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An Exploratory Content Analysis Of Creative Thinking In Elementary School Science Textbooks For Grades One, Three, And Five.

Anthony Thomas Rinaldi

University of the Pacific

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AN EXPLORATORY CONTENT ANALYSIS OF CREATIVE THINKING
IN ELEMENTARY SCHOOL SCIENCE TEXTBOOKS
FOR GRADES ONE, THREE, AND FIVE

A Dissertation
Presented to
the Faculty of the Graduate School
University of the Pacific

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

by
Anthony Thomas Rinaldi
August 1976
This dissertation, written and submitted by

ANTHONY THOMAS RINALDI

is approved for recommendation to the Committee on Graduate Studies, University of the Pacific

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Dated Aug 16, 1976
AN EXPLORATORY CONTENT ANALYSIS OF
CREATIVE THINKING IN ELEMENTARY
SCHOOL SCIENCE TEXTBOOKS FOR
GRADES ONE, THREE, AND FIVE

Abstract of the Dissertation

PROBLEM: This study examined the content of textbooks for levels one, three, and five of six elementary science series to determine the extent to which the development of creative thinking skills was emphasized.

PROCEDURES: Four elementary science textbook series published from 1970 to 1972 were randomly selected for analysis from a list of seven recommended for adoption by the California State Curriculum Development and Supplemental Materials Commission to the State Board of Education (under AB 531, November 1972.) The study also examined a sample of the textbook series adopted by the California State Department of Education for use in the public schools from 1959 to 1967 and the series adopted from 1967 to 1974 to determine changes in emphasis placed on creative thinking.

Three elements of textbook content were analyzed: (1) the introduction to the textbook in the teacher's edition, (2) the questions for students, and (3) the activities for students.

The documentary analysis method of research was used. The analysis of textbook questions was based upon categories selected from the Aschinger-Gallagher System for the Classification of Thought Processes in Verbal Classroom Interaction. Criteria for the evaluation of student activities were developed by the investigator based upon the "creative learning process" identified by E. Paul Torrance and F. E. Myers; processes in the act of learning by Jerome S. Bruner, and the summary of problem-solving methods by J. H. McPherson.

FINDINGS and CONCLUSIONS:

1. The textbooks placed only minor emphasis on the development of creative thinking.

2. Textbook questions strongly emphasized cognitive-memory and convergent thinking. Questions requiring divergent and evaluative thinking received minor emphasis in all the textbooks. The newer textbook series (published in 1970-72) differed only slightly from the two older series (published in 1966 and in 1959) in the percentage of questions in categories based on the thinking operations that they elicited.

3. Textbook activities provided students with limited experiences for the development of intellectual skills needed to cope with the ambiguities and uncertainties associated with creative problem solving. Student activities in the newer textbook series while still limited, did meet more of the criterion objectives related to creative problem solving than did the activities in either of the older series.

4. Of the two older series, the activities in the series published in 1966 met more of the criterion objectives related to creative problem solving than did the activities in the series published in 1959.

5. To the extent that the textbooks examined in this study were representative of the science textbooks in current use in the elementary grades, teachers, who rely on the textbooks as a primary source of instruction, must assume upon themselves most of the burden of responsibility for learning experiences appropriate for the development of creative thinking.

RECOMMENDATIONS FOR FURTHER STUDY: There is a need for studies directed toward devising methods of reordering elementary science textbook priorities and effecting changes in the questions and activities; so that they accommodate creative thinking.
"The world is being broken down to be built up again, and eventually the sense of the new worlds will come out of the laboratory and penetrate into the smallest living techniques and habits of the whole people. . . . Finally, one can live in a prefabricated world, smugly and without question, or one can indulge perhaps the greatest of human excitement: that of observation to speculation to hypothesis. This is a creative process, probably the highest and most satisfactory we know."\(^1\)

\(^1\) John Steinbeck in the Foreword, Between Pacific Tides, by Edward Ricketts and Jack Calvin, Stanford, California: Stanford University Press, 1952.
ACKNOWLEDGMENTS

The writer expresses his appreciation for the advantage in preparing, conducting, and reporting this investigation gained from the invaluable advice, constructive criticism, and support of Professors Robert Hamernik, J. Marc Jantzen, Carl Lang, and Dale W. McNeal.

Profound indebtedness is due, especially, to my major advisor, John V. Schippers, who shared his knowledge and gave generously of his time.

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This study and I owe much to my wife, Jeanne, for her interest, encouragement, and for her creative suggestions and devoted labors.
# 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>LIST OF TABLES</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>ix</td>
</tr>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>I. THE PROBLEM AND DEFINITION OF TERMS</td>
<td>1</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>THE PROBLEM</td>
<td>4</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>4</td>
</tr>
<tr>
<td>Objectives</td>
<td>5</td>
</tr>
<tr>
<td>Significance of the Study</td>
<td>6</td>
</tr>
<tr>
<td>PURPOSE OF THE STUDY</td>
<td>9</td>
</tr>
<tr>
<td>RESEARCH METHODOLOGY</td>
<td>10</td>
</tr>
<tr>
<td>ASSUMPTIONS AND LIMITATIONS</td>
<td>11</td>
</tr>
<tr>
<td>Assumptions of the Study</td>
<td>11</td>
</tr>
<tr>
<td>Limitations of the Study</td>
<td>12</td>
</tr>
<tr>
<td>DEFINITIONS OF TERMS USED</td>
<td>13</td>
</tr>
<tr>
<td>SUMMARY</td>
<td>15</td>
</tr>
<tr>
<td>II. REVIEW OF THE LITERATURE RELATED TO THIS STUDY.</td>
<td>16</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>16</td>
</tr>
<tr>
<td>ROLE OF THE BASAL TEXTBOOK IN EDUCATION</td>
<td>16</td>
</tr>
<tr>
<td>Questioning Practices</td>
<td>25</td>
</tr>
<tr>
<td>Textbooks and Creativity</td>
<td>28</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Textbook and Non-Textbook Based Instruction</td>
<td>29</td>
</tr>
<tr>
<td>ELEMENTARY SCHOOL SCIENCE TRENDS.</td>
<td>32</td>
</tr>
<tr>
<td>THE CONCEPT OF CREATIVITY</td>
<td>43</td>
</tr>
<tr>
<td>Definitions of Creativity</td>
<td>44</td>
</tr>
<tr>
<td>Creativity and Problem Solving</td>
<td>58</td>
</tr>
<tr>
<td>Creativity and Discovery</td>
<td>66</td>
</tr>
<tr>
<td>The Teachability of Creativity</td>
<td>69</td>
</tr>
<tr>
<td>SUMMARY AND CONCLUSIONS FROM REVIEWED LITERATURE</td>
<td>71</td>
</tr>
<tr>
<td>III. DESCRIPTION OF THE DESIGN AND PROCEDURE OF THE STUDY</td>
<td>73</td>
</tr>
<tr>
<td>SELECTION OF THE SAMPLES</td>
<td>73</td>
</tr>
<tr>
<td>Selection of Sample Chapters</td>
<td>75</td>
</tr>
<tr>
<td>OBJECTIVES</td>
<td>76</td>
</tr>
<tr>
<td>Introductory Textbook Statements</td>
<td>76</td>
</tr>
<tr>
<td>Textbook Questions.</td>
<td>77</td>
</tr>
<tr>
<td>Textbook Activities</td>
<td>77</td>
</tr>
<tr>
<td>PROCEDURES AND DESCRIPTION OF INSTRUMENTS</td>
<td>79</td>
</tr>
<tr>
<td>Introductory Statements</td>
<td>80</td>
</tr>
<tr>
<td>The Analysis of Questions</td>
<td>80</td>
</tr>
<tr>
<td>The Analysis of Student Activities</td>
<td>86</td>
</tr>
<tr>
<td>Reliability</td>
<td>90</td>
</tr>
<tr>
<td>SUMMARY</td>
<td>94</td>
</tr>
<tr>
<td>IV. FINDINGS OF THE STUDY</td>
<td>95</td>
</tr>
<tr>
<td>FINDINGS OF THE ANALYSIS OF THE TEXTBOOK</td>
<td>96</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>96</td>
</tr>
<tr>
<td>Objective 1</td>
<td>96</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Objective 2</td>
<td>97</td>
</tr>
<tr>
<td>Objective 3</td>
<td>98</td>
</tr>
<tr>
<td>Objective 4</td>
<td>99</td>
</tr>
<tr>
<td>Objective 5</td>
<td>101</td>
</tr>
<tr>
<td>Objective 6</td>
<td>102</td>
</tr>
<tr>
<td>Objective 7</td>
<td>103</td>
</tr>
<tr>
<td>FINDINGS OF THE ANALYSIS OF TEXTBOOK QUESTIONS</td>
<td>104</td>
</tr>
<tr>
<td>Objective 8</td>
<td>104</td>
</tr>
<tr>
<td>FINDINGS OF THE ANALYSIS OF TEXTBOOK STUDENT ACTIVITIES</td>
<td>106</td>
</tr>
<tr>
<td>Objective 9</td>
<td>106</td>
</tr>
<tr>
<td>Objective 10</td>
<td>108</td>
</tr>
<tr>
<td>Objective 11</td>
<td>110</td>
</tr>
<tr>
<td>Objective 12</td>
<td>112</td>
</tr>
<tr>
<td>Objective 13</td>
<td>114</td>
</tr>
<tr>
<td>COMPARISON OF FINDINGS OF NEWER SERIES WITH EACH OF THE OLDER SERIES</td>
<td>117</td>
</tr>
<tr>
<td>Objective 14</td>
<td>117</td>
</tr>
<tr>
<td>SUMMARY</td>
<td>123</td>
</tr>
<tr>
<td>V. CONCLUSIONS BASED UPON THE INVESTIGATION AND RECOMMENDATIONS FOR FURTHER RESEARCH.</td>
<td>124</td>
</tr>
<tr>
<td>GENERAL CONCLUSIONS</td>
<td>125</td>
</tr>
<tr>
<td>CONCLUSIONS RELATED TO TEXTBOOK INTRODUCTIONS</td>
<td>126</td>
</tr>
<tr>
<td>CONCLUSIONS RELATED TO TEXTBOOK QUESTIONS</td>
<td>127</td>
</tr>
<tr>
<td>CONCLUSIONS RELATED TO TEXTBOOK STUDENT ACTIVITIES</td>
<td>129</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>CONCLUSIONS RELATED TO THE COMPARISON OF THE NEWER SERIES WITH EACH OF</td>
<td></td>
</tr>
<tr>
<td>THE OLDER SERIES</td>
<td>132</td>
</tr>
<tr>
<td>RECOMMENDATIONS FOR FURTHER STUDY.</td>
<td>134</td>
</tr>
<tr>
<td>SUMMARY.</td>
<td>135</td>
</tr>
<tr>
<td>REFERENCES CITED</td>
<td>137</td>
</tr>
<tr>
<td>APPENDIXES</td>
<td>151</td>
</tr>
<tr>
<td>A. Basic Textbook Series for Science Grades One Through Six Recommended Nov. 1972 to California State Board of Education for Adoption</td>
<td>152</td>
</tr>
<tr>
<td>B. Forty-Sixth Yearbook Listing of Science Experiences</td>
<td>153</td>
</tr>
<tr>
<td>C. Worksheet for the Analysis and Classification of Textbook Questions.</td>
<td>154</td>
</tr>
<tr>
<td>D. J. P. Guilford's Structure of the Intellect Problem Solving Model</td>
<td>155</td>
</tr>
<tr>
<td>E. Worksheet for the Analysis of Student Activities</td>
<td>156</td>
</tr>
<tr>
<td>AUTOBIOGRAPHICAL STATEMENT</td>
<td>159</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Comparison of Codings by Investigator and Co-Rater in the Classification of Textbook Questions</td>
<td>92</td>
</tr>
<tr>
<td>2.</td>
<td>Comparison of Codings by Investigator and Co-Rater in the Analysis of Student Activities</td>
<td>93</td>
</tr>
<tr>
<td>3.</td>
<td>Summary of Series Introductory Statements: Creative Thinking Goal</td>
<td>96</td>
</tr>
<tr>
<td>4.</td>
<td>Summary of Series Introductory Statements: Creative Teaching-Learning References</td>
<td>97</td>
</tr>
<tr>
<td>5.</td>
<td>Summary of Series Introductory Statements: Scientific Inquiry Goal</td>
<td>98</td>
</tr>
<tr>
<td>6.</td>
<td>Summary of Series Introductory Statements: Classroom Environment</td>
<td>100</td>
</tr>
<tr>
<td>7.</td>
<td>Summary of Series Introductory Statements: Types of Questions</td>
<td>101</td>
</tr>
<tr>
<td>8.</td>
<td>Summary of Series Introductory Statements: Different Student Interests and Aptitudes</td>
<td>102</td>
</tr>
<tr>
<td>9.</td>
<td>Summary of Series Introductory Statements: Student Instructional Media Sources</td>
<td>103</td>
</tr>
<tr>
<td>10a.</td>
<td>Frequency and Percentage Distribution of Textbook Questions According to the Thinking Operations They Elicit</td>
<td>105</td>
</tr>
<tr>
<td>10b.</td>
<td>Frequency and Percentage Distribution of Textbook Questions According to Thinking Operations They Elicit: Summary of Levels One, Three, and Five by Series</td>
<td>106</td>
</tr>
<tr>
<td>11.</td>
<td>Frequency and Percentage Distribution of Textbook Student Activities According to Outcomes Given or Not Given</td>
<td>107</td>
</tr>
<tr>
<td>12.</td>
<td>Frequency and Percentage Distribution of Textbook Student Activities with Specified Criteria of the Confrontation Phase of the Creative Thinking Process</td>
<td>109</td>
</tr>
</tbody>
</table>
Table

<table>
<thead>
<tr>
<th>Table Number</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Frequency and Percentage Distribution of Textbook Student Activities with</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Specified Criteria of the Preparation Phase of the Creative Thinking Process</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Frequency and Percentage Distribution of Textbook Student Activities with</td>
<td>113</td>
</tr>
<tr>
<td></td>
<td>Specified Criteria of the Ideation Phase of the Creative Thinking Process</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Frequency and Percentage Distribution of Textbook Student Activities with</td>
<td>116</td>
</tr>
<tr>
<td></td>
<td>Specified Criteria of the Verification Phase of the Creative Thinking Process</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Comparative Summary of Series Analysis of Introductory Statements of Newer</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>with each of the Older Textbook Series</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Comparative Summary of Series Analysis of Textbook Questions (Newer with</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Each of Older Series)</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Comparative Summary of Series Analysis of Student Activities (Newer with Each</td>
<td>121</td>
</tr>
<tr>
<td></td>
<td>Older Series)</td>
<td></td>
</tr>
</tbody>
</table>
LIST OF FIGURES

<table>
<thead>
<tr>
<th>Chart</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Steps in Problem-Solving Methods</td>
<td>88</td>
</tr>
</tbody>
</table>
CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS

I. INTRODUCTION

Contemporary American society may be characterized by rapid and profound change. The acceleration in the growth of knowledge, new technology, and changes in the life patterns of people make many school instructional practices and materials obsolete or relatively ineffective in a short time. In response to social and individual needs brought about by this accelerated change, new curricula and methods of instruction have emerged. These educational changes were largely the result of efforts to apply research to educational practice (Bruner, 1966:32; Hillson and Hyman, 1971:2; Shumsky, 1965:3,4; Smith et al., 1950:14-60; Taba, 1962:3).

During the 1960s agencies of the federal government as well as several private foundations provided funds in significant amounts in support of a number of curriculum improvement projects. At the same time the works of cognitive psychologists, regarding the systematic development of thinking abilities, were making their impact. Rekindled by the concern for the development of cognitive structures and mental
operations, program planners viewed learning in the elementary school from a new perspective. The restructured and reoriented educational experiences planned for children, which resulted from these projects, stressed learning through discovery, inquiry, and productive thinking rather than organized knowledge as the main product of learning. In science education, groups of eminent scientists, psychologists, and educators worked together to affect reforms in science curricula (Bruner, 1960:3,4,19; Frost and Rowland, 1969:308-311; Haney, 1966:1).

According to the California State Advisory Committee on Science Education, as stated in the Science Framework for California Public Schools,

1. To be consistent with the nature of science, teaching must provide opportunities for students to practice some of the same kinds of inquiry processes that scientists use in investigating the natural environment.

2. Research in learning has demonstrated repeatedly that learning takes place best when the child is actively, not passively, involved. Attitudes, cognitive processes, skills, and concepts are learned as a totality in an individual's experience (California State Advisory Committee on Science Education, 1970:38).

Public schools, traditionally, have had as a basic goal the perpetuation of knowledge, skills, and cultural values. A premium is put on critical thinking in order to arrive at the most likely or the correct answer (Weber, 1973:135; Burns and Brooks, 1970:8; Bruner, 1960:55).
Today, however, renewed emphasis upon the concept of individualized development is likely to influence change in school programs and practices to a greater extent than ever before. Paul F. Brandwein (1970:104) notes that more and more methods of instruction are shifting from the "system of conveying the archives to the child to a system where the child conveys his powers to the ardent pursuit of his various excellences."

In addition to the mastery of the fundamental concepts and generalities of a discipline, science education needs to cultivate the attitudes toward learning and the forms of thinking appropriate to the generation and evaluation of new knowledge (California State Advisory Committee on Science Education, 1970:30).

The curriculum orientation that emerged from the efforts of the various science education groups emphasized direct pupil investigation. The problem-solving methods of the "new" elementary science programs closely parallel elements of the creative thinking processes identified by E. Paul Torrance (1963a:4), and Mary Lee Marksberry (1965:17,20).

In recent times greater attention has been focused on the creative thinking process. In this process facts, ideas, generalities, and skills are combined in unique ways to produce new answers and solutions. The accumulation of knowledge regarding the nature of creative
thinking has delineated new dimensions for human intelligence and has stimulated renewed interest in creativity among educators in all fields and at all levels (Mohan, 1973:175-6; Torrance, 1963a; Wight, 1970:234-5; Zirbes, 1959:1-4).

Historically, the schoolbook has been the core of education determining both the content and method of instruction (Black, 1967:3; McCaffrey, 1970:1-15). Today, while the textbook cannot do this job alone, there is considerable evidence that it remains the most important and basic teaching material in the classroom (Beechhold, 1971:1-9; Talmage, 1972:20-25; McCloud, 1974:438-441).

In order to remain effective as a principal instrument of instruction, the textbook should reflect the findings of contemporary studies regarding the nature of the teaching-learning process and the development of creative thinking in particular (Stoddard, 1959:182; Guilford, 1967b:154; Marksberry, McCarter, and Noyce, 1969:422-429).

II. THE PROBLEM

Statement of the Problem

New directions in elementary science education developed in the last decade place greater emphasis on direct pupil involvement in creative problem solving experiences (Hutchins, 1970:7-11; Haney, 1966:3-21).
Textbooks, as a principal means of instruction in the public schools, should reflect these new developments. Educators need to know the degree to which elementary science textbooks are effective in facilitating creative thinking.

This study was designed to show the emphasis selected basic elementary science textbooks published from 1970 to 1972 placed on creative thinking. The study also examined a sample of basic science textbook series adopted by the State of California for use in the elementary schools from 1959 to 1974 in order to determine any changes in emphasis placed on creative thinking.

Objectives

The objectives of the study were:

1. To determine from the authors' statements of educational philosophy and approaches in the introduction to the textbooks, the extent to which:
   a. A deliberate effort was made to provide for the development of creative thinking.
   b. The development of the processes of scientific inquiry was a textbook program goal.
   c. The elements of a creative problem-solving (classroom) environment were described for the teacher.
d. Provisions were made for individualized instruction.

2. To determine the emphasis placed on creative thinking from the types of textbook questions presented.

3. To determine the textbook's emphasis in creative thinking from the nature of student activities.

4. To determine if there were any changes in the emphasis placed on creative thinking in textbook series published from 1970 to 1972 as compared with the two State of California adopted series published in 1959 and 1966.

These objectives will be definitively restated in Chapter III.

Significance of the Study

The study will attempt to provide evidence to determine whether samples of recently published basic science textbooks designed to be used in the elementary schools are appropriate for use in the development of creative-thinking skills. The findings of this study should be of value to educators, particularly those concerned with the production or selection of instructional materials. It should supply authors and publishers with data useful in the production, evaluation, and revision of science textbooks and other instructional materials. In addition, the study will provide teachers and
curriculum specialists with data which show the emphasis placed on various categories of intellectual operations in textbooks.

Creative thinking in the school curriculum. According to E. Paul Torrance (1962a:2-15), research evidence clearly indicates that creative thinking is important in mental health, educational achievement, vocational success, and many other valued areas in life.

In her comprehensive book, Foundations of Creativity, Mary Lee Marksberry (1963:5) points out that today's school curriculum must provide for the extension of objectives beyond the mastery of subject matter. The development of creativity, according to Marksberry, should be a definite and specific curriculum objective to be thoughtfully implemented rather than a by-product of other learning experiences. She acknowledges that

... all thinking depends upon knowledge secured from previous experience. ... [but cautions] ... This is not to say that children should learn knowledge first and learn to think, but rather that it is from a rich background of wide and varied experiences emphasizing thinking and problem solving that children acquire facts, form concepts, and arrive at generalizations. Through relating these knowledges to old situations and using them in new ones, connections are made which separate them from the specific situations in which they were originally learned and free them for still wider use (Marksberry, 1963:94-95).

In the school curriculum science should be thought of not only as a body of information and explanations of
how the world works but also as methods of learning more about the world that include the development of synthesizing as well as analytical skills. The art of scientific investigation, whether it be a simple classroom exercise or a complex laboratory experiment, is essentially the same. In Paul Brandwein's words "creativity is the most essential attribute of a scientist's approach" (1962:11). It should be also the essential quality nurtured in children at school. It is reasonable to assume, therefore, that the materials of instruction and learning, particularly the textbooks, reflect these curriculum goals and objectives.

This study will attempt to provide curriculum workers and other educators with information in order to assess the role of the elementary science textbook in developing thinking skills in children in general and creative thinking in particular.

The textbook as a principal vehicle of classroom instruction and learning. While science textbooks are currently being supplemented by new instructional technology and materials of instruction, for the next few decades at least the textbook will continue to be the most widely used instructional material (McCaffrey, 1970:1-15).

A survey of the literature by the investigator reveals that there was no research to determine the
adequacy of elementary science textbooks in terms of presenting science as modes of inquiry that stimulate creative thinking. Because of the wide use of textbooks today and their continued use in the foreseeable future, it is reasonable to assume that it will be possible to enhance the quality of the book as a teaching-learning tool and to invest extensively in the search for improvement (Armsey and Dahl, 1973:71).

The extensive use of questions and activities for students, written into the narrative or employed at the end of topics, chapters, or units as aids to learning, is one way to distinguish the textbook from other types of books. An analysis of the questions and activities in terms of the thinking operations they elicit gives evidence of the cognitive goals and objectives emphasized in the textbooks.

To the extent that the contents of textbooks represent what and how science is being taught in the classroom today, a content analysis gives strong evidence of what the curriculum is in practice rather than in theory.

III. PURPOSE OF THE STUDY

In order to remain effective as a principal material of instruction, textbooks should reflect significant development in educational research and practice. Educators have stressed the importance of creative thinking in
studies involving school curriculum. Elementary science textbooks in particular should show evidence that they provide for the development of creative thinking.

This study was designed to provide evidence of the emphasis placed on creative-thinking skills in the selected elementary science textbook series in use in the early elementary grades to determine their utility as a material of instruction in the development of creative thinking.

IV. RESEARCH METHODOLOGY

This study is concerned with the classification, quantification, and comparison of the content of textbooks; consequently, the research methodology was that of documentary analysis (Van Dalen, 1973:201-203).

Four elementary science textbook series were randomly selected for analysis from a list of seven recommended for adoption by the California State Department of Education for use in the public schools. A sample of basic science textbooks in two series adopted by the State of California for use in the elementary schools from 1959 to 1974 were selected to determine any changes in emphasis placed on creative thinking. These textbooks were analyzed to determine their utility as a material of instruction for the development of creative-thinking processes in students.
Three elements of textbook content were analyzed: (1) the introduction to the textbook in the teacher's edition, (2) the questions for students, and (3) the activities for students. Instruments for the analysis of textbook questions and activities were developed by the investigator.

The questions of each textbook, listed under their general science topics, were classified into one of four categories of thinking operations adapted from Guilford's Model of the Intellect (1960) as defined by Aschner-Gallagher (1965:10-32).

The textbook student activities were analyzed in accordance with criteria developed by the investigator based upon the phases of the Creative Learning Process identified by Torrance and Myers (1972:22-23), the processes in the act of learning described by Bruner (1960:48), and the problem-solving methods described by J. H. McPherson (1968:103-108).

V. ASSUMPTIONS AND LIMITATIONS

Assumptions of the Study

The following assumptions were considered to be the underlying qualifications of the study:

1. All the relevant cognitive and motivational processes which account for creative behavior are to be found to some degree in every individual, not only in a chosen few (Wallach and Kegan, 1965:64-5).
2. Creative thinking can be nurtured and developed in young children (Torrance and Torrance, 1973:11-19; Johnson, 1974; Torrance and Myers, 1972:68-9).

3. Schools have a responsibility for encouraging creativeness in children and of giving it opportunity to develop (Torrance and Myers, 1972:210).

4. The textbook is now and will continue to be, in the foreseeable future, a principal material of instruction in the schools. The elementary science textbook should, therefore, be a useful and effective tool in fostering the development of creative thinking (McCaffrey, 1970:1-15).

5. The nature of a textbook question determines the thinking operations served as the student responds (Torrance and Myers, 1972:153; Sanders, 1966:2-3).

6. The process of scientific investigation emphasizes creative thinking in addition to disciplined, rational, ordered, and critical thinking (MacKinnon, 1961:1-6; Blough and Schwartz, 1964:6).

7. Creative endeavors in science are basically similar to those in the literary and artistic fields (Rugg, 1965:5-6).

Limitations of the Study

The limitations listed below would restrict the applicability of the findings of this study:

1. Those set by the sample selection of the textbooks used in the study. Four of the seven basic elementary science textbook series were selected from the list of instructional materials recommended for adoption by the California State Curriculum Development and Supplemental Materials Commission in 1972, and the two elementary science textbook series in previous adoptions in California in the years 1960-67 and 1968-74.
2. Those set by the investigator's decision to analyze the introductory statements for teachers, textbook questions, and student activities and not other textbook content.

VI. DEFINITIONS OF TERMS USED

The following definitions of terms have been used throughout this study:

1. Basic textbook: "a book designed for use by pupils as a principal source of instructional material for a given subject, at a given grade level, and meeting in organization and content the basic requirements of the intended course" (Education Code, State of California, Vol. One, 1971).

2. Convergent production (thinking): "the generation of information from given information, where the emphasis is on a single response in terms of commonly accepted criteria" (Guilford, 1967a:214).

3. Creative: "those behaviors where a person reflects and realizes a new idea, image, or form of which he was not previously aware" (Hausman, 1968:216).

4. Creative learning process: "one of becoming sensitive to or aware of problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; bringing together available information; defining the difficulty or identifying the missing element; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses, and modifying and retesting them; perfecting them; and finally communicating the results (Torrance and Myers, 1972:22).

5. Creative products: "are the manifest and tangible expressions or resultants of creative activity" (MacKinnon, 1961:1-4). Marksberry's classification on the basis of end product includes three types, "unique communication, problem-solving, and derivation of a set of abstract relations" (Marksberry, 1963:37).

6. Creative potential: "a collection of abilities and other traits that contribute toward successful creative thinking. Creative thinking is
distinguished by the fact that there is something novel about it; novel, that is, to the thinking individual. The degree of creativity shown is directly proportional to the degree of novelty" (Guilford, 1963:96).

7. Critical thinking: "the examination of an idea or product in the light of some norm or standard (Russell, 1956:283).

8. Discovery: "rearranging or transforming evidence in such a way that one is enabled to go beyond the evidence so reassembled to additional new insights" (Bruner, 1961:160). In this study the term includes any formulation new to the learner but not necessarily unknown generally.

9. Divergent production (thinking): "the generation of information from given information where the emphasis is upon variety and quantity of output from the same source; likely to involve transfer" (Guilford, 1967a:213)[output of many and qualitatively different responses].

10. Documentary analysis: "is sometimes referred to as 'content,' 'activity,' or 'informational' analysis, for it is concerned with the classification, quantification, and comparison of the content of communication" (Van Dale, 1973:201).

11. Instructional materials: "written or graphic things of learning useful in (1) transmitting information, (2) serving as role models, (3) assisting with the practice of specific skills, and (4) contributing to the provision of feedback" (Armsay and Dahl, 1973:8).


13. Textbook: "defined in terms of the characteristic textbook content; the textbook in contrast to all other kinds of books, contains exercises, study questions, and practice materials" (Deighton, 1971:211).
VII. SUMMARY

It is reasonable to assume that social and technological change will continue unabated in our society. Educators must respond to the problems and opportunities affecting the schools. It is difficult to imagine changes in educational goals, curricula, and educational technology without corresponding changes in the nature and role of the materials of instruction in general and textbooks in particular.

In Chapter I the problem has been introduced and stated; the significance, purpose, and research methodology for the study presented. The assumptions, limitations, and hypotheses of the research as well as the definitions of terms used have been developed.

The remainder of the study includes four additional chapters. Chapter II reviews the literature related to the study. Chapter III describes the design and the procedures of the study. The collected data resulting from the investigation are presented in Chapter IV. Chapter V contains the conclusions of the study and recommendations for future investigations.
CHAPTER II

REVIEW OF THE LITERATURE RELATED TO THIS STUDY

I. INTRODUCTION

The literature reviewed for this study was organized under three main headings: (1) the role of the basal textbook in education, (2) the current trends in elementary school science education, and (3) the concept of creativity. The writer attempted to provide a systematic review of the meaning of creativity, according to leading authorities in the field, in order to determine its applicability to the goals and objectives of elementary science education, and to determine the potential use of the elementary science textbook in the creative teaching-learning process.

II. ROLE OF THE BASAL TEXTBOOK IN EDUCATION

The extensive use of textbooks in the teaching-learning process is a well-established characteristic of our educational enterprise. Hillel Bialack (1967:3) illustrated the important role of the textbook by pointing out that during a child's school career, he will have attempted to absorb at least 32,000 textbook pages. By the time a student completes high school, he will have
intensely studied in over sixty textbooks. Black cited data that estimated about 80 percent of the nation's elementary teachers used textbooks as their principal teaching tool and source of information.

Austin McCaffrey (1970:8) quoted statistics published by the American Publishers Institute to illustrate the use of textbooks in education. The reported sales in 1967 were 92,525,000 textbooks, both hard bound and paperback, for elementary schools, plus 131,900,000 units of workbooks and objective tests. At the high school level there were 44,290,000 textbooks and 21,170,000 units of workbooks and objective tests. For the college level, there were 63,655,000 textbooks and 5,970,000 workbooks.

A survey made of fifty state departments of public instruction regarding state textbook programs established that over half of the states had state-funded textbook programs (Paul I. McCloud, 1974:438-441).

Walter Johnson (1974), Supervisor of the Textbook Distribution Office for the California State Department of Education, reported that during the school year 1973-74, the total number of textbooks distributed to the various school districts throughout the state amounted to over 8,200,000.

The continued dominance of the textbook as the primary medium of instruction is attributable to many causes and conditions. McCaffrey (1970:1-15) traced the
historical development of educational publishing from the
hornbook to present day textbooks. He acknowledged that
recent innovations in educational technology and the
increasing demands for individualized instruction made it
apparent that the textbook was no longer the single tool
of instruction or sole source of knowledge on a particular
subject. However, textbooks will most likely maintain
their important central role in education in the future.
The following reasons were given by McCaffrey for the
continued dominance of textbooks in education:

1. Textbooks are economical, since no equipment
   is required.

2. Textbooks are effective in presenting facts,
   concepts, and generalizations sequentially
   in any subject.

3. Textbooks can easily be integrated with other
   media into a complimentary structure.

4. Textbooks are flexible in that they can be
   used by an individual or by groups almost
   anywhere.

5. Textbooks are responsive to the rapid expan-
   sion of knowledge available to man.

The editorial staff of The Grade Teacher (1969:
99-100) sought to determine the status of the textbook in
elementary education in an era that saw the introduction
of an unprecedented array of new instructional media.
After consulting with editors and executives of the nation's
major publishing houses, the conclusion was that despite
the grandiose acclaims on behalf of new instructional
media, the basal text was still the core of the curriculum.
The reasons given for the continuing central status of the textbook were that the standard textbook provided teachers with both a basic structure of subject matter in a particular field and a theoretical and methodological approach to the subject. Many teachers found security in following a basic text while innovation was difficult and unpredictable. The textbook was economical and was still the best buy in a period of escalating costs. Among criticisms leveled at textbooks by teachers were that they were frequently out-of-date; and publishers failed to include teachers in their assessment of classroom needs.

The lack of proficiency in all the subjects that elementary school teachers are expected to teach was found to be a contributing factor in the dependency on textbooks. George Ackerlund (1959:283-5), in his study of teacher competence in dealing with elementary subjects, found:

... of the 260 generalist teachers who took part in the study, 47 percent felt that they were "less than well prepared" in content and method to teach reading, handwriting, history, geography, science, art, and music. There were only three areas in which 70 percent or more of the teachers felt competent in both content and method. These areas were arithmetic, English, and spelling. Only four of the 260 teachers considered themselves well prepared in all the subjects they taught.

Where the curriculum was built around the textbook series, the teacher often became a part of an interlocking
system in the school's program. Each teacher was expected to use the textbook assigned to his or her grade level in such a way that the teacher at the next higher grade level, using the next textbook of the series, could properly "plug-in." The textbook, therefore, became the dominating element of the curriculum (Henry F. Beechhold, 1971: 1-9).

Richard Merrill (1969:46-7) in his discussion of the types of materials of instruction, listed the following role for the textbook: a repository of verbal information, a guide for the structure and sequence for a subject matter, and a source of vicarious experiences for students. Merrill listed some of the advantages and disadvantages of textbooks. Among the advantages were the general acceptability of textbooks by both teachers and students, the relatively low cost, portability, and that textbooks were an easily accessible source of information.

Textbooks provide for the individualization of learning, in that they may be used independently and at a rate set by the student. According to Merrill, textbooks also have some serious limitations. Some students have difficulty responding to printed material. Reading generally places the student in a passive learning role. Textbooks encourage authority dependence on the part of students. Information presented in the text is most often unresponsive to the needs of a student at a particular time.
The content is often not up-to-date, especially in science. Textbooks tend to perpetuate obsolete curriculum structure.

Harriet Talmage (1972:20-25) indicated some of many administrative advantages of a single textbook approach. The textbook was the least expensive method of getting instructional material in the hands of students. The instructional program easily could be monitored to assess the "progress" of classes. The textbook assured a uniform and systematic presentation of content. Textbooks could readily be used by either small or large groups. Talmage added that textbook series provided a school system with a ready-made philosophy of education, the learning objectives, and methods of instruction.

The 1960s witnessed the influx of a wide variety of supplementary teaching materials. In addition to workbooks and audiovisual materials, the instructional package or kit was introduced. In science education the kits included consumable supplies and permanent equipment as well as student manuals and teacher guides. Talmage pointed out that "however elaborate instructional packages have become, whether we use the term textbook or instructional materials, these materials serve as the arbiter of the curriculum of a school system" (Talmage, 1972:25).

Among those who critically cautioned that education has not assumed adequate leadership for the development and improvement of many areas of the curriculum, A. Rice (1960:55) suggested that textbook publishers had been
improperly left with most of the burden of content improvement in various subject fields. Rice emphasized that commercial textbook publishers too often must yield to the economics of the market and speculated that many areas of learning had been avoided as a consequence.

A lesser but a deeper new role for the textbook in terms of creativity was advocated by George Stoddard (1950:182). Though not itself creative, a good textbook could show the way to creativeness. Its main purpose would be introductory, stimulating the student to ask and to find answers to key questions. Textbooks should send students to original sources and to new experiences of which a student might not be aware. Stoddard quoted Oscar Handlin (1957:110-113) who stated:

... with few exceptions (the textbook) is dogmatic and dull, an obstacle rather than an aid to learning. ... Generally, publishers, authors, and teachers follow one another in a frustrating circle that strengthens the pattern. The publisher is constrained by the market to turn out books for existing courses; the author writes what will be published; and the teacher shapes his course by the available texts. The result is endless imitation.

J. P. Guilford (1967b:154) contended that the nature of the reading material, in part, determined whether the reader was encouraged to think productively. Materials that stir the imagination of the reader leave something for the reader to do, and open up alternative and inviting avenues that are conducive to divergent thinking. Content that leads the reader step by step in logical sequence
toward an inevitable conclusion provides for the development of convergent thinking skills. Reading materials that require the verification of facts and the testing of ideas, call for critical or evaluative thinking.

One way to encourage teachers to value creative thinking was to provide them with materials "which are administered and which lead naturally into 'creative' activity" (Torrance, 1965:74).

In a review of research in textbook content analysis done in the last several years, Ellen Campbell (1973) found that the studies examined texts from a number of points of view: the adequacy of treatment of particular minority groups in society (degree to which bias of various sorts exist), sex-role stereotyping, the relationship between text and illustration, comparisons between children's interests and textbook content, and the adequacy of the treatment of special issues. According to Campbell, all of the studies seem to have been in the reading or social studies areas; and she states, "undoubtedly teachers in other subject areas might raise additional kinds of questions. One might wish to know, for example, the degree to which texts in science present scientific theory or hypotheses as absolute truth."

Campbell found throughout the studies that two fundamental deficiencies were apparent; some texts perpetuated stereotypes and negative images in their
treatment of particular groups in society, while other texts omitted important ideas.

If textbooks are considered to be plans for teaching and learning, in addition to sources of information on given subjects, then their contents should be organized so that they serve the goals and objectives of education.

In their study of the relation between cognitive objectives from selected texts and from recommendations of national committees, Mary Lee Marksberry, Mayme McCarter, and Ruth Noyce (1969:422-9), analyzed the suggested questions and activities from primary and intermediate levels of the teacher's editions of selected textbooks in language arts, mathematics, reading, and social studies. The questions and activities were classified according to the categories in the Taxonomy of Educational Objectives Handbook I: Cognitive Domain. The findings of the study revealed that in the primary level, the vast majority of the questions and activities were in the categories of knowledge and comprehension; approximately 77 percent in language arts; 91 percent of those in reading; 95 percent in social studies; 71 percent in mathematics. Only in mathematics was there a strong emphasis in another category (29 percent in application). Data for the intermediate grades followed a similar pattern. The findings also indicated that textbook writers placed relatively
minor emphasis on objectives classified in the three highest cognitive categories (analysis, synthesis, and evaluation).

**Questioning Practices**

The intrinsic explanation-seeking behavior of students is the result of a natural curiosity about things and ideas that they encounter. An important role of education is to preserve and extend this interest through learning experiences that foster the development of inquiry skills. Questions are a central part of all learning and are especially important in scientific investigation. Questions provide focus and direction to investigations and stimulate productive thinking when the learner is confronted with a situation that challenges his understanding of the world around him.

O. L. Davis and Francis P. Hunkins (1966:285-292) examined three fifth grade social studies textbooks in order to determine to what extent textbook questions emphasize the higher intellectual processes. The analytical scheme employed in judging the cognitive levels of questions was Bloom's *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain*. Eighty-seven percent of the questions were found to be in the category of knowledge. Of the 732 questions classified, one required synthesis, and only two questions involved evaluative thinking. The obvious conclusion of the investigators
was that these textbooks were not fostering the development of thinking skills in pupils. To the extent that the analyzed textbooks were representative of all social studies textbooks, teachers who base their instructional program on textbooks are neglecting a significant portion of learning.

In a similar study, Aida Alcala (1971) examined the relative frequencies of questions at various cognitive levels in third and fourth grade social studies textbooks published since 1963. Of the 1108 questions analyzed, 482 required memory, only 31 involved synthesis and 49 necessitated evaluative thinking.

Victoria Chew (1966) analyzed nineteen second grade social science textbooks chosen for final evaluation prior to adoption in California. She found that only three books contained textual material at the analysis, synthesis levels (Bloom's Taxonomy). In all of these three books, the frequency was less than ten percent of the content.

Types of questions asked by teachers of students in grades one, two, and three, and questions suggested in teacher's guidebooks in relation to the objectives purported to be accomplished in primary reading were examined by P. Bartolome (1968). The results of the study indicated that the categories of objectives intended to be accomplished and the categories of questions asked in
order to attain these objectives differed widely for both teachers and the authors of the guidebooks. The categories of objectives frequently stated involved analysis and application while the category of questions most often asked involved memory.

In the analysis of contemporary American history textbooks, Clarence Wadleigh (1969) indicated that texts did not provide a range of questions which elicited all the categories of thinking skills listed in Bloom's Taxonomy. The text questions were predominantly of the knowledge and comprehension levels, while the incidence of application, analysis, and evaluation was negligible.

In an article, "Questioning and Creative Thinking: A Research Perspective," U. S. Chaudhari (1975:30-33) summarized the opinions and studies of many writers regarding the role of questions in the development of thinking skills. Chaudhari cited evidence that suggests that the majority of classroom and textbook questions require little more than memorized responses. He concluded, from a number of studies, if questions of the right type were included in the textbooks, pupils could be led to creative thinking and suggested that efforts to increase the cognitive level of classroom and textbook questions should continue.
Textbooks and Creativity

Catherine Nurse (1969) analyzed selected general elementary curriculum textbooks used in pre- and in-service teacher training in order to determine the emphasis placed on the topic "creating." From the minor portion of content space devoted to the topic, Nurse concluded that creativity was not considered of significance within the elementary school curriculum if it could be assumed that textbooks were a guide to topics of importance and emphasis in education. Nurse expressed concern that while many leading authorities regard creative thinking of major importance to the individual and society, curriculum textbooks for teachers gave only minor attention to the subject.

The learning exercises of three language arts textbook series for grades four, five, and six were analyzed by Frederick Preston, Jr. (1973) in order to determine the emphasis the textbooks placed on creative thinking. The study revealed that the activities classified as being "creative" varied among the series examined from 2.45 percent to 38.63 percent. The data also suggested that a large number of student exercises were not necessarily indicative of an emphasis on creative thinking. Preston's general criticism of the textbooks was that they included too much step-by-step material which emphasized conformity rather than divergent thinking. Preston also was critical of the textbooks for their presentation of knowledge as
"Science instruction in the elementary school is the ideal vehicle for stimulating creative energy," according to William S. O'Bruba (1973:34). However, he cautions that if science is merely a reading activity, it is impossible to develop creativity. O'Bruba believes that the textbook, in its present state, should be used only as a reference or as a sourcebook in conjunction with other materials of instruction.

Textbook and Non-Textbook Based Instruction

During the 1960s, various major elementary science improvement projects introduced programs with a non-textbook orientation. These programs focused on the student's direct and active involvement with the processes and materials of science rather than learning about science by reading.

John E. Novinsky (1974) compared the effects of two science programs for fifth grade students relative to achievement, creativity, and attitudes. One program, termed "traditional," embodied formal lectures, laboratory demonstrations, recitations, and textbook reading assignments. The other program was Science, A Process Approach (SAPA) developed by the Commission on Science Education of the American Association for the Advancement of Science (AAAS). This non-textbook program is based on identified investigative skills employed by scientists.
On the basis of the findings of the study, Novinsky concluded that, in addition to any benefits gained from the problem-solving approaches, fifth grade students who were exposed to the SAPA program would be expected to do about as well on standardized science achievement tests emphasizing subject matter concepts as those students in the "traditional" science programs. Students in the SAPA program would also be more likely to develop higher levels of performance on a variety of creative thinking tasks. They would have more favorable attitudes toward school-related factors than would students in "traditional" science programs.

Marvin C. Weber (1971) compared the effectiveness of developing science process skills of an elementary science curriculum, a non-textbook approach, developed by the Science Curriculum Improvement Study (SCIS) with a textbook-oriented course of study. The investigator measured student performance on thirty-four tasks based on six selected process skills; observation, classification, measurement, experimentation, interpretation, and prediction. The findings of the study indicated that the textbook program was not as effective for developing the science processes as the non-textbook SCIS curriculum.

In studies associated with the development of new elementary science programs, three approaches were tested by John A. Struthers (1969). One approach was textbook
based while the other two involved the use of the Elementary Science Study (ESS) materials and Science-A Process Approach (SAPA). The findings revealed that the non-textbook courses favored creative thinking.

The vast fund of knowledge and experience accumulated through the ages makes it possible to explore and to understand more of the world around us. A rich storehouse of comprehension appears to be essential in creative production. It is unrealistic to expect children to discover all the knowledge that they need in order to function effectively and productively; therefore, books are undoubtedly one of the best methods of presenting information. In addition to textbooks, Dewey Chambers (1971:77) advocated the use of trade books as sources of information and as a method of enhancing and expanding investigative activities in elementary science programs.

The dominant role of the textbook in education has been well established. While some may argue that textbooks are primarily materials of instruction and not teaching methodology, it seems reasonable to assume that the textbook authors' approach and content emphasis significantly affect the teacher's classroom program. Open-ended materials are essential components of open-ended methods. Both activities and materials should be organized to include problem-solving processes in order to enhance creativity and discovery.
III. ELEMENTARY SCHOOL SCIENCE TRENDS

The technological-industrialized character of our present society demands a scientifically literate citizenry. In addition to the basic understanding of natural phenomena and operations of scientific principles, a pluralistic cultural value system, and today's exploding knowledge, individual needs include the capability of dealing with problems in rational and original ways. The goals of science education are concerned with both the acquisition of knowledge and the development of skills related to the methods of scientific investigation.

The California State Advisory Committee on Science Education (1970:8) depicts science as "a systematic way of answering questions and an organization of knowledge." In this context science may be thought of as man's attempt to bring order and meaning to a seemingly chaotic world. Relationships among observable facts are organized into coherent systems. These cognitive models are the inventions of man that enable him to explain, predict, and in many instances, control objects and events.

The process of establishing order and relationships may be thought of in terms of two basic sets of investigative procedures. While both procedures are related to productive thinking in response to a recognized problem; in one the force of the solution is in the critical validation and perfection of existing constructs. The
elements or steps of this process are described in the traditional explanation of the "scientific method."
The phases of the second procedure are not so clearly defined. The procedure is generally associated with a difficult problem that seemingly defies solution. It is characterized by the sudden insight of a probable solution to the problem following a period of intense concentration and effort and a period of interlude or exhaustive withdrawal. Unconscious rather than conscious effort is thought to be the source of the insight. The tentative solution is then critically tested and perfected in accordance with the well-established methods of scientific validation. This latter procedure is often referred to as the "creative process" (Brandwein, 1965: 20-24; Torrance and Myers, 1972:78-83; J. Smith, 1966:84-87).

Bartlett A. Wagner (1969:5-10) considered science and creative learning to be problem solving, and from a theoretical point of view there is probably no difference between the two. A science program that fosters creative thinking provides children with relatively unstructured experiences from which they are able to build their own individual structure and style, and, thereby, learn how to learn.

The contention that problem solving, inquiry, discovery, and invention were related elements of the creative process--the ability to view the familiar in
unique ways, to make transformations, to see multiple things in a single object, and to synthesize isolated schemes in new and original ways—was upheld by Rodger Bybee (1972:22-26). Inquiry, or the search for solutions, is initiated by a perceived need or problem. The search may result in the discovery of an existing product or condition or in the invention of a new product or relationship that has not previously existed. Science activities can facilitate creativity by providing conditions which encourage free exploration and multiple and diverse responses.

Paul E. Blackwood (1965:59) emphasized the need to reexamine the meaning of science in terms of both content and method of instruction. Historically, science educators have stressed the importance of the processes of scientific investigation in the science curriculum, according to Blackwood. However, classroom instruction has been characterized by the acquisition of knowledge rather than the methods of science. Trends and developments in elementary and secondary school science indicate a reawakening and a rededication to the goals and objectives of science education. These emphasize the methods of inquiry and investigation that challenge students and teachers to formulate creative ways of gathering and processing data for making valid descriptions of natural phenomena.
David L. Williams and Wayne L. Herman, Jr. (1971: 247), in their book, *Current Research in Elementary School Science*, observed that classroom instruction appeared to move back and forth from one end of the continuum to the other, conforming with the current stress in education.

With the introduction of new science programs which emphasize the active involvement of students in the processes of science, some teachers stopped "read-about-science" activities. Williams and Herman felt that polarity is inappropriate. Both modes of instruction are important in a well-structured science program, and each activity should be used when it is pertinent to the teaching-learning objectives.

Glenn O. Blough and Julius Schwartz (1964:6), in their comprehensive book, *Elementary School Science and How to Teach It*, emphasized that science in the elementary school was essentially the same as science at any other level. According to Blough and Schwartz,

... it is characteristic of science that it starts with a perplexing problem, proceeds with the trying of different methods of solution, and results in new discovery. It is also characteristic that new discoveries in science lead to new perplexing problems.

The elementary school science program, therefore, should provide opportunities for children to find answers through the development of problem-solving skills. While the level of intellectual development should be considered when planning activities for children, Bruner (1960:39),
pointed out that instruction in scientific ideas at the elementary level need not rigidly follow the natural sequence of cognitive development. Challenging experiences presented in a manner understandable to children can lead them into higher levels of intellectual activity.

The science curriculum improvement movement of the 1960s stressed an approach to elementary school science that emphasized the processes of scientific investigation. Common among the science programs developed were the wide array of student activities that were based on elements of inquiry and discovery. These activities were designed to foster the self-directed learning potential in children and to recognize the experimental problem solving strategies employed by scientists (Thier, 1970:209).

While all the science improvement projects stress the active involvement of students in activities, provision for concept development is also an important part of most new programs. Subject-matter content is organized to produce a functional understanding of fundamental generalizations rather than the presentation of specific facts (Brandwein, 1965:26).

Efforts were made by the developers of some programs to structure concepts into a hierarchical framework so that each concept could be acquired and used at different levels of understanding through successive grade levels. These programs stress continuity and sequence in both subject-
matter content and methods of inquiry, thus, moving students through higher levels of abstraction and complexity (Thier, 1970:213-4). In addition to cognitive development and conceptual understanding, new science programs also deal with scientific attitudes and values in recognition of their role in problem solving and discovery (Gagne, 1966:4, 49).

Another important aspect of the science programs is the heavy emphasis placed on the purposeful manipulation of materials by students for exploration and experimentation. This emphasis on student experiences with materials and equipment presents a new problem of supply and management to the already overburdened classroom teacher. The problems associated with programs that have high material and equipment requirements were partially met by developers through the production of science kits. The kits developed for the various topics or units of study contain all of the essential materials, consumable and permanent, for students to carry on the activities suggested in the printed texts (Thier, 1966:215; Frost and Rowland, 1969:308-311; Hutchins, 1970; Dunfee, 1967:1-16).

The importance of direct contact with "real things" for pupils in the early grades was substantiated by Asahel Woodruff (1959:72). Gathering a rich supply of basic perceptual information is fundamental to the ability to respond effectively to written materials in later grades.
Books, according to Woodruff, contain only descriptions of subject matter and do not provide students with the vivid experiences of concrete objects and direct experiences needed to sustain the natural curiosity and interest of young children.

Kenneth George and Maureen Dietz (1971:527-532) in their study involving an attempt to improve the science problem-solving skills of inner-city children, found that the physical manipulation of materials enhanced the problem-solving skills of first grade children.

In the study to explore the effects of the child's manipulation of the concrete objects involved in a problem situation and the quantity and quality of creative responses, Torrance (1963b:110-118) found that in tasks permitting manipulation of objects, the degree of manipulation significantly affected both fluency and flexibility.

Allan McCormack and Gary Doi (1972:9-12) identified conditions that have been found to be effective in motivating creativity in science with elementary school children. The first condition centers on a problem. The student is confronted with objects and events that focus attention and interest on an open-ended problem. The second condition sustains the initial enthusiasm through a responsive and supportive environment. Students receive encouragement to explore ample resources in imaginative ways in the form of tangible materials and information, and plenty of time to
formulate and test ideas.

Other elementary science programs developed in the 1960s based on an autonomous-thinking and learning approach, emphasized the development of the student's inquiry skills.

In the Inquiry Training Program developed by J. Richard Suchman (1962) children were motivated to discover causal relationships in response to problems presented to them in the form of discrepant events. They did this by asking questions in order to gather data.

John Schippers (1962) developed materials and procedures for a child-centered, problem-solving method of instruction. In this program the students, guided by the teacher, identified questions fundamental to their understanding of basic science concepts.

In creative learning and teaching it is important that questions encourage children to extend their thinking and to see new relationships, to discover gaps in their knowledge, and to cause them to want to acquire more information or to engage in new activities (Torrance and Myers, 1970:210).

Peter Gega (1966:13-17) indicated that instructional approaches in elementary science could stress the content or the process of science. Learning experiences could be divided into two broad types, "background-centered" and "solution-centered." The objective of the background-
centered activities was to help students establish a fund of knowledge that they could draw upon when needed. Problems in this category made a hypothesis unnecessary or the "solution" a foregone conclusion. Examples of this type of question were: "Will snow melt when heated? Does running water move soil from one place to another? Does paint prevent iron from rusting?" The solutions to background-centered problems, according to Gega, were generally immediately available from authority-based explanations. Solution-centered activities, on the other hand, involved students in productive-thinking processes in which several plausible solutions were acceptable. While authority sources might be used to collect needed data, solutions were developed primarily through the student's own problem-solving efforts. An example of this type of problem was: "Why can a ship carry a heavier cargo on the ocean than on the Great Lakes? . . . Solution-centered questions are probably the best means we have to foster such a wide range of thinking procedures," states Gega.

Traditional science activities impose a structure that requires a student to follow a step-by-step procedure designed to produce certain specific results. William Romey (1968:23-24) suggested a relatively unstructured approach which offered students greater opportunities for creative problem solving. Romey affirmed that students
should be allowed time to mull over a problem and to later propose alternative solution-seeking procedures. Information should be available in moderate detail to guide students so that they could devise, test, analyze, and modify specified tentative solutions and make reasonable generalizations on the basis of their own data. Romey maintained that all laboratory activities should be open-ended even if students have had little or no previous experience with unstructured exercises.

Studies involving the analysis of teacher question-asking behavior in the classroom indicated that a high frequency of questions asked by teachers were in the category of memory (Ozgener, 1971; Floyd, 1960). Projects designed to provide teachers with instruction in asking questions have not always been successful in effecting greater use of questions at higher cognitive levels than memory (Bozardt, 1974; Douce, 1971).

The results of investigations (Jacob Getzels and Philip Jackson, 1962:30-31) designed to compare highly intelligent and highly creative students, showed that teachers preferred high I.Q. students over high C.Q. students even though their academic performances, as measured by achievement tests, were the same.

In their analysis of research related to instructional procedures in elementary science, Gregor Ramsey and Robert Howe (1969:32) identified only two studies
which made an attempt to develop materials and procedures for encouraging creative thinking in students.

Edward DeRoche (1966) found that students, after thirty creative lessons in space science, scored higher on the Minnesota Tests of Creative Thinking than did pupils exposed to the same content but without the creative exercises. No significant differences, however, were found on achievement tests between the two groups.

In a study involving ways of developing creative thinking in elementary school science, Marcela Tating (1965) obtained more divergent responses from trained groups (in terms of question-asking skills of the students). However, Tating found that the development of hypotheses-generating skills was not as responsive to training.

Norris M. Sanders (1971:775) listed possible reasons why the teaching and learning which emphasized memory had survived countless curriculum reform movements. In memory instruction both students and the teacher understand and generally agree on goals. The less academically-inclined student can attain reasonable success, and brighter students can be challenged to master all the information in a text. Textbook and teacher questions can be stated in an objective format that requires clear-cut answers that can easily be evaluated by the simple criterion of correctness. Higher level questions, on the other hand, call for more subjective thinking. Teachers and students are less comfortable with ambiguity and lack of closure. Exposing
one's own thoughts rather than those of a recognized authority is a risk many students are reluctant to assume. Teachers find it rather difficult to construct, evaluate, and correct tests that involve productive thinking.

The analysis of the role of the elementary teacher by Haney (1966:33), and that of Shumsky (1965:161) suggested that the responsibility to teach all the major facets of the total school program in a self-contained classroom, and the lack of in-depth training of teachers in areas of the curriculum such as science, are contributing factors. Teachers, as generalists, are overburdened with the accountability for delivering the basic skills of reading, writing, and computation, to deal effectively with matters pertaining to productive thinking skills.

One might also reasonably argue that, in addition to matters related to teacher competency and the organizational patterns of elementary schools, the materials of instruction, especially textbooks, available to teachers, are equally important in the determination of the instructional program presented in the classroom.

IV. THE CONCEPT OF CREATIVITY

A primary goal of education is to establish conditions by which each student may realize his uniqueness. In order to identify the creative child in the classroom and
to provide for his development, we must have a clear understanding of what creativity is. The lack of universal agreement in defining intelligence is also present in forming a definition of creativity.

Definitions of Creativity

K. Yamamoto (1964:403-409) reported that no single definition covered all the meanings attached to the term creativity, based on data derived from a survey of the literature related to creativity. He cited findings on which the following traits were related to the concept of creativity in various ways: imagination, inquisitiveness, curiosity, exploration, and discovery.

Most researchers perceive creativity in terms of the product and the process, and differ mainly in the relative emphasis given these two categories. For example:

James Smith (1966:4) described creativity as "sinking down taps into our past experiences and putting these selected experiences together into new patterns, new ideas or new products."

William H. Burton and Helen Heffernan (1964:16) stated, "creativity means the ability to or the quality of producing something new, unique, original, not existent before."

Mary Lee Marksberry's (1963:37) classification of
creativity included producing unique communications, problem solving, and deriving sets of abstract relations. Paul Smith (1959:18) described the creative process as "the ability to relate previously unrelated things."

Herbert Gutman (1967:5), a genetic psychologist, contended "creative behavior consists in any activity by which man imposes a new order upon his environment."

Morris I. Stein (1953:312) wrote, "the creative work is a novel work that is accepted as tenable or useful, or satisfying by a group at some point in time."

Wallach and Kogan (1965:64-65) after a review of the findings of a number of studies relating creativity to I.Q. concluded that the research procedures employed did not give evidence that support a distinction of creativity from that of general intelligence. They considered the failure to discriminate statistically between intelligence and creativity was possibly due to a diffuse starting definition of creativity. With creativity defined as "the ability to generate many cognitive associates and many that are unique" in an evaluation free context without the pressure of time limits, Wallach and Kogan, working with a sample of 151 fifth grade children, demonstrated that this concept of creativity is clearly independent of general intelligence while at the same time, is a "unitary
and pervasive dimension of individual differences in its own right."

Carl Rogers (1959:71) defined the creative process in relationship to the effectiveness of an observable product as "the emergence in action of a novel relational product, growing out of the uniqueness of the individual on the one hand, and the materials, events, people, or circumstances of his on the other." Rogers felt that the unique product of a creative act should be independent of social value. Social values in a rapidly changing society are subject to frequent fluctuation and modification.

From a similar viewpoint, Frank Barron (1969:10) believed that something considered to be without social redemption today may in a relatively short period of time be accepted as constructive and useful. Barron defined creativity "as the ability to bring something new into existence" ... the something new [physical and mental] always involves "the reshaping of something old" since no one is able to make something out of nothing.

Charles S. Whiting (1958:168) differentiated creative thinking and original thinking; creative thinking combines usefulness and originality, original thinking involves the production of new, but not necessarily useful, ideas. He regarded attempts to solve new problems with old methods and social restrictions as the two primary mental blocks to creativity.
Getzels and Jackson (1962:13-14) identified two basic intellectual modes:

1. Retaining the known is characterized by learning and conserving the predetermined. Thinking in this category tends primarily toward the usual and the expected and favors certainty and conformity.

2. Revising the known involves exploring and constructing the undetermined. This process favors the novel, speculative, risk, and innovation.

Guilford described the two processes as "convergent" and "divergent" thinking; Maslow used "safety" and "growth"; and Rogers, "defensiveness" and "openness." Regardless of the terms used, it is evident that thinking in one process is channeled toward a single conclusion or answer considered to be inevitable and correct; the other process is less goal-bound and favors exploration in various and new directions in an attempt to find new answers and solutions.

Colin Martindale (1975:53), in his investigation of physiological basis of creativity, found that creative people process information differently. They appear to be more sensitive and conscious of incoming stimuli. Electroencephalograms of high, medium, and low creative people suggest that the degree of cortical arousal is directly related to creativity. Normally, alpha waves are produced at a higher rate when a person is relaxed and reduced in frequency when the individual is working on a problem.
Creative people, on the other hand, produce less alphas when relaxed; and the level of alpha production is increased when they are involved in creative processes.

In Ward Weldon's (1972:55-60) approach to the definition of creativity, an analogy was made to the principle of supply and demand in economics. Creativity was thought of in terms of two major categories. The first category was called "producer approach" because it focused attention on the individual who supplied innovation. The second category was called the "consumer approach" in that it emphasized the role of those who used and gave further diffusion to an innovation if they learned about it and chose to accept it. In the consumer theory of creativity, the receivers and evaluators of innovations have a voice in determining the society's level of creativity. The ultimate goal is the general acceptance and use of a new method. Innovations which do not serve the needs and interest of others are considered not really creative at all. Weldon challenged our present frame of reference which places heavy emphasis on the creative individual as a producer and called for a reinterpretation of creativity from the perspective of the society as a whole.

With respect to J. P. Guilford's Structure of the Intellect Model (Guilford and Merrifield, 1960:13), it seemed reasonable to expect that all operations of the intellect were involved to some degree in creative
thinking. Creative thinking appears to differ from other forms of thinking by way of emphasis. Divergent thinking and the ability to effect transformation of information are the dominant aspects of creative thinking with the abilities of fluency, flexibility, elaboration, redefinition and evaluation playing an important role. In divergent production, fluency, the calling out of memory storage data needed to meet particular specifications, facilitates the generation of a quantity of ideas. Along with fluency, flexibility is said to be the ease of producing transformations of concepts in order to make them useful in solving problems. Elaboration abilities contribute additions and lead to the achievement of completion. Redefinition represents transformation of thought, reinterpretation, and a freedom from categorical fixedness associated with convergent production. Evaluative thinking involves the making of judgments concerning the fitness of information based on criteria of identity, consistency and goal satisfaction. Guilford proposed that evaluative-thinking operations were not restricted to the last step in the problem-solving process. Evaluation is also an important factor during the analysis of the problem as well as during the stage of idea generation in order to select the most appropriate information and ideas (Guilford and Merrifield, 1960:11; 1967:96-106).
The sequential and cumulative nature of Benjamin Bloom's (1956) *Taxonomy of Educational Objectives, Handbook No. I: Cognitive Domain* supported Guilford's conception that productive intellectual operations included more fundamental cognitive elements or processes. While each category of thinking represented in the six classes of the Taxonomy had certain unique elements, all the lower categories on the hierarchical scale also were included.

Irving A. Taylor's (1959:61-66) description of the identifiable stages in creative production represented an elaboration of the four basic steps in the creative process first formulated by Graham Wallas in 1925.

The first was the *Preparatory*, or as Taylor preferred to call it, "the Exposure stage." During this initial stage, data (raw materials) are collected from the environment. Any and all life experiences are absorbed. In the second or *Incubation* stage, experiences flow freely about without mental sets. These "raw materials" are selectively and tentatively combined into meaningful new relationships. The dynamic interactions of this phase are mostly unconscious and often produce a feeling of uncomfortableness. Incubation is followed by the *Illumination* phase. The incubated parts are formed into a recognizable and meaningful experience in a moment of insight when new ideas are formulated. Exhilaration and tension release accompany the insight. The final stage,
Elaboration, which Taylor termed the Execution phase, "involves the difficult communicative task of transforming implicit experiences into objective symbolic form."

Irving Taylor (1959:73-80) pointed out that in practice the stages do not necessarily follow one another in orderly sequence but frequently interact and overlap. He considered the two most important aspects of the creative process to be Perception and Communication. Taylor defined perception as the ability "to mold experiences into new and different organizations and to perceive the environment plastically." He termed communication as the ability "to communicate the resulting unique experience to others" [by] "transforming subjective experiences into objective verbal or nonverbal form."

In the 1961 Conference on Creativity at the University of California Alumni Center, Lake Tahoe, California, Dr. Donald MacKinnon (1961:I,1-2) delineated the phases of creativity as follows:

1. Preparation: acquisition of knowledge, skills, and techniques which enable the individual to pose problems.

2. Concentrated effort to solve problems often involving tension and discomfort.

3. Withdrawal: a period of relaxation from a conscious effort to solve a problem that seemingly defies solution.

4. Insight: into the probable solution accompanied by exhilaration, the "aha."
5. Verification: evaluation, elaboration of the insight.

According to Alex Osborn (1957:115, 318) the creative process usually includes some or all of the following phases:


2. Preparation: information gathering stage.

3. Analysis: processing of gathered data [breaking down the relevant material].

4. Ideation: generation of tentative alternate solutions.

5. Incubation: unconscious activity associated with a conscious withdrawal when the problem solution is not immediately forthcoming—ending with illumination.

6. Synthesis: combining several ideas into one new idea.

7. Evaluation: judging the resulting idea.

Alex Osborn (1957:318) also stressed the importance of the generation of a number of tentative ideas in order to arrive at a solution that may be the most indispensable part of any problem-solving process. Osborn subscribed to the principle that quantity breeds quality. He reasoned that only a few of many ideas proposed will have value. The likelihood of arriving at a useful solution is greatly enhanced when a large number of viable ideas are produced. Osborn suggested nine ways to help one combine ideas and to generate a number of alternatives by self-questioning:
1. Put to other uses? New ways to use as is? Other uses if modified?

2. Adapt? What else is like this? What other idea does this suggest? Does past offer parallel? What could I copy? Whom could I emulate?


Arthur Foshay (1961:22-40) identifies four major aspects of the creative process which appear to account for creativity:

1. Openness: to raw new experiences; unstructured look at the data available; suspension of judgment; lowering the usual defenses and an abandonment, for a time, of the usual definitions and old stereotypes.
2. Focus: ordering experiences; a deliberate attempt to refine undifferentiated input data in the search for new meaning.

3. Discipline: in the search for meaning; systematic approach to resolving a discrepancy; processes that mediate between the focus and the product.

4. Closure: the personal decision that the product is complete and ready for public scrutiny; may be regarded as an act of prideful self-discovery.

Richard S. Crutchfield (1961:VI,5-6) in his analysis of the creative process concluded that once a problem has been established, the creative solution-seeking behavior is essentially combining or recombining or transforming selected ideas in a novel and adaptive way. He listed the essential conditions for the occurrence of a creative combination or transformation of the cognitive elements [ideas] in a problem:

1. Available: elements to be combined must be available . . . either in the immediate stimulus situation or in the memory of the individual.

2. Selective: activation of essential elements out of a welter of available elements.

3. Contiguity: elements are activated more or less simultaneously in order to search out their possible connections.

4. Salient: the appropriate elements must stand out from their surroundings in such a manner as to make each in some sense accessible to the other.

5. Free: not be so rigidly embedded or confined with respect to other cognitive structures that the new combination is prevented.
6. Fitting: characteristics of each element must be such that it is capable of locking together with the other elements, as in the pieces of a jigsaw puzzle or in a chemical bond.

E. Hintschman (1960:278), in reporting psychoanalytic studies of great men, described the creative process in the following manner:

... creation tends to be experienced in two phases. In the first, the creator is driven; he is in an exceptional state. This is what he calls the moment of inspiration. The ecstasy of the creative state has been variously described as divine, pathological, superhuman. Everything is slowly developed, in a particular individualistic way. The moment of inspiration is most probably the moment of narcissistic acknowledgment of something which has been unconsciously prepared for a long time. The second phase is no longer exceptional; it is elaboration.

MacKinnon (1961:1,6) made a distinction between artistic and scientific creativity. In artistic creativity the product is seen as an expression of the inner state of the creator. Examples of this kind of creativity are found in the painting, sculpting, musical composition, and literary authorship. In scientific creating, by contrast, the creator is unrelated to the creative product in terms of personality. The creator acts largely as a mediator between externally defined goals and needs. He adds little of himself to the results and operates on some aspect of the environment to produce a novel and effective product. This kind of creativity is found in science, engineering and industrial invention.
All creative thinking is not done under the same environment or conditions. The procedure which is effective for one type of problem may prove to be wholly inadequate for another. Inherently we go through the same mental process but the direction and stresses are different (Bernard Goldner, 1962:50-51).

From a comprehensive sample of the autobiographies and case studies of eminent men of science and the arts Harold Rugg (1963:5-6) identified four indispensable stages in a prolonged creative act. The steps in the cycle of creative work were found to be essentially the same regardless of the field of study. For example, the artists' creative episodes are basically similar to those of the scientists although their problems are very different.

They are:

1. **Preparatory**: a prolonged period of conscious baffled struggle. The creator immerses himself deeply in the problem with intense concentration and effort.

2. **Interlude**: the creator apparently "gives up" and pushes the problem "out-of-mind" leaving it for the unconscious to work on.

3. **Flash of Insight**: intuitively, suddenly, and unexpectedly, come ideas, when the mind is "off-guard," with such certitude that a logical solution can be immediately formulated.

4. **Verification**: logical experimentation leading to the acceptance or rejection of the insight. . . . the elaboration of the insight.

Rugg (1963:13) stated "the flash will not occur unless the mind, conscious and unconscious, has been stored
with a rich body of percepts, images, motor adjustments and concepts that are pertinent to the new concept struggling to be born."

Henri Poincare (1952:38), in relation to mathematical creation, discussed sudden illumination associated with the search for a solution to a difficulty as being independent of conscious work. "It might be said that the conscious work has been more fruitful because it has been interrupted and the rest has given back to the mine its force and freshness. But it is more probably that this rest has been filled out with unconscious work and that the result of this work has afterward revealed itself. . . ."

Guilford (1963:95-106) did not support the concept of illumination whereby ideas suddenly emerge after periods of withdrawal in which no problem-solving conscious effort was made. Incubation, according to Guilford, could be logically thought of "as spaced practice in learning." It was probably in the same category as trying to recall a person's name without success but coming suddenly to mind sometime later without any additional or immediate cues.

Torrance and Myers (1972:23) contended that in creative learning the product formulated in the process was new to the learner and was to some extent original. The implication here is that there are degrees of creativity, but the process is essentially the same.
Crutchfield (1961:VI,12-13) referred to the attitudinal dimension of the creative process and pointed out that the degree and type of motivational factors facilitate or inhibit creativity. Too little in the degree of motivation discourages or diverts effort; too much rigidifies creative mental processes. There are two major types of motivation, extrinsic and intrinsic. The extrinsic, where external motivation is directed toward reward or the avoidance of punishment, may hinder creative production when it is the dominant factor for the individual. Intrinsic motivation is derived from the activity itself based on the individual's inward needs rather than the stimuli of external goals. Crutchfield stated that research evidence supported the notion that intrinsic motivation was related to creativity, but extrinsic might be an important factor, too. The value of extrinsic motivation in the creative process lies in allowing the initial impetus to somehow become caught by the intrinsic challenge.

Creativity and Problem-Solving

Marksberry (1963:17-18) summarized the conclusions of a number of researchers and stated that the creative process is a series of problem-solving situations, each of which builds upon what has gone on in preceding experiences in a continuous merging process until the "final whole" is realized. Marksberry described the creative process in terms of the following four separate stages:
1. Period of Preparation: In the long range it encompasses all past life experiences. For a particular creative process it concerns identification of a problem situation and the collection of pertinent data or material. The duration of the period varies from a relatively short period of time to many years depending on the nature of the problem and the resources available to the individual. The period is characterized by intense thought and study in efforts to gain insights for the solution of the problem.

2. Period of Incubation: If strategies leading to the solution of the problem do not evolve as the result of the preparation, a period (of incubation) follows in which progress toward the solution appears to halt. This is a period of restlessness and frustration where unconscious activity seeks insights into the solution of the perplexing problem.

3. Period of Insight: This is a period of revelation, a moment of insight or illumination where the creator finally sees a possible solution. The period is marked by an exhilaration and feeling of accomplishment.

4. Period of Verification: In the period of verification, ideas are tested, modified, perfected, and evaluated. The creator methodically elaborates on his ideas until he is satisfied as to its efficacy and worth.

Although four separate periods of the creative process have been identified, Marksberry pointed out that the process was a total pattern of behavior. The various periods overlap and interweave with ever-changing emphasis. Most researchers agree that the creative process cannot be rigidly sequenced according to her study. In practice, creative effort may include some or all of the stages.

The notion that creative learning must be instigated by the perception of a gap, incompleteness, or a discrepancy between the input of the moment and some cognitive
model existing in the individual was well documented in research (Marksberry, 1963:17-20; Torrance and Myers, 1972:23,79,210).

According to Bernard Goldner (1962:43), "nothing creative really takes place until a question or a problem or a need, expressed or implied, exists."

To Sidney J. Parnes (1975:26) problem solving is related to the heightened self-awareness of one's own vast storehouse of energy and resources as well as the awareness of the environment. Problem solving, according to Parnes, "becomes the task of finding the greatest number of inter-connections and interrelationships among these vast resources.

Guilford (1967a:98-106) observed the high degree of similarity between steps in problem-solving and the stages of creative thinking. Both processes are initiated by a sensitivity to a problem followed by problem analysis and a search for information and ideas. Elaboration and evaluative abilities guide production to the final end product.

Robert D. Kranyik (1969:2-3) described common elements of creativity and problem-solving as follows:

1. Sensitivity: "some type of sensitivity to a problem, block or inadequacy."
2. Problem definition: "an attempt to clarify or bring it into focus."
3. Ideation: "the development of ideas which have certain potentialities to solve the problem, remove the blockage, or fill the void."
4. Evaluation and implementation: "the actual implementation of such ideas, possibly including further modification."

John Dewey's (1933:106-118) analysis of the problem-solving process contained five steps:

1. A felt difficulty or perplexity.
2. Definition of the problem.
3. Hypothesis formulation.
4. Elaboration of the hypothesis.
5. Testing the hypothesis and developing conclusions.

In practice, according to Dewey, the five phases do not necessarily follow one another in a set order. Depending on the intellectual tact and sensitiveness of the individual, two of them may be combined; some of them may be passed over hurriedly; and the burden of reaching a conclusion may fall mainly on a single phase.

Brandwein (1962:6-12) agreed with the observations of many writers and researchers that the process of problem solving seldom proceeds in a precise and sequential way. However, the art of scientific investigation is a systematic search for meaning, and certain elements that are involved can be identified. Brandwein described the process as follows:

1. Comprehension: the wisdom and knowledge the individual brings to his work in the form of concepts and all the still raw information not conceptualized.
2. Confrontation: involves the recognition of a problem as the result of an awareness of discrepancies, gaps in knowledge or incompleteness and may include an identification of the problem as well as its probable solution in a flash of insight.

3. Creation: insights into hidden likenesses. Although creativeness is perhaps the most essential attribute of the scientist's approach, little is known of its exact nature, according to Brandwein.


5. Contribution: new knowledge stated in a logical assertion or in a systematic demonstration of proof.

J. H. McPherson (1956:133) made a distinction between the "traditional" and "new" problem-solving methods. Traditional methods emphasize more rational and logical approaches; the "new" methods attempt "to train the individual through freeing him from his emotional inhibitions" for use in the creative process. As an example of a traditional process, he cited that E. K. von Fange (1959) reported the one used in General Electric's program involving the following nine steps:

1. Define problem.
2. Search for methods.
3. Evaluate all methods.
4. Generalize the results.
5. Select method.
6. Make the preliminary design.
7. Perform tests and evaluation.
8. Generalize the results.

McPherson also discussed methods which differ from the usual problem-solving approaches; such as the "attribute listing" method defined by Robert P. Crawford (1954) of the University of Nebraska. It involved looking at all aspects of a problem by progressive examination of the positive and the negative attributes of various aspects of a situation until a solution was reached. He also described a somewhat similar method called "the morphological analysis method," proposed by Fred Zwicky (1957) of the Aerojet Corporation in California. This technique facilitated the imagination through concentrating on each major variable of a problem in all possible combinations with other variables.

Two other approaches described by McPherson attempt to alter the emotional disposition of a person by freeing him from inhibitions that block creative activity. These two approaches are "brainstorming," Osborn (1957), and "synectics," Gordon (1961). In order to develop new insights, the problem solver attempts to alter his emotional disposition during invention; so that he can view elements of the problem in a new context.

Based on their study involving the development of a group test to measure problem-solving skills in science with children in grades one, two, and three, Maureen Dietz...
and Kenneth George (1970:341-351) identified the following specific skills that are thought to be basic in the problem-solving process:

1. The ability to recognize the problem presented.
2. The ability to collect data through accurate visual observations.
3. The ability to arrive at a solution to the problem by reasoning with "if-then" statements.

E. Paul Torrance (1962a:32) considered creativity as "the process of forming ideas or hypotheses, testing hypotheses, and communicating the results." Torrance (1967:73-76) cited the work of Newell, Shaw, and Simon who stated that problem solving may be called creative "to the extent that one or more of the following conditions are satisfied:

1. The product of the thinking has novelty and value (either for the thinker or for his culture).
2. The thinking is unconventional, in a sense that it requires modification or rejection of previously accepted ideas.
3. The thinking requires high motivation and persistence, taking place either over a considerable span of time (continuously or intermittently) or at high intensity.
4. The problem as initially posed was vague and undefined, so that part of the task was to formulate the problem itself.

Problem solving is a creative process. It requires an abundance of raw materials (facts connected by simple and complex association) in order to turn out its products. However, a curriculum which has as its goal the
accumulation of knowledge because it may prove useful in the future is of doubtful value in productive thinking.

Henry P. Cole suggests:

... if creative thinking is to be promoted through instruction, classroom materials and procedures must be selected according to certain conditions. First, the instructional materials themselves must be directly geared to teach processes of problem-solving and creative idea generation and testing (not simply facts, information, and content topics). Second, the methods and materials must also enhance teacher and pupil learning roles which result in a cooperative adventure of recognizing problems and creating multiple tentative hypotheses, generalizations, and theories toward the explanation and prediction of events and the solution of problems (Henry P. Cole, 1976:3).

In his analysis of the curriculum reform movements of the 1960s, Louis Rubin (1968:80) summarizes the relationship among the many approaches to creative-learning processes with the statement, "The parallel between curriculum innovation and creativity research is most visible in their mutual concern for problem solving, for self-determined learning activity, and for dealing with unknowns."

On the basis of the literature reported involving creativity, most writers appear to be in essential agreement with the following generalities regarding the creative process:

1. The creative process is initiated from a data-poor situation in which the problem is vague and undefined.

2. The creative process involves methods of thinking that represent a departure from the conventional way of processing ideas.
3. The creative process is characterized by high intensity, motivation, and persistence.
4. The creative process results in an original outcome.

Creativity and Discovery

As a consequence of the diverse meanings of creativity, creative thinking is sometimes considered synonymous with discovery learning.

Marksberry (1963:6) stated that:

... creativity is not measured by the resulting product but rather by the way an individual approaches the problems and incidents of life. An individual is being creative and reaping the benefits of creativity in terms of self-perfection needs not only when he gives to the world something that has never been made before, but also every time he really makes a discovery, even if similar discoveries have been made before.

Jerome J. Hausman (1968:216) believed that creative behaviors were those where "a person reflects and realizes a new idea, image, or form of which he was not previously aware."

In the Journal of Clinical Psychology, J. E. Drevdahl (1956:21-26) included in the factors of importance for creativity "the capacity of persons to produce compositions, products, or ideas of any sort which are essentially new or novel, and previously unknown to the producer."

Rochell Wilson Meyer (1970), in a doctoral thesis covering the identification and encouragement of mathematical creativity in the first grade, wrote "creativity is
something which a person produces from the combination of two or more ideas known to him in a way which is new to him."

William H. Burton and Helen Heffernan (1964:16) stated "creativity means the ability to or quality of producing something new, unique, original, not existent before." They argued that everything learned by a student for the first time regardless of the process involved, cannot be considered creative. In discovery teaching general and specific cues presented to the learner are directed toward a unique outcome that represents a complete system. Products and processes that already exist are recognized as functional wholes. In creativity a new entity is brought into being that did not previously exist.

Robert Glaser (1966:14-21) characterized learning-by-discovery sequences in terms of two essential properties; induction and trial-and-error learning. Concrete exemplars are presented to the learners. From these exemplars the students make inferences regarding the common attributes of a classification in order to learn the concept or generalization. In the inductive process, students are apt to make errors by pursuing blind alleys and negative instances since the understandings sought may not be obvious from the data immediately available. Advocates of self-discovery maintain that students profit
from their mistakes. Terminal understandings are the result of the processes, assimilation and accommodation. Learning by induction may actually be the process of scanning stored constructs to find and fit appropriate models to the problem at hand.

Calvin W. Taylor (1960:7-12) maintained that quite different psychological processes were involved when we learned existing knowledge and systems than when we produced new knowledge and systems.

The distinction between creativity and discovery teaching becomes clearer when we examine the objectives of problem-solving activities as commonly used in elementary schools. In discovery teaching a selected generalization is presented to the learner in the form of concrete problems. The objective is the formulation of the predetermined understanding. The dominant-thinking operation is, therefore, convergent thinking in that a single unique product is the acceptable outcome. In creative problem solving several plausible solutions are possible; consequently, divergent thinking is the dominant intellectual operation.

It is reasonable that both discovery and creative learning are effective and productive and should be included as essential elements of a balanced curriculum. The point was further emphasized by Burton and Heffernan (1964:18) in their statement,
... the modern school is designed to introduce the learner to the world in such a way that he discovers this world and does not have it thrust upon him, unready and unwilling. The individual discovers not only the organized society in which he lives but also how this society evolved. He discovers how each succeeding generation improves both the social structures and understanding of the physical world; and finally, he discovers the methods by which he may continue the creative process.

Of the different approaches to the study of creativity, Torrance and Myers' (1972:22) concept of creativity meets the requirements of this research and relates the best to the subject of elementary science education in that it permits objective observation and measurement. Torrance defined creativity as,

... the process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty, searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally, communicating the results.

The Teachability of Creativity

Mildred Lunaas (1963) in a study involving the nature and nurture of creativity described creativity in terms of seven interrelated statements:

Creativity is a process. Creativity may exist in all people. Creativity is an individual and social process. Creativity is a complex of traits. Creativity may be applied in many areas. Creativity is influenced by the environment. Creativity can be developed.

Jerald E. Johnson (1974) sought to determine the effects of instruction in creative thinking upon the creative-thinking abilities of fourth grade pupils. The
results of the study indicated that students do benefit from lessons specifically designed to develop creative-thinking skills in elementary school children.

E. Paul Torrance and Pansy Torrance (1973:11-19) summarized a survey of many studies involving the teachability of creativity. The studies employed a wide variety of methods to stimulate creative thinking. Of the 142 studies, 102 indicated success. On the basis of the author's rating system, instructional methods based on the Osborn-Parnes training program and other disciplined approaches were judged to be the most effective. The Osburn-Parnes program provided training in creative problem solving in three steps. The first step was concerned with problem definition. The second step involved idea finding for solutions. The third step dealt with the development of criteria and the evaluation of ideas.

Torrance and Myers (1972:25) stated that genotype did set limits on an individual's potential, but it did not guarantee that this potential in capacity would be reached. The achievement of genotypic potential appears to be a function of a continuous interaction between the individual and his environment. The longer an individual is deprived of a given kind of informational interaction with the environment, the more likely is the effect of that deprivation to become permanent.
V. SUMMARY AND CONCLUSIONS FROM REVIEWED LITERATURE

In summarizing the review of the literature relevant to this study, the investigator concluded:

1. Studies involving the content analysis of textbooks revealed that a high percentage of questions and activities involved memory rather than higher intellectual processes.

2. Major innovations have been introduced in elementary science education in recent years; nevertheless, textbooks are still dominant in many instructional programs according to the information from educators, authors, and publishers.

3. Authorities in the field of science education recognized the importance of creative production in the teaching-learning process. However, little evidence was found in the literature reviewed of any significant effort to evaluate materials of instruction, especially science textbooks, in order to determine the emphasis placed on creativity.

4. The goals in elementary science education include fostering the development of scientific literacy and the processes associated with the techniques of scientific investigation.

5. While creativity was defined in various ways, the descriptions by most authorities involved an elaboration of a problem-solving process which resulted in an original product.

6. E. Paul Torrance's definition of creativity, "the process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying the results" is the most useful one for planning in creative teaching and learning (Torrance and Myers, 1972:22).
7. Evidence was presented in the literature indicating that creative thinking skills can be nurtured under proper conditions and with appropriate materials. These skills are generally transferrable because the creative process is essentially the same in all fields.

8. The identified phases of the creative thinking process closely parallel the problem-solving strategies employed by scientists.

The literature related to this study was reviewed under three main headings: (1) the concept of creativity, (2) the current trends in elementary school science education, and (3) the role of the basal textbook in today's education. The research design and the procedure used in the study will be presented in Chapter III.
CHAPTER III

DESCRIPTION OF THE DESIGN AND PROCEDURE OF THE STUDY

The investigator evaluated the contents of selected elementary science textbooks in order to determine the extent to which they met certain criteria for the development of creative thinking skills.

A description of the design and the procedures used in this study are presented in detail in this chapter under the main headings: (1) selection of the samples, (2) objectives, (3) procedures and description of the instruments, and (4) research methodology.

I. SELECTION OF THE SAMPLES

Four basic science textbook series published from 1970 to 1972 were selected for the study. These four were:

   SCIENCE: UNDERSTANDING YOUR ENVIRONMENT

   THE NEW LAIDLAW SCIENCE PROGRAM: MODERN SCIENCE
   DISCOVERING SCIENCE

   THE YOUNG SCIENTIST

These four basic science textbook series for grades one through six were randomly selected from a total of seven series recommended for adoption by the California State Curriculum Development and Supplemental Materials Commission to the State Board of Education (under AB 531, November 1972) (Appendix A.). The random selection process was accomplished by placing the names of individual textbook series by publisher on separate cards. These cards were shuffled thoroughly face-down. An unbiased observer drew four cards from the selection for this study.

In order to provide insight into changes that may have occurred in science textbooks for the elementary grades in the last fifteen years with respect to the emphasis placed on creativity, the textbook series adopted by the California State Department of Education for use in the public schools from 1959 to 1967, and the series adopted from 1967 to 1974, were included in the study. These two series were:

   CONCEPTS IN SCIENCE, adoption period 1967-74.

HEATH SCIENCE SERIES, adoption period 1959-67.

For purposes of discussion in the study, the two series published in 1959 and 1966 will be referred to as older series; the four more recently published editions (1970-1972) will be termed newer series.

The textbooks designed for grades one, three, and five from each series were selected for analysis in the study.

Selection of Sample Chapters

The contents of each textbook were briefly examined to determine the subject matter presented. Six chapters in each book were selected for analysis and evenly distributed on the basis of planned experiences listed in the Forty-Sixth Yearbook of the National Society for the Study of Education, Part II, "Science Education in American Schools": The Universe, The Earth, Conditions Necessary for Life, Living Things, Physical and Chemical Phenomena [Matter and Energy], Man's Attempt to Control His Environment, and The Nature and Methods of Science (Appendix B).

Glenn Blough and Julius Schwartz (1964:41-42) refer to the Forty-Sixth Yearbook as "an important work that even though it was issued some time ago, still gives us excellent guidance." The statements in the yearbook indicate that these experiences should be included for
children's growth in the broader areas of the physical and biological environment. Albert Shuster and Milton Ploghoft (1963:316) in their discussion of the elementary curriculum, also recommended the categories of planned experiences from the Forty-Sixth Yearbook.

II. OBJECTIVES

The objectives stated in Chapter I are restated in detail:

Introductory Textbook Statements

1. The authors will state in the textbook introduction that either creative thinking is a program goal; or open-ended problem-solving experiences are provided for students.

2. The authors will provide in the textbook introduction or in the teacher's guide references to publications on creative teaching-learning.

3. The authors will include statements in the textbook introduction that either indicate inquiry as a goal, or list at least five of the following processes of scientific inquiry as goals: observing, experimenting, verifying, predicting, organizing, inferring, analyzing, synthesizing, and generalizing.

4. The authors will recommend in the textbook introduction that teachers provide at least three of the following elements of a classroom environment: a variety of materials, free access to work areas, encouragement for the expression of ideas and experimentation without penalty for failure, open communication between student and teacher, a discovery approach, and a time for students to mull over (incubate) a problem in order to organize and restructure their ideas.
5. The authors will include in the textbook introduction descriptions of types of questions that teachers may ask students in order to elicit various thinking operations.

6. The authors will include a statement in the introduction that the textbooks have made allowances for different student interests and aptitudes.

7. The authors will provide in the textbook introduction or in the teacher's guide sources of data for students (publications and instructional media) other than the textbook.

Textbook Questions

8. There will be an equal distribution of questions in the categories: cognitive-memory, convergent thinking, divergent thinking, and evaluative thinking.

Textbook Activities

9. The textbook activities will be presented in such a way that the outcomes are not revealed to the students.

10. The textbook student activities under confrontation,

   a) will be presented in the form of a discrepant event or a problem,

   b) will be structured only enough to give operational clues and direction,

   c) will be designed so that several acceptable responses are possible.

11. The textbook student activities under preparation,

   a) will include basic or "raw" information (or suggest other sources of data) in order to build upon the student's knowledge with respect to the activity,
12. The textbook student activities under ideation,
   a) will involve students in observations and the manipulation of materials as well as ideas,
   b) will request "if ... then" predictions (hypotheses),
   c) will ask students to defer judgment until a pool of ideas has been produced.

13. The textbook student activities under verification,
   a) will require students to test hypotheses through methods of systematic procedure,
   b) will ask students to formulate a generalization or concepts based upon the "solutions" of the problem,
   c) will include opportunities for self-initiated learning through additional activities,
   d) will require students to communicate the results of the findings of the activities.


Objectives one through seven, related to the introductory textbook statements, were set forth by the investigator based on the general analysis and appraisal outlines.

III. PROCEDURES AND DESCRIPTION OF THE INSTRUMENTS

The textbooks were evaluated by series in grade level sequence of one, three, and five. The six series were analyzed in random order. The evaluation sequence for each textbook was as follows; first, the textbook introduction, then, the questions, and finally, the activities. The evaluation procedures and the description of the instruments for the textbook elements are described below.
Introductory Statements

The investigator examined the introduction to the teacher's edition of the textbooks to determine the presence of the authors' statements specified in objectives one through seven. This was recorded and reported in tabular form.

The Analysis of Questions

The analysis of questions asked in the teaching-learning process is widely used by educators and researchers as a method of revealing the kind of thinking stimulated in students. Questions have complex and diverse dimensions and can be classified in different ways, according to the thinking processes that they elicit; e.g., The Taxonomy of Educational Objectives, Handbook I: Cognitive Domain, edited by B. S. Bloom (1956); and "The Structure of the Intellect-Model," by J. P. Guilford and P. R. Merrifield (1960).

In this study, four primary categories, Cognitive-Memory, Convergent Thinking, Divergent Thinking, and Evaluative Thinking, were used to classify textbook questions. These categories were selected from the "Aschner-Gallagher System for the Classification of Thought Processes in Verbal-Classroom Interaction" (1962:10-32). These four primary categories of the Aschner-Gallagher System represent an adaptation from Guilford's model of the operation of the intellect. The four categories provide an effective
conceptual framework for the classification of textbook questions in terms of the thinking processes that they elicit.

The Aschner-Gallagher categories used in this study for the classification of questions are described below. The examples under each category were taken from the textbook series analyzed in this study.

"Cognitive-Memory (C-M) operations represent the simple reproduction of facts, formulas and other items of remembered content through use of such processes as recognition, rote memory and selective recall" (Aschner-Gallagher, 1965:v).

Examples:

1. What part of the plant is an orange?" (Piltz et al., 1970a:150T)

2. Teacher's edition--"When the first fish appeared they were quite different from those we know today. These fish ate smaller sea animals and the smaller sea animals ate still smaller ones. Ask: What did the smallest sea animals eat?"

   Student edition--"Tiny water animals eat the tiny plants. Bigger animals eat animals that eat these tiny plants. And these bigger animals are food of still other animals" (Schneider, 1959a: T66, 133).

"Convergent Thinking (CT) is thought operation involving the analysis and integration of given or remembered data. It leads to one expected result because of the tightly-structured framework which limits it" (Aschner-Gallagher, 1965:vi).
Examples:

1. "Compare an open-pit mine with a shaft mine" (Mallinson, 1972b:79).

2. "If you have a coffee percolator with a glass top at home, watch what happens when it works. What pushes the hot water up the tube?" (Brandwein et al., 1966:116).

"In a Divergent Thinking (DT) sequence, individuals are free to independently generate their own data within a data-poor situation, often taking a new direction or perspective" (Aschner-Gallagher, 1965:vii).

Examples:

1. "What questions would you ask if you wanted to learn more about why the white birches are or are not abundant where you live?" (H. A. Smith et al., 1972a:123).

2. "Will man be turning more and more to the ocean for basic needs? Make predictions" (Navarra and Zafforoni, 1971b:179).

"Evaluative Thinking (ET) deals with matters of value rather than matters of fact and is characterized by verbal performance by its judgmental character" (Aschner-Gallagher, 1965:vii).

Examples:

1. "Sometimes food that is kept too long spoils. This is also a chemical change. Is this a useful chemical change?" (Mallinson et al., 1972a:118).

2. [Referring to the wave theory and the particle theory of light] "Do you think one theory is better than the other?" (Brandwein et al., 1966b:T144).

A fifth category in the Aschner-Gallagher System, Routine, included typical verbal classroom procedural and
management maneuverings of students and teachers; therefore, this category was not used in this study.

Torrance and Myers (1972:152-153) developed a method for classifying questions which also is directly related to the major thinking operations defined by Guilford. Frederick Preston (1973:32-34) in his investigation of the emphasis on creative thinking in language arts textbooks for grades four, five, and six, had to modify the Torrance and Myers ten question-type scheme in order to make it applicable to the analysis of textbook questions; because he could not make an effective distinction between some of the categories.

Since the work of Torrance and Myers and the classification system developed by Aschner and Gallagher are directly related to the operations of the intellect defined in Guilford's model, the investigator selected the Aschner-Gallagher System. The Aschner-Gallagher categories are mutually exclusive and applicable to the analysis of elementary science textbook questions.

For the purposes of this study it was the decision of the investigator that data regarding the frequency and distribution of textbook questions in the four primary categories—namely, Cognitive-Memory, Convergent Thinking, Divergent Thinking, and Evaluative Thinking—provided sufficient evidence to help determine the emphasis that the textbooks placed on creative thinking.
A Worksheet for the Analysis and Classification of Textbook Questions was developed with four headings: Science Topic, Page, Question, and Category. The first three headings identified a particular question in the textbook. The heading, Category, included the four primary thinking operations into which each question was classified: Cognitive-Memory (C-M), Convergent Thinking (CT), Divergent Thinking (DT), and Evaluative Thinking (ET) (Appendix C).

Each question was identified, listed on the worksheet, analyzed to determine its classification, and recorded in the appropriate category. The goal of the classification system was to classify each question in a single category. However, some questions could reasonably be classified in several categories. According to Norris Sanders (1966:10) a question with multiple category characteristics should be classified at its highest level. Although Sanders was referring specifically to a question classification based on the hierarchical organization of Bloom's Taxonomy (1956), it also is applicable to the classification system used in this study. A question calling for evaluative thinking not only has the unique elements of that category but most often includes some form of all the other categories as well. Torrance and Myers (1972:153) also acknowledge that some questions may include several kinds of thinking, and recommend that the classification be based on the dominant characteristic of the question.
For example, the recall of information is an important element of most questions. If, however, a question, in addition to the recall of certain data, called for the production of a number of different possible solutions (could be answered in different ways), the latter thinking operation was considered the dominant element, and the question was classified in the category, Divergent Thinking (DT).

If the answer to a question was given directly or could be found in the immediate narrative of the text, and hence, required no transformation of the given information, then only cognition or memory was involved. The question, consequently, was classified in the category, Cognitive-Memory, regardless of the dominant character of the question itself.

Some authors pose questions in order to stimulate interest and provide focus. The questions are primarily employed as an introductory technique at the beginning of a chapter, a unit, or a section. For example: Do you live in a city? Have you visited one? "Have you ever planted seeds in a garden or pulled weeds or dug a hole in the ground? If you have, you know how soil feels. Soil is an important part of the earth" (Piltz et al., 1970a:95). Since no response from the student other than acknowledgment or personal reaction is intended, questions of this type were excluded from the analysis and classification of questions in this study.
The Analysis of Student Activities

Science activities in general extend the dimensions of questions by stipulating something for the student to do. The emphasis is more on process than on the product. Activities may involve the student directly and actively in an investigation or exploratory experience requiring him to gather data from various sources and to manipulate equipment and materials as well as ideas. Therefore, a different approach was used in the analysis of activities from the one used in the analysis of interrogative statements.

In this study, criteria for the evaluation of activities were developed by the investigator based on the "Creative Learning Process" identified by Torrance and Myers (1972:22-23), the processes in the act of learning by Bruner (1960:48), and the summary of problem-solving methods by McPherson (1968:103-109).

Torrance and Myers defined the "Creative Learning Process" as,

... one of becoming sensitive to or aware of problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; bringing together available information; defining the difficulty or identifying the missing element; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and modifying and retesting them; perfecting them; and finally communicating the results (Torrance and Myers, 1972:22-23).
Bruner described the act of learning in three processes,

... First, there is ACQUISITION of new information that often runs counter to or is a replacement for what is previously known. The second aspect of learning, TRANSFORMATION, involves processing information to make it fit new tasks. A third aspect of learning is EVALUATION, or checking to see if the manipulated information is adequate to the task (Bruner, 1960:48).

Categories of activity objectives (criteria) used in this study and steps in problem-solving methods identified by McPherson are set forth in Chart I. Certain similarities are noted among the various problem-solving procedures. Common to each of the models is the recognition of a problem, a deficiency or informational gap which serves as a stimulus to creative and productive endeavor. The next stage is the gathering of facts and ideas together--seeking new relationships that may be relevant. This attack on the problem may take the form of either or both conscious or unconscious effort. In each method there is a stage of insight in which tentative solutions are advanced. Finally, the creative product or products are tested, evaluated, and perfected.

J. P. Guilford's Structure of the Intellect Problem-Solving Model (Appendix D) represents a multi-channel behavioral approach that an individual may follow for handling a given situation. The complex cyclic model may be represented in linear form as in Chart I providing no additional information (input) is required; and the problem
<table>
<thead>
<tr>
<th>Categories of Activity Objectives in this Study</th>
<th>Torrance and Myers</th>
<th>Bruner</th>
<th>Guilford</th>
<th>Wallas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confrontation:</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>a) presented as a discrepant event or problem</td>
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<tr>
<td>b) structured only enough to give operational clues and direction</td>
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<tr>
<td>c) several acceptable outcomes possible</td>
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<tr>
<td>Preparation:</td>
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<tr>
<td>a) basic information...</td>
<td></td>
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<tr>
<td>b) open-ended questions... examine information different ways</td>
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<tr>
<td>c) previous activities or another field brought to bear on task</td>
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<td></td>
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<tr>
<td>d) identify and define problem</td>
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<tr>
<td>Ideation:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) observation; manipulation of materials and ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>b) predictions (hypotheses)</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>c) defer judgment, produce pool of ideas</td>
<td></td>
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</tr>
<tr>
<td>Verification:</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>a) test hypotheses</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>b) formulate generalizations and concepts</td>
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<tr>
<td>c) self-initiated learning</td>
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<tr>
<td>d) communicate results...</td>
<td></td>
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</tbody>
</table>

**Torrance and Myers**
- Awareness of problem or deficiencies

**Bruner**
- Acquisition
- Filtering: attention aroused and directed

**Guilford**
- Input I
- Cognition; problem sensed and structured

**Wallas**
- Preparation
- Incubation
- Evaluation
- Illumination
- Verification

**Notes:**
- Bruner: Acquisition, Cognition, Production, Transformation
- Guilford: Input I, Cognition, Production, Evaluation
- Wallas: Preparation, Incubation, Evaluation, Illumination, Verification

**Additional Notes:**
- Input I
- Cognition; problem sensed and structured
- Evaluation
- Illumination
- Verification
<table>
<thead>
<tr>
<th>Dewey</th>
<th>Rossman</th>
<th>Osborn</th>
<th>Osborn and Parnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty is felt</td>
<td>Need or difficulty observed</td>
<td>Observation</td>
<td>Looking at mess</td>
</tr>
<tr>
<td>Difficulty located, defined</td>
<td>Problem formulated</td>
<td>Preparation</td>
<td>Finding fuzzy problem</td>
</tr>
<tr>
<td></td>
<td>Available information surveyed</td>
<td></td>
<td>Fact finding</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Problem finding</td>
</tr>
<tr>
<td>Possible solutions suggested</td>
<td>Solutions formulated</td>
<td>Ideation</td>
<td>Idea finding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incubation</td>
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<td></td>
<td></td>
<td>Synthesis</td>
<td></td>
</tr>
<tr>
<td>Consequences are considered</td>
<td>Solutions critically examined</td>
<td>Verification</td>
<td>Solution finding</td>
</tr>
<tr>
<td></td>
<td>New ideas formulated</td>
<td></td>
<td></td>
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<tr>
<td>Solution is accepted</td>
<td>New ideas tested</td>
<td></td>
<td>Acceptance finding</td>
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</tbody>
</table>
is not dodged or abandoned before an acceptable solution is reached.

In the Worksheet for the Analysis of Student Activities (Appendix E), the activities in each of the selected chapters were identified by science topic, textbook page, and by numerical code. The determination was then made and recorded on the worksheet as to whether or not the outcomes of the activities were revealed in the text. Activities whose outcomes were given in the text were not subject to further evaluation because they precluded problem solving. The activities in which the outcomes were not revealed were then analyzed in terms of the criterion objectives listed in this chapter (see Objectives 9 through 13).

Validity of the Worksheet for the Analysis of Student Activities. Three Professors of Education, John V. Schippers, Ph.D.; J. Marc Jantzen, Ph.D.; and Lloyd H. King, Ed.D., at the University of The Pacific, Stockton, California, attested to the validity of this worksheet constructed by the investigator and based upon the "Creative Learning Process" identified by Torrance and Myers (1972), the processes in the act of learning by Bruner (1960), and the summary of problem-solving methods by McPherson (1968).

Reliability

Each of the 5209 questions and 1852 activities in the eighteen textbooks examined in the study were analyzed
and coded independently by the investigator and a co-rater applying the Worksheet for the Analysis and Classification of Textbook Questions and the Worksheet for the Analysis of Student Activities in accordance with the procedures described in this chapter. The textbook series were examined by series in the order shown in Tables 1 and 2, beginning with the Silver Burdett Series.

Disagreements regarding the classification of questions and activities were discussed by the investigator and the co-rater and resolved through mutual agreement. The data recorded in the tables in Chapter IV reflect a total consensus.

Textbook questions. In Table 1 the total number of questions analyzed is shown by textbook series. "N Agreements" and "% Agreement" indicate the number and percentage of the questions classified in similar categories by the independent coding of the investigator and the co-rater.

The level of agreement between the investigator and the co-rater ranged between 86 percent and 97 percent. The table also shows that the second coding (reevaluation) of the first textbook series analyzed differed from the original analysis and classification by one and two percent.
# Table 1

**Comparison of Codings by Investigator and Co-rater in the Classification of Textbook Questions**

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<tbody>
<tr>
<td><strong>Level One</strong></td>
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<tr>
<td>Total</td>
<td>193</td>
<td>394</td>
<td>457</td>
<td>202</td>
<td>307</td>
<td>82</td>
</tr>
<tr>
<td>N Agreements</td>
<td>178</td>
<td>382</td>
<td>433</td>
<td>180</td>
<td>265</td>
<td>70</td>
</tr>
<tr>
<td>% Agreement</td>
<td>92%</td>
<td>97%</td>
<td>95%</td>
<td>89%</td>
<td>86%</td>
<td>85%</td>
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<tr>
<td><strong>Level Three</strong></td>
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<tr>
<td>Total</td>
<td>268</td>
<td>343</td>
<td>634</td>
<td>152</td>
<td>432</td>
<td>58</td>
</tr>
<tr>
<td>N Agreements</td>
<td>244</td>
<td>298</td>
<td>577</td>
<td>131</td>
<td>395</td>
<td>50</td>
</tr>
<tr>
<td>% Agreement</td>
<td>91%</td>
<td>87%</td>
<td>91%</td>
<td>86%</td>
<td>91%</td>
<td>86%</td>
</tr>
<tr>
<td><strong>Level Five</strong></td>
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<tr>
<td>Total</td>
<td>141</td>
<td>278</td>
<td>295</td>
<td>202</td>
<td>679</td>
<td>86</td>
</tr>
<tr>
<td>N Agreements</td>
<td>132</td>
<td>250</td>
<td>272</td>
<td>176</td>
<td>624</td>
<td>77</td>
</tr>
<tr>
<td>% Agreement</td>
<td>94%</td>
<td>93%</td>
<td>92%</td>
<td>87%</td>
<td>92%</td>
<td>90%</td>
</tr>
</tbody>
</table>

**Re-evaluation**

|                  |                             |                                 |                                 |                            |                                     |                         |
| **Level One**    |                             |                                 |                                 |                            |                                     |                         |
| Total            | 193                         |                                 |                                 |                            |                                     |                         |
| N Agreements     | 174                         |                                 |                                 |                            |                                     |                         |
| % Agreement      | 90%                         |                                 |                                 |                            |                                     |                         |

**Level Three**

|                  |                             |                                 |                                 |                            |                                     |                         |
| Total            | 268                         |                                 |                                 |                            |                                     |                         |
| N Agreements     | 250                         |                                 |                                 |                            |                                     |                         |
| % Agreement      | 93%                         |                                 |                                 |                            |                                     |                         |

**Level Five**

|                  |                             |                                 |                                 |                            |                                     |                         |
| Total            | 141                         |                                 |                                 |                            |                                     |                         |
| N Agreements     | 134                         |                                 |                                 |                            |                                     |                         |
| % Agreement      | 95%                         |                                 |                                 |                            |                                     |                         |
TABLE 2

COMPARISON OF CODINGS BY INVESTIGATOR AND CO-RATER
IN THE ANALYSIS OF STUDENT ACTIVITIES

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Total Activities</td>
<td>216</td>
<td>117</td>
<td>207</td>
<td>178</td>
<td>182</td>
<td>103</td>
</tr>
<tr>
<td>(Outcomes Not Given)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Criterion Objectives</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Activities x</td>
<td>3024</td>
<td>1638</td>
<td>2898</td>
<td>2492</td>
<td>2548</td>
<td>1442</td>
</tr>
<tr>
<td>Criterion Objectives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N Agreements</td>
<td>2480</td>
<td>1474</td>
<td>2550</td>
<td>2218</td>
<td>2293</td>
<td>1341</td>
</tr>
<tr>
<td>% Agreement</td>
<td>82%</td>
<td>90%</td>
<td>88%</td>
<td>89%</td>
<td>90%</td>
<td>93%</td>
</tr>
<tr>
<td>RE-EVALUATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N Agreements</td>
<td>2843</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Agreement</td>
<td>94%</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Textbook student activities. In Table 2 the number of activities with outcomes not given in the texts for each textbook series and the total for all six series are shown. Each activity was analyzed in terms of fourteen criteria set forth in the study for the evaluation of student activities. The total number of activities multiplied by 14 represents the number of elements of evaluation for each series (see Objectives 9-13, Textbook Activities).

Table 2 indicates that evaluative agreement between the investigator and the co-rater ranged from 82% to 93% among the individual series and a combined agreement of 88% over all.

SUMMARY

In Chapter III the design and procedures of the study were presented. Included were the selection of the sample, the objectives, procedures and description of the instruments, and the research methodology.

Chapter IV offers the findings of the study from the application of the instruments and procedures specified in Chapter III.
CHAPTER IV

FINDINGS OF THE STUDY

Chapter III incorporated a description of the design and procedures of the study. Objectives were formulated to measure the extent to which selected elementary science textbooks emphasized the development of creative thinking skills. In order to collect and analyze the data, the instruments were designed and applied as described in Chapter III.

This chapter presents the findings of the investigation in four sections: (1) the findings of the analysis of the textbook introductions, (2) the findings of the analysis of the textbook questions, (3) the findings of the analysis of textbook student activities, and (4) the comparison of the newer series (published 1970-72) with each of the two older California State Adopted series (published 1959 and 1966).
I. FINDINGS OF THE ANALYSIS OF THE TEXTBOOK
INTRODUCTION

Objective 1

The authors will state in the textbook introduction
that either creative thinking is a program goal, or open-ended problem-solving experiences are provided for
students.

| TABLE 3 |
| SUMMARY OF SERIES INTRODUCTORY STATEMENTS: |
| CREATIVE THINKING GOAL |

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The authors will state in the textbook introduction that either</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) creative thinking is a program goal,</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) open-ended problem-solving experiences are provided for students.</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 indicates that the objective was met by
five of the six textbook series. The Charles E. Merrill
Series specifically stated, "creativity at all levels
of development is encouraged in the textbook program (Piltz and Van Bever, 1970:3T). The D. C. Heath Series did not meet the objective.

**Objective 2**

The authors will provide in the textbook introduction or in the teacher's guide reference to publications on creative teaching-learning.

---

**Table 4**

**SUMMARY OF SERIES INTRODUCTORY STATEMENTS:**

**CREATIVE TEACHING-LEARNING REFERENCES**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver Burdett</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laidlaw Brothers Series</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charles E. Merrill Series</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harper &amp; Roy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harcourt World Series</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. C. Heath Series</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

2. The authors will provide in the textbook introduction or in the teacher's guide reference to publications on creative teaching-learning.

Table 4 shows that the objective was met by Charles E. Merrill Series. The objective was not met by the other five series.
Objective 3

The authors will include statements in the textbook introduction that either indicate scientific inquiry as a goal, or list at least five of the following processes of scientific inquiry as goals: observing, experimenting, verifying, predicting, organizing, inferring, analyzing, synthesizing, and generalizing.

TABLE 5
SUMMARY OF SERIES INTRODUCTORY STATEMENTS:
SCIENTIFIC INQUIRY GOAL

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. The authors will include statements in the textbook introduction that either
   a) indicate scientific inquiry as a goal, x x x x
   or
   b) list at least five of the following processes of scientific inquiry as goals:
      observing x x x x
      experimenting x x x x
      verifying x x x
      predicting x x x
      organizing x x
      inferring x
      analyzing x x
      synthesizing x
      generalizing x


Table 5 verifies that the objective was met by all of the textbook series except D. C. Heath.

**Objective 4**

The authors will recommend in the textbook introduction that teachers provide at least three of the following elements of a classroom environment: a variety of materials, free access to work areas, encouragement for the expression of ideas and experimentation without penalty for failure, open communication between student and teacher, a discovery approach, a time for students to mull over (incubate) a problem in order to organize and restructure their ideas.

Table 6 indicates that the objective was met by the Silver Burdett Series and the Laidlaw Brothers Series. Specified conditions of the classroom environment, to be implemented by teachers, was not stressed in the Harper & Row; Harcourt, Brace & World; and D. C. Heath Series.
4. The authors will recommend in the textbook introduction that teachers provide at least three of the following elements of a classroom environment:

a) a variety of materials   x   x  
b) free access to work areas    x  
c) encouragement for the expression of ideas and experimentation without penalty for failure  x  
d) open communication between student and teacher  
e) a discovery approach      x   x   x   x   x  
f) a time for students to mull over (incubate) a problem in order to organize and restructure their ideas  x  

---

**TABLE 6**

**SUMMARY OF SERIES INTRODUCTORY STATEMENTS:**

**CLASSROOM ENVIRONMENT**

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Silver Burdett</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laidlaw Brothers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charles E. Merrill</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harper &amp; Row</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harcourt, Brace &amp;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>World</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.C. Heath</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Objective 5

The authors will include in the textbook introduction descriptions of types of questions that teachers may ask students in order to elicit various thinking operations.

TABLE 7

SUMMARY OF SERIES INTRODUCTORY STATEMENTS:
TYPES OF QUESTIONS

<table>
<thead>
<tr>
<th>Series</th>
<th>Types of Questions Elicited</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver Burdett Series, 1972</td>
<td>X</td>
</tr>
<tr>
<td>Laidlaw Frothers Series, 1972</td>
<td></td>
</tr>
<tr>
<td>Charles E. Merrill Series, 1970</td>
<td></td>
</tr>
<tr>
<td>Harper &amp; Row Series, 1971</td>
<td>X</td>
</tr>
<tr>
<td>Harcourt World Series, 1966</td>
<td>X</td>
</tr>
<tr>
<td>D. C. Heath Series, 1959</td>
<td>X</td>
</tr>
</tbody>
</table>

5. The authors will include in the textbook introduction descriptions of types of questions that teachers may ask students in order to elicit various thinking operations.

Table 7 shows that the objective was met by one textbook series. Only the Silver Burdett Series included a description of various kinds of questions and the thinking they elicit.
Objective 6

The authors will include a statement in the introduction that the textbooks have made allowances for different student interests and aptitudes.

Table 8 indicates that all six textbook series met the objective.
Objective 7

The authors will provide in the textbook introduction or in the teacher's guide, sources of data for students (publications and instructional media) other than the textbook.

<table>
<thead>
<tr>
<th>TABLE 9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SUMMARY OF SERIES INTRODUCTORY STATEMENTS:</strong></td>
</tr>
<tr>
<td><strong>STUDENT INSTRUCTIONAL MEDIA SOURCES</strong></td>
</tr>
<tr>
<td>X</td>
</tr>
</tbody>
</table>

7. The authors will provide in the textbook introduction or in the teacher's guide sources of data for students (publications and instructional media) other than the textbook. x x x x x

Table 9 establishes that the objective was met by five of the six textbook series. Laidlaw Brothers Series did not include a list of recommended reference materials for students.
II. FINDINGS OF THE ANALYSIS OF TEXTBOOK QUESTIONS

Objective 8

There will be an equal distribution of questions in the categories; cognitive-memory, convergent thinking, divergent thinking, and evaluative thinking. The distribution of textbook questions classified in the thinking operation categories (Cognitive-Memory, Convergent Thinking, Divergent Thinking, and Evaluative Thinking) is shown in Table 10a by textbook levels one, three, and five for each of the textbook series. In Table 10b, the combined frequency and percentage distribution for textbook levels one, three, and five is shown for each series.

Tables 10a and 10b disclose that none of the textbook series met the objective. Over 90 percent of the questions tabulated in each of the textbook series involved cognitive-memory and convergent thinking. The percentage range of questions involving divergent thinking was from eight percent to less than one percent. For questions involving evaluative thinking the range was from three percent to zero percent.
<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>One</td>
<td>193</td>
<td>384</td>
<td>457</td>
<td>202</td>
<td>307</td>
<td>82</td>
<td>5209</td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>268</td>
<td>343</td>
<td>634</td>
<td>152</td>
<td>433</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Five</td>
<td>141</td>
<td>278</td>
<td>295</td>
<td>205</td>
<td>681</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Series</td>
<td>602</td>
<td>1015</td>
<td>1386</td>
<td>559</td>
<td>1421</td>
<td>226</td>
<td></td>
</tr>
<tr>
<td>Cognitive- Memory</td>
<td>One</td>
<td>22(11%)</td>
<td>126(32%)</td>
<td>82(18%)</td>
<td>91(45%)</td>
<td>65(21%)</td>
<td>20(24%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>62(23%)</td>
<td>148(43%)</td>
<td>288(45%)</td>
<td>109(72%)</td>
<td>258(60%)</td>
<td>31(34%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Five</td>
<td>54(38%)</td>
<td>143(52%)</td>
<td>71(24%)</td>
<td>184(90%)</td>
<td>423(62%)</td>
<td>31(36%)</td>
<td></td>
</tr>
<tr>
<td>Convergent Thinking</td>
<td>One</td>
<td>156(81%)</td>
<td>237(60%)</td>
<td>374(82%)</td>
<td>103(51%)</td>
<td>226(74%)</td>
<td>60(73%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>185(69%)</td>
<td>189(55%)</td>
<td>355(53%)</td>
<td>37(24%)</td>
<td>168(39%)</td>
<td>25(43%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Five</td>
<td>75(53%)</td>
<td>126(45%)</td>
<td>218(74%)</td>
<td>18(9%)</td>
<td>243(36%)</td>
<td>47(55%)</td>
<td></td>
</tr>
<tr>
<td>Divergent Thinking</td>
<td>One</td>
<td>15(8%)</td>
<td>31(8%)</td>
<td>1</td>
<td>6(3%)</td>
<td>16(5%)</td>
<td>2(3%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>19(7%)</td>
<td>6(2%)</td>
<td>12(2%)</td>
<td>4(3%)</td>
<td>6(1%)</td>
<td>2(3%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Five</td>
<td>9(7%)</td>
<td>9(3%)</td>
<td>6(2%)</td>
<td>2(1%)</td>
<td>13(2%)</td>
<td>5(6%)</td>
<td></td>
</tr>
<tr>
<td>Evaluative Thinking</td>
<td>One</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>2(1%)</td>
<td>1</td>
<td>2(1%)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Five</td>
<td>3(2%)</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 10b
FREQUENCY AND PERCENTAGE DISTRIBUTION OF TEXTBOOK QUESTIONS ACCORDING TO THINKING OPERATIONS THEY ELICIT:
SUMMARY OF LEVELS ONE, THREE, AND FIVE BY SERIES

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive-Memory</td>
<td>138 (23%)</td>
<td>417 (41%)</td>
<td>441 (32%)</td>
<td>384 (69%)</td>
<td>746 (53%)</td>
<td>82 (36%)</td>
</tr>
<tr>
<td>Convergent</td>
<td>416 (68%)</td>
<td>552 (54%)</td>
<td>925 (67%)</td>
<td>158 (28%)</td>
<td>637 (45%)</td>
<td>132 (59%)</td>
</tr>
<tr>
<td>Divergent</td>
<td>43 (7%)</td>
<td>46 (5%)</td>
<td>19 (1%)</td>
<td>12 (2%)</td>
<td>35 (2%)</td>
<td>9 (4%)</td>
</tr>
<tr>
<td>Evaluative</td>
<td>5 (1%)</td>
<td>1 (1%)</td>
<td>5 (1%)</td>
<td>3 (2%)</td>
<td>3 (2%)</td>
<td>3 (1%)</td>
</tr>
<tr>
<td>Total</td>
<td>602 (100%)</td>
<td>1015 (100%)</td>
<td>1386 (100%)</td>
<td>559 (100%)</td>
<td>1421 (100%)</td>
<td>226 (100%)</td>
</tr>
</tbody>
</table>

III. FINDINGS OF THE ANALYSIS OF TEXTBOOK STUDENT ACTIVITIES

Objective 9
The textbook activities will be presented in such a way that the outcomes are not revealed to the students.
### TABLE 11

FREQUENCY AND PERCENTAGE DISTRIBUTION OF TEXTBOOK
STUDENT ACTIVITIES ACCORDING TO
OUTCOMES GIVEN OR NOT GIVEN

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEVEL ONE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Activities</td>
<td>116</td>
<td>48</td>
<td>95</td>
<td>59</td>
<td>86</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Outcomes Given</td>
<td>66 (57%)</td>
<td>32 (67%)</td>
<td>56 (59%)</td>
<td>29 (49%)</td>
<td>55 (64%)</td>
<td>32 (80%)</td>
<td></td>
</tr>
<tr>
<td>Outcomes Not Given</td>
<td>50 (43%)</td>
<td>16 (33%)</td>
<td>39 (41%)</td>
<td>30 (51%)</td>
<td>31 (36%)</td>
<td>8 (20%)</td>
<td></td>
</tr>
<tr>
<td><strong>LEVEL THREE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Activities</td>
<td>165</td>
<td>105</td>
<td>171</td>
<td>90</td>
<td>125</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Outcomes Given</td>
<td>44 (27%)</td>
<td>45 (43%)</td>
<td>94 (55%)</td>
<td>24 (27%)</td>
<td>62 (50%)</td>
<td>41 (44%)</td>
<td></td>
</tr>
<tr>
<td>Outcomes Not Given</td>
<td>121 (73%)</td>
<td>60 (57%)</td>
<td>77 (45%)</td>
<td>66 (73%)</td>
<td>63 (50%)</td>
<td>52 (56%)</td>
<td></td>
</tr>
<tr>
<td><strong>LEVEL FIVE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Activities</td>
<td>59</td>
<td>75</td>
<td>152</td>
<td>112</td>
<td>167</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>Outcomes Given</td>
<td>14 (24%)</td>
<td>34 (45%)</td>
<td>61 (40%)</td>
<td>30 (27%)</td>
<td>79 (47%)</td>
<td>51 (54%)</td>
<td></td>
</tr>
<tr>
<td>Outcomes Not Given</td>
<td>45 (76%)</td>
<td>41 (55%)</td>
<td>91 (60%)</td>
<td>82 (73%)</td>
<td>88 (53%)</td>
<td>43 (46%)</td>
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</tr>
<tr>
<td><strong>SERIES</strong></td>
<td></td>
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</tr>
<tr>
<td>Total Activities</td>
<td>340</td>
<td>228</td>
<td>418</td>
<td>261</td>
<td>378</td>
<td>227</td>
<td>1852</td>
</tr>
<tr>
<td>Outcomes Given</td>
<td>124 (36%)</td>
<td>111 (49%)</td>
<td>211 (50%)</td>
<td>83 (32%)</td>
<td>196 (52%)</td>
<td>124 (55%)</td>
<td></td>
</tr>
<tr>
<td>Outcomes Not Given</td>
<td>216 (64%)</td>
<td>117 (51%)</td>
<td>207 (50%)</td>
<td>178 (68%)</td>
<td>182 (48%)</td>
<td>103 (45%)</td>
<td></td>
</tr>
</tbody>
</table>
In Table 11 the total activities were divided into two categories, Outcomes Given and Outcomes Not-given. These were tabulated by textbook levels one, three, five, and total for each of the six textbook series. Table 11 shows that none of the textbook series presented all the activities in such a way that the outcomes were not revealed. In three of six textbook series, the outcomes of 50% or more of the activities were revealed in the texts. The percentage of activities by series that met Objective 9 (outcomes not given in the text) ranged from 45 to 68 percent.

**Objective 10**

The textbook student activities under confrontation, a) will be presented in the form of a discrepant event or a problem, b) will be structured only enough to give operational clues and direction, and c) will be designed so that several acceptable responses are possible.

In Table 12, section 10a, of the eighteen textbooks examined, in the six series, fourteen had less than 50 percent of the activities presented in the form of a discrepant event or a problem. The objective was not reached by 63 percent of the activities in the six textbook series.

Section 10b indicates that a high percentage of the activities were not overly structured (were structured only
TABLE 12
FREQUENCY AND PERCENTAGE DISTRIBUTION OF TEXTBOOK STUDENT ACTIVITIES
WITH SPECIFIED CRITERIA OF THE CONFRONTATION PHASE
OF THE CREATIVE THINKING PROCESS

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</thead>
<tbody>
<tr>
<td></td>
<td>One</td>
<td>19 (38%)</td>
<td>10 (63%)</td>
<td>14 (36%)</td>
<td>17 (57%)</td>
<td>8 (26%)</td>
<td>3 (38%)</td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>31 (26%)</td>
<td>16 (27%)</td>
<td>21 (27%)</td>
<td>21 (32%)</td>
<td>19 (30%)</td>
<td>17 (33%)</td>
</tr>
<tr>
<td></td>
<td>Five</td>
<td>26 (58%)</td>
<td>9 (22%)</td>
<td>55 (60%)</td>
<td>33 (40%)</td>
<td>36 (41%)</td>
<td>24 (77%)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>One</td>
<td>49 (98%)</td>
<td>16 (100%)</td>
<td>33 (25%)</td>
<td>30 (100%)</td>
<td>24 (77%)</td>
<td>6 (75%)</td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>108 (89%)</td>
<td>49 (82%)</td>
<td>71 (92%)</td>
<td>62 (94%)</td>
<td>60 (95%)</td>
<td>50 (96%)</td>
</tr>
<tr>
<td></td>
<td>Five</td>
<td>40 (89%)</td>
<td>40 (98%)</td>
<td>71 (78%)</td>
<td>81 (99%)</td>
<td>84 (95%)</td>
<td>40 (93%)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>One</td>
<td>29 (58%)</td>
<td>3 (19%)</td>
<td>15 (38%)</td>
<td>16 (53%)</td>
<td>13 (42%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>42 (35%)</td>
<td>5 (8%)</td>
<td>35 (45%)</td>
<td>23 (35%)</td>
<td>44 (70%)</td>
<td>31 (60%)</td>
</tr>
<tr>
<td></td>
<td>Five</td>
<td>17 (38%)</td>
<td>21 (51%)</td>
<td>50 (55%)</td>
<td>33 (40%)</td>
<td>59 (67%)</td>
<td>24 (56%)</td>
</tr>
</tbody>
</table>

10. The textbook student activities under confrontation,
   a) will be presented in the form of a
      discrepant event or a problem
   b) will be structured only enough to
      give operational clues and direction
   c) will be designed so that several
      acceptable answers are possible.
enough to give operational clues and direction). In eleven of the textbooks 90 percent of the activities met the objective.

Section 10c shows that the majority of the activities (55-100%) in ten of the eighteen textbooks required a single response or solution, and therefore, did not meet the objective. In eight of the textbooks over 50 percent of the activities (51-70%) were structured so that several acceptable responses were possible and met the objective.

Objective 11

The textbook student activities under preparation, a) will include basic or "raw" information (or suggest other sources of data) in order to build upon the student's knowledge with respect to the activity, b) will include open-ended questions requiring examination of information in different ways, c) will refer students to previous activities or another field for information to be brought to bear upon a problem or task, and d) will require students to identify and define a problem.

In Table 13 the presence of the criteria in the activity analysis category, preparation, is recorded for each of the textbooks by frequency and percentage. In section 11a, three textbooks at level one, four at level three, and five at level five contained activities of which 50 percent or more met the objective. The range was 50-80 percent.
<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>50</td>
<td>16</td>
<td>39</td>
<td>30</td>
<td>31</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Three</td>
<td>121</td>
<td>60</td>
<td>77</td>
<td>66</td>
<td>63</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Five</td>
<td>45</td>
<td>41</td>
<td>91</td>
<td>82</td>
<td>88</td>
<td>43</td>
<td></td>
</tr>
</tbody>
</table>

11. The textbook student activities under preparation,

a) will include basic or "raw" information (or suggest other sources of data) in order to build upon the student's knowledge with respect to the activity

b) will include open-ended questions requiring examination of information in different ways

c) will refer students to previous activities or another field for information to be brought to bear upon a problem or task

d) will require students to identify and define a problem.
In section 11b, one textbook contained activities of which 66 percent met the objectives. The activities in the remaining seventeen textbooks that met the objective ranged from zero to 44 percent.

Section 11c shows that none of the activities in five of the eighteen textbooks referred to students to previous activities. In twelve textbooks ten percent or less of the activities met the objective. In one textbook 31 percent of the activities met the objective.

In section 11d five percent or less of the activities in the eighteen textbooks met the objective.

Objective 12

The textbook student activities under ideation, a) will involve students in observations and the manipulation of materials as well as ideas, b) will request "if . . . then" predictions (hypotheses), and c) will ask students to defer judgment until a pool of ideas has been produced.

In Table 14, the presence of the criteria in the activity analysis category, ideation, is recorded for each of the textbooks by frequency and percentage. In section 12a all eighteen textbooks contained at least 50 percent of the activities that involved the students in observations and the manipulation of materials as well as ideas. Of these 90 percent or more of the activities
### TABLE 14
FREQUENCY AND PERCENTAGE DISTRIBUTION OF TEXTBOOK STUDENT ACTIVITIES WITH SPECIFIED CRITERIA OF THE IDEATION PHASE OF THE CREATIVE THINKING PROCESS

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>50</td>
<td>16</td>
<td>39</td>
<td>30</td>
<td>31</td>
<td>8</td>
</tr>
<tr>
<td>Three</td>
<td>121</td>
<td>60</td>
<td>77</td>
<td>66</td>
<td>63</td>
<td>52</td>
</tr>
<tr>
<td>Five</td>
<td>45</td>
<td>41</td>
<td>91</td>
<td>82</td>
<td>88</td>
<td>43</td>
</tr>
</tbody>
</table>

12. The textbook student activities under ideation,

a) will involve students in observations and the manipulation of materials as well as ideas

- One 45(90%) 13(81%) 38(97%) 25(83%) 27(87%) 6(75%)
- Three 104(86%) 50(83%) 74(96%) 65(95%) 46(76%) 36(69%)
- Five 34(76%) 28(68%) 69(76%) 61(74%) 69(78%) 23(54%)

b) will request "if...then" predictions (hypotheses)

- One 6(12%) 8(13%) 4(10%) 2(3%) 2(6%)
- Three 5(4%) 10(13%) 2(3%) 1(2%)
- Five 2(4%) 1(1%) 8(9%) 1(2%)

c) will ask for students to defer judgment until a pool of ideas has been produced.

- One 1(2%) 1(3%)
- Three 2(3%) 14(18%) 3(5%)
- Five 1(2%) 1(1%) 7(9%) 2(2%)
met the objective in four of the textbooks. From 80 to 89 percent of the activities in five textbooks met the objective.

In section 12b there were no activities in five textbooks that required students to make predictions. In the remaining thirteen textbooks, the objectives were met by only 13 percent or less of the activities.

In section 12c none of the activities in nine of the textbooks requested students to defer judgment until pools of ideas had been produced. In one textbook 18 percent of the activities met the requirements of the objective. In eight textbooks nine percent or less met the objective.

Objective 13

The textbook student activities under verification, a) will require students to test hypotheses through methods of systematic procedure, b) will ask students to formulate a generalization or concepts based upon the "solutions" of the problem, c) will include opportunities for self-initiated learning through additional activities, and d) will require students to communicate the results of the findings of the activities.

In Table 15 the presence of the criteria in the activity analysis category, verification, is shown for each of the textbooks by frequency and percentage. In section 13a, of the eighteen textbooks analyzed, none of
the activities in seven textbooks required students to test hypotheses. In eight textbooks 10 percent or less of the activities, and in three textbooks 11 to 16 percent of the activities met the requirements of the objective.

In section 13b, 55 and 62 percent of the activities in two of the textbooks required students to formulate a generalization or concepts based upon the "solutions" of the problem. In sixteen of the textbooks the percentage of activities that met the requirements of the objective ranged from five to 45 percent.

In section 13c less than ten percent of the activities in ten of the textbooks included opportunities for self-initiated learning through additional activities. None of the activities in eight of the textbooks met the objective.

In section 13d more than 50 percent of the activities (56 to 91 percent) in ten of the textbooks required students to communicate the results of the findings of the activities. In eight textbooks the percentage of the activities that met the requirements of the objective ranged from 16 to 43 percent.
TABLE 15
FREQUENCY AND PERCENTAGE DISTRIBUTION OF TEXTBOOK STUDENT ACTIVITIES
WITH SPECIFIED CRITERIA OF THE VERIFICATION PHASE
OF THE CREATIVE THINKING PROCESS

<table>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One</td>
<td>50</td>
<td>16</td>
<td>39</td>
<td>30</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Three</td>
<td>121</td>
<td>60</td>
<td>77</td>
<td>66</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Five</td>
<td>45</td>
<td>41</td>
<td>91</td>
<td>82</td>
<td>88</td>
</tr>
</tbody>
</table>

13. The textbook student activities under verification,

a) will require students to test hypotheses through methods of systematic procedure
   One            | 5(10%)          | 1(3%) | 1(3%) | 1(2%) |
   Three          | 1(1%)           | 2(3%) | 8(10%)| 7(11%)| 1(2%) |
   Five           | 5(6%)           | 13(16%)| 11(13%)| 1(2%) |

b) will ask students to formulate a generalization or concepts based upon the "solutions" of the
   problem
   One            | 16(32%)         | 6(38%)| 13(33%)| 8(27%)| 14(45%)| 1(13%) |
   Three          | 34(28%)         | 4(7%) | 42(55%)| 26(39%)| 4(6%) | 3(6%)  |
   Five           | 15(29%)         | 6(15%)| 56(62%)| 26(32%)| 13(15%)| 2(5%)  |

c) will include opportunities for self-initiated learning through additional activities
   One            | 4(8%)           | 3(8%) |
   Three          | 2(2%)           | 7(9%) | 1(2%) | 1(2%) | 1(2%) |
   Five           | 5(6%)           | 1(1%) |

d) will require students to communicate the results of the findings of the activities.
   One            | 41(82%)         | 5(31%)| 23(59%)| 18(60%)| 5(16%) | 5(63%) |
   Three          | 79(65%)         | 37(62%)| 48(62%)| 18(27%)| 27(43%)| 13(25%) |
   Five           | 18(40%)         | 24(59%)| 51(56%)| 46(56%)| 22(25%)| 8(19%) |

116
IV. COMPARISON OF FINDINGS OF NEWER SERIES WITH EACH OF OLDER SERIES

Objective 14

The selected elementary science textbook series, published between 1970 and 1972, will meet more of the objectives, one through thirteen, than either of the two State of California adopted series published in 1959 and 1966.

The data in Table 16 indicate that all four of the newer series met more of the objectives of the study related to the textbook introduction (Objectives 1-7) than D. C. Heath Series (1959). Two newer textbook series met more of the objectives than Harcourt, Brace & World Series (1966).

Table 17 indicates that there was no appreciable difference in the types of questions presented in the newer textbook series (published 1970-72) from those in the two older series. Over 94 percent of the questions in the newer series and in each of the two older series involved memory or convergent thinking. Less than six percent of the questions required divergent and evaluative thinking.
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</thead>
<tbody>
<tr>
<td>1. The authors will state in the textbook introduction that either</td>
<td></td>
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</tr>
<tr>
<td>a) creative thinking is a program goal,</td>
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<td>or</td>
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<tr>
<td>b) open-ended problem solving experiences are provided for students.</td>
<td></td>
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<td></td>
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<td>X</td>
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</tr>
<tr>
<td>2. The authors will provide in the textbook introduction or in the</td>
<td></td>
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<td></td>
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<tr>
<td>teacher's guide reference to publications on creative teaching-</td>
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<tr>
<td>learning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>3. The authors will include statements in the textbook introduction</td>
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<tr>
<td>that either</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>a) indicate scientific inquiry is a goal,</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>or</td>
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<tr>
<td>b) list at least five of the following processes of scientific</td>
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<tr>
<td>inquiry as goals:</td>
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<tr>
<td>observing</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>experimenting</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>verifying</td>
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<td>X</td>
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<tr>
<td>predicting</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<td>X</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<td>synthesizing</td>
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<td>X</td>
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<td>generalizing</td>
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TABLE 16 (continued)

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</thead>
<tbody>
<tr>
<td>a) Variety of materials</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>b) Free access to work areas</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>c) Encouragement for the expression of ideas and experimentation without penalty for failure</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>d) Open communication between students and teachers</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>e) A discovery approach</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>f) A time for students to mull over (incubate) a problem in order to organize and restructure their ideas</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

5. The authors will include in the textbook introduction descriptions of types of questions that teachers have used successfully to elicit various levels of thinking operations: divergent thinking, convergent thinking, and criterion-related thinking.
### Table 17
Comparative Summary of Series Analysis of Textbook Questions (Newer with Each of Older Series)

<table>
<thead>
<tr>
<th>Category</th>
<th>Four Newer Series Published 1970-72</th>
<th>Harcourt Brace &amp; World Series Published 1966</th>
<th>D. C. Heath Series Published 1959</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive-Memory</td>
<td>1380 (58.7%)</td>
<td>746 (52.5%)</td>
<td>82 (36.3%)</td>
</tr>
<tr>
<td>Convergent Thinking</td>
<td>2051 (57.6%)</td>
<td>637 (44.8%)</td>
<td>132 (58.4%)</td>
</tr>
<tr>
<td>Sub-Total <em>(C-M+CT)</em></td>
<td>3431 (96.3%)</td>
<td>1383 (97.3%)</td>
<td>214 (94.7%)</td>
</tr>
<tr>
<td>Divergent Thinking</td>
<td>120 (3.4%)</td>
<td>35 (2.5%)</td>
<td>9 (4%)</td>
</tr>
<tr>
<td>Evaluative Thinking</td>
<td>11 (.3%)</td>
<td>3 (.2%)</td>
<td>3 (1.3%)</td>
</tr>
<tr>
<td>Sub-Total †(DT+ET)</td>
<td>131 (3.7%)</td>
<td>38 (2.7%)</td>
<td>12 (5.3%)</td>
</tr>
<tr>
<td>Total Questions</td>
<td>3562 (100%)</td>
<td>1421 (100%)</td>
<td>226 (100%) = 5209</td>
</tr>
</tbody>
</table>

*(C-M+CT)* is Cognitive-Memory plus Convergent Thinking
†(DT+ET) is Divergent Thinking plus Evaluative Thinking

In Table 18 the fourteen objective criteria are listed. The table shows that eight of the criteria were met by a greater percentage of activities contained in the newer series than did the activities contained in the Harcourt, Brace & World Series. The table also shows that ten of the criteria were met by a greater percentage of activities contained in the newer series than did the activities contained in the C. C. Heath Series.
**TABLE 18**

**COMPARATIVE SUMMARY OF SERIES ANALYSIS OF STUDENT ACTIVITIES (NEWER WITH EACH OLDER SERIES)**

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Percentage of Activities Meeting Criterion Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>10. CONFRONTATION</strong></td>
<td></td>
</tr>
<tr>
<td>a) presented as a discrepant event or problem</td>
<td>38% 35% 38%</td>
</tr>
<tr>
<td>b) structured only enough to give operational clues and direction</td>
<td>91% 92% 93%</td>
</tr>
<tr>
<td>c) several acceptable outcomes possible</td>
<td>40% 64% 53%</td>
</tr>
<tr>
<td><strong>11. PREPARATION</strong></td>
<td></td>
</tr>
<tr>
<td>a) basic information...</td>
<td>51% 80% 52%</td>
</tr>
<tr>
<td>b) open-ended questions... examine information different ways</td>
<td>29% 23% 20%</td>
</tr>
<tr>
<td>c) previous activities or another field brought to bear on task</td>
<td>5% 15% 2%</td>
</tr>
<tr>
<td>d) identify and define problem</td>
<td>2% 1%</td>
</tr>
</tbody>
</table>

*Newer Series* | *Older Series* | *Harcourt Brace Jovanovich Series, 1966* | *D.C. Heath Series, 1959* | *1970-1972 Published*
TABLE 18 (continued)

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Percentages of Activities Meeting Criterion Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>*Newer Series</td>
</tr>
<tr>
<td></td>
<td>Published</td>
</tr>
</tbody>
</table>

12. IDEATION
   a) observation, manipulation of materials and ideas 84% 78% 63%
   b) predictions (hypotheses) 6% 6% 1%
   c) defer judgment, produce pool of ideas 4% 1%

13. VERIFICATION
   a) test hypotheses 6% 6% 2%
   b) formulate generalizations and concepts 35% 17% 6%
   c) self-initiated learning 4% 1% 1%
   d) communicate results 57% 30% 25%

*Newer Textbook Series include Silver Burdett, 1972; Laidlaw Brothers, 1972; Charles E. Merrill, 1970; and Harper & Row, 1971
SUMMARY

This chapter presented data from the analysis of textbooks, levels one, three, and five, in six basic elementary science series to determine the emphasis placed on the development of creative-thinking skills.

The introduction, questions, and student activities of each textbook were analyzed to determine the extent to which objectives one through thirteen were met.

To determine if there were any changes placed on creativity and to what extent they occurred, the findings from the analysis of the 1959, D. C. Heath Series, and the 1966, Harcourt, Brace & World Series, were compared with the later series by Silver Burdett, 1972; Laidlaw Brothers, 1972; Charles E. Merrill, 1970; and Harper & Row, 1971.

The conclusions based on the findings reported in this chapter are presented in Chapter V. Recommendations for further study are also offered by the investigator.
CHAPTER V

CONCLUSIONS BASED UPON THE INVESTIGATION AND RECOMMENDATIONS FOR FURTHER RESEARCH

This study examined the content of textbooks for levels one, three, and five in six elementary science series to determine the extent to which the development of creative thinking skills was emphasized. The analysis of content was conducted in accordance with the design and procedures of the study specified in Chapter III.

The findings of the study, reported in Chapter IV, were based on data collected from the application of the methods and instruments designed for this study to eighteen textbooks. These textbooks consisted of a representative sample of the basic textbook series recommended for adoption by the California State Curriculum Development and Supplemental Materials Commission to the State Board of Education and the two textbook series in previous adoptions by the State of California in the years 1959-1967 and 1967-1974.

The conclusions drawn from the study and based upon the findings reported in Chapter IV are presented in this chapter under the main headings: (1) general conclusions, (2) conclusions related to textbook introductions,
(3) conclusions related to textbook questions, (4) conclusions related to textbook student activities, and (5) conclusions related to the comparison of the newer series (published in 1970-1972) with each of the older series (published in 1966 and in 1959). A sixth heading contains recommendations for further study.

I. GENERAL CONCLUSIONS

From the content analysis of the elementary science textbooks of this study the investigator drew the following general conclusions:

1. The textbooks placed only minor emphasis on the development of creative thinking.

2. Textbook questions strongly emphasized cognitive-memory and convergent thinking. Questions requiring divergent and evaluative thinking received minor emphasis in all the textbooks. The newer textbook series (published in 1970-72) differed only slightly from the two older series (published in 1966 and in 1959) in the percentage of questions in categories based on the thinking operations that they elicit.

3. Textbook activities provided students with limited experiences for the development of intellectual skills needed to cope with the ambiguities and uncertainties associated with creative problem
solving. Student activities in the newer textbook series while still limited, did meet more of the criterion objectives related to creative problem solving than did the activities in either of the other series.

4. Of the two older series, the activities in the series published in 1966 met more of the criterion objectives related to creative problem solving than did the activities in the series published in 1959.

5. To the extent that the textbooks examined in this study were representative of the science textbooks in current use in the elementary grades, teachers, who rely on the textbooks as a primary source of instruction, must assume upon themselves most of the burden of responsibility for learning experiences appropriate for the development of creative thinking.

II. CONCLUSIONS RELATED TO TEXTBOOK INTRODUCTIONS

From the statements of educational philosophy and approaches in the introductions to the textbooks examined in this study, the investigator concluded:

1. Some provision for the development of creative thinking skills was made by the authors in each
of the textbook series. The degree of emphasis derived from the analysis of the authors' introductory statements varied among the textbook series. The most deliberate effort to provide for creative thinking was made by the authors of the Silver Burdett Series followed in order by the Charles E. Merrill Series; the Laidlaw Brothers Series, the Harper & Row Series, the Harcourt, Brace & World Series; and finally the D. C. Heath Series.

2. The development of inquiry process skills was a goal of all textbook series except D. C. Heath.

3. The authors' statements generally neglected questioning procedures related to eliciting various thinking operations, and teachers' roles in setting the learning environment for the development of problem-solving skills.

4. According to the authors' statements in the textbook introduction, all textbooks made provision for the diverse interests and aptitudes of the students.

III. CONCLUSIONS RELATED TO TEXTBOOK QUESTIONS

From the analysis and classification of textbook questions in terms of the kinds of thinking that they elicit, the investigator concluded:
1. Creative thinking was not emphasized in the textbooks examined in this study.

The distribution of questions, classified by the thinking operations they serve, showed that the textbooks strongly emphasized cognitive-memory and convergent thinking. Of the 5209 textbook questions analyzed and classified in the six textbook series in the study, 5028 (97%) were in the categories of cognitive-memory and convergent thinking. Questions requiring divergent and evaluative thinking received only minor emphasis in all of the textbooks. In J. P. Guilford's Structure of the Intellect Model (Guilford and Merrifield, 1960:11), although all of the specified intellectual operations are presumed to be involved to some degree in creative thinking, divergent and evaluative thinking are considered to be dominant in creative production.

The infrequency with which questions involving divergent and evaluative thinking were presented in the textbooks (less than 4% of the 5209 textbook questions analyzed in the study) gave evidence that the judgment of the learner was suppressed and the development of creative thinking skills was not a primary objective of any of the textbook series.
2. The findings of this study supported those of Davis and Hunkins (1966); Alcala (1971); Chew (1966); and Wadleigh (1969), that textbook questions stressed the acquisition of knowledge and did not emphasize higher cognitive levels.

Far too little emphasis was placed on questions that stimulate the kinds of thinking which encourage students to explore and express their own ideas. The incidence of questions that invited diverse responses and encouraged students to extend their thinking through the formulation of new relationships was negligible.

IV. CONCLUSIONS RELATED TO TEXTBOOK STUDENT ACTIVITIES

The following conclusions were drawn by the investigator from the analysis of student activities in the textbooks:

1. The pattern of textbook student activities did not emphasize the nurturing of creative thinking. The textbook activities provided students with limited experiences for the development of intellectual skills needed to cope with the ambiguities and uncertainties associated with creative problem solving.
Of the 1852 student activities examined in the eighteen elementary science textbooks in this study, answers or solutions were immediately available in the texts for 849 (46%) of the activities. Further analysis of the remaining 1003 student activities whose outcomes were not given in the text revealed that many of these activities were presented as exercises designed to develop specified inquiry skills but were detached from problem-solving encounters. A large proportion (629 or 63%) of these activities were not presented in the form of deficiencies, disharmonies, missing elements, or problems.

2. A large majority of student activities lacked the guiding principles or a method of procedure that might have assisted students in gathering and applying new data according to their individual interests and needs. Only 27 percent of the activities included open-ended questions which provide reorientation and opportunities for students to see objects, events, and ideas in a new perspective.

Activities rarely required students to gather pertinent data from sources other than the information immediately available in the text. Only six percent of the textbook activities analyzed
in the study referred students to previous activities or to other fields.

3. The findings of George and Dietz (1971:527-532), Torrance (1963b:110-118), and Woodruff (1959:72) gave strong evidence that the manipulation of materials enhanced creativity and problem solving. While the majority (54%-97%) of the activities in the textbooks required students to make direct observations and/or to manipulate materials as well as ideas; few of the activities involved students in the manipulation of materials for exploration and experimentation in problem-solving situations.

4. Experiences in problem identification and definition were extremely limited.

No more than thirteen (1%) of the 1003 activities asked students to identify or define a problem.

5. Textbook activities were dominated by preconceived formulas and procedures for arriving at conclusions. Activities offered students few opportunities to generate their own ideas relative to solutions to problems. Activities seldom requested students to make predictions. None of the activities analyzed in five of the eighteen textbooks required students to formulate hypotheses. Only five percent of the
total number of activities in the eighteen textbooks required students to formulate hypotheses.

6. The testing of hypotheses through methods of systematic procedure was seriously neglected in all the textbooks.

7. Inadequate attention was paid to the process of making generalizations from given or derived information.

In a majority of the textbooks less than one-third of the activities asked students to formulate concepts or a central idea based upon problem outcomes. Textbooks very seldom (29 of 1003 or 3%) encouraged the application of knowledge through opportunities for self-initiated learning activities. The number of activities requiring students to communicate the results of the findings varied from nineteen percent to 91 percent among the textbooks and the series.

V. CONCLUSIONS RELATED TO THE COMPARISON OF THE NEWER WITH EACH OF THE OLDER SERIES

From the comparison of the introductory statements made by the textbook authors, the analysis and classification of questions and the analysis of student activities
of the newer series (published in 1970-72) with each of the older series (published in 1966 and 1959) the investigator concluded:

1. The greatest noticeable change in the authors' stated educational philosophy, goals, and methods of instruction in relation to creative problem solving occurred with the introduction of the Harcourt, Brace & World Series, published in 1966.

2. There was a more deliberate effort to organize content favorable to the development of creative thinking in the newer series (1970-72) and Harcourt, Brace & World Series (1966) than in the D. C. Heath Series (1959).

3. All of the newer series and Harcourt, Brace & World Series included objectives related to the processes of science in addition to science content.

4. There was little change in the questioning procedures of the newer series in comparison with the older series.

   Over 94 percent of all questions in both the newer and older series involved cognitive-memory or convergent thinking.

5. The student activities in the newer textbook series reflected more of the elements and
conditions related to creative thinking specified in this study than did either Harcourt, Brace & World Series or D. C. Heath Series.

More of the criterion objectives related to creative problem solving were met by the activities in Harcourt, Brace & World Series than in the D. C. Heath Series.

VI. RECOMMENDATIONS FOR FURTHER STUDY

It was the opinion of the investigator that the findings of this study should serve to accentuate the awareness of many educators of the limitation of elementary science textbooks, particularly in the nurturing of creative thinking.

Since the textbook is a principle material of instruction in the classroom, there is a continuous need to reevaluate its content in relation to current educational needs.

The following recommendations for further study are suggested:

1. Studies involving content analysis of other science textbooks at various grade levels.

2. Studies comparing the goals and objectives expressed by the authors in the textbook commentary for teachers with the objectives derived from the analysis of the questions and activities presented in the text.
3. Studies that focus on the design of instruments and procedures that provide an effective basis for evaluating instructional materials by classroom teachers.

4. Studies directed toward devising methods and procedures that expedite the implementation of educational innovation into practice.

5. Studies related to the teachability of creative thinking through problem-solving encounters in science at the primary grade levels.

6. Studies involving the design and evaluation of elementary science activities that recognize the contributions of intuition and unconscious insight in addition to disciplined reasoning in scientific discovery.

7. Studies directed toward devising methods of reordering textbook priorities and effecting changes in the questions and activities to accommodate creative thinking.

SUMMARY

The main purpose of this study was to determine the extent to which specified elementary science textbooks made provisions for creative thinking. The findings of the study indicated that creative thinking received little emphasis in the textbooks examined in the study as evidenced by the characteristics and frequency of the
questions and activities presented. Textbook content was heavily dominated by questions that required memory or convergent thinking. Questions that involved divergent and evaluative thinking were infrequently provided.

A serious criticism of the textbooks in general with respect to creative thinking was that many of the activities were presented at the periphery of their potential as loosely connected and discrete exercises involving specific inquiry processes. Students were given only limited opportunity to use their knowledge and intellectual skills in creative problem-solving encounters. Too much emphasis was directed toward the transmission of information to students. Balance was lacking between the development of critical and of creative thinking processes.

The findings of this study should serve to stimulate related future investigations.
REFERENCES CITED
REFERENCES CITED


Handlin, Oscar. 1957. Textbooks that Don't Teach," Atlantic Monthly


APPENDIXES
APPENDIX A

BASIC TEXTBOOK SERIES FOR SCIENCE GRADES ONE THROUGH SIX, RECOMMENDED NOV. 1972, CALIFORNIA STATE BOARD OF EDUCATION

Instructional Materials in Science
Grades 1-6

American Book Co., A Division of Litten
Educational Publishing, Inc., 1972
INVESTIGATING IN SCIENCE

General Learning Corporation,
Silver Burdett Company Division, 1972
SCIENCE: UNDERSTANDING YOUR ENVIRONMENT SERIES

THE YOUNG SCIENTIST

Holt, Rinehart and Winston, Inc., 1971
MODERN ELEMENTARY SCIENCE

Laidlaw Brothers, Publishers,
Division of Doubleday Co., Inc., 1972
MODERN SCIENCE

Charles E. Merrill Publishing Company, 1970
DISCOVERING SCIENCE SERIES

Recommended for Adoption by the State Curriculum Development and Supplemental Materials Commission to the State Board of Education under AB 531, November 9, 1972.

From Lists Prepared by the Bureau of Textbooks, Division of School Administration and Finance.
APPENDIX B

FORTY-SIXTH YEARBOOK LISTING OF SCIENCE EXPERIENCES

The experiences listed are:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Universe</td>
</tr>
<tr>
<td></td>
<td>Stars, sun, moon, planets; seasonal changes, tides, eclipses, etc.</td>
</tr>
<tr>
<td>2</td>
<td>The Earth</td>
</tr>
<tr>
<td></td>
<td>Origin, formation of mountains, erosion, volcanism, pre-historic life, weather, etc.</td>
</tr>
<tr>
<td>3</td>
<td>Conditions Necessary for Life</td>
</tr>
<tr>
<td></td>
<td>What living things need for growth, development, and reproduction, in struggle for conditions necessary to life.</td>
</tr>
<tr>
<td>4</td>
<td>Living Things</td>
</tr>
<tr>
<td></td>
<td>Variety of living things, social life of animals, how they obtain their food, adaptations for protection, life cycles of plants and animals, structure of living things.</td>
</tr>
<tr>
<td>5</td>
<td>Physical and Chemical Phenomena [Matter and Energy]</td>
</tr>
<tr>
<td></td>
<td>Light, sound, gravity, magnetism, electricity, heat</td>
</tr>
<tr>
<td>6</td>
<td>Man's Attempt to Control his Environment</td>
</tr>
<tr>
<td></td>
<td>Man's control in gardens, on farms, in orchards; inventions, discoveries, etc.</td>
</tr>
<tr>
<td>7</td>
<td>Nature and Methods of Science</td>
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</table>

### APPENDIX C

**Worksheet for the Analysis and Classification of Textbook Questions**

<table>
<thead>
<tr>
<th>TEXTBOOK</th>
<th>LEVEL</th>
<th>PUBLISHER</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>SCIENCE TOPIC</th>
<th>Pg.</th>
<th>QUESTIONS</th>
<th>CATEGORY</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>C-M</td>
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</tbody>
</table>

|               |     |           | C-M  | CT | DT | ET |
|               |     |           |      |    |    |    |

| TOTAL         |     |           |      |    |    |    |


APPENDIX D

J. P. GUILFORD'S STRUCTURE OF THE INTELLECT PROBLEM SOLVING MODEL (ROLES OF INTELLECTUAL OPERATIONS)

(With possible incubation)

Input I

Filtering (attention aroused and directed)

Cognition (problem sensed and structured)

Evaluation (input tested; cognition tested)

Loop I

Output I

Evaluation (input tested; cognition tested)

Evaluation (answers tested)

Evaluation (new input tested)

Evaluation (new answers tested)

Output III

Output IV

Input II

Cognition (search for new information)

Output II

Production (answers generated)

Production (new answers generated)

Output III

Production (new answers generated)

Input III

Memory Storage

Visual-figural information (concrete; perceivable)

Symbolic information (signs)

Semantic information (meaningful)

Behavioral information (psychological)

APPENDIX E

WORKSHEET FOR THE ANALYSIS OF STUDENT ACTIVITIES

<table>
<thead>
<tr>
<th>SCIENCE TOPIC</th>
<th>Pg.</th>
<th>ACTIVITY</th>
<th>CONFRONTATION</th>
<th>PRESENTATION</th>
<th>IDEATION</th>
<th>VERIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>9 10a 10b 10c</td>
<td>11a 11b 11c</td>
<td>11d 12a 12b</td>
<td>12c 13a 13b</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13c 13d</td>
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WORKSHEET FOR THE ANALYSIS OF STUDENT ACTIVITIES (continued)

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<th>Unknown Ans.</th>
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<td>1.1 1.2 1.3</td>
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<td>Earth</td>
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<tr>
<td>Conditions for Life</td>
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<tr>
<td>Living Things</td>
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<td></td>
<td></td>
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<tr>
<td>Matter &amp; Energy</td>
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<tr>
<td>Man's Control of Environment</td>
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<tr>
<td>Nature &amp; Methods of Science</td>
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WORKSHEET FOR THE ANALYSIS OF STUDENT ACTIVITIES (continued)

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