Acquisition Test (L-SCAT).**--A test developed by the investigator to assess life-science concept acquisition by beginning kindergarten children. No relationship exists between the L-SCAT and the School and College Ability Test (SCAT) published by the Educational Testing Service. The L-SCAT total score is equal to the summation of nonverbal and verbal scores. The L-SCAT is described more fully in Chapter three and Appendix B.

**Beginning Kindergarten Children**--A child who is enrolled but has attended no more than two months in a regularly scheduled kindergarten class of a state approved school system.
Inner-Urban Community Setting.--A school district which possesses the following characteristics:

1. The school district is located within the boundary limits of a major city of at least 500,000 inhabitants.

2. No boundary of the school district intersects, serves as, or coincides with the boundary limits of the city.

3. The school district serves a population in which a minimum of 10 per cent of the families with children between five and seventeen years of age receive support under the Aid to Families of Dependent Children (AFDC) program.

Outer-Urban Community Setting.--A school district which possesses the following characteristics:

1. A minimum of one school district boundary intersects, serves as, or coincides with the boundary limits of a major city of at least 500,000 inhabitants.

2. The school district serves a population in which a maximum of 1 per cent of the families with children between five and seventeen years of age receive support under the AFDC program.

Rural-Farm Community Setting.–A school district which possesses the following characteristics:

1. The school district is located outside of the
boundary limits of a major city of at least 500,000 inhabitants.

2. No school district boundary intersects, serves as, or coincides with the boundary limits of a major city of at least 500,000 inhabitants.

3. The school district is composed, in part, of real estate on which farming is practiced as a principal occupation.

4. Any town, village, or municipality within the district contains less than 2500 inhabitants.

Room/Occupant Index.—A synonym is living space. It is the number of rooms in the home divided by the number of persons living there.

Nuclear Family.—A family composed of the father, the mother, and their offspring.

Extended Family.—A family, living in one home, which includes members other than the nuclear family.

Early Childhood.—That part of a child's life from two to six years of age (Loomis, 1964, p. 8).

Physical Variables.—Variables $x_2$ and $x_3$ listed in hypothesis $H_0$ 2 above.

Mental Variables.—Variables $x_4$, $x_5$, and $x_6$ listed in hypothesis $H_0$ 2 above.

Personal Make-Up Variables.—A combination of physical and mental variables.
Socio-Cultural Variables.—A synonym is external variables. All the variables, other than the personal make-up variables, listed in hypothesis $H_0$ above.

Other People Variables.—The socio-cultural variables which pertain to other people in the life of the child. Variables $x_{22}, x_{24}, x_{25}, x_{26}, x_{27}, x_{28}, x_{29}, x_{30}$, and $x_{31}$ listed in hypothesis $H_0$ above.

Assumptions, Delimitations, and Limitations

Assumptions

The following assumptions are made in this investigation:

1. Children have acquired some life-science concepts by the time they begin kindergarten.

2. The life-science concepts acquired by beginning kindergarten children can be assessed by their verbal and/or nonverbal behavior.

3. The test developed by the investigator to measure life-science concept acquisition is valid and reliable.

4. The subjects are physically, mentally, and socio-culturally different.

5. The I.Q. tests used are valid and reliable.

6. The socio-cultural data provided by the parents are valid and reliable.
7. The statistical procedures employed are appropriate for the data collected, sampling methods, and analyses desired.

**Delimitations**

The present study is delimited by the following:

1. The subjects are from beginning kindergarten level; other age levels are not included.
2. The subjects are from three school districts; other school districts are not included.
3. The total number of subjects is fifty-one.
4. The concept assessment treats life-science concepts; earth-space and physical science concepts are not assessed.
5. The concepts deal with life-science content; inquiry processes and historical concepts are not assessed.
6. The study's primary focus is on overall L-SCAT performance; it is not an exhaustive study of individual life-science concepts.

**Limitations**

The following limitations are realized for this investigation:

1. The sampling procedure limits generalization to the relatively small populations from which the samples were selected.
2. The quality of results obtained from the L-SCAT is, in part, dependent upon the skill and ability of the interviewer.

3. Generalization is limited to those concepts included in the L-SCAT.

Chapter Summary

This chapter, chapter one, has presented the problem to be investigated. The chapter included the rationale for the study, the problem statement, the hypotheses to be tested, and the assumptions, delimitations, and limitations of the investigation.

The next chapter, chapter two, is a review of related research. The chapter is divided into different sections which treat categories of research in concept development.
CHAPTER II

REVIEW OF RELATED RESEARCH

Introduction

The body of research related to concept development is voluminous. Roughly, the research related to the present investigation can be divided into five different categories. The categories represent studies which deal with: (1) the developmental psychology of Jean Piaget, (2) science concept acquisition prior to instruction, (3) science concept acquisition as a result of instruction, (4) the development of instruments for measuring science concept acquisition, and (5) the psychological development of a single child. Because of the diverse nature of the present investigation, the instrument development requirement, and the several variables dealt with, many of the concept studies are related to this study in some way.

For the purpose of delimiting this review, only a selected sample of related research is presented. The sample does not deal with research above the elementary school level. To further delimit the review, research is divided into two major sections. The first section treats research which is related to the present investigation in a
primary way. This section presents the first two categories above and examines several studies in some detail. The second section treats studies which are related to this investigation in a secondary way. It presents the last three categories above. The section includes only a few exemplary studies and treats each in rather limited detail. In some instances, reference is made to bibliographies where other works in a particular category can be found.

A general bibliography covering a broad range of literature related to concepts has been assembled by Klausmeier, et al. (1969). This extensive bibliography deals with studies in concept learning from 1950 to 1967.

Studies Related to the Present Investigation in a Primary Way

The Developmental Psychology of Jean Piaget

The work of Jean Piaget stands as a landmark in the study of cognitive development. He is attributed with publishing some twenty-five books and 160 articles dealing with the development of intelligence (Rowland and McGuire, 1968).

Piaget's studies are many faceted. Some, for example, deal with the development of concepts of "life" and the origins of plants and animals (Piaget, 1967). Others deal with various aspects of change and conservation of quantities (Piaget, 1965). Still others are concerned with
the development of concepts of physical causality (Piaget, 1930). Piaget's primary method of collecting data is the individual clinical interview. His studies have lead him to hypothesize that there are seventeen types of causal explanations which children give to natural phenomena. Further, he hypothesizes that (Piaget, 1964) "... each element of learning occurs as a function of total development" and that the following developmental stages can be identified:

1. Sensory-motor, pre-verbal (0-2 years)
2. Pre-operational (2-7 years)
3. Concrete operations (7-11 years)
4. Formal or hypothetic-deductive operations (11-15 years)

Piaget places great stress on the idea that the development of intelligence occurs in the sequence above. Rowland and McGuire (1968), however, point out that the common "American misinterpretation" of Piaget is that time per se is the significant variable in cognitive development. The more appropriate interpretation is that the sequence is constant but that the rate of development or time of occurrence of each stage varies with several factors.

Honstead (1968) reviews Piaget's theory and points out that he (Piaget) actually considers four factors as influences on intellectual development. The factors are: (1) experience, (2) maturation, (3) social transmission, and (4) equilibration. It seems unfortunate that this component of the theory has not received more attention. One of the
basic elements, often overlooked in Piaget's reasoning is summarized in the National School Public Relations Association's statement (Honstead, 1968) that "Ideas grow on ideas, and they are the start of learning."

Piaget's studies have served as catalysts for many psychological investigations. A sample of those investigations relating to science concept development is presented below.

Susan Isaacs (1948) was studying young children in Cambridge, England, at about the same time that Piaget was conducting some of his early investigations. She used a method of extended observation over a three-year period instead of the isolated clinical interview. Her results, first published in book form in 1930, led her to question Piaget's hypotheses (p. 97). She concluded that Piaget presents...

...a picture of the child's mind as a homogeneous structure in which every part implies every other part at each stage. The material given in this volume, however, shows many disparate types of behavior coexisting in the same children, and ranging freely between phenomena characterised by Piaget to clear logical statement and reasonable action.

Her statements about life-science interests in young children have definite significance to the present study in terms of its stated implications for curriculum development. She writes (p. 158) that young children have a great interest in pets and plants but that...

...these early pleasures and curiosities of little children, catered for in very well conducted
infant school, have not been satisfactorily carried forward in the following years, nor well linked up with later biological interests.

Deutsche (1937) studied the development of concepts of causal relations among 732 children in grades three through eight. She used a two-part evaluation instrument. In the first part, she performed demonstrations and asked the students to explain their observations. The second part consisted of simply asking the students questions without the use of a demonstration. She concluded that there was little evidence to support the classification of causal explanations into seventeen separate types or that children's reasoning develops by stages.

The study by Oakes (1947) was yet another extension of the work of Piaget. He used the clinical interview to collect data from 153 children in grades K, two, four, and six. Among his conclusions (pp. 93-94) were:

In explaining experiments which they had seen, the children gave a higher percentage of cause-and-effect (physical) explanations than they did in response to verbal questions. . . . No evidence was found to corroborate Piaget's interpretation that there is a definite stage in the child's thinking which is characteristic of a given age.

King (1965) used a questionnaire and follow-up interview to determine concept acquisition among 1,235 British children ranging in ages from six to eleven. The questionnaire, consisting of seventy questions, was administered by the student's regular classroom teacher under normal classroom conditions. The investigator assumed that this
technique would promote responses free from outside influences. He concluded that the main factors determining the types of answers received were the experiences the students had had and the general increase of vocabulary with age. He found that there was "... no evidence of Piaget's stages of development but only a gradual development of the reasoning processes by more systematic organisation of concepts."

Anderson (1965) investigated the ability of 180 children in grades three through six to form mental models to explain natural phenomena. He related his findings to sex, mental ability and chronological age of the children. The clinical-interview was used. A series of six demonstrations was performed and the children were asked to explain what they had observed. He classified answers into only four types: (1) atomistic, (2) nonatomistic, (3) magical and animistic, and (4) no explanation. For the six demonstrations performed, he found a significant difference in responses, based on sex, in only one demonstration. Likewise, scores based on chronological age were significant in only one instance. Three of the six demonstrations resulted in scores which were significantly different when the independent variable considered was mental ability.

Leeper (1968) reported an investigation of the development of five science-related concepts in Negro and white first graders. The concepts, previously defined by
Piaget, were conservation of continuous substance, conservation of discontinuous substance, conservation of number, conservation of length, and conservation of area. He studied the relationship between the acquisition of the above concepts and social status (measured by the McGuire-White Index of Value Orientation), race, and reading readiness (measured by the Metropolitan Reading Readiness Test). Eighty-five first grade children (thirty Negro, fifty-five white) were interviewed individually with the examiner manipulating various objects as part of the interview. He found significant differences among the high, medium, and low social status levels within each group (Negro and white). When sixty Negro and white subjects (thirty each) were matched on social status, there were significant differences between the scores of the two groups on three of the five concepts. The investigator concluded that

These differences, according to the interpretation presented in this study, can be accounted for by differences in the subjects' backgrounds. The study did not reflect any innate differences in the subjects. . . . And finally, it is concluded that the practice of grouping students for science instruction on the basis of the Metropolitan Reading Readiness scores should be seriously questioned.

Raven's study (1968) was designed to determine the sequence of acquisition of subconcepts that were postulated as being necessary for an understanding of the concept of momentum. The investigation is grounded on a basic Piagetian assumption that concepts are acquired in a hierarchical order. The subjects were 160 pupils from
grades K through three at the Whittier Elementary School in Berkeley, California. The children were tested on six different concept tasks. The tasks were administered to individual children in random order to control for the effect of learning. The tasks were: (1) conservation of matter, (2) speed, (3) proportional use of matter with momentum held constant, (4) proportional use of speed with momentum held constant, (5) first momentum task, and (6) second momentum task. The sequence of psychological development of the components was found to be: conservation of matter $\rightarrow$ speed $\rightarrow$ the proportional use of mass and speed $\rightarrow$ momentum. Raven concluded that "The results of the study were in agreement with Piaget's description of thinking in the preoperational and concrete stages."

Science Concept Acquisition
Prior to Instruction

The studies reported here are ones in which formal instruction is not a part of the procedures employed. Subjects might have received instruction at some previous time but that instruction is not directly related to the investigation reported.

Near the end of the nineteenth century, G. Stanley Hall (1891) published "The Contents of Children's Minds on Entering School." In this landmark study, he compared concept development of young children from differing environments. Not only did he find differences in concept
acquisition between city children and rural children, but also among children from different parts of the same city. He concluded that "... there is next to nothing of pedagogic value the knowledge of which it is safe to assume at the outset of school life." Hall's studies made him increasingly confident that it was educationally unsound to treat all children as if they had the same backlog of experiences.

It seems ironic that these findings of some eighty years ago have stimulated so little research on the concepts that children hold prior to instruction. Some examples of related research that has been done in science are presented below.

Haupt (1948) studied concepts of the moon held by first-grade children. He studied both pre-instructional and instructional concepts. The children's concepts were grouped into five categories: (1) surface and composition, (2) size, (3) motion, (4) moonlight, and (5) phases. He wrote that

We note a gradation from concepts that result from direct observation through a range of reasonings. . . . We note, also, differences among those concepts that result from reasoning.

Haupt (1952) continued his study of concepts and later published a study which sought to ascertain what experiences with magnetism elementary school children had encountered. He was also concerned with grade and age differences in their experiences and explanations and whether or not the children's concepts of magnetism
paralleled the historical development of man's knowledge of the subject. Twenty-five pupils in grades one through seven were examined individually by the investigator. During the interview, children were permitted to manipulate two bar magnets, a steel knitting needle, a piece of paper, a splinter of wood, and a dipping needle. He found that

... data seems to indicate that the children in the lower grades have attained to concepts that are equivalent in complexity and maturity to those from children in the higher grades. ... This study of parallels of children's thinking with that of the race reveals primitive ideas that are used to conceptualize the raw data of experience.

Silano (1952) also studied the concept of magnetism. He presented magnets and pieces of metal to students in grades one and three. He then recorded the free discussion among the children and used this record to evaluate the pupils understanding of magnetism. He concluded that the remarks of the children from both grades were quite similar and that younger children are more interested in "what" happens than "why" it happens. He also concluded that science experiences in the elementary school should be based on direct experiences.

McCollum's (1952) study was designed to determine the maturity of elementary school children in science. There were 324 subjects selected from grades one through six. An interview schedule was used to collect data. The individual interviews were conducted with the use of such things as pictures, a thermometer, an electric bell, and
samples of rock. Responses elicited were of verbal and nonverbal types. The content for the interview schedule was based upon recommended courses of study in elementary science and covered both the biological and physical sciences. He found four general types of responses:

First, there were those that tended to increase in frequency from the first grade toward the sixth. Second, there were those that tended to decrease through the grades. Third, there were those that had their highest percentage and frequencies in the middle grades with lower ones in the first and sixth. Fourth, there were those that were irregular with no discernible trend toward either an increase or decrease through the grades.

He concluded that "The first two were of most interest in that they identified responses indicative of changing maturity through the grades."

Young (1958) begins her study by stating that "The teacher needs information about the concepts children possess in order to plan effectively." She interviewed seventy-five third grade children and used a questionnaire with sixty-eight sixth grade pupils in order to determine their concepts of atomic energy. The results indicate . . . that many third and sixth graders have developed concepts of atomic structure and the use of atomic energy. . . . The wide range of understandings within a class reiterates the importance of understanding individual differences. . . . The impact of television, newspaper, and adult conversation was clearly shown. . . . The evidence of differences in concepts held by boys and girls indicates the need to work with parents to change the cultural expectation that girls should not be interested in science.
Garone (1960) studied the development of science concepts and factors influencing that development. A major purpose of the investigation was to develop and illustrate a general approach to the study of concept acquisition. He used a threefold approach consisting of: (1) anecdotal records, (2) tape recordings of verbal interaction in the classroom, and (3) collections of the children's written materials. The sample consisted of twenty-nine subjects, ages ten through twelve years, of superior intelligence. Besides the general conclusion that such a threefold approach to data collection was feasible, he found that all children needed guidance at some time in developing scientific concepts. . . . Concept development as a categorizing activity was repeatedly manifested. . . . Concepts are not always arrived at directly. . . . The children's innate intellectual capacity, perceptive ability, competency for making interpretations, eagerness and capacity to recognize and to solve problematic situations, and the quantity and the variety of pertinent experiences significantly influence their scientific concept development.

Laura Yuckenberg (1962) was concerned with simple astronomical concepts held by twenty-seven first grade children. Each child was presented with ten questions dealing with simple concepts about the sun, moon, day and night, and gravity. She found that many responses showing the children's readiness to learn about space were brought about by outside influences . . . their immediate knowledge had been extended to include many of the concepts held by adults . . . it would seem wise to begin a study of astronomy at an early age . . . a foundation upon which future learnings and understandings may be built should be made as early as possible in the child's school life.
In the first phase of the McNeil and Keisler study (1962), seventy-two pupils were randomly selected from lower elementary classrooms and were individually interviewed to determine their conceptualizations of certain natural phenomena. Four categories of responses were identified. They concluded that the children were developing functional rather than animistic and theoretical approaches to interpretations of natural phenomena.

Helfrich (1963) studied "science learnings" known by eighty-eight kindergarten children in Shaker Heights, Ohio. The children were: (1) asked questions about natural phenomena, (2) given picture tests in which they were asked to identify certain animals, parts of plants, different seasons, etc., and (3) asked to identify various objects, such as magnets, nails, testtubes, and paper clips. He found that children were most successful in naming animals and least successful in naming pieces of scientific apparatus. Fifty per cent of the children were able to generalize to some extent. The subjects gave a greater number of acceptable responses when stimuli of a concrete nature were presented rather than verbal stimuli by themselves.

Inbody's (1963) investigation was of kindergarten children's understanding of natural phenomena. He used a demonstration-interview technique to evaluate the "understandings" of fifty children. The children were primarily from middle socio-economic status homes. The interview
schedule consisted of twelve topics or experiences with physical phenomena commonly found in primary science textbooks. The study was conducted in a large residential suburb of Kansas City, Kansas and Kansas City, Missouri. The population was almost entirely white, native American.

Among his findings and suggestions were:

There seems little doubt that the nature of children's thinking changes with maturity and experience. . . . Evidence produced in the present study has shown that young children are capable of understanding cause and effect relationships. . . . Rural and urban children should also be compared to determine if their environments have any effect on their understanding. . . . A study similar to the present one conducted either before children enter kindergarten or in the early weeks of the kindergarten year should prove helpful in planning instruction.

A study involving 140 randomly selected first grade children was conducted by Olmsted (1963). She used the personal interview technique based on a schedule of eighteen questions. The questions were derived from thirty different ideas inherent in eleven concepts found to be common to five different first grade science textbooks. The eighteen questions were presented verbally without reference to pictures, models, or apparatus. She concluded that more difficult concepts could be included at first grade level, as well as the inclusion of more physical science concepts. In addition she found that there was no significant difference in the performance of the boys and girls but that there was a significant difference in the performance of children who had attended kindergarten and those who had
not. She added, however, that

This study did not include consideration of many variables which could have affected the results of the tests between the responses of children with kindergarten experiences and responses of children without kindergarten experience. Therefore, those findings should be interpreted with caution. Further study in this area is needed.

Hildegard Kuse's study (1965) was designed to ascertain: (1) what objects in outer space children in grades one through three have heard about or seen, (2) what concepts these children have concerning objects in space, (3) what children know about space exploration, and (4) from what sources children have obtained their information. One hundred fifty tape recorded interviews were conducted with children from three Wisconsin counties. Among her conclusions were that

An increase in information from first to third grade appeared for nearly all topics. . . . Descriptions of appearance of objects are more common than explanations of causes of phenomena in the responses of the children. . . . Books ranked highest among children's stated sources of information, with direct observation cited almost as often. These were followed by television, teachers at school, space toys, parents, children's newspapers, and a wide variety of less frequently mentioned sources.

Studies Related to the Present Investigation in a Secondary Way

Science Concept Development as a Result of Instruction

Research on teaching science concepts to kindergarten children is limited. Zeitler (1969) has made a preliminary report on a study which deals with two samples of three,
four, and five year old children. One sample is made up of a group of "deprived" children; the other sample is representative of a cross section of the population. The preliminary evidence suggests that there is a great difference in the performances of the two groups.

A study on adapting a unit on "seeds" for the kindergarten level is reported by Bennett (1969). Results are reported in a subjective manner. The results indicate that the children were able to learn the material and that their interest was high.

The Wisconsin Research and Development Center for Cognitive Learning, located at The University of Wisconsin, has been quite prolific during the past five years in its production of research on the teaching of science concepts. Most of the research, however, has been done with children above the first grade level. Examples of the type and breadth of this research are the investigations of Helgeson (1968), Stauss (1968), and Voelker (1968). These three studies were concerned with teaching selected concepts of force, the biological cell, and chemical and physical change, respectively, in grades two and above. The bibliographies included in these investigations present a representative coverage of earlier studies concerned with the teaching of science concepts.
The Development of Instruments for Measuring Concept Acquisition

Every study which assesses concept acquisition must use some means for determining when a concept has been acquired. The means reported in the several studies above are quite varied. There has been some limited work, however, on the development and standardization of concept tests.

Scott's (1964) chief purpose was to determine how a child's ability to acquire science concepts would relate to his cognitive style in categorization behavior and to his inductive reasoning ability. He developed a test for ten and eleven year olds which would indicate the child's ability to predict an effect when a cause was given, to control a cause to obtain an effect, and to explain the relationship between those elements of a given science problem.

Butler (1966) developed a test specifically to measure life-science concept development by children in grades one through six. The subjects responded to questions about groups of pictures by marking yes or no in the test booklet. It was a group test. Each test booklet was complete with pictures (drawings) and marking spaces.

A nonverbal test was developed by Haney (1965) to determine children's concepts of animals. It was a group test and was standardized on grades three through six. The nature of the test is revealed in the following oral
instructions given to the students:

At the top of each question you will find a group of four things which are alike in some way. At the bottom of the question are pictures of four other things. Only one of these objects is like those in the group above and belongs with them. You are to mark its letter on the answer sheet.

Brown's (1968) instrument was called the Concept Pre-requisite and Development test. It was designed to evaluate five skills and abilities assumed to be necessary for a child to conceptualize efficiently. The skills and abilities were: (1) attend to a task, (2) remember logically, (3) detect similarities, (4) detect differences, and (5) use all these skills in the conceptualizing process. The test was standardized on first grade pupils. It is a group test in which instructions are given orally. The subjects mark their choices of answers in a test booklet.

Studies in the Psychological Development of a Single Child

Generalization from studies on the psychological development of a single child is greatly limited. However, as Navarra (1955, p. 2) points out, "... there is a need for data concerning the way an individual child learns—since the acquisition of concepts is, in the last analysis, an individual affair." His investigation was a longitudinal study of the development of science concepts in a young child over a period of time from three years of age into the sixth year of the child's life. His findings and those reported in his review of the literature (pp. 2-21) present
many insights into the nature of development of the science concepts which a young child brings to kindergarten for the first time.

The bibliography compiled by Dennis (1936) is probably the most thorough listing of studies done on young children up to that time. This review of "baby bibliographies" contains some sixty-four investigations.

Chapter Summary

This chapter, chapter two, has presented a review of related research. The review was divided into two major sections. The first section dealt with research related to the present investigation in a "primary" way. The second section treated research related to the present investigation in a "secondary" way.

The next chapter, chapter three, describes the procedures used in this study. The chapter is designed to show both the chronological and logical steps used in conducting the investigation.
CHAPTER III

PROCEDURE

Introduction

The present investigation was designed to test several hypotheses related to life-science concept acquisition. The subjects were beginning kindergarten children from three different community settings--inner-urban, outer-urban, and rural-farm.

Hypotheses Tested

Three major hypotheses were tested in this study. The hypotheses are listed below. A parenthetical statement follows those independent variables, listed in hypothesis $H_0$ 2, where some question might arise as to the nature of the information sought or the numerical coding used in analyzing the data. The hypotheses tested were:

$H_0$ 1. There are no significant differences, at alpha equals .05, among the total scores made on the Life-Science Concept Acquisition Test by the subjects in this study.

$H_0$ 2. There is no significant correlation, at alpha equals .05, between the total scores made on
the Life-Science Concept Acquisition Test by
the subjects in this study and any of the fol­
lowing independent variables. The subjects'

\[ x_1 \text{ Community settings (inner-urban = 1; outer-
urban = 2; rural-farm = 3)} \]

\[ x_2 \text{ Chronological ages (in months)} \]

\[ x_3 \text{ Sex (male = 1; female = 2)} \]

\[ x_4 \text{ Language intelligence quotients (in I.Q.}
points) \]

\[ x_5 \text{ Nonlanguage intelligence quotients (in I.Q.}
points) \]

\[ x_6 \text{ Total intelligence quotients (in I.Q. points)} \]

\[ x_7 \text{ Nursery school attendance (yes = 1; no = 2)} \]

\[ x_8 \text{ Head Start attendance (yes = 1; no = 2)} \]

\[ x_9 \text{ Possession of pets (yes = 1; no = 2)} \]

\[ x_{10} \text{ Participation in caring for house plants}
(yes = 1; no = 2) \]

\[ x_{11} \text{ Participation in caring for a flower garden}
(yes = 1; no = 2) \]

\[ x_{12} \text{ Participation in caring for a vegetable}
garden (yes = 1; no = 2) \]

\[ x_{13} \text{ Participation in caring for a bird feeder}
(yes = 1; no = 2) \]

\[ x_{14} \text{ Participation in caring for animals used}
for food purposes (yes = 1; no = 2) \]

\[ x_{15} \text{ Zoo visitation (yes = 1; no = 2)} \]

\[ x_{16} \text{ Farm visitation (yes = 1; no = 2)} \]

\[ x_{17} \text{ Examination by a physician within the past}
two years (yes = 1; no = 2) \]

\[ x_{18} \text{ Examination by a dentist within the past}
two years (yes = 1; no = 2) \]
x_{19} \text{ Time spent watching television (hours per day)}

x_{20} \text{ Time spent with someone reading to them (hours per week)}

x_{21} \text{ Parents' occupation (father's occupation if father is present—if not, mother's occupation; occupations numerically coded 0 through 5; least professional = 0; most professional = 5)}

x_{22} \text{ Mothers employed outside of home (yes = 1; no = 2)}

x_{23} \text{ Homes' room/occupant index (in decimal numeration)}

x_{24} \text{ Fathers' education (number of years)}

x_{25} \text{ Mothers' education (number of years)}

x_{26} \text{ Fathers' presence in the home (yes = 1; no = 2)}

x_{27} \text{ Mothers' presence in the home (yes = 1; no = 2)}

x_{28} \text{ Older siblings' presence in the home (yes = 1; no = 2)}

x_{29} \text{ Younger siblings' presence in the home (yes = 1; no = 2)}

x_{30} \text{ Birth-order ranks (first-born = 1; second-born = 2, et cetera)}

x_{31} \text{ Extended families (the child lives in an extended family; yes = 1; no = 2)}

H_0 3. The relative importance of the independent variables, listed in H_0 2, above, as predictors of a subject's total score performance on the Life-Science Concept Acquisition Test cannot be determined.
Selection of Participating Schools

Three elementary schools, each from a different community setting, were selected to participate in this study. Their selection was based on criteria which, it was assumed, would provide subjects from varying socio-cultural backgrounds. The criteria used to determine the community settings of the school districts from which the participating schools were selected are listed below.

Inner-Urban Community Setting.—A school district which possesses the following characteristics:

1. The school district is located within the boundary limits of a major city of at least 500,000 inhabitants.

2. No boundary of the school district intersects, serves as, or coincides with boundary limits of the city.

3. The school district serves a population in which a minimum of 10 per cent of the families with children between five and seventeen years of age receive support under the Aid to Families of Dependent Children (AFDC) program.

Outer-Urban Community Setting.—A school district which possesses the following characteristics:

1. A minimum of one school district boundary intersects, serves as, or coincides with the boundary limits of a major city of at least 500,000 inhabitants.
2. The school district serves a population in which a maximum of 1 per cent of the families with children between five and seventeen years of age receive support under the AFDC program.

Rural-Farm Community Setting.—A school district which possesses the following characteristics:

1. The school district is located outside of the boundary limits of a major city of at least 500,000 inhabitants.

2. No school district boundary intersects, serves as, or coincides with the boundary limits of a major city of at least 500,000 inhabitants.

3. The school district is composed, in part, of real estate on which farming is practiced as a principal occupation.

4. Any town, village, or municipality within the district contains less than 2,500 inhabitants.

Two schools of the Columbus, Ohio, Public School System satisfied the criteria established for the inner-urban and outer-urban community settings and were selected to participate in the study. A consolidated school district located in Madison County, Ohio, met the criteria established for the rural-farm community setting and represented that setting in the investigation.
Collection of Socio-Cultural Data

A Kindergarten Enrollment Information form was developed by the investigator. The form was utilized to collect data from the parents about the subjects' background experiences. Each participating school required the completion of the form as part of the procedure for registering a child in kindergarten. Appendix A contains a copy of the Kindergarten Enrollment Information form.

Sample Selection

Students were assigned to kindergarten classes beginning autumn, 1969, by the local personnel in each participating school. A decision to use all morning classes was made by the investigator. One class was selected from each school to serve as the participating class. Each class roster was divided into a list of boy's names and a list of girl's names. Each list was alphabetized and numbered separately. Eight girls and nine boys were selected from each class by means of random numbers tables. A total of fifty-one subjects, seventeen from each school, comprised the sample used in this investigation.

Subject-Investigator Interactions

Three phases of the study involved subject-investigator interaction (phase one: rapport building visits; phase two: concept testing; and phase three: intelligence testing). Each phase was carried out according to a
schedule which cycled visits among the three schools. Such cycling was an attempt at keeping the effects of interaction between the study and the children's rapidly unfolding school experiences as constant as possible among the three groups.

Phase one was initiated during the first week of the public school autumn term, 1969. Six weeks were required to complete the three phases of the study involving interaction with the children.

Rapport Building Prior to Testing

It was assumed that, in an interview situation, the beginning kindergarten child would respond more freely if he felt at ease with the interviewer. Further, it was assumed that a most appropriate means of establishing this rapport was to provide for interaction between the investigator and the child in some nonterrorizing setting before the interview. Therefore, the investigator spent a minimum of six clock-hours in each classroom before attempting to collect data from the children. The time was spent in direct contact with the students. The "work-play" period seemed to lend itself most readily to the building of harmonious relations between the children and the investigator.

Life-Science Concept Testing

A Life-Science Concept Acquisition Test (L-SCAT) for beginning kindergarten children was developed by the
investigator. The first-grade textbooks of eleven elementary school science series were used as references in developing the content for the L-SCAT (science series are listed in Appendix B). Each item on the test was designed to represent one or more concepts under one of the seven life-science content themes defined by the Biological Sciences Curriculum Study (Andrews, 1964, p. 3). The seven themes are:

Conceptual Theme 1.—The change of living things through time—evolution.

Conceptual Theme 2.—Diversity of type and unity of pattern in living things.

Conceptual Theme 3.—The genetic continuity of life.

Conceptual Theme 4.—Complementarity of organism and environment.

Conceptual Theme 5.—Biological roots of behavior.

Conceptual Theme 6.—Complementarity of structure and function.

Conceptual Theme 7.—Regulation and homeostasis—preservation of life in the face of change.

Three pilot studies were conducted during the development of the L-SCAT. The pilot studies provided base-line data on the appropriateness of the several components of the individual items, length of the test, and scoring procedures. They also provided the investigator with experience in interviewing young children.

The final copy of the L-SCAT used in this study consisted of twenty-one sets of colored pictures and an
accompanying interview schedule. The pictures were the symbolic representations of thirty-five concept items distributed among the seven content themes. Each item was designed to elicit a nonverbal and a verbal response.

The second phase of interaction between the investigator and the children involved the administration of the L-SCAT. It was administered as a picture-stimulus, structured-interview. Each subject was tested individually in a private conference room near his own classroom. A thirty-minute time period was reserved for each interview.

As a set of pictures was presented to a subject, he was asked to respond nonverbally to a statement about the pictures. The nonverbal response was made by pointing to a specific picture or part of a picture. The subject was then asked to verbalize why he had made that particular selection. The verbalization of a concept was expanded through the use of probing questions asked by the interviewer. Nonverbal responses were scored during the interview. Each interview was audio tape recorded. The tape recordings were used to score the verbal responses at a time after the interview was completed. Verbal responses were scored in accord with a previously established verbal-response criterion-scale for each item. Each subject received a nonverbal and a verbal score on each item and on the test as a whole. The summation of the nonverbal and verbal scores resulted in a total score.
Appendix B contains a more detailed description of the L-SCAT. Various aspects of the development, pilot testing, and administration are treated there.

**Intelligence Testing**

Intelligence quotients (I.Q.'s) were obtained in the third phase of subject-investigator contacts. The test used was the *California Short-Form Test of Mental Maturity*, Level 0, 1963 Revision. The test provides total, language, and nonlanguage I.Q.'s. The publisher's *Technical Report* presents data on the Pearson product-moment correlation coefficients, corrected for range and attenuation, between the test and the Stanford-Binet Intelligence Scale, 1960 Revision. The correlation coefficients for the total, language, and nonlanguage I.Q.'s are .87, .85, and .86, respectively (California Test Bureau, 1965, p. 24).

Tests were administered to small groups consisting of six to eight subjects each. All tests were administered by the investigator and an experienced assistant. Testing was conducted in private conference rooms near the children's own classrooms.

**Data Analysis**

1. The one-way analysis of variance (ANOVA) was used to determine the significance of differences among the scores made on the L-SCAT by subjects from the three community settings. The computer program used was the
BioMedical Data OIV (BMD OIV), version of June 15, 1966, Health Sciences Computing Facility, University of California at Los Angeles (UCLA).

2. In instances where a significant F-ratio was obtained from the ANOVA, the Tukey (a) posteriori procedure (Winer, 1962, p. 87) was employed to search for the source of the significance.

3. The Pearson product-moment correlation technique was used to determine the correlations among variables. The computer program used was the BMD 03D, version of March 1, 1966, Health Science Computing Facility, UCLA.

4. Multiple linear regression procedure was used to determine the variables which were the best predictors of performance on the L-SCAT. The computer program used was the BMD 02R, version of May 2, 1966, Health Sciences Computing Facility, UCLA.

Chapter Summary

This chapter, chapter three, has described the procedures used in the study. The chapter was designed to show both the chronological and logical steps followed in conducting the investigation.

The next chapter, chapter four, presents the results of the study. Discussions of results are included in the chapter also.
CHAPTER IV

RESULTS AND DISCUSSIONS

Introduction

The results and discussions are presented under three headings. One of the major hypotheses tested is treated under each heading. The headings are Differences in Life-Science Concept Acquisition Test Results among the Three Community Settings, Correlations of Independent Variables with Life-Science Concept Acquisition Test Results, and Independent Variables as Predictors of Performance on the Life-Science Concept Acquisition Test.

Differences in Life-Science Concept Acquisition Test Results among the Three Community Settings

The analysis of variance analyses on the L-SCAT results are presented in two sections. The first section treats analyses of difference on the overall L-SCAT results. The second section deals with analyses of difference on each of the seven conceptual themes. The three community settings are inner-urban, outer-urban, and rural-farm; the settings are referred to in the tables below as I-U, O-U, and R-F, respectively.

47
Overall Life-Science Concept Acquisition Test Results

Analysis of variance analyses were done on the results on each of the overall total, nonverbal, and verbal L-SCAT measures among the three community settings.

L-SCAT Total Score Results

Tables 1 and 2 present the results of this analysis.

**TABLE 1.—L-SCAT Total Score Results: Summary Table for Analysis of Variance with an Alpha of .05**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>F (critical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>1992.2344</td>
<td>8.14</td>
<td>3.19</td>
</tr>
<tr>
<td>Within Groups</td>
<td>48</td>
<td>244.7961</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 2.—L-SCAT Total Score Results: Tests on Differences between Pairs of Means Using the Tukey (a) Posteriori Procedure**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I-U</td>
<td>44.5882</td>
<td>55.7647</td>
<td>66.2353</td>
</tr>
<tr>
<td>R-F</td>
<td>55.7647</td>
<td>11.1765</td>
<td>21.6471</td>
</tr>
<tr>
<td>O-U</td>
<td>66.2353</td>
<td></td>
<td>10.4706</td>
</tr>
</tbody>
</table>

\[ q_{.95} (3,48) = 3.424 \]
\[ q_{.99} (3,48) = 4.334 \]
\[ q_{.95} (3,48) \sqrt{\text{MS}_{\text{error}}/n} = 12.9930 \ (\text{critical value}) \]
\[ q_{.99} (3,48) \sqrt{\text{MS}_{\text{error}}/n} = 16.4462 \ (\text{critical value}) \]
Examination of Tables 1 and 2 reveals that:

1. The L-SCAT total scores of the subjects of the three community settings are significantly different beyond the .05 level.

2. The outer-urban and inner-urban subjects' mean scores are significantly different beyond the .01 level.

3. The differences between the rural-farm and inner-urban subjects' mean scores and the differences between rural-farm and outer-urban subjects' mean scores are not significant at the .05 level.

4. Based on subjects' mean scores, the community setting rank-order, from low-to-high, is inner-urban, rural-farm, and outer-urban, respectively.

A subject's total L-SCAT score was the summation of his nonverbal and verbal scores. Because of the significance of the total score results above, the decision was made to analyze the data further to determine if the subjects' performances were significantly different on the nonverbal scores, the verbal scores, or both.

L-SCAT Nonverbal Score Results

Tables 3 and 4 present the results of this analysis.
TABLE 3.—L-SCAT Nonverbal Score Results: Summary Table for Analysis of Variance with an Alpha of .05

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>F (critical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>199.8434</td>
<td>8.27</td>
<td>3.19</td>
</tr>
<tr>
<td>Within Groups</td>
<td>48</td>
<td>24.1592</td>
<td>8.27</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 4.—L-SCAT Nonverbal Score Results: Tests on Differences between Pairs of Means Using the Tukey (a) Posteriori Procedure

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I-U</td>
<td>19.0588</td>
<td>23.0588</td>
<td>25.8823</td>
</tr>
<tr>
<td>R-F</td>
<td>23.0588</td>
<td></td>
<td>6.8235</td>
</tr>
<tr>
<td>O-U</td>
<td>25.8823</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

q .95 (3,48) = 3.424
q .99 (3,48) = 4.334
q .95 (3,48) √MSerror/n = 4.0821 (critical value)
q .99 (3,48) √MSerror/n = 5.1670 (critical value)

Examination of Tables 3 and 4 reveals that:
1. The L-SCAT nonverbal scores of the subjects of the three community settings are significantly different beyond the .05 level.
2. The outer-urban and inner-urban subjects' mean scores are significantly different beyond the .01 level.
3. The differences between the rural-farm and inner-urban subjects' mean scores and the differences between the rural-farm and outer-urban subjects'
mean scores are not significant at the .05 level. Based on subjects' mean scores, the community setting rank-order, from low-to-high, is inner-urban, rural-farm, and outer-urban, respectively.

L-SCAT Verbal Score Results

Tables 5 and 6 present the results of this analysis.

TABLE 5.— L-SCAT Verbal Score Results: Summary Table for Analysis of Variance with an Alpha of .05

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>F (critical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>934.1980</td>
<td>7.66</td>
<td>3.19</td>
</tr>
<tr>
<td>Within Groups</td>
<td>48</td>
<td>121.9091</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 6.— L-SCAT Verbal Score Results: Tests on Differences between Pairs of Means Using the Tukey (a) Posteriori Procedure

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I-U</td>
<td>25.5294</td>
<td>--</td>
<td>7.1765</td>
<td>14.8235</td>
</tr>
<tr>
<td>R-F</td>
<td>32.7059</td>
<td>--</td>
<td></td>
<td>7.6470</td>
</tr>
<tr>
<td>O-U</td>
<td>40.3529</td>
<td>--</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
q_{.95}(3,48) = 3.424 \\
q_{.99}(3,48) = 4.334 \\
\sqrt{\frac{MS_{\text{error}}}{n}} = 9.1691 \text{ (critical value)} \\
\sqrt{\frac{MS_{\text{error}}}{n}} = 11.6060 \text{ (critical value)}
\]
Examination of Tables 5 and 6 reveals that:

1. The L-SCAT verbal scores of the subjects of the three community settings are significantly different beyond the .05 level.

2. The outer-urban and inner-urban subjects' mean scores are significantly different beyond the .01 level.

3. The differences between the rural-farm and inner-urban subjects' mean scores and the differences between the rural-farm and outer-urban subjects' mean scores are not significant at the .05 level.

4. Based on subjects' mean scores, the community setting rank-order, from low-to-high, is inner-urban, rural-farm, and outer-urban, respectively.

Discussion of Overall L-SCAT Results

The initial set of analysis of variance analyses was conducted on the total, nonverbal, and verbal L-SCAT results. In every case, the F-ratio was significant beyond the .05 level (Tables 1, 3, and 5). Subsequent comparisons between means revealed that a major source of significance in each F-ratio was between the mean scores of the subjects of the inner-urban and outer-urban settings.

A body of research exists which deals with variations in general verbal facility among different children (Cazden, 1966). The results of the present study are supportive of these findings. There is little doubt that
conceptualization and language development go hand in hand (Thompson, 1962, p. 354). It should be pointed out, however, that the present investigation reveals that the subjects from the three community settings differed significantly in nonverbal performances, as well. It is assumed that a nonverbal response requires a less sophisticated level of conceptualization than does a verbalized response. Hurd (1969, p. 70), for example, states that a concept might exist in an "embryonic phase" even though the child is unable to verbalize it. The results of the present investigation suggest that concept acquisition, including that at the "embryonic" or nonverbal phase, can vary greatly among children who differ physically, mentally, and socio-culturally. Further research is needed to determine how "embryonic" concepts form, how they can be more effectively evaluated, and how they are related to the more sophisticated verbalizations of concepts.

The overall results show that the subjects from the three community settings were quite different in terms of their L-SCAT performances. The results raise several new questions, however. The L-SCAT covers life-science concepts from seven different conceptual themes. Do the subjects from the three community settings vary significantly in performance on each of the conceptual themes? On which theme does the most difference occur? Are all the themes appropriate for inclusion in the kindergarten program?
What is the rank-order, by community setting, of the subjects' mean scores on each conceptual theme? In an effort to answer these and other questions, a second set of analysis of variance analyses was conducted on the results made by the subjects of the three community settings on each conceptual theme.

**Conceptual Theme Results**

Only the analyses of total conceptual theme scores are reported below. The total score on any one theme was the summation of the nonverbal and verbal scores for that theme.

**Conceptual Theme 1.—The change of living things through time—evolution**

Tables 7 and 8 present the results of this analysis.

**TABLE 7.—Conceptual Theme 1. Total Score Results: Summary Table for Analysis of Variance with an Alpha of .05**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>F (critical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>16.7255</td>
<td>7.20</td>
<td>3.19</td>
</tr>
<tr>
<td>Within Groups</td>
<td>48</td>
<td>2.3235</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 8.—Conceptual Theme 1. Total Score Results: Tests on Differences between Pairs of Means Using the Tukey (a) Posteriori Procedure

<table>
<thead>
<tr>
<th>Comm. Sett.</th>
<th>I-U</th>
<th>R-F</th>
<th>O-U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means</td>
<td>2.0000</td>
<td>2.2353</td>
<td>3.8235</td>
</tr>
<tr>
<td>I-U</td>
<td>2.0000</td>
<td>--</td>
<td>2.2353</td>
</tr>
<tr>
<td>R-F</td>
<td>2.2353</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>O-U</td>
<td>3.8235</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

q .95 (3,48) = 3.424
q .99 (3,48) = 4.334
q .95 (3,48) \( \sqrt{\frac{MS_{error}}{n}} \) = 1.2631 (critical value)
q .99 (3,48) \( \sqrt{\frac{MS_{error}}{n}} \) = 1.5619 (critical value)

Examination of Tables 7 and 8 reveals that:

1. The Conceptual Theme 1. total scores of the subjects of the three community settings are significantly different beyond the .05 level.
2. The outer-urban and inner-urban subjects' mean scores are significantly different beyond the .01 level.
3. The rural-farm and outer-urban subjects' mean scores are significantly different beyond the .05 level.
4. The rural-farm and inner-urban subjects' mean scores are not significantly different at the .05 level.
5. Based on subjects' mean scores, the community setting rank-order, from low-to-high, is inner-
urban, rural-farm, and outer-urban, respectively.

Conceptual Theme 2.—Diversity of type and unity of pattern in living things

Tables 9 and 10 present the results of this analysis.

TABLE 9.—Conceptual Theme 2. Total Score Results: Summary Table for Analysis of Variance with an Alpha of .05

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>F (critical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>85.0781</td>
<td>8.26</td>
<td>3.19</td>
</tr>
<tr>
<td>Within Groups</td>
<td>48</td>
<td>10.3039</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 10.—Conceptual Theme 2. Total Score Results: Tests on Differences between Pairs of Means Using the Tukey (a) Posteriori Procedure

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7.0588</td>
<td>8.1176</td>
<td>11.3529</td>
</tr>
<tr>
<td>I-U</td>
<td></td>
<td>--</td>
<td>1.0588</td>
<td>4.2941</td>
</tr>
<tr>
<td>R-F</td>
<td></td>
<td>8.1176</td>
<td>--</td>
<td>3.2353</td>
</tr>
<tr>
<td>O-U</td>
<td></td>
<td>11.3529</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

q .95 (3,48) = 3.424
q .99 (3,48) = 4.334
q .95 (3,48) \sqrt{MS_{error/n}} = 2.6652 (critical value)
q .99 (3,48) \sqrt{MS_{error/n}} = 3.3735 (critical value)

Examination of Tables 9 and 10 reveals that:

1. The Conceptual Theme 2. total scores of the subjects of the three community settings are significantly different beyond the .05 level.
2. The outer-urban and inner-urban subjects' mean
scores are significantly different beyond the .01 level.

3. The outer-urban and rural-farm subjects' mean scores are significantly different beyond the .05 level.

4. The inner-urban and rural-farm subjects' mean scores are not significantly different at the .05 level.

5. Based on subjects' mean scores, the community setting rank-order, from low-to-high, is inner-urban, rural-farm, and outer-urban, respectively.

Conceptual Theme 3.—The genetic continuity of life.

Tables 11 and 12 present the results of this analysis.

### TABLE 11.—Conceptual Theme 3. Total Score Results: Summary Table for Analysis of Variance with an Alpha of .05

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>F (critical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>24.7255</td>
<td>3.72</td>
<td>3.19</td>
</tr>
<tr>
<td>Within Groups</td>
<td>48</td>
<td>6.6470</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 12.—Conceptual Theme 3. Total Score Results: Tests on Differences between Pairs of Means Using the Tukey (a) Posteriori Procedure

<table>
<thead>
<tr>
<th>Comm. Sett.</th>
<th>I-U</th>
<th>O-U</th>
<th>R-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means</td>
<td>7.7059</td>
<td>9.7647</td>
<td>9.8235</td>
</tr>
<tr>
<td>I-U</td>
<td>7.0759</td>
<td>2.0588</td>
<td>2.1176</td>
</tr>
<tr>
<td>O-U</td>
<td>9.7647</td>
<td>0.0588</td>
<td></td>
</tr>
<tr>
<td>R-F</td>
<td>9.8235</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examination of Tables 11 and 12 reveals that:

1. The Conceptual Theme 3. total scores of the subjects of the three community settings are significantly different beyond the .05 level.

2. None of the pairs of means are significantly different at the .05 level.

3. Based on subjects' mean scores, the community setting rank-order, from low-to-high, is inner-urban, outer-urban, and rural-farm, respectively.

Conceptual Theme 4.—Complementarity of organism and environment

Table 13 presents the results of this analysis.
Examination of Table 13 reveals that:

1. The Conceptual Theme 4. total scores of the subjects of the three community settings are not significantly different at the .05 level.

   Based on subjects' mean scores, the community setting rank-order, from low-to-high, on Conceptual Theme 4. total score results is inner-urban, rural-farm, and outer-urban, respectively.

Conceptual Theme 5.—Biological roots of behavior

Tables 14 and 15 present the results of this analysis.
TABLE 15.—Conceptual Theme 5. Total Score Results: Tests on Differences between Pairs of Means Using the Tukey (a) Posteriori Procedure

<table>
<thead>
<tr>
<th>Comm. Sett.</th>
<th>I-U</th>
<th>R-F</th>
<th>O-U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means</td>
<td>6.9412</td>
<td>9.2353</td>
<td>10.5882</td>
</tr>
<tr>
<td>I-U</td>
<td>6.9412</td>
<td>--</td>
<td>2.2941</td>
</tr>
<tr>
<td>R-F</td>
<td>9.2353</td>
<td>--</td>
<td>1.3529</td>
</tr>
<tr>
<td>O-U</td>
<td>10.5882</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

\[ q_{.95 (3,48)} = 3.424 \]
\[ q_{.99 (3,48)} = 4.334 \]
\[ q_{.95 (3,48)} \sqrt{\frac{MSError}{n}} = 2.6101 \text{ (critical value)} \]
\[ q_{.99 (3,48)} \sqrt{\frac{MSError}{n}} = 3.3038 \text{ (critical value)} \]

Examination of Tables 14 and 15 reveals that:

1. The Conceptual Theme 5. total scores of the subjects of the three community settings are significantly different beyond the .05 level.
2. The outer-urban and inner-urban subjects' mean scores are significantly different beyond the .01 level.
3. The differences between the rural-farm and outer-urban subjects' mean scores and the differences between the rural-farm and inner-urban subjects' mean scores are not significant at the .05 level.
4. Based on subjects' mean scores, the community setting rank-order, from low-to-high, is inner-urban, rural-farm, and outer-urban, respectively.
Conceptual Theme 6.—Complementarity of structure and function

Tables 16 and 17 present the results of this analysis.

TABLE 16.—Conceptual Theme 6. Total Score Results: Summary Table for Analysis of Variance with an Alpha of .05

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>F (critical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>49.7842</td>
<td>7.04</td>
<td>3.19</td>
</tr>
<tr>
<td>Within Groups</td>
<td>48</td>
<td>7.0662</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 17.—Conceptual Theme 6. Total Score Results: Tests on Differences between Pairs of Means Using the Tukey (a) Posteriori Procedure

<table>
<thead>
<tr>
<th>Comm.</th>
<th>I-U</th>
<th>R-F</th>
<th>O-U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means</td>
<td>5.7059</td>
<td>7.6471</td>
<td>9.1176</td>
</tr>
<tr>
<td>I-U</td>
<td>5.7059</td>
<td>--</td>
<td>1.9412</td>
</tr>
<tr>
<td>R-F</td>
<td>7.6471</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>O-U</td>
<td>9.1176</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

q .95 (3, 48) = 3.424
q .99 (3, 48) = 4.334
q .95 (3, 48) $\sqrt{\text{MS}_{\text{error}}/n} = 2.2074$ (critical value)
q .99 (3, 48) $\sqrt{\text{MS}_{\text{error}}/n} = 2.7941$ (critical value)
Examination of Tables 16 and 17 reveals that:

1. The Conceptual Theme 6. total scores of the subjects of the three community settings are significantly different beyond the .05 level.

2. The outer-urban and inner-urban subjects' mean scores are significantly different beyond the .01 level.

3. The differences between the rural-farm and outer-urban subjects' mean scores and the differences between the rural-farm and inner-urban subjects' mean scores are not significant at the .05 level.

4. Based on subjects' mean scores, the community setting rank-order, from low-to-high, is inner-urban, rural-farm, and outer-urban, respectively.

Conceptual Theme 7.— Regulation and homeostasis—preservation of life in the face of change

Tables 18 and 19 present the results of this analysis.

TABLE 18.—Conceptual Theme 7. Total Score Results: Summary Table for Analysis of Variance with an Alpha of .05

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>F (critical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>30.3529</td>
<td>5.86</td>
<td>3.19</td>
</tr>
<tr>
<td>Within Groups</td>
<td>48</td>
<td>5.1765</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>5.1765</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 19.—Conceptual Theme 7. Total Score Results: Tests on Differences between Pairs of Means Using the Tukey (a) Posteriori Procedure

<table>
<thead>
<tr>
<th>Comm Sett.</th>
<th>I-U</th>
<th>R-F</th>
<th>O-U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means</td>
<td>8.8235</td>
<td>9.1765</td>
<td>11.2941</td>
</tr>
<tr>
<td>I-U</td>
<td></td>
<td>0.3530</td>
<td>2.4706</td>
</tr>
<tr>
<td>R-F</td>
<td>2.1176</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O-U</td>
<td>11.2941</td>
<td>2.1176</td>
<td></td>
</tr>
</tbody>
</table>

\[ q_{.95} (3,48) = 3.424 \]
\[ q_{.99} (3,48) = 4.334 \]
\[ q_{.95} (3,48) \sqrt{\frac{\text{MSE}}{n}} = 1.8897 \text{ (critical value)} \]
\[ q_{.99} (3,48) \sqrt{\frac{\text{MSE}}{n}} = 2.3919 \text{ (critical value)} \]

Examination of Tables 18 and 19 reveals that:
1. The Conceptual Theme 7. total scores of the subjects of the three community settings are significantly different beyond the .05 level.
2. The outer-urban and inner-urban subjects' mean scores are significantly different beyond the .01 level.
3. The rural-farm and outer-urban subjects' mean scores are significantly different beyond the .05 level.
4. The inner-urban and rural-farm subjects' mean scores are not significantly different at the .05 level.
5. Based on the subjects' mean scores, the community setting rank-order, from low-to-high, is inner-
urban, rural-farm, and outer-urban, respectively.

Discussion of Conceptual Theme Results

The analysis of variance analyses on six of the seven conceptual themes revealed F-ratios significant beyond the .05 level. The rank-order of themes, from largest-to-smallest F-ratio (critical F at .05 level equals 3.19), is

Conceptual Theme 2.—Diversity of type and unity of pattern in living things (F=8.26).

Conceptual Theme 1.—The change of living things through time—evolution (F=7.20).

Conceptual Theme 6.—Complementarity of structure and function (F=7.04).

Conceptual Theme 7.—Regulation and homeostasis—preservation of life in the face of change (F=5.86).

Conceptual Theme 5.—Biological roots of behavior (F=5.85).

Conceptual Theme 3.—The genetic continuity of life (F=3.72).

Conceptual Theme 4.—Complementarity of organism and environment (F=2.61).

The analysis on Conceptual Theme 3. revealed results that were unique in at least three respects. The first was in the rank-order, by community setting, of the subjects' mean scores. The rank-order, from low-to high, on Conceptual Theme 3. was inner-urban, outer-urban, and rural-farm, respectively. On all of the other conceptual themes the rank-order, from low-to-high, was inner-urban, rural-farm, and outer-urban, respectively.
A second feature in the uniqueness of Conceptual Theme 3. results was in the sources of information expressed by the subjects. The major sources referred to in discussing all of the themes were other people, television, books, and direct experience. The rural-farm children, in general, relied more on direct experience than did the children of the other settings. This was outstandingly so on Conceptual Theme 3. Such responses as "Our old dog had six pups" (Subject III, 17.) or "I saw the seeds in apples before" (Subject III, 4.) are examples of responses from direct experience.

The third unique feature is found in the results of the posteriori test on Conceptual Theme 3. Table 11 reveals that the F-ratio among the means of the three community settings is significant at the .05 level. The posteriori test (Table 12) shows that none of the between-mean values is significant. The lack of significance in between-mean values does not invalidate the significant F-ratio. It only indicates that the posteriori test used was not sensitive enough to locate the significance. The significant F-ratio was probably due to additive effects of several factors and not simply the difference between any two pairs of means. Hays (1963, p. 485) summarizes the meaning of a significant F-test when he states

This does not mean that just because the overall F was significant you will necessarily find the significant comparisons, but only that they
exist to be found. Hence, our interpretation of a significant F as a signal, "Something's here—start looking."

Inferences drawn from the subjects' performances on the individual themes must be viewed as guarded speculations, at best. The present investigation was not designed as an exhaustive examination of the conceptual themes or of the specific concepts included therein. There is no question, however, that there were marked differences in the performances among students from the three community settings on the different themes. Further in-depth research is needed to determine more precisely the reasons for differences in performance within each theme. Some speculative inferences can be made here, however.

The nature of the subjects' responses suggest to the investigator that at least some of the difference in performance among the subjects is the result of differences in the acquisition of basic nondisciplinary concepts. For examplary purposes, only, consider the first two themes in which the differences in performance among the subjects were most striking. One of the basic nondisciplinary concepts underlying Conceptual Theme 1. (The change of living things through time—evolution) is time. The subjects in this study were sometimes confused about terms such as "used to live," "long, long, time ago," "before," "most time," and so on. Research supports the findings of the present investigation that temporal
relationships, especially those of the past, are not well developed at kindergarten age (Thompson, 1962, pp. 333-337). Research (Leeper, 1968) on young children's ability to deal with concepts of conservation of substance, area, and so on, suggests that the concept of change, itself, might not be well developed at five or six years of age. Leeper (1968) concluded that the significance of the difference in children's performances on conservation concepts could be largely attributed to differences in their background experiences.

Conceptual Theme 2. (Diversity of type and unity of pattern in living things) is grounded in the basic non-disciplinary concepts of likeness and difference. Subjects in this study varied greatly in their abilities to deal with these basic concepts. Other research supports the contention that the concepts of likeness and difference are the forerunners of the ability to group and classify on the basis of increasing numbers of characteristics and that such an ability is not well developed at kindergarten age (Inhelder and Piaget, 1964).

The examples above are intended to emphasize the investigator's belief that there are basic nondisciplinary concepts which might be the key elements in a child's understanding relationships inherent in the life-sciences. Specially designed research is needed to test this belief. Further implications are presented in the final chapter.
Correlations of Independent Variables with Results from the Life-Science Concept Acquisition Test

Each of the thirty-one independent variables was correlated with each of the three L-SCAT measures (non-verbal, verbal, and total) across the total sample population (N=51). The results of these analyses are presented in Table 20.

TABLE 20. Correlations of Independent Variables with L-SCAT Results

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>L-SCAT Nonverbal</th>
<th>L-SCAT Verbal</th>
<th>L-SCAT Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x_1) (com-set)</td>
<td>0.29532&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.23813</td>
<td>0.25977</td>
</tr>
<tr>
<td>(x_2) (age)</td>
<td>0.09637</td>
<td>0.11490</td>
<td>0.11082</td>
</tr>
<tr>
<td>(x_3) (sex)</td>
<td>0.00710</td>
<td>0.02010</td>
<td>0.01631</td>
</tr>
<tr>
<td>(x_4) (I-I.Q.)</td>
<td>0.69406&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.70954&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.71550&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>(x_5) (II-I.Q.)</td>
<td>0.51703&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.46497&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.48845&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>(x_6) (I-Q.)</td>
<td>0.71124&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.69564&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.71116&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>(x_7) (n-s-att)</td>
<td>0.03423</td>
<td>0.01448</td>
<td>0.02092</td>
</tr>
<tr>
<td>(x_8) (H-S-att)</td>
<td>0.25940</td>
<td>0.29907&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.29114&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(x_9) (pets)</td>
<td>-0.11934</td>
<td>-0.04467</td>
<td>-0.06886</td>
</tr>
<tr>
<td>(x_{10}) (h-plant)</td>
<td>-0.23226</td>
<td>-0.28477&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.27259&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(x_{11}) (f-gard)</td>
<td>-0.11379</td>
<td>-0.11342</td>
<td>-0.11526</td>
</tr>
<tr>
<td>(x_{12}) (v-gard)</td>
<td>-0.27003</td>
<td>-0.19988</td>
<td>-0.22501</td>
</tr>
<tr>
<td>(x_{13}) (b-feed)</td>
<td>-0.12092</td>
<td>-0.07623</td>
<td>-0.09147</td>
</tr>
<tr>
<td>(x_{14}) (a-food)</td>
<td>-0.02404</td>
<td>0.05113</td>
<td>0.02824</td>
</tr>
<tr>
<td>(x_{15}) (zoo)</td>
<td>-0.19477</td>
<td>-0.23749</td>
<td>-0.22767</td>
</tr>
<tr>
<td>(x_{16}) (farm)</td>
<td>-0.27281&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.31811&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.30871&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(x_{17}) (doc-ex)</td>
<td>0.13640</td>
<td>0.12802</td>
<td>0.13261</td>
</tr>
<tr>
<td>(x_{18}) (dent-ex)</td>
<td>-0.28031&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.32619&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.31676&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(x_{19}) (t.v.)</td>
<td>0.12265</td>
<td>0.12811</td>
<td>0.12835</td>
</tr>
</tbody>
</table>
TABLE 2A--Continued

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>L-SCAT Nonverbal</th>
<th>L-SCAT Verbal</th>
<th>L-SCAT Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>x20 (reading)</td>
<td>0.21155</td>
<td>0.22358</td>
<td>0.22320</td>
</tr>
<tr>
<td>x21 (pt-occ)</td>
<td>0.44005b</td>
<td>0.44944b</td>
<td>0.45334b</td>
</tr>
<tr>
<td>x22 (mo-empl)</td>
<td>0.04323</td>
<td>-0.04495</td>
<td>-0.01788</td>
</tr>
<tr>
<td>x23 (r/o)</td>
<td>0.31609a</td>
<td>0.36978b</td>
<td>0.35853b</td>
</tr>
<tr>
<td>x24 (y-ed-fa)</td>
<td>0.38286b</td>
<td>0.42365b</td>
<td>0.41727b</td>
</tr>
<tr>
<td>x25 (y-ed-mo)</td>
<td>0.46316b</td>
<td>0.53389b</td>
<td>0.51977b</td>
</tr>
<tr>
<td>x26 (fa-pres)</td>
<td>-0.09937</td>
<td>-0.12495</td>
<td>-0.11880</td>
</tr>
<tr>
<td>x27 (mo-pres)</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>x28 (ol-sibs)</td>
<td>0.10087</td>
<td>0.21658</td>
<td>0.18346</td>
</tr>
<tr>
<td>x29 (yo-sibs)</td>
<td>0.29694a</td>
<td>0.33680a</td>
<td>0.32939a</td>
</tr>
<tr>
<td>x30 (b-o-ra)</td>
<td>-0.21486</td>
<td>-0.32001a</td>
<td>-0.29179a</td>
</tr>
<tr>
<td>x31 (ext-fam)</td>
<td>0.30696a</td>
<td>0.29165a</td>
<td>0.30092a</td>
</tr>
</tbody>
</table>

\(a\) Significant at or beyond an alpha of .05 for a two-tailed test.

\(b\) Significant at or beyond an alpha of .01 for a two-tailed test.

Discussion of Correlation Results

Table 20 shows the results of the correlation analysis. Most of these results are more meaningful in the discussion of the multiple regression analyses. Two factors should be pointed out at this time, however.

Results in Table 20 must be interpreted with care. Responses on several variables were reported on a yes or no basis. In cases of a yes or no type response, a yes was scored as one; a no was scored as two. For example, consider the variable \(x26\) (the presence of the father in the home). The negative correlation on this variable indicates
that the presence of the father in the home ($x_{26}$) is, in fact, associated with children scoring higher on the L-SCAT. Chapter three, on procedure, should be consulted where some question exists as to the nature of the response required on any variable.

It is important to note that every subject in this investigation had a mother present in the home. As a result, the zero correlation of this variable ($x_{27}$) has no meaning. The variable is dropped in the multiple regression analyses.

Independent Variables as Predictors of Performance on the Life-Science Concept Acquisition Test

The thirty independent variables which correlated with the L-SCAT results ($x_{27}$ was excluded) were subjected to several multiple regression analyses. These analyses were used to determine the importance of each independent variable (predictor) and combinations of independent variables as predictors of total, nonverbal, and verbal performances on the L-SCAT (the dependent or criterion variables).

There are several measures which can be used to determine the importance of predictor variables. When, as in this investigation, the primary focus is on simple prediction, the measure of relative usefulness is of most interest (Darlington, 1968).
The computer output from the step-wise multiple regression program used in this study provided two indicators of the relative usefulness of any predictor variable \( (x_1) \). One indicator is related to the increase in the square of the multiple correlation coefficient \( (R^2) \) as a result of the variable \( (x_1) \) being added to the regression equation. The increase in \( R^2 \), multiplied by 100, reveals the maximum per cent of variance that can be attributed to the variable \( (x_1) \) in the regression equation. A second indicator is related to the rank-order of entry of the variable \( (x_1) \) into the regression equation.

The first predictor variable entered into a specified regression equation in this investigation was the one which had the highest simple correlation with the criterion. After a variable was entered, new partial correlation coefficients and F-ratios were computed for each remaining predictor not yet in the equation. The remaining predictor with the largest F-ratio was then selected as the next variable to be entered. Following the entry of each variable, the variables then in the equation were reweighted and a new multiple correlation coefficient and F-ratio were computed for that equation. The process was continued and printed out in a step-wise form until all the predictors were in the equation for predicting performance on the L-SCAT.
The first set of regression analyses included all thirty independent variables which correlated with the L-SCAT results (Table 20). A second set of regression analyses included independent variables selected from the thirty variables included in the first analysis.

The results of the regression analyses are presented below in summary form. It has been assumed that a predictor variable has a low relative usefulness when it contributes .01 or less to the square of the multiple correlation coefficient (\( R^2 \)). Therefore, the tables presented below summarize the results of the entry of each variable into the equation down through the entry of the last variable which contributes greater than .01 to the square of the multiple correlation coefficient (\( R^2 \)).

**Multiple Regression Analyses Using All of the Thirty Independent Variables**

These analyses were conducted using all thirty independent variables as predictors of the total, non-verbal, and verbal performances on the L-SCAT. Results are summarized below in Tables 21, 22, and 23.
TABLE 21.—Summary of Regression Analysis Using All Thirty Independent Variables as Predictors of Total Performance on the L-SCAT.

<table>
<thead>
<tr>
<th>Independent Variables in Equation</th>
<th>Multiple R</th>
<th>Multiple R²</th>
<th>Increase in Multiple R²</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>x₁ (1-I.Q.)</td>
<td>0.7155</td>
<td>0.5119</td>
<td>0.5119</td>
<td>1/49</td>
<td>51.40</td>
</tr>
<tr>
<td>x₂ (age)</td>
<td>0.7773</td>
<td>0.6042</td>
<td>0.0923</td>
<td>2/48</td>
<td>36.62</td>
</tr>
<tr>
<td>x₅ (nl-I.Q.)</td>
<td>0.7968</td>
<td>0.6349</td>
<td>0.0307</td>
<td>3/47</td>
<td>27.24</td>
</tr>
<tr>
<td>x₂₃ (r/o)</td>
<td>0.8127</td>
<td>0.6605</td>
<td>0.0256</td>
<td>4/46</td>
<td>22.37</td>
</tr>
<tr>
<td>x₂₈ (ol-sibs)</td>
<td>0.8251</td>
<td>0.6808</td>
<td>0.0203</td>
<td>5/45</td>
<td>19.19</td>
</tr>
<tr>
<td>x₁₀ (h-plant)</td>
<td>0.8344</td>
<td>0.6962</td>
<td>0.0154</td>
<td>6/44</td>
<td>16.80</td>
</tr>
<tr>
<td>x₁₅ (zoo)</td>
<td>0.8439</td>
<td>0.7122</td>
<td>0.0160</td>
<td>7/43</td>
<td>15.20</td>
</tr>
<tr>
<td>x₁ (com-set)</td>
<td>0.8531</td>
<td>0.7278</td>
<td>0.0156</td>
<td>8/42</td>
<td>14.04</td>
</tr>
<tr>
<td>x₂₁ (pt-occ)</td>
<td>0.8609</td>
<td>0.7411</td>
<td>0.0133</td>
<td>9/41</td>
<td>13.04</td>
</tr>
<tr>
<td>x₂₂ (mo-empl)</td>
<td>0.8667</td>
<td>0.7512</td>
<td>0.0101</td>
<td>10/40</td>
<td>12.08</td>
</tr>
<tr>
<td>Thirty Variables in Equation</td>
<td>0.8982</td>
<td>0.8067</td>
<td>---</td>
<td>30/20</td>
<td>2.78</td>
</tr>
</tbody>
</table>

aAll F-ratios are significant beyond the .05 level.

Examination of Table 21 reveals that when all thirty independent variables are included in the regression equation for predicting total performance on the L-SCAT:

1. Language I.Q. (x₁) is the most useful predictor.
2. Chronological age (x₂) is the second most useful predictor in combination with language I.Q. (x₁).
3. The first ten variables entered into the equation contribute a maximum of 75.12 per cent to the accountable variance.
4. The last twenty variables entered into the equation contribute a maximum combined total of only 5.5 per cent to the accountable variance.

<table>
<thead>
<tr>
<th>Independent Variables in Rank-Order of Entry</th>
<th>Multiple R</th>
<th>Multiple R²</th>
<th>Increase in Multiple R²</th>
<th>df</th>
<th>F²</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x_6 (t\text{-I.Q.}) )</td>
<td>0.7112</td>
<td>0.5058</td>
<td>0.5058</td>
<td>1/49</td>
<td>50.16</td>
</tr>
<tr>
<td>( x_2 \text{(age)} )</td>
<td>0.7720</td>
<td>0.5960</td>
<td>0.0902</td>
<td>2/48</td>
<td>35.41</td>
</tr>
<tr>
<td>( x_{29} \text{(yo-sibs)} )</td>
<td>0.7843</td>
<td>0.6151</td>
<td>0.0191</td>
<td>3/47</td>
<td>25.05</td>
</tr>
<tr>
<td>( x_{21} \text{(pt-occ)} )</td>
<td>0.7947</td>
<td>0.6315</td>
<td>0.0164</td>
<td>4/46</td>
<td>19.71</td>
</tr>
<tr>
<td>( x_{14} \text{(a-food)} )</td>
<td>0.8077</td>
<td>0.6524</td>
<td>0.0209</td>
<td>5/45</td>
<td>16.89</td>
</tr>
<tr>
<td>( x_{12} \text{(v-gard)} )</td>
<td>0.8169</td>
<td>0.6673</td>
<td>0.0149</td>
<td>6/44</td>
<td>14.70</td>
</tr>
<tr>
<td>( x_{11} \text{(f-gard)} )</td>
<td>0.8318</td>
<td>0.6919</td>
<td>0.0246</td>
<td>7/43</td>
<td>13.79</td>
</tr>
<tr>
<td>( x_9 \text{(pets)} )</td>
<td>0.8374</td>
<td>0.7012</td>
<td>0.0093</td>
<td>8/42</td>
<td>12.32</td>
</tr>
<tr>
<td>( x_{10} \text{(h-plant)} )</td>
<td>0.8435</td>
<td>0.7115</td>
<td>0.0103</td>
<td>9/41</td>
<td>11.23</td>
</tr>
<tr>
<td>( x_{26} \text{(fa-pres)} )</td>
<td>0.8501</td>
<td>0.7227</td>
<td>0.0112</td>
<td>10/40</td>
<td>10.42</td>
</tr>
</tbody>
</table>

Thirty Variables in Equation: 0.8912 0.7942 --- 30/20 2.57

a All F-ratios are significant beyond the .05 level.

Examination of Table 22 reveals that when all thirty independent variables are included in the regression equation for predicting nonverbal performance on the L-SCAT:

1. Total I.Q. \((x_6)\) is the most useful predictor.

2. Chronological age \((x_2)\) is the second most useful predictor in combination with total I.Q. \((x_6)\).
3. The first ten variables entered into the equation contribute a maximum of 72.27 per cent to the accountable variance.

4. The last twenty variables entered into the equation contribute a maximum combined total of only 7.15 per cent to the accountable variance.

TABLE 23.—Summary of Regression Analysis Using All Thirty Independent Variables as Predictors of Verbal Performance on the L-SCAT.

<table>
<thead>
<tr>
<th>Independent Variables in Rank-Order of Entry</th>
<th>Multiple R</th>
<th>Multiple $R^2$</th>
<th>Increase in Multiple $R^2$</th>
<th>df</th>
<th>$F^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_4$ (1-I.Q.)</td>
<td>0.7095</td>
<td>0.5034</td>
<td>0.5034</td>
<td>1/49</td>
<td>49.68</td>
</tr>
<tr>
<td>$x_2$ (age)</td>
<td>0.7728</td>
<td>0.5972</td>
<td>0.0928</td>
<td>2/48</td>
<td>35.59</td>
</tr>
<tr>
<td>$x_{23}$ (r/o)</td>
<td>0.7944</td>
<td>0.6311</td>
<td>0.0339</td>
<td>3/47</td>
<td>26.80</td>
</tr>
<tr>
<td>$x_{10}$ (h-plant)</td>
<td>0.8109</td>
<td>0.6576</td>
<td>0.0265</td>
<td>4/46</td>
<td>22.08</td>
</tr>
<tr>
<td>$x_{15}$ (zoo)</td>
<td>0.8288</td>
<td>0.6869</td>
<td>0.0293</td>
<td>5/45</td>
<td>19.74</td>
</tr>
<tr>
<td>$x_1$ (com-set)</td>
<td>0.8386</td>
<td>0.7032</td>
<td>0.0163</td>
<td>6/44</td>
<td>17.38</td>
</tr>
<tr>
<td>$x_{21}$ (pt-occ)</td>
<td>0.8458</td>
<td>0.7154</td>
<td>0.0122</td>
<td>7/43</td>
<td>15.44</td>
</tr>
<tr>
<td>$x_{29}$ (yo-sibs)</td>
<td>0.8528</td>
<td>0.7273</td>
<td>0.0119</td>
<td>8/42</td>
<td>14.00</td>
</tr>
<tr>
<td>$x_7$ (n-s-sibs)</td>
<td>0.8581</td>
<td>0.7363</td>
<td>0.0090</td>
<td>9/41</td>
<td>12.72</td>
</tr>
<tr>
<td>$x_{22}$ (mo-empi)</td>
<td>0.8641</td>
<td>0.7467</td>
<td>0.0104</td>
<td>10/40</td>
<td>11.79</td>
</tr>
<tr>
<td>--</td>
<td>0.8959</td>
<td>0.8026</td>
<td>--</td>
<td>30/20</td>
<td>2.71</td>
</tr>
</tbody>
</table>

$^a$All $F$-ratios are significant beyond the .05 level.

Examination of Table 23 reveals that when all thirty independent variables are included in the regression equation for predicting verbal performance on the L-SCAT:

1. Language I.Q. ($x_4$) is the most useful predictor.
2. Chronological age \( (x_2) \) is the second most useful predictor in combination with language I.Q. \( (x_4) \).

3. The first ten variables entered into the equation contribute a maximum of 74.67 per cent to the accountable variance.

4. The last twenty variables entered into the equation contribute a maximum combined total of only 5.59 per cent to the accountable variance.

Discussion of Multiple Regression Analyses Which Included All Thirty Variables

In discussing all results of this investigation, it is imperative that certain cautions be observed so as not to imply erroneous relationships. All independent variables are ex post facto in nature. Therefore, no causal relationships between independent and dependent variables can be inferred.

The results of the regression analyses using all thirty independent variables clearly indicate that the most useful predictor of L-SCAT performance is intelligence quotient (I.Q.). Chronological age is the second most useful predictor in combination with I.Q. (Tables 21, 22, and 23).

The relatively high positive correlations between I.Q. and L-SCAT measures and the recent revival of the controversy over the nature of I.Q., intelligence, and intelligence testing, suggests that some interpretations by the
investigator should occur at this point. The investigator is well aware of many of the deficiencies and present concerns over I.Q. testing. Voyat (1969) addresses himself to the controversy and expresses deep concern over what I.Q. tests measure, how they measure it, and the fact that they "can never be culture fair." Neither the purpose nor the scope of the present investigation permits an in-depth study of intelligence and intelligence testing. A cursory examination of the I.Q. test used in the present investigation, however, suggests that the high correlations might be the expected result. Further, findings from such an examination support an assumption made above under the discussion of conceptual theme results. The assumption was made that basic non-disciplinary concepts played some part in the subjects' performance on the L-SCAT. A large part of the I.Q. test deals with basic non-disciplinary concepts such as "opposite," "most," "difference," "go together," "same," "tallest," "lightest," "smallest," and so on. Therefore, it does not seem unusual that there be a relatively high correlation between L-SCAT scores and the scores on this particular I.Q. test. The major assumption is that both the I.Q. test and the L-SCAT measure some factor of intellectual functioning. Further, it seems probable that I.Q., like concept development, is not a fixed quantity but that it can be altered by environmental factors (Hunt, 1961). However, from the standpoint of the present investigation, the
important conclusion is that performance on the I.Q. test is a very useful predictor of performance on the L-SCAT. The investigator's general interpretation of I.Q. is supported by Bloom and others (1964, pp. 9-13) when they state that

... recent research has demonstrated that for children growing up under adverse circumstances the I.Q. may be depressed by a significant amount ... while there is nothing sacred about the I.Q., it has been a useful indicator of general learning capability in the schools. A change in I.Q. is symptomatic of a change in general learning capability and is likely to be verified by some direct measure of school learning.

The usefulness of chronological age (x2) as a predictor is of interest. Since all of the subjects were beginning kindergarten children, the differences in ages were quite small (mean = 67.1 months; S.D. = 3.9; S.E. of Mean = 0.5). The simple correlation of age with any of the L-SCAT measures was not significant (Table 20). However, in the multiple regression analyses, age (x2) was the most useful predictor in combination with a measure of I.Q. (Tables 21, 22, and 23). This result can be interpreted as supportive of the hypothesis that chronological age is a significant factor in life-science concept acquisition. Such an interpretation is in agreement with Piaget's general contention that chronological age is one major factor in cognitive development (Piaget, 1964).

The abundance of other research on sex differences and performance of elementary school children warrants some
discussion of the impact of the variable, $x_3$ (sex), in this investigation. Table 20 shows that sex had a very low correlation with the L-SCAT measures. Further, the regression analyses (Tables 21, 22, and 23) reveal that sex did not contribute more than 1 per cent to the accountable variance in any of the equations. Sex differences, then, in this investigation, were of little significance. Sex role identification has its greatest growth between the ages of five and nine years (Thompson, 1962, p. 475). It is quite probable, therefore, that the sex role identification has not yet established itself at beginning kindergarten age to the point that it is a significant factor in life-science concept development. It might be a very significant factor at a later age, however.

**Multiple Regression Analyses Using Twenty-Five Selected External Independent Variables**

A review of Tables 21, 22, and 23 above shows that, in every case, the two most useful predictors of L-SCAT performance are some measure of I.Q. and chronological age. Both of these variables are part of the "personal" make-up of the child. The present investigation treats relationships among children from varied socio-cultural backgrounds. Therefore, it seemed desirable to continue the analysis of data to determine the usefulness of only those predictors which are "external" to the personal make-up of the child himself. These "external" variables are closely related to
the environmental context within which the child lives.

Examination of the thirty independent variables used as predictors in the results reported above reveals that five of the variables are partially or totally within the personal make-up of the child. The five variables that are a part of the child are $x_2$ (age), $x_3$ (sex), $x_4$ (language I.Q.), $x_5$ (nonlanguage I.Q.), and $x_6$ (total I.Q.). There is little doubt that the first two measures (age and sex) are within the personal make-up of the child. Some argument might be made, however, about the I.Q. measures. The investigator readily supports the premise that I.Q. can be greatly affected by environment. He takes the position, however, that the child's I.Q., regardless of its cause, is an integral part of the child. The investigator is also aware that the environment's response to the child and the child's response to the environment might be highly associated with any of the five variables. Such complementarity is assumed to be closely related to concept formation. The fact remains, however, that the five variables ($x_2$, $x_3$, $x_4$, $x_5$, and $x_6$) are partially or totally within the personal make-up of the child.

Another variable, $x_{30}$ (birth-order rank), could be considered as more closely related to the personal make-up of the child than to external factors. However, since the variable, ($x_{30}$), is viewed in light of the child's relationships to older and younger siblings, it is designated as an external variable.
A second set of multiple regression analyses was conducted to determine the usefulness of only those predictors which were external to the personal make-up of the child, himself.

For these analyses, twenty-five predictors were selected from the original group of thirty independent variables by the elimination of $x_2$ (age), $x_3$ (sex), $x_4$ (languages I.Q.), $x_5$ (nonlanguage I.Q.) and $x_6$ (total I.Q.). Results are summarized below in Tables 24, 25, and 26.

**TABLE 24.--Summary of Regression Analysis Using a Selection of Twenty-five External Independent Variables as Predictors of Total Performance on the L-SCAT.**

<table>
<thead>
<tr>
<th>Independent Variables in Rank-Order of Entry</th>
<th>Multiple $\text{R}$</th>
<th>Multiple $\text{R}^2$</th>
<th>Increase in Multiple $\text{R}^2$</th>
<th>df</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_{25}(y-ed-mo)$</td>
<td>0.5198</td>
<td>0.2702</td>
<td>0.2702</td>
<td>1/49</td>
<td>18.14a</td>
</tr>
<tr>
<td>$x_{29}(yo-sibs)$</td>
<td>0.5929</td>
<td>0.3515</td>
<td>0.0813</td>
<td>2/48</td>
<td>13.01a</td>
</tr>
<tr>
<td>$x_{31}(ext-fam)$</td>
<td>0.6405</td>
<td>0.4102</td>
<td>0.0587</td>
<td>3/47</td>
<td>10.90a</td>
</tr>
<tr>
<td>$x_{15}(zoo)$</td>
<td>0.6803</td>
<td>0.4628</td>
<td>0.0526</td>
<td>4/46</td>
<td>9.91a</td>
</tr>
<tr>
<td>$x_{10}(h-plant)$</td>
<td>0.7007</td>
<td>0.4910</td>
<td>0.0282</td>
<td>5/45</td>
<td>8.68a</td>
</tr>
<tr>
<td>$x_{17}(doc-ex)$</td>
<td>0.7171</td>
<td>0.5142</td>
<td>0.0232</td>
<td>6/44</td>
<td>7.76a</td>
</tr>
<tr>
<td>$x_{30}(b-o-ra)$</td>
<td>0.7316</td>
<td>0.5352</td>
<td>0.0210</td>
<td>7/43</td>
<td>7.07a</td>
</tr>
<tr>
<td>$x_{28}(ol-sibs)$</td>
<td>0.7596</td>
<td>0.5770</td>
<td>0.0418</td>
<td>8/42</td>
<td>7.16a</td>
</tr>
<tr>
<td>$x_{19}(t.v.)$</td>
<td>0.7698</td>
<td>0.5926</td>
<td>0.0156</td>
<td>9/41</td>
<td>6.63a</td>
</tr>
<tr>
<td>$x_1$(com-set)</td>
<td>0.7783</td>
<td>0.6057</td>
<td>0.0131</td>
<td>10/40</td>
<td>6.15a</td>
</tr>
<tr>
<td>$x_{18}$(dent-ex)</td>
<td>0.7917</td>
<td>0.6268</td>
<td>0.0211</td>
<td>11/39</td>
<td>5.96a</td>
</tr>
<tr>
<td>Twenty-five Variables in Equation</td>
<td>0.8101</td>
<td>0.6563</td>
<td>---</td>
<td>25/25</td>
<td>1.91</td>
</tr>
</tbody>
</table>

$^aF$-ratios significant at or beyond the .05 level.
Examination of Table 24 reveals that when a selection of twenty-five external independent variables is included in the regression equation for predicting total performance on the L-SCAT:

1. Number of years education of mother ($x_{25}$) is the most useful predictor.

2. Presence of younger siblings ($x_{29}$) is the second most useful predictor in combination with number of years education of mother ($x_{25}$).

3. The first eleven variables entered into the equation contribute a maximum of 62.68 per cent to the accountable variance.

4. The last fourteen variables entered into the equation contribute a maximum combined total of only 2.95 per cent to the accountable variance.
<table>
<thead>
<tr>
<th>Independent Variables in Rank-Order of Entry</th>
<th>Multiple R</th>
<th>Multiple R²</th>
<th>Increase in Multiple R²</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_{25}(y-ed-mo)$</td>
<td>0.4632</td>
<td>0.2145</td>
<td>0.2145</td>
<td>1/49</td>
<td>13.38a</td>
</tr>
<tr>
<td>$x_{1}(com-set)$</td>
<td>0.5523</td>
<td>0.3050</td>
<td>0.0905</td>
<td>2/48</td>
<td>10.53a</td>
</tr>
<tr>
<td>$x_{15}(zoo)$</td>
<td>0.5934</td>
<td>0.3521</td>
<td>0.0471</td>
<td>3/47</td>
<td>8.52a</td>
</tr>
<tr>
<td>$x_{29}(yo-sibs)$</td>
<td>0.6277</td>
<td>0.3940</td>
<td>0.0419</td>
<td>4/46</td>
<td>7.48a</td>
</tr>
<tr>
<td>$x_{31}(ext-fam)$</td>
<td>0.6519</td>
<td>0.4250</td>
<td>0.0310</td>
<td>5/45</td>
<td>6.65a</td>
</tr>
<tr>
<td>$x_{28}(ol-sibs)$</td>
<td>0.6716</td>
<td>0.4510</td>
<td>0.0260</td>
<td>6/44</td>
<td>6.03a</td>
</tr>
<tr>
<td>$x_{19}(t.v.)$</td>
<td>0.7073</td>
<td>0.5003</td>
<td>0.0493</td>
<td>7/43</td>
<td>6.15a</td>
</tr>
<tr>
<td>$x_{30}(b-o-ra)$</td>
<td>0.7247</td>
<td>0.5252</td>
<td>0.0249</td>
<td>8/42</td>
<td>5.81a</td>
</tr>
<tr>
<td>$x_{18}(dent-ex)$</td>
<td>0.7367</td>
<td>0.5427</td>
<td>0.0175</td>
<td>9/41</td>
<td>5.41a</td>
</tr>
<tr>
<td>$x_{12}(v-gard)$</td>
<td>0.7513</td>
<td>0.5644</td>
<td>0.0217</td>
<td>10/40</td>
<td>5.18a</td>
</tr>
<tr>
<td>$x_{10}(h-plant)$</td>
<td>0.7586</td>
<td>0.5755</td>
<td>0.0111</td>
<td>11/39</td>
<td>4.81a</td>
</tr>
<tr>
<td>$x_{17}(doc-ex)$</td>
<td>0.7642</td>
<td>0.5840</td>
<td>0.0085</td>
<td>12/38</td>
<td>4.44a</td>
</tr>
<tr>
<td>$x_{21}(pt-occ)$</td>
<td>0.7701</td>
<td>0.5930</td>
<td>0.0090</td>
<td>13/37</td>
<td>4.15a</td>
</tr>
<tr>
<td>$x_{9}(pets)$</td>
<td>0.7752</td>
<td>0.6009</td>
<td>0.0079</td>
<td>14/36</td>
<td>3.87a</td>
</tr>
<tr>
<td>$x_{26}(fa-pres)$</td>
<td>0.7833</td>
<td>0.6136</td>
<td>0.0127</td>
<td>15/35</td>
<td>3.71a</td>
</tr>
</tbody>
</table>

Twenty-five Variables in Equation

<table>
<thead>
<tr>
<th>Multiple R</th>
<th>Multiple R²</th>
<th>Increase in Multiple R²</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7900</td>
<td>0.6241</td>
<td>---</td>
<td>25/25</td>
<td>1.66</td>
</tr>
</tbody>
</table>

aF-ratios significant at or beyond the .05 level.

Examination of Table 25 reveals that when a selection of twenty-five external independent variables is included in the regression equation for predicting nonverbal performance on the L-SCAT:

1. Number of years education of mother ($x_{25}$) is the most useful predictor.
2. Community setting \((x_1)\) is the second most useful predictor in combination with number of years education of mother \((x_{25})\).

3. The first fifteen variables entered into the equation contribute a maximum of 61.36 per cent to the accountable variance.

4. The last ten variables entered into the equation contribute a maximum combined total of only 1.05 per cent to the accountable variance.

TABLE 26.—Summary of Regression Analysis Using a Selection of Twenty-five External Independent Variables as Predictors of Verbal Performance on the L-SCAT

<table>
<thead>
<tr>
<th>Independent Variables in Rank-Order of Entry</th>
<th>Multiple (R)</th>
<th>Multiple (R^2)</th>
<th>Increase in Multiple (R^2)</th>
<th>df</th>
<th>(p^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x_{25}(y-ed-mo))</td>
<td>0.5339</td>
<td>0.2850</td>
<td>0.2850</td>
<td>1/49</td>
<td>19.54</td>
</tr>
<tr>
<td>(x_{29}(yo-sibs))</td>
<td>0.6082</td>
<td>0.3699</td>
<td>0.0849</td>
<td>2/48</td>
<td>14.09</td>
</tr>
<tr>
<td>(x_{31}(ext-fam))</td>
<td>0.6508</td>
<td>0.4235</td>
<td>0.0536</td>
<td>3/47</td>
<td>11.51</td>
</tr>
<tr>
<td>(x_{15}(zoo))</td>
<td>0.6924</td>
<td>0.4794</td>
<td>0.0559</td>
<td>4/46</td>
<td>10.59</td>
</tr>
<tr>
<td>(x_{10}(h-plant))</td>
<td>0.7156</td>
<td>0.5121</td>
<td>0.0327</td>
<td>5/45</td>
<td>9.44</td>
</tr>
<tr>
<td>(x_{30}(b-o-ra))</td>
<td>0.7374</td>
<td>0.5438</td>
<td>0.0317</td>
<td>6/44</td>
<td>8.74</td>
</tr>
<tr>
<td>(x_{28}(ol-sibs))</td>
<td>0.7642</td>
<td>0.5840</td>
<td>0.0402</td>
<td>7/43</td>
<td>8.62</td>
</tr>
<tr>
<td>(x_{16}(farm))</td>
<td>0.7743</td>
<td>0.5995</td>
<td>0.0155</td>
<td>8/42</td>
<td>7.86</td>
</tr>
<tr>
<td>(x_{17}(doc-ex))</td>
<td>0.7812</td>
<td>0.6103</td>
<td>0.0108</td>
<td>9/41</td>
<td>7.13</td>
</tr>
<tr>
<td>(x_{18}(dent-ex))</td>
<td>0.7895</td>
<td>0.6233</td>
<td>0.0130</td>
<td>10/40</td>
<td>6.62</td>
</tr>
<tr>
<td><strong>Twenty-five Variables in Equation</strong></td>
<td><strong>0.8153</strong></td>
<td><strong>0.6647</strong></td>
<td><strong>---</strong></td>
<td><strong>25/25</strong></td>
<td><strong>1.98</strong></td>
</tr>
</tbody>
</table>

\(^a\)All \(F\)-ratios are significant at or beyond the .05 level.
Examination of Table 26 reveals that when a selection of twenty-five external independent variables is included in the regression equation for predicting verbal performance on the L-SCAT:

1. Number of years education of mother (\(x_{25}\)) is the most useful predictor.

2. Presence of younger siblings (\(x_{29}\)) is the second most useful predictor in combination with number of years education of mother (\(x_{25}\)).

3. The first ten variables entered into the equation contribute a maximum of 62.33 per cent to the accountable variance.

4. The last fifteen variables entered into the equation contribute a maximum combined total of only 4.14 per cent to the accountable variance.

Discussion of Multiple Regression Analyses Which Included Twenty-five External Variables

Examination of the independent variables listed in Table 20 reveals that nine of the variables are strongly "other people" oriented. That is, they pertain directly to the presence of other people in the life of the child. The nine "other people" variables are \(x_{22}\) (mother employed), \(x_{24}\) (number of years education of father), \(x_{25}\) (number of years of education of mother), \(x_{26}\) (father present), \(x_{27}\) (mother present), \(x_{28}\) (presence of older sibling), \(x_{29}\) (presence of younger sibling), \(x_{30}\) (birth-order rank), and \(x_{31}\) (extended family). It was pointed out above that the
mother was present in the home \( (x_{27}) \) in every case so that variable \( (x_{27}) \) correlates at zero with the L-SCAT measures.

Table 20 shows that the "other people" independent variables which correlate most highly with the L-SCAT measures are the number of years education of the mother \( (x_{25}) \) and the number of years education of the father \( (x_{24}) \). If one assumes the number of years education of the parents to be related, in some way, to the general home environment and experiences provided for the child, the results are expected ones. There is a body of research on social class and parental influences which lend support this assumption (Thompson, 1962, pp. 634-635).

Although both independent variables \( x_{24} \) (number of years education of father) and \( x_{25} \) (number of years education of mother) correlate positively beyond the .01 level with the L-SCAT measures, the results of the regression analyses are quite revealing. Tables 24, 25, and 26 show the results of the regression analyses using the twenty-five external independent variables of which the "other people" variables are a part. In every case, the number of years education of the mother \( (x_{25}) \) is the most useful predictor. Further examination reveals that the number of years education of the father \( (x_{24}) \) contributes less than 1 per cent to the variance. This result is also in accord with other research. Thompson (1962, p. 630) summarizes the inferences from other research when he states that
In terms of time spent with the child, the mother has more opportunities than the father to influence her offspring's psychological growth and behavior. Tradition also favors the mother's influence, since child rearing in our culture is generally recognized as primarily the mother's privilege and responsibility.

Tables 24, 25, and 26 lead to further speculation about "other people" variables. In the verbal and total analyses (Tables 24 and 26), the presence of younger siblings \(x_{29}\) is the second most useful variable to enter in combination with \(x_{25}\) (number of years education of the mother). In each of these cases, \(x_{29}\) (presence of younger siblings) contributes a maximum of 8 per cent to the accountable variance. The same variable contributes a maximum of 4 per cent to the accountable variance in predicting nonverbal performance on the L-SCAT (Table 25). The presence of younger siblings \(x_{29}\) correlates significantly at the .05 level with each of the L-SCAT measures (Table 20). The nature of the correlation coefficient indicates that those children who had younger siblings did less well than those who did not. These results and those on birth-order rank \(x_{30}\) and presence of older siblings \(x_{28}\) show that the only child performed better on the L-SCAT than did children with either older or younger siblings (Tables 20, 24, 25, and 26). Direct causal inferences about the effects of older or younger siblings on cognitive development cannot be made from these results. The results are, however, in agreement with those reported
by Altus (1966) in his review of the literature on birth-order rank and general performance.

Another "other people" variable, extended family \( x_{31} \), shows some usefulness as a predictor of performance. Tables 24 and 26 reveal it to be the third variable entered and contributing a maximum of between 5 and 6 per cent to the accountable variance. Table 20 shows that \( x_{31} \) (extended family) correlates significantly at or beyond the .05 level with each of the L-SCAT measures and that subjects who lived in extended families did less well than those who did not.

The present investigation indicates that "other people" variables were more useful in the prediction of verbal L-SCAT performance than in the prediction of nonverbal performance. Table 26 reveals, for example, that approximately 50 per cent of the variance in verbal performance might be attributed to "other people" variables; Table 25 reveals that approximately 36 per cent of the variance in nonverbal performance might be attributed to "other people" variables. Cazden's (1966) review of related literature points to the influence of other people on a child's language development. Thompson (1962, p. 354) refers to the close relationship between conceptual development and the development of language skills. Therefore, it is not surprising that "other people" variables were
better predictors of verbal than nonverbal performance on the L-SCAT.

Chapter Summary

This chapter, chapter four, has presented the results of this investigation and discussions of those results. The results and discussions were presented under three headings. One of the major hypotheses tested was treated under each heading.

The next chapter, chapter five, is a summary of this investigation. The summary presents the conclusions and implications derived from the investigation.
CHAPTER V

SUMMARY

Conclusions

The conclusions in this study are limited to the procedures employed, the populations from which the samples were selected, and the specific life-science concepts which made up the Life-Science Concept Acquisition Test (L-SCAT). The subjects were beginning kindergarten children from three different community settings—inner-urban, outer-urban, and rural-farm.

I. There are significant differences, at alpha equals .05, among the total scores made on the L-SCAT by the subjects in this study. Therefore hypothesis $H_0$ is rejected.

A. There are also significant differences, at alpha equals .05, among both the nonverbal and verbal L-SCAT scores made by the subjects.

B. The differences between the inner-urban and outer-urban subjects' mean scores on each of the L-SCAT measures (total, nonverbal and verbal) are significant at alpha equals .01.
C. Based on subjects' mean scores, the community setting rank-order, from low-to-high, on the L-SCAT total, nonverbal, and verbal measures is inner-urban, rural-farm, and outer-urban, respectively.

D. There are significant differences, at alpha equals .05, among total scores made by the subjects on six of the seven conceptual themes. The rank-order of the six themes, from largest-to-smallest F-ratio, is

- Conceptual Theme 2.—Diversity of type and unity of pattern in living things.
- Conceptual Theme 1.—The change of living things through time—evolution.
- Conceptual Theme 6.—Complementarity of structure and function.
- Conceptual Theme 7.—Regulation and homeostasis—preservation of life in the face of change.
- Conceptual Theme 5.—Biological roots of behavior.
- Conceptual Theme 3.—The genetic continuity of life.
- Conceptual Theme 4.—Complementarity of organism and environment.

E. There are no significant differences, at alpha equals .05, among the total scores made by the subjects on Conceptual Theme 4.—Complementarity of organism and environment.
F. Based on subjects' mean scores, the community setting rank-order, from low-to-high, on Conceptual Themes 1., 2., 4., 5., 6., and 7. is inner-urban, rural-farm, and outer-urban, respectively.

G. Based on subjects' mean scores, the community setting rank-order, from low-to-high, on Conceptual Theme 3. is inner-urban, outer-urban, and rural-farm, respectively.

H. Differences on each of the L-SCAT and conceptual theme mean scores between the inner-urban and outer-urban subjects were greater than either the differences between rural-farm and inner-urban subjects or the differences between rural-farm and outer-urban subjects.

I. The differences found among the scores of the subjects from the three community settings on the individual conceptual themes seemed, in some cases, to be chiefly due to differences in the development of basic nondisciplinary concepts such as time relationships, change, likeness and difference, cause and effect, and so on.

II. There are significant correlations, at alpha equals .05, between the subjects' L-SCAT total scores and some of the independent variables in
this study. Therefore, hypotheses $H_0$ 2 is rejected.

A. There are also significant correlations, at alpha equals .05, between some of the independent variables and both nonverbal and verbal L-SCAT scores made by the subjects.

III. The relative importance of the independent variables in this study as predictors of a subject's total performances on the L-SCAT was determined. Therefore, hypothesis $H_0$ 3 is rejected.

A. When all of the independent variables are included in the analysis, the most useful predictors of L-SCAT performances are variables which are partially or totally a part of the personal make-up of the child.

1. A subject's language I.Q. is the most useful variable in predicting his total or verbal L-SCAT performance. The correlations between predictor and criterion variables are positive.

2. A subject's total I.Q. is the most useful variable in predicting his nonverbal L-SCAT performance. The correlations between predictor and criterion variables are positive.

3. A subject's chronological age is the second
most useful variable, in combination with I.Q., in predicting his total, nonverbal, or verbal L-SCAT performance. The correlations between predictor and criterion variables are positive.

4. A subject's sex is not a useful variable in predicting his performance on any of the L-SCAT measures.

B. When only selected independent variables which are external to the personal make-up of the child, himself, are included in the analysis, the most useful predictors of L-SCAT performance are ones related to "other people" in the life of the child.

1. The number of years education of the subject's mother is the most useful variable in predicting his total, nonverbal, or verbal L-SCAT performance. The correlations between predictor and criterion variables are positive.

2. The presence of younger siblings and whether or not a subject lived in an extended family are the second and third most useful variables, respectively, in combination with number of years education of the mother, in predicting his total or verbal L-SCAT performance.
3. A subject who was an only child in a family with only the mother and father performed better on the total, nonverbal, and verbal L-SCAT measures than a subject with either older or younger siblings and/or living in an extended family.

4. In combination with the number years education of the mother, a subject's community setting and whether or not he had visited a zoo, are the second and third most useful variables, respectively, in predicting his nonverbal L-SCAT performance. Based on subjects' mean nonverbal scores, the community setting rank-order, from low-to-high, is inner-urban, rural-farm, and outer-urban, respectively. Children who had visited a zoo out-performed those who had not.

5. Variables related to "other people" in the life of the child are more useful in predicting verbal L-SCAT performance than in predicting nonverbal L-SCAT performance.

Implications

The implications presented below are derived from this study and subject to its limitations. Many of the implications, however, seem applicable to other aspects of the study of early childhood, as well.
Life-Science in the Kindergarten Curriculum

A major problem facing curriculum planners pertains to decisions about what content should be included in the program. The children in this study seemed, in general, to be highly motivated by the content of the Life-Science Concept Acquisition Test. They were most eager to share their thoughts and stories about plants and animals and the various relationships investigated during the testing. The first-grade textbooks of eleven elementary school science series were used as references in developing the content for the L-SCAT (Appendix B). From the standpoint of interest and motivation alone, these factors lead to the implication that the life-science content found in many of the existing first-grade textbooks is appropriate for inclusion at the kindergarten level.

The implication derived in the paragraph above is believed to be a sound one. In a sense, it is only an affirmation of Bruner's (1960, p. 33) general hypothesis that "... any subject can be taught effectively in some intellectually honest form, to any child at any stage of development." The key word in Bruner's statement is not the thrice repeated word, any, but rather the word, some, in the phrase "... in some intellectually honest form. . . ." Bruner does not say "in the one and only intellectually honest form." This is just the point for curriculum planners and textbook writers! Pedagogical theory dictates
that different children learn at different rates and in different ways. The present investigation reveals that beginning kindergarten children can be markedly different in life-science concept development. Therefore, no single life-science program can be suitable for all kindergarten children. Existing primary school textbooks, however, make little or no provision for children with differing physical, mental, and socio-cultural make-ups. Therefore, the general life-science content in existing programs might be judged appropriate under the Brunerian hypothesis stated above, but, the unidimensional approaches used in presenting the content cannot be accepted.

Basic research is needed to determine the importance of nondisciplinary concepts in understanding the different conceptual themes. Follow-up research should be designed to determine "some intellectually honest form" for presenting the different conceptual themes to children who differ physically, mentally, and socio-culturally. Kindergarten teachers should strive to arrange concept building experiences at a level from which the children can move. The results of the present investigation, for example, suggest that some children do not understand time-sequence relationships. Therefore, an intellectually honest form of dealing with Conceptual Theme 1. (Change of living things through time--evolution) might initially be in helping the students understand the sequence of events of the school
day; snack-time comes "after" work-play but "before" rest period. The appropriateness of other activities for encouraging the development of change-through-time concepts should be investigated. Arranging and discussing the time-sequence of sets of pictures is such an activity. Decisions about the methods of presenting any specific life-science concept in the kindergarten program must be based on the students' readiness (cognitively and emotionally) to deal effectively with that concept at that point in time.

Efforts should be made to collect as much information as possible about children prior to and at the time of their kindergarten entrance. The best of this information should be used for determining and/or predicting present levels of conceptualization. Life-science programs with multidimensional approaches for dealing with the different themes should be developed. The multidimensional approaches should consider the varying needs of children who differ physically, mentally, and socio-culturally.

The present investigation is a study of life-science content. Research is also needed to determine kindergarten children's understanding and abilities in dealing with science as a process or method of inquiry.

Factors Affecting Concept Development

Several variables have been found to be useful in predicting life-science concept development in beginning kindergarten children. These variables should be a part of
the background information collected on each child. Further research, however, is needed to determine the effects and interactions of these and other variables which might be related to life-science concept development in early childhood. Research programs should be designed to determine when, in a child's life, the various factors begin to affect life-science concept development and what the effects of planned intervention at this early age might be. Special attention should be given to problems related to the effects of physical and intellectual deprivation in early childhood as factors in the ability to conceptualize.

The usefulness of "other people" variables in predicting verbal performance on the L-SCAT suggests that verbal facility is, in some way, related to socialization. This inference is supported by the literature (Cazden, 1966). Further research is needed to determine how other people in the child's environment influence his language development and, more specifically, the extent to which that language development is related to life-science concept acquisition. This implication seems especially pertinent in light of the species-specific nature of language and concept formation. David Krech (1969, p. 374) carries this argument further when he supports McNeill's judgment that "... the study of how language is acquired may provide insight into the very basis of mental life."
Concept Tests

The concept test (L-SCAT) and techniques developed in pilot testing and used in this study were adequate to the demands placed on them. Similar testing techniques are recommended for similar studies. The general L-SCAT format as a picture-stimulus, structured-interview worked well. The nonverbal response of pointing provided active and physical involvement on the part of the subjects. This involvement seemed to be an important factor in maintaining subjects' interest and encouraging their verbal responses during the interview. Additional studies should be done to determine children's reactions when allowed to handle and manipulate real objects as a part of the test situation.

"Rapport-building-visits" prior to actual interviewing, are strongly recommended as a desirable technique in studies dealing with young children. The initial apprehensiveness of the subjects in this study would have made interviewing a difficult and nonproductive task during the first school visits. Their anxieties diminished quickly, however, as the investigator participated in classroom activities. Recording of nonverbal responses during the interview and the use of an audio-tape recorder to record verbal responses caused little or no distraction for the interviewee. In fact, the tape recorder served as a motivational device in instances where a shy child would become much more "talkative" after hearing a playback of his own voice.
The L-SCAT was not designed to determine different areas or levels of cognition in a contrived or existing hierarchial scheme. Further research with beginning kindergarten children is needed to determine cognitive levels in such schemes. Life-science concept development, for example, could be investigated in accord with a scheme which categorizes concepts as classificational, correlational, or theoretical (Pella, 1966).

The nonverbal responses on the L-SCAT were dependent on the subjects' understanding of verbal stimuli provided by the interviewer. To obtain a true nonverbal response, evaluation devices and methods need to be developed which do not rely on a verbal stimulus.

**Teaching Life-Science Concepts**

The most direct and outstanding implication to be derived from the results of this study is that curriculum planners and kindergarten teachers must accept and act on the premise that children come to them initially with a wide range of understanding of life-science concepts. This acceptance and action is especially important for the kindergarten level because it is there that the child normally begins his long career in formal education. If concepts are, in fact, built on other concepts (Hurd, 1969, p. 56), then this is indeed an important implication!

Long range and continuous research through all grade levels is needed to determine what life-science concepts can
be taught and the most effective method for teaching them to children who differ physically, mentally, and socio-culturally. The present investigation suggests that mental ability (I.Q.) and chronological age should be carefully considered at the kindergarten level in determining what to teach and how to teach it. Further research should be done to determine the relationship of these variables to life-science concept development at higher grade levels.

Sex does not appear to be an important factor in life-science concept development at the kindergarten age. However, sex role identification grows very rapidly between the ages of five and nine years (Thompson, 1962, p. 475). Therefore, the role of sex in concept acquisition above the kindergarten level should be further investigated.

Other Sciences in the Kindergarten Curriculum

It is assumed that children need and encounter all of the sciences in their daily lives. Therefore, research should be done to determine the physical and earth-space concepts held by beginning kindergarten children. The relationship of these concepts to the many variables associated with the differing lives of children needs to be established. Appropriate methods for teaching physical and earth-space sciences should be investigated.

Preschool Programs

The years between birth and kindergarten seem to be
very important in terms of cognitive development. Further study on the role of preschool programs and their effectiveness in fostering intellectual growth should be undertaken.

The job of fostering intellectual growth in early childhood, however, might be too great for "in-school" preschool programs alone. The results of this study and related research suggest that the mother plays an important role in a young child's cognitive development. Therefore, research is needed to develop ways of helping mothers learn how to work more effectively with their children in the home setting.

Chapter Summary

This chapter, chapter five, has summarized the present investigation. The chapter presented several conclusions and implications.

In chapter one, it was suggested that a first step in planning a kindergarten science curriculum is to determine or predict what science concepts children with differing physical, mental, and socio-cultural characteristics bring to kindergarten for the first time. Although the task is far from complete, the present investigation has shed some light on life-science concept development among differing children. The results of the study can be viewed as initial input for the second step of program planning in kindergarten science. That second step involves the building of frameworks for curriculum design which are based on information obtained in the first step.
Please answer the following questions in relation to the child you are enrolling in kindergarten. Feel free to write in any comments which you think are necessary to explain your answers further.

I. Place an X in the box which best answers each of the following questions.

1. Has your child attended a nursery school before kindergarten?
   ☐ yes ☐ no comments:

2. Has your child attended a Head Start program before kindergarten?
   ☐ yes ☐ no comments:

3. Has your child ever had any animal pets?
   ☐ yes ☐ no comments:

4. Has your child ever helped care for house plants in the home?
   ☐ yes ☐ no comments:

5. Has your child ever helped care for a flower garden?
   ☐ yes ☐ no comments:

6. Has your child ever helped care for a vegetable garden?
   ☐ yes ☐ no comments:

7. Has your child ever helped care for a bird feeder for wild birds?
   ☐ yes ☐ no comments:

8. Has your child ever helped care for animals used for food purposes (for example, chickens for meat or eggs, cattle for meat or milk, and so on?)
   ☐ yes ☐ no comments:

9. Has your child ever visited a zoo?
   ☐ yes ☐ no comments:

10. If your child does not live on a farm, has he ever visited a farm?
    ☐ yes ☐ no comments:

11. Has your child been examined by a doctor (physician) within the past 2 years?
    ☐ yes ☐ no comments:

12. Has your child been examined by a dentist within the past 2 years?
    ☐ yes ☐ no comments:
13. About how much time does your child spend each day watching television?
☐ none ☐ ½ hour ☐ 1 hour ☐ 3 hours ☐ 5 hours ☐ more than 5 hours
comments: (What are your child's favorite programs? Please list here.)

14. About how much time each week does someone in the home spend reading to the child?
☐ none ☐ ½ hour ☐ 1 hour ☐ 3 hours ☐ 5 hours ☐ more than 5 hours
comments: (What kinds of stories does your child like best? Please list.)

II. Place the correct answer in the blank following each question below.

15. What is the child's father's occupation? _________________________________
16. What is the child's mother's occupation? _________________________________
17. What does the child say he wants to be when he grows up? (If he hasn't said, just leave this one blank.)
__________________ comments:
18. Counting only kitchens, living rooms, dining rooms, and bedrooms, how many rooms are in the home in which this child lives?
__________________ comments:
19. About how many years of schooling has this child's father completed? ______
20. About how many years of schooling has this child's mother completed? ______

III. Place a numeral (0, 1, 2, 3, 4, 5, etc.) in the blank space before each group of words to show how many of each of these family members are actually living in the same home with the child.

The child's father (or stepfather) ______ The child's grandparent(s)
The child's mother (or stepmother) ______ The child's aunt(s)
The child's older brother(s) ______ The child's uncle(s)
The child's younger brother(s) ______ The child's cousin(s)
The child's older sister(s) ______ Others not listed above
The child's younger sister(s)
This appendix treats the Life-Science Concept Acquisition Test (L-SCAT). The appendix is divided into three sections under the following headings: (1) Test Format and Development, (2) Interview Schedule and Verbal Scoring Scale, and (3) Pilot Testing.

Test Format and Development

The L-SCAT consists of twenty-one sets of colored pictures which are the symbolic representations of thirty-five concept items. The first-grade textbooks of eleven elementary school science series were used as references in developing the content for the L-SCAT. The series used were the following:


The thirty-five concept items were distributed among the seven Biological Sciences Curriculum Study (BSCS) content conceptual themes. The themes are (Andrews, 1964, p. 3):

1. The change of living things through time—evolution.
2. Diversity of type and unity of pattern in living things.
3. The genetic continuity of life.
4. Complementarity of organism and environment.
5. Biological roots of behavior.
6. Complementarity of structure and function.
7. Regulation and homeostasis—preservation of life in the face of change.

Each of the colored pictures in the L-SCAT was bordered in white. Then, each of the twenty-one sets of pictures was mounted on an 8 1/2 X 11 inch section of black construction paper and placed in a transparent plastic folder. The folders were enclosed in a loose-leaf ring-binder. The folders were arranged in a sequential order which cycled among the several conceptual themes. Such cycling was an effort to reduce the effects of subjects' fatigue on the results on any one conceptual theme.

During the development of the L-SCAT, a measure of content validity was achieved from evaluations of the instrument by a panel of judges. The panel consisted of a professor in elementary school science education, a primary grade teacher with expertise in the teaching of reading,
and three kindergarten teachers. The judges were asked to rate each of the sets of picture items and accompanying interview schedule in terms of the concept, the symbolic representation, and the verbal instructions given by the interviewer. Each set was rated in accord with an "Item Evaluation Form." A copy of the form appears on the following page. An item which received a "weak" rating by any judge on any part of the evaluation was repaired and resubmitted for a second evaluation. The final form of the test consisted of twenty-one sets of pictures.

Each subject was interviewed individually in a private room near his own classroom. The loose-leaf binder was placed before the child and the pictures were shown to him, one set at a time. As a set of pictures was presented to a subject, he was asked to respond nonverbally to a statement about the pictures. The nonverbal response was made by pointing to a specific picture or part of a picture. The subject was then asked to verbalize why he had made that particular selection. The verbalization of a concept was expanded through the use of probing questions asked by the interviewer. Nonverbal responses were scored during the interview. Each interview was audio tape recorded. The tape recordings were used to score the verbal responses at a time after the interview was completed. Verbal responses were scored in accord with a previously established verbal-response criterion-scale for
ITEM EVALUATION FORM

In response to each question below, please circle your estimate (good, average, weak) of the item. Make any additional comments you feel are appropriate.

CONCEPT:

The Concept

1. Is this a concept? good average weak
2. Is this a valid concept under this biological theme? good average weak
3. Does the conceptual idea require a level of cognition within the range of which one might "reasonably expect" a 5-year old to operate? good average weak

The Symbolic Representation

1. Does the symbolic representation portray the conceptual idea? good average weak
2. Are the symbolic representations clear, distinct, and easily recognizable to one familiar with the objects or things? good average weak
3. Are the picture choices similar enough in size characteristics so that one choice is not emphasized? good average weak
4. Are the picture choices similar enough in color characteristics so that one choice is not emphasized? good average weak
5. Are the pictures mounted similarly enough so that one choice is not emphasized? good average weak
6. Are the "things" represented in the pictures within a frame of reference which one might "reasonably expect" a 5-year old to operate? good average weak

The Questions and Instructions

1. Does the language used in the questions and instructions approximate that of a 5-year old? good average weak
2. Are the questions and instructions worded so they are consistent with a "reasonable expectation" of a 5-year old's storehouse of information? good average weak
3. Are the questions and instructions phrased so as not to suggest the appropriate answer? good average weak
4. Are the questions and instructions limited to a number of ideas which one might "reasonably expect" a 5-year old to be able to process at one time? good average weak
5. Are the questions presented in a sequence from broad, open ones to more direct and specific ones (funneling approach)? good average weak
each item. Each subject received a nonverbal and a verbal score on each item and on the test as a whole. The summation of the nonverbal and verbal scores resulted in a total score.

**Interview Schedule and Verbal Scoring Scale**

Each set of pictures was accompanied by a structured interview schedule. The decision to use a picture-stimulus structured-interview was based on several factors. Among those factors were the following: (1) objective data was desired, (2) there was need for an interview format which was consistent and repetitive, (3) less skill and experience would be required of the interviewer than in interviewing and interpreting results from a nonstructured and solely verbal interview, (4) there was a desire to provide subjects with stimuli other than those which were verbal in nature, and (5) the colored pictures served as a compromise between using stimuli which were solely verbal and the use of real objects and/or live materials as stimuli during the interview. The writings of Yarrow (1960) and Piaget (1967, pp. 1-32) provided much direction in the development of the interview format.

The interview schedule and verbal response scoring scale for each of the thirty-five concept items are presented below. The pictures used as symbolic representations of the concepts are described in the interview schedule after
the symbol S.R. The interviewer's first statements, designed to elicit the subject's nonverbal response, are presented in the interview schedule after the symbol N-V. The questions designed to elicit the subject's verbal responses are presented below after the symbol V. These are guide questions only. The exact nature of questioning was determined by the subject's initial response.

The alphabetical ordering of the concepts under each conceptual theme does not necessarily follow the exact sequence of the alphabet. For example, Conceptual Theme 1 is made up of concept items IA and IC; concept item IB is missing. Concept item IB was judged inappropriate as a result of the pilot testing and was, therefore, eliminated from the final form of the L-SCAT. Code numbers for the concept items (IA, IB, et cetera) were kept constant throughout the development of the L-SCAT so that comparisons of results on any item could be easily made.

I. CONCEPTUAL THEME: The change of living things through time—evolution.

A. CONCEPT: Some of the life-forms of past geologic times are now extinct.

1. The dinosaur (Brontosaurus) lived on the earth a long, long time ago but does not live today.

2. The contemporary butterfly, porpoise, and elephant are life-forms of the present.

3. Fossils provide evidence of life-forms of past geologic times.

S.R.: Pictures of a Brontosaurus, a contemporary butterfly, a contemporary porpoise, and a contemporary elephant.
N-V: Here are pictures of some animals. Point to the picture of the animal that lived a long, long time ago but does not live today.

V: Why did you point to that one?
What is the name of that animal?
Are any _____ living today?
How do people know that _____ lived a long, long time ago?

Points  Verbal scoring criteria for concept IA.
0  No response; inappropriate response
1  Verbally identifies the animal that lived a long, long, time ago. Credit "dinosaur."
1  States that dinosaurs (may or may not use the term dinosaur) do not live today. Credit a "no" response to the interviewer asking if dinosaurs are alive today.
1  Gives scientific evidence for the previous existence of dinosaurs (may or may not use the term dinosaur). Credit the use of evidence such as "fossils," "bones," "parts of bodies," "remains," etc.

I. CONCEPTUAL THEME: The change of living things through time—evolution.

C. CONCEPT: Time must pass in order for change to occur.

1. A candle gets shorter as it burns over a period of time.

S.R.: Drawings of four candles of varying lengths.

N-V: Here are pictures of some candles. Point to the one that has been burning the most (greatest amount, longest) time.

Note: The child is not told, unless he asks, that the candles were all the same length and that they were lit at the same time. It is felt that this inclusion would complicate the question by adding too much information for the subject to process.
V: Why did you pick that candle?
Why do you think it has burned the most time?

Points | Verbal scoring criteria for concept IC.
0      | No response; inappropriate response.
1      | States why he selected the shortest candle as the one that has burned the most time. Credit "it is smaller," "it is shortest," "it has all burned down," "it has melted down," etc.

II. CONCEPTUAL THEME: Diversity of type and unity of pattern in living things.

B. CONCEPT: Animals can be placed into different groups (classified) on the basis of their observable characteristics.

1. Birds have observable likenesses that justify the placing of them together in a group.

2. The squirrel has observable characteristics different from those of the group of birds and, thus, set it apart from that group.

S.R.: Pictures of three birds and one squirrel.

N-V: Here are pictures of some animals. Point to the picture of the animal that should not be with the others.

V: Tell me why you think that one should not be with the others.
Are they alike or different?
Tell me how they are different (alike).

Points | Verbal scoring criteria for concept IIB.
0      | No response; inappropriate response.
1      | States that the squirrel is different from the birds. Credit even if subject does not identify "squirrel." Credit such responses as "this is a squirrel, these are birds," "they are dif-
ferent kinds of animals," "they belong to dif­
ferent families," etc.

1 Gives one scientific reason how they are dif­
ferent. Credit such responses as "birds fly,
squirrels don't," "squirrels have four feet,
birds have two," etc.

1 Gives at least one additional scientific reason
how they are different.

II. CONCEPTUAL THEME: Diversity of type and unity of pattern
in living things.

C. CONCEPT: Animals have many kinds of body coverings.

1. The snail has a hard shell.
   a. Several other kinds of animals have hard shells.

2. Birds have feathers.
   a. The pigeon is a bird.

3. Some fish have scales.
   a. The catfish does not have scales.

4. Rabbits have fur (hair).
   a. Other mammals have fur (hair).

S.R.: Pictures of a bird (pigeon), a fish (with
scales), a rabbit and a snail.

N-V: Here are pictures of some animals.

1. Point to the picture of the one that has a
   hard shell.
2. Point to the picture of the one that has
   feathers.
3. Point to the picture of the one that has
   scales.
4. Point to the picture of the one that has
   fur or hair.

N-V: (Immediately after each N-V response above,
interviewer asks...)

1. Why did you point to that one?
   What is that called?
   Can you name some other animals that
   have hard shells?
2. Why did you point to that one?
   What is that called?
   What kind of a (bird) is it?
3. Why did you point to that one?
   What is that called?
   Do all (fish) have scales?
   What kinds do not?
4. Why did you point to that one?
   What is that called?
   Can you name some other animals that have fur or hair?

<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept IIC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response.</td>
</tr>
<tr>
<td>1</td>
<td>(1.) Verbally identifies snail. Credit &quot;snail.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(1.) Names another animal that has a hard shell. Credit &quot;turtle,&quot; &quot;oyster,&quot; &quot;clam,&quot; &quot;armadillo,&quot; or any arthropod with a hard exoskeleton (e.g. &quot;lobster&quot;).</td>
</tr>
<tr>
<td>1</td>
<td>(2.) Verbally identifies bird. Credit &quot;bird.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(2.) States that the bird is a pigeon. Credit &quot;pigeon.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(3.) Verbally identifies fish. Credit &quot;fish.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(3.) States that catfish do not have scales. Credit &quot;catfish.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(4.) Verbally identifies rabbit. Credit &quot;rabbit&quot; or &quot;bunny.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(4.) Verbally identifies another animal that has hair or fur. Credit any mammal.</td>
</tr>
</tbody>
</table>
II. CONCEPTUAL THEME: Diversity of type and unity of pattern in living things.

D. CONCEPT: The world contains living and nonliving things.

1. A rat, a frog, and a tree are living things.
2. An automobile is a nonliving thing.
3. Living things have characteristics which distinguish them from nonliving things.

S.R.: Pictures of a frog, a tree, a rat, and an automobile.

N-V: Here are pictures of some things. Point to the picture of something that is not a living thing.

V: Tell me about that one.

Is a _____ alive?

How do you know when something is alive?

<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept IID.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response</td>
</tr>
<tr>
<td>1</td>
<td>Verbally identifies vehicle. Credit &quot;car,&quot; &quot;ambulance,&quot; &quot;automobile,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>States that the vehicle is not a living thing. Credit &quot;it is not alive,&quot; &quot;cars are not living things,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>Gives at least one scientific characteristic of life. Credit &quot;living things move,&quot; &quot;they grow,&quot; &quot;they need water,&quot; &quot;they breathe,&quot; etc.</td>
</tr>
</tbody>
</table>
III. CONCEPTUAL THEME: The genetic continuity of life.

A. CONCEPT: Animals produce offspring similar to themselves in appearance.

1. Mother dachshunds (dogs) have babies similar to themselves in appearance.

a. Baby dogs come from inside mother dogs.

2. A baby kitten has a cat mother.

S.R.: Pictures of a mother dachshund and four baby animals—a baby dachshund, 2 other puppies (not dachshunds), and a baby kitten.

N-V: Here is a picture of a mother dog (interviewer points to the mother dog). Here are some pictures of baby animals (interviewer moves hand over pictures of baby animals).

Point to the picture of the baby (interviewer moves hand over pictures of baby animals) that belongs to this mother (interviewer points to mother dog).

V: Why did you point to that one?

Where do baby dogs come from?

(Interviewer points to the picture of the kitten and asks...)

What kind of a mother would this baby have?

<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept IIIA1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response.</td>
</tr>
<tr>
<td>1</td>
<td>States that he selected the baby dachshund because it looks like the mother dog. Credit &quot;they look alike,&quot; &quot;they look the same,&quot; &quot;they are the same color,&quot; &quot;they both have long ears,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>States that the baby kitten would have a cat mother. Credit &quot;a cat,&quot; &quot;a mother kitten,&quot; etc.</td>
</tr>
</tbody>
</table>
1 States that baby dogs come from their mothers. Credit "baby dogs come out of mother dogs," "out of the mother's tummy," "from a special place inside the mother," etc.

III. CONCEPTUAL THEME: The genetic continuity of life.

B. CONCEPT: Some plants produce seeds which have the potential for growing into new plants.

1. Some oranges have seeds that can grow into new plants.

2. Seeds must have moisture and warmth in order to germinate.

3. A seed has a tiny plant inside it.

S.R.: Picture of an orange which is cut open so as to expose the seeds.

N-V: Here is a picture of an orange. It has been cut open so you can see inside of it. Point to something in the orange that might grow into a new plant if you put it in the dirt and took good care of it.

V: Why did you point to that?

What is that called?

How do you take good care of a (seed) after you put it in the dirt?

What is inside of a (seed)?

Points | Verbal scoring criteria for concept IIIB.
---|---
0 | No response; inappropriate response
1 | Verbally identifies the seeds. Credit "seeds."
1 | Gives a way that one can take care of seeds. Credit such responses as "water it," "put fertilizer on it," "keep it warm," "don't bother it," etc.
1 | States what is inside of a seed. Credit such responses as "a tiny plant," "a little tree," "a root," etc.
III. CONCEPTUAL THEME: The genetic continuity of life.

C. CONCEPT: A plant that grows from a seed is similar to the plant that produced the seed.

1. Some orange trees that grow from orange seeds produce oranges.

2. Orange trees that grow from orange seeds do not produce apples, pumpkins, or squash.

3. Apple (pumpkin) plants can be grown from apple (pumpkin) seeds.

4. Apple (pumpkin) seeds come from apples (pumpkins).

S.R.: Picture of an orange cut open so as to expose the seeds. Pictures of four baskets of fruit—oranges, apples, pumpkins, and squash.

N-V: (Have baskets of fruit covered)

Let's make believe you took these seeds (interviewer points to orange seeds), put them in dirt and took good care of them. Make believe that trees grew from them and that something grew on the trees. Play-like you picked (pulled) the things off of the trees and put them in a basket.

(Uncover baskets of fruit)

Point to the basket of things that you picked (pulled) off of the trees.

V: Why did you point to that basket?

What is in the basket?

(Interviewer points to the basket of apples. He points to the basket of pumpkins if subject selected apples in N-V above.)

What are these?

What kind of seeds would you plant to get ____ trees (plants)?

Where do ____ seeds come from?
### Points Verbal scoring criteria for concept IIIC.

<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept IIIC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response.</td>
</tr>
<tr>
<td>1</td>
<td>Verbally identifies what is in the basket. Credit &quot;oranges.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>Verbally identifies the basket of apples (or pumpkins). Credit &quot;apples&quot; (or &quot;pumpkins&quot;).</td>
</tr>
<tr>
<td>1</td>
<td>States the kind of seeds that must be planted to grow apple trees (or the kind of seed that must be planted to grow pumpkin plants). Credit &quot;you plant apple seeds to get apple trees,&quot; etc., or &quot;you plant pumpkin seeds to get pumpkin plants,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>States where apple seeds come from (or where pumpkin seeds come from). Credit &quot;apple seeds come from apples&quot; (or &quot;pumpkin seeds come from pumpkins&quot;).</td>
</tr>
</tbody>
</table>

### IV. CONCEPTUAL THEME: Complementarity of organism and environment.

**A. CONCEPT:** Animals live in many different kinds of environments.

1. The crayfish lives in the water.
2. The pig lives on a farm.
3. The camel lives in the desert where it is hot, dry, and sandy.
4. The polar bear lives at the north pole where there is snow and ice and it is very cold.

**S.R.:** 1. Separate pictures of a farm, a stream, a polar landscape, and a desert.

2. Separate pictures of a polar bear, a camel, a pig, and a crayfish.

**N-V:** Here are pictures of some different kinds of animals. (Interviewer moves hand over pictures of animals.)

Here are pictures of some places where different animals live. (Interviewer moves hand over pictures of different environments.)
I want you to point to the place (interviewer moves hand over pictures of environments) where each of these animals (interviewer moves hand over pictures of animals) lives.

1. Let's start with this one. (Interviewer points to the crayfish.) Point to the picture of the place where this animal lives.

2. (Interviewer points to pig.) Point to the picture of the place where this animal lives.

3. (Interviewer points to camel.) Point to the picture of the place where this animal lives.

4. (Interviewer points to polar bear.) Point to the picture of the place where this animal lives.

V: (Immediately after each nonverbal response above, interviewer says...) 1.-4. Tell me about that animal and the place where it lives.

   What is that animal called?
   What is the name of the place where it lives?
   What is that place like? (Tell me something about a ______.)

Points | Verbal scoring criteria for concept IVA.
---|---
0 | No response; inappropriate response.
1 | Verbally identifies animal. Credit (1) "Crayfish," "lobster," (2) "pig," "hog," "sow," "boar," (3) "camel," (4) "polar bear."
1 | Verbally identifies environment. Credit (1) "water," "stream," "creek," "river," "lake," etc. (2) "farm," (3) "desert," (4) "North Pole."
1 | Gives at least one characteristic of the environment. Credit (1) "fish live there," "there are rocks for them to hide under," "fish eat crawdads," "green stuff grows on the rocks," etc. (2) "there are barns," "other animals live there too," "you grow corn on a farm," etc. (3) "it is sandy," "it is hot," "it is dry," "there is no grass," etc. (4) "it is cold," "it is icy," "it is snowy," etc.

Note: For each item, one through four, there are three points possible.
IV. CONCEPTUAL THEME: Complementarity of organism and environment.

B. CONCEPT: Changes in environment are often accompanied by visible changes in living things.

1. Some trees lose their leaves in the winter.

S.R.: Four pictures of trees in the four different seasons (fall, winter, spring and summer).

N-V: Here are pictures of some trees. Point to the picture that shows how a tree looks in the winter time.

V: Why did you point to that one?

How does a tree look in the winter time?

Points Verbal scoring criteria for concept IVB.

0 No response; inappropriate response.

1 States that in the winter time trees lose their leaves. Credit "they don't have leaves," "all the leaves have fallen off," etc.

IV. CONCEPTUAL THEME: Complementarity of organism and environment.

C. CONCEPT: Animals use plants and other animals in their environment as sources of food.

1. Man uses different parts of plants for food.
   a. The carrot root is a food which grows under the ground.
   b. Apples and grapes do not grow under the ground (and they are fruits).

2. Man uses animals and animal products for food.
   a. The eggs eaten by man generally come from chickens.
   b. Man uses the chickens, themselves, as sources of meat.

S.R.: Pictures of an apple, a carrot, grapes, and an egg.
N-V: Here are pictures of some things to eat.

1. Point to the picture of the thing to eat that grows under the ground (in the dirt).

2. Point to the picture of the thing to eat that comes from an animal.

V: (Immediately after each N-V response above, interviewer asks...)

1. Why did you point to that one?
   What is that called?
   (Interviewer points to the root and asks...)
   What is this part of the (carrot) called?

2. Why did you point to that one?
   What is that called?
   What animal does it come from?
   What else are (chickens) used for?

<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept IVC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response.</td>
</tr>
<tr>
<td>1</td>
<td>(1) Verbally identifies carrot. Credit</td>
</tr>
<tr>
<td></td>
<td>&quot;carrot.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(1) States that the orange part of the</td>
</tr>
<tr>
<td></td>
<td>carrot is the root. Credit &quot;root.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(2) Verbally identifies egg. Credit &quot;egg.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(2) States the origin of the eggs we eat.</td>
</tr>
<tr>
<td></td>
<td>Credit &quot;chickens,&quot; &quot;hens,&quot; &quot;ducks,&quot; or</td>
</tr>
<tr>
<td></td>
<td>&quot;geese.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(3) States that chickens (ducks, hens,</td>
</tr>
<tr>
<td></td>
<td>geese) are also a source of meat for humans. Credit &quot;we eat chickens,&quot; etc.</td>
</tr>
</tbody>
</table>
V. CONCEPTUAL THEME: Biological roots of behavior.

A. CONCEPT: Much of animal behavior is determined by instinct and/or the ability to think and reason.

1. Man is more intelligent (smarter) than a fly, a horse, or a monkey.

2. Some of man's behavior is the result of his unique ability to think and reason.

S.R.: Pictures of a man, a fly, a horse, and a monkey.

N-V: Here are some pictures of some living things. Point to the picture of the one that is smarter than any of the others.

V: Why did you pick that one? What is that one?

Tell me why you think the ______ is smarter than any of the others.

<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept VA.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response.</td>
</tr>
<tr>
<td>1</td>
<td>Verbally identifies the man as the smartest. Credit &quot;man,&quot; &quot;human,&quot; &quot;person,&quot; &quot;the daddy,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>Gives one scientific reason why he thinks the man is smartest. Credit &quot;he can think,&quot; &quot;he can drive a car,&quot; &quot;he has a better brain,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>Gives at least one additional scientific reason why he thinks the man is the smartest.</td>
</tr>
</tbody>
</table>
V. CONCEPTUAL THEME: Biological roots of behavior.

B. CONCEPT: Animals cope with they environments in a variety of ways.

1. The woodchuck (and several other animals) sleeps (hibernates) in a hole in the ground during the winter months.

2. Some birds (e.g., the brown thrasher) fly far away (migrate) to a warmer part of the world when winter begins.

3. The grasshopper and the cow cope with the winter months in ways other than hibernation and migration.

S.R.: Pictures of a woodchuck, a bird (brown thrasher), a grasshopper, and a cow.

N-V: Here are pictures of some animals.

1. Point to the picture of the animal that sleeps in a hole in the ground all through the winter time.

2. Point to the picture of the animal that goes far, far away to a warmer part of the world in the winter time.

V: (Immediately after each N-V response above, interviewer asks...)

1. Why did you point to that one?
   What is that animal called?

   What is the word that means to sleep all through the winter?

2. Why did you point to that one?
   What is that animal called?
   Where does the bird go in the winter time?

   What is the word that means to go far away to another part of the world.
Points Verbal scoring criteria for concept VB.

0 No response; inappropriate response.

1 (1) Verbally identifies woodchuck (may or may not specifically identify woodchuck). Credit "woodchuck," "groundhog," "ground squirrel," "chipmunk," or "bear." (Do not credit "beaver.")

1 (1) Verbally identifies word that means to sleep all winter. Credit "hibernation."

1 (2) Verbally identifies bird. Credit "bird," "robin," "thrush," etc.

1 (2) States where the bird goes in the winter time. Credit "south," "Florida," or "South America."

1 (2) Verbally identifies word that means to move from one region to another. Credit "migration."

V. CONCEPTUAL THEM: Biological roots of behavior.

C. CONCEPT: Animals often display emotions so that others are aware of the emotions.

1. Children sometimes cry when they are afraid.

2. A child's fear may be caused by many things.

S.R.: Pictures of four children. Three of the children appear to be happy. The remaining child is crying.

N-V: Here are some pictures of children. Point to the child that you think is afraid (scared).

V: Why did you point to that one?

What do you think that child might be afraid of?
<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept VC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response.</td>
</tr>
<tr>
<td>1</td>
<td>States why the child looks like he is afraid. Credit &quot;he is crying,&quot; &quot;children scream when they are afraid,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>States at least one reason why he thinks the child might be afraid. Credit &quot;he is afraid of a dragon,&quot; &quot;he is afraid of a bad man,&quot; &quot;his mother has left him to go to the store,&quot; etc.</td>
</tr>
</tbody>
</table>

V. CONCEPTUAL THEME: Biological roots of behavior.

D. CONCEPT: Baby animals get food in many different ways.

1. Some mother birds feed their babies worms.

2. Mother cats feed their babies milk.
   a. The milk comes from teats located on the ventral side of the mother.

3. There are other animals (mammals) that feed their babies milk.

4. Snakes and turtles do not feed their babies.

S.R.: Pictures of adult and young turtle, adult and young snakes, adult and young birds, and mother cat and babies.

N-V: Here are pictures of some mothers and their babies.

1. Point to the picture of the mother that feeds her babies worms.

2. Point to the picture of the mother that feeds her babies milk.

V: (Immediately after each N-V response above, interviewer asks...)

1. What is that one called?
2. What is that one called?

Where does the milk come from?

Can you tell me some other animals that feed milk to their babies?

<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept VD.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response.</td>
</tr>
<tr>
<td>1</td>
<td>(1) Verbally identifies bird. Credit &quot;bird,&quot; &quot;mother bird,&quot; &quot;sparrow,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>(2) Verbally identifies cat. Credit &quot;cat,&quot; &quot;mother cat,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>(2) States where the milk that the mother cat feeds her babies comes from. Credit &quot;from her tummy,&quot; &quot;from underneath her,&quot; &quot;the mother's belly,&quot; &quot;special places under her,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>(2) Verbally identifies one other animal that feeds its babies milk. Credit any mammal.</td>
</tr>
</tbody>
</table>

VI. CONCEPTUAL THEME: Complementarity of structure and function.

B. CONCEPT: Some plants have different parts which perform a variety of functions.

1. Roots help anchor a plant in the soil.

2. Flowers are often the site where seeds are formed.

S.R.: Diagram of a plant showing flowers, stems, leaves, and roots.

N-V: Here is a picture of a plant.

1. Point to something (a part of the plant) that helps hold the plant in the ground.

2. Point to something (a part of the plant) that makes seeds or where you might find seeds.
V: (Immediately after each N-V response above, the interviewer asks...)

1. Why did you point to that?
   What is that called?

2. Why did you point to that?
   What is that called?

<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept VIB.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response.</td>
</tr>
<tr>
<td>1</td>
<td>(1) Verbally identifies roots. Credit &quot;roots.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(2) Verbally identifies flowers. Credit &quot;flowers.&quot;</td>
</tr>
</tbody>
</table>

VI. CONCEPTUAL THEME: Complementarity of structure and function.

C. CONCEPT: Animals move in many different ways.

1. The motion of a fish's fins and tail help to propel it through the water.

S.R.: Picture of a fish.

N-V: Here is a picture of a fish.

1. Point to something that helps move the fish through the water.

2. Point to something else that helps move the fish through the water.

V: (Immediately after each N-V response above, the interviewer asks...)

1. What is that called?

2. What is that called?
Points | Verbal scoring criteria for concept VIC.
---|---
0 | No response; inappropriate response.
1 | (1) Verbally identifies fins. Credit "fins," only. Do not credit "hands," "wings," etc.
1 | (2) Verbally identifies tail. Credit "tail," only.

VI. CONCEPTUAL THEME: Complementarity of structure and function.

D. CONCEPT: The human body has many internal parts which perform different functions.

1. The heart pumps blood throughout the body.
   a. Blood vessels carry blood throughout the body.

2. The eyes are the organs of sight.

3. The brain is the center of thinking.

S.R.: A cut-away diagram showing some of man's internal structures.

N-V: Here is a picture of the insides of a man.

1. Point to the thing in the man that moves or pumps blood through his body.

2. Point to what the man uses to see with.

3. Point to what the man uses to think with.

V: (Immediately after each N-V response above, the interviewer asks...)

1. Why did you point to that?
   What is that called?

2. Why did you point to that?
   What is that called?
3. Why did you point to that?

What is that called? (If answer is "head" or "skull," ask...)

What is inside the head (skull) that the man thinks with?

(If response is "brain," ask...) What is the brain inside of?

<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept VID.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response</td>
</tr>
<tr>
<td>1</td>
<td>(1) Verbally identifies what moves or pumps blood through the body. Credit &quot;heart&quot; or &quot;veins.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(2) Verbally identifies the organs of sight. Credit &quot;eyes.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(3) Verbally identifies the center of thinking. Credit &quot;brain.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(3) Verbally states the location of the center of thinking. Credit &quot;in the head,&quot; or &quot;in the skull.&quot;</td>
</tr>
</tbody>
</table>

VII. CONCEPTUAL THEME: Regulation and homeostasis—preservation of life in the face of change.

A. CONCEPT: Plants often die when their life-processes are interrupted.

1. Green plants sometimes die if they do not have water, light, minerals, "air," and "warmth."

2. Green plants sometimes die from plant diseases.

3. Green plants sometimes die from mechanical injury.

4. When green plants die they turn brown and wilt.

S.R.: Pictures of four potted plants. One plant is brown and wilted.
N-V: Here are pictures of some plants. Point to the plant that looks like it has something wrong with it.

V: Why did you point to that one? Are there other reasons?

Tell me some reasons why a plant might (get brown) (bend over). Are there other reasons?

Points | Verbal scoring criteria for concept VIIA.
--- | ---
0 | No response; inappropriate response.
1 | States one reason why the plant looks like it has something wrong with it. Credit "it is brown," "it is bent over," "it is wilted," "it is leaning down," etc.
1 | States at least one additional reason why the plant looks like it has something wrong with it.
1 | States one reason why the plant might have something wrong with it. Credit "not enough water," "too much water," "no sun on it," "someone broke it," "it got too cold," "it's sick," etc.
1 | States at least one additional reason why the plant might have something wrong with it.

VII. CONCEPTUAL THEME: Regulation and homeostasis—preservation of life in the face of change.

B. CONCEPT: In order to maintain their life processes, humans need to choose carefully among the many substances found in their environments.

1. Cigarettes, whiskey, and gum can have harmful effects on the body.

2. Bread is good for the body.

3. Most things to eat or drink which are good for the body are called foods.

S.R.: A gum wrapper and pictures of a loaf of bread, a package of cigarettes, and a bottle of whiskey.
N-V: Here are pictures of some things.

1. Point to a picture of something that is not good for your body.

2. Point to the picture of something that is good for your body.

V: (Immediately after each N-V response above, interviewer says...)

1. Why did you point to that one?

What is it?

What will it do to your body?

2. Why did you point to that one?

What is it?

How will it help your body?

Can you name some other things to eat or drink that will help your body?

What are these good things to eat or drink called?

<table>
<thead>
<tr>
<th>Points</th>
<th>Verbal scoring criteria for concept VIIIB.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No response; inappropriate response.</td>
</tr>
<tr>
<td>1</td>
<td>(1) Verbally identifies something that is harmful to the body. Credit &quot;cigarettes,&quot; &quot;gum,&quot; &quot;whiskey,&quot; &quot;beer,&quot; &quot;gin,&quot; or &quot;wine.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>(1) States why the above is harmful. Credit &quot;cigarettes make you cough,&quot; &quot;cigarettes cause cancer,&quot; &quot;cigarettes make you have heart trouble,&quot; &quot;gum makes you have cavities,&quot; &quot;whiskey makes you drunk,&quot; &quot;wine makes you sick,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>(2) Verbally identifies bread as good for the body. Credit &quot;bread&quot; &quot;Wonder Bread,&quot; etc.</td>
</tr>
<tr>
<td>1</td>
<td>(2) States how bread is good for the body. Credit &quot;it makes you grow,&quot; &quot;it makes you strong,&quot; &quot;it keeps you from getting sick,&quot; etc.</td>
</tr>
</tbody>
</table>
(2) Verbally identifies one additional thing to eat or drink which is good for the body. Credit "meat," "gravy," "potatoes," "grits," "juice," "milk," etc. (Although water is technically not a food, credit it also.)

(2) Classifies the things to eat or drink which are good for the body as foods. Credit "foods," only.

VII. CONCEPTUAL THEME: Regulation and homeostasis—Preservation of life in the face of change.

C. CONCEPT: The human body must have rest in order to maintain its life processes.

1. Children need to rest when they are tired.

2. During periods of rest, the body can repair many of the effects of fatigue and over-exertion.

S.R.: Pictures of four children. Three of the children are playing and one is resting.

N-V: Here are pictures of some kindergarten children. They have been playing and are very, very, tired. Point to the picture of the one that is now doing something that will help its body.

V: Why did you point to that one?

What is that one doing?

How will that help (his or her) body?

Points Verbal scoring criteria for concept VII C.

0 No response; inappropriate response.

1 States what the child is doing. Credit "he is resting," "he is sleeping," "he has his head down," etc.

1 States how the child's actions will help his body. Credit "it will get him untired," "it will make him healthy," "it will get him strong again," "it will keep him from getting sick," etc.
Pilot Testing

Three pilot studies were conducted during the development of the L-SCAT. The studies were conducted to collect base-line data on the validity and reliability of the test, the interview procedures, and the methods used in recording and scoring responses.

Nonparametric statistics were used in analyzing the data from the pilot studies. The Mann-Whitney U test (Siegel, 1956, pp. 116-127) was used to test for significance of difference between two independent samples. To determine associations between two samples, Kendall's rank correlation coefficient, tau, (Siegel, 1956, pp. 213-223) was used. Nedelsky's (1965, pp. 96-99) procedure was used for determining the index of discrimination and the difficulty index for each item. An adaptation of the index of consistency (Bennett, et al., 1954) was used to determine the percentage of agreement (including a correction for chance) between the investigator and an independent rater in scoring verbal responses.

Pilot Study I

This study was conducted during the spring, 1969, in two kindergarten classes (morning and afternoon) composed primarily of children of caucasian blue-collar workers. The same teacher taught both classes. Each class was divided by the classroom teacher into three strata based on her
estimate of the students' general academic ability and achievement. The strata were designated as good, average, and poor. The test was administered to eighteen children. Approximately equal numbers of boys and girls were randomly selected from each stratum. One week after the initial testing, four children were randomly selected and retested. Additional procedures and results are summarized below.

1. An item analysis was conducted to obtain an index of discrimination and a difficulty index for each item.

2. The scores made by the boys and those made by the girls were not significantly different at the .05 level.

3. The scores made by the good students and those made by the poor students were significantly different at the .01 level.

4. The scores made by the morning class and those made by the afternoon class were not significantly different at the .05 level.

5. The difference between a subject's verbal and non-verbal scores was more significant for the poor students than for the average or good students. The levels of chance probability of the differences were: good = .5, average = .12, and poor = .05.

6. There was a perfect positive correlation (1.0) between the ranks of the test-retest scores of the four subjects who were administered the L-SCAT a second time.

7. The mean administration time was 23.4 minutes.

Pilot Studies II and III

Pilot study I was conducted with the children of caucasian blue-collar workers. The children were near the end of their kindergarten experience. Pilot studies II and
III were conducted during the summer, 1969, with "disadvantaged" preschool children who were participating in the summer Head Start program. The same Head Start class was used for both studies. Negro children composed 75 per cent of the class.

In pilot study II, thirteen children were randomly selected and administered the same form of the L-SCAT which was used in pilot study I. Some of the results and findings are summarized below.

1. The initial apprehensiveness of the subjects to the investigator substantiated the need for "rapport-building" visits prior to administering the L-SCAT.

2. The verbal scores made by the subjects in pilot study I and those made by the subjects in pilot study II were significantly different at the .002 level.

3. The nonverbal scores made by the subjects in pilot study I and those made by the subjects in pilot study II were significantly different at the .01 level.

4. An index of discrimination and a difficulty index were computed for each item. Comparisons of these results from pilot studies I and II provided a basis for selecting and repairing individual items of the L-SCAT.

Based on the results from pilot studies I and II, the L-SCAT was revised and administered again to six subjects who were randomly selected from the thirteen that had participated in pilot study II. These six subjects composed the sample for pilot study III. Pilot study III was conducted approximately two weeks after the termination of pilot study II. Some of the results and findings from
pilot study III are summarized below.

1. The correlation between the ranks of the scores of the six subjects in pilot study III and the ranks of their scores in pilot study II was .73.

2. The mean administration time was 25.3 minutes.

3. There was a 75 per cent agreement between an independent scorer and the investigator in scoring the verbal responses.

4. An item analysis provided additional data for minor repair of items.
SELECTED BIBLIOGRAPHY


