1972

Test Questions Employed by Science Teachers in Public Junior High and Middle Schools of Louisiana.

Guy Von Schilling
Louisiana State University and Agricultural & Mechanical College

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A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
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Doctor of Education

in
The Department of Education

by
Guy Von Schilling
B.S., Louisiana State University, 1957
M.Ed., Louisiana State University, 1968
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# 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>vi</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>vii</td>
</tr>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>STATEMENT OF THE PROBLEM</td>
<td>3</td>
</tr>
<tr>
<td>DELIMITATION OF THE STUDY</td>
<td>4</td>
</tr>
<tr>
<td>DEFINITION OF TERMS</td>
<td>4</td>
</tr>
<tr>
<td>BLOOM'S HIERARCHY OF COGNITIVE SKILLS</td>
<td>4</td>
</tr>
<tr>
<td>HYPOTHESIS</td>
<td>6</td>
</tr>
<tr>
<td>IMPORTANCE OF THE STUDY</td>
<td>6</td>
</tr>
<tr>
<td>PROCEDURES USED IN THE STUDY</td>
<td>7</td>
</tr>
<tr>
<td>ORGANIZATION OF THE STUDY</td>
<td>11</td>
</tr>
<tr>
<td>2. REVIEW OF THE LITERATURE</td>
<td>13</td>
</tr>
<tr>
<td>EVIDENCE SUPPORTING THE PROCEDURE AND USE OF THE TAXONOMY IN THE STUDY</td>
<td>13</td>
</tr>
<tr>
<td>RECOGNITION OF NEEDED CHANGES IN SCIENCE TEACHING AND TESTING</td>
<td>17</td>
</tr>
<tr>
<td>RELATED STUDIES</td>
<td>19</td>
</tr>
<tr>
<td>SUMMARY</td>
<td>25</td>
</tr>
<tr>
<td>3. PRESENTATION OF DATA</td>
<td>26</td>
</tr>
<tr>
<td>OBTAINING THE TEST QUESTIONS</td>
<td>27</td>
</tr>
<tr>
<td>CLASSIFICATION OF QUESTIONS</td>
<td>28</td>
</tr>
<tr>
<td>Classification by Individual Panelists</td>
<td>28</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Levels of Agreement on Question Classification</td>
<td>30</td>
</tr>
<tr>
<td>QUESTION CLASSIFICATIONS AND TEACHER VARIABLES</td>
<td>33</td>
</tr>
<tr>
<td>Question Types and Teaching Experience</td>
<td>33</td>
</tr>
<tr>
<td>Question Types and Teacher Certification</td>
<td>36</td>
</tr>
<tr>
<td>Question Types and Teacher's College Degrees</td>
<td>38</td>
</tr>
<tr>
<td>Question Types and Science Teaching Experience</td>
<td>41</td>
</tr>
<tr>
<td>Question Types from Users and Non-Users of Modern Science Curriculum Projects</td>
<td>43</td>
</tr>
<tr>
<td>Question Types from the State-Wide Test Sample</td>
<td>46</td>
</tr>
<tr>
<td>4. SUMMARY AND CONCLUSIONS</td>
<td>48</td>
</tr>
<tr>
<td>SUMMARY OF FINDINGS</td>
<td>49</td>
</tr>
<tr>
<td>Question Classifications by Individual Panelists</td>
<td>49</td>
</tr>
<tr>
<td>Levels of Agreement on Question Classification</td>
<td>49</td>
</tr>
<tr>
<td>Question Types and Teaching Experience</td>
<td>50</td>
</tr>
<tr>
<td>Question Types and Teacher Certification</td>
<td>51</td>
</tr>
<tr>
<td>Question Types and Teacher's College Degrees</td>
<td>51</td>
</tr>
<tr>
<td>Question Types and Science Teaching Experience</td>
<td>52</td>
</tr>
<tr>
<td>Question Types from Users and Non-Users of Modern Science Curriculum Projects</td>
<td>53</td>
</tr>
<tr>
<td>Question Types from the Total Test Sample</td>
<td>54</td>
</tr>
<tr>
<td>CONCLUSIONS</td>
<td>54</td>
</tr>
<tr>
<td>REFERENCES CITED</td>
<td>58</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>APPENDICES</td>
<td>60</td>
</tr>
<tr>
<td>A. Letter to Teachers in the State-Wide Sample from the Louisiana State Department of Education (Science Section)</td>
<td>60</td>
</tr>
<tr>
<td>B. Cover Letter to Teachers in the State-Wide Sample from the Researcher</td>
<td>61</td>
</tr>
<tr>
<td>C. Teacher Questionnaire</td>
<td>62</td>
</tr>
<tr>
<td>D. Instructions to Members of the Classification Panel</td>
<td>64</td>
</tr>
<tr>
<td>E. Samples of Test Questions Classified at Each Cognitive Level by the Classification Panel</td>
<td>67</td>
</tr>
<tr>
<td>VITA</td>
<td>71</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>Number and Percentage of Questions Classified at Each Cognitive Level by Individual Panel Members</td>
<td>29</td>
</tr>
<tr>
<td>2.</td>
<td>Levels of Agreement on Question Classifications by Panel Members</td>
<td>31</td>
</tr>
<tr>
<td>3.</td>
<td>Number and Percentage of Questions at Each Cognitive Level Based on Years of Teaching Experience</td>
<td>34</td>
</tr>
<tr>
<td>4.</td>
<td>Number and Percentage of Questions at Each Cognitive Level Based on Area of Teacher Certification</td>
<td>37</td>
</tr>
<tr>
<td>5.</td>
<td>Number and Percentage of Questions at Each Cognitive Level Based on the College Degree Held by the Teacher</td>
<td>40</td>
</tr>
<tr>
<td>6.</td>
<td>Number and Percentage of Questions at Each Cognitive Level Based on Teachers' Experience Teaching Science</td>
<td>42</td>
</tr>
<tr>
<td>7.</td>
<td>Number and Percentage of Questions at Each Cognitive Level from Users and Non-Users of Modern Science Curriculum Projects</td>
<td>45</td>
</tr>
<tr>
<td>8.</td>
<td>Number and Percentage of Questions of Each Cognitive Level from the State-Wide Test Sample</td>
<td>47</td>
</tr>
</tbody>
</table>
ABSTRACT

The central problem of this study was to answer two questions: (1) what cognitive skills are emphasized by written test items constructed by eighth grade science teachers in the public schools of Louisiana?; and (2) are there differences of emphasis on the cognitive skills when comparisons are made among test questions from those teachers based on the following teacher-variables: (a) teaching experience; (b) area of certification; (c) college degree; (d) science teaching experience; and (e) user or non-user of modern science curriculum project.

Test questions were taken from teacher-made tests obtained from a state-wide random sample of 190 science teachers, or approximately 25 percent of the teacher population at the designated level. Using random number tables, two questions were selected from each of two tests obtained from each teacher. Seven hundred and sixty questions formed the state-wide question sample. Information on the teacher-variables was obtained by means of a questionnaire; there was a 95 percent return.

A five-member panel of experienced science educators, working individually, classified the sample test items according to the six levels of mental skills presented in Bloom's Taxonomy of Educational Objectives, Handbook I: Cognitive Domain. Final classification of each item was made where three or more of the five members were in agreement.
A high level of agreement was observed in the percentage of questions classified at each cognitive level by the individual panel members. However, the data indicated that knowledge type questions were easiest to identify and lower levels of agreement in the classification of questions at each succeedingly higher level of cognition were evident.

No consistent evidence was observed to indicate that questions from more experienced or less experienced teachers place greater or lesser emphasis on the higher mental skills. Teachers in each category of years teaching experience placed similarly great emphasis on the lowest cognitive level, knowledge. The teachers, regardless of their years of teaching experience, college degrees, or years of science teaching experience, asked questions requiring only the skills of recall in 75 to 85 percent of the cases. Approximately four-fifths of the questions from teachers with either upper elementary or secondary certification were the knowledge type and those constructed by teachers with T-certificates (temporary certification) placed even greater emphasis on the recall of information.

Teachers with secondary certification asked slightly more comprehension and application type questions (two percentage points) than did teachers with upper elementary certification. However, the test items from both upper elementary and secondary teachers failed to challenge students at the highest cognitive levels of synthesis and evaluation.

The data indicated that teachers in the intermediate ranges of science teaching experience (4-7 years and 8-12 years)
placed greater emphasis on application and analysis questions than did teachers in the 0-3 years category.

The study revealed that approximately 91 percent of the teachers were using a science curriculum designed for themselves or by the local science department or a local curriculum committee. Thus, about 9 percent of the teachers were using one of the modern science curriculum projects that have been recognized in professional publications. A comparison of questions from the two groups of teachers showed that teachers who were using one of the newer curriculum projects in their teaching asked more questions in the comprehension, application, and analysis categories. However, regardless of the curriculum used the teachers did not provide opportunities in the test items for their students to exercise mental skills at the highest cognitive levels.

The number and percentage of questions classified at each cognitive level from the state-wide sample were as follows: knowledge, 617 (81.2 percent); comprehension, sixty-six (8.7 percent); application, forty-nine (6.4 percent); analysis, fifteen (2.0 percent); synthesis, one (.1 percent); evaluation, zero (.0 percent); and unclassified, twelve (1.6 percent).
Chapter 1

INTRODUCTION

It has been said that "to question well is to teach well" (Grossier, 1964:5). Indeed, from the time of Socrates, history's greatest teachers have generally been penetrating questioners (Grossier, 1964).

Today the written test question is a widely used procedure in teaching, and it is often the only means of measuring pupil achievement. At frequent intervals in every classroom across this nation youngsters are bombarded with test questions of one kind or other. There is little doubt that the types of questions employed by teachers have an effect upon the nature and degree of learning experienced by the students.

The following statement released by the Los Angeles City Schools (1967) expresses the significant impact teacher questioning has on student science inquiry:

Effective questioning is an important key to science exploration and learning. A central part of all learning activity, particularly of scientific inquiry, is the asking of questions by teachers to give purpose and direction to investigation. Teachers' encouragement and cultivation of the use of questioning are among the important objectives of science instruction. Pupils need to understand that a questioning attitude is encouraged... and that questions often result in exciting exploration, discovery, and other types of learning. The teacher establishes this 'learning climate' by arranging for situations which stimulate questions. The teachers' techniques of questioning serve as models for pupils as they develop and improve their own skills.
Educators have long recognized significant differences in the types of questions employed by teachers. Accurate clues to the kind of teaching methods being used are reflected in the questions the teacher uses in measuring student progress. Some questions can be answered with a yes or no response or by supplying a missing word. Other questions motivate the use of various methods to find answers. Still other questions require that the student exercise a broad range of higher mental faculties in solving problems under investigation.

Learning how to investigate problems and find answers should be an objective of high priority in science teaching. Through effective questioning the teacher builds into science lessons and tests opportunities for students to develop the mental behavioral skills that are essential in exploring the problems of science (Los Angeles City Schools, 1967).

In the process of speculating or making hypotheses, pupils must draw on their knowledge and past experience to arrive at the present best answers. The particular phrasing of a question by the teacher either opens or closes the door to speculation. Students are likely to engage in imaginative and creative thinking when they know that speculation is not only permissible but also desirable. Questions can permit the pupils' responses (speculation) to lead directly into further investigation. In this manner the importance of scientific inquiry is reflected as an outgrowth of effective teacher questioning.
The extent to which pupils are involved directly in discovery is often determined by the nature of the teachers' questions. The questions employed can emphasize teacher-directed procedures to be imposed upon the pupils, or they can provide opportunities for pupils to decide for themselves on what frame of reference certain objects can be explained.

Teachers who limit their test questions to who, what, when, where, limit the possible answers to person, fact, time, or place. This approach, if used exclusively, tends to reinforce the kind of learning which fails to penetrate beyond the literal meaning and which depends mainly upon the rote memory process (Snyder, 1963). The testing goals tend to dominate the students' learning goals.

Statement of the problem

1. What cognitive behaviors are emphasized by test questions employed by science teachers in the public junior high and middle schools of Louisiana?

2. Is there a difference in emphasis on cognitive skills required of students in answering test questions asked by:

   a. Teachers with various college degrees?

   b. Teachers with varying years teaching experience?

   c. Teachers with various years experience teaching science?

   d. Teachers with different areas of certification?
e. Teachers who use one of the modern science curriculum projects and teachers who use their own or a locally developed curriculum.

**Delimitation of the study**

This study included written test questions from major tests that covered materials for at least a six weeks period and used by eighth grade teachers who taught one or more science classes during the 1971-72 school year.

**DEFINITION OF TERMS**

**Junior high schools**

This included all schools listed in the Louisiana School Directory (1971-72) with grades seven through nine or any combination of grades in this range that included grade eight.

**Bloom's Hierarchy of Cognitive Skills**

This is a taxonomy of educational objectives arranged from the more simple to increasingly complex mental behaviors. The following six levels are recognized and discussed by Bloom (1956):

**Level I: Knowledge.** This includes those behaviors which emphasize what a pupil remembers, either by recognition or recall of ideas, materials, or phenomena. This level is basic to working at any other level.
Level II: Comprehension. This level emphasizes a grasp of the meaning and intent of a "material" (i.e., a communication in oral or written form, in verbal or symbolic form, or in concrete form). It includes a pupil's ability to translate, interpret, or extrapolate.

Level III: Application. The emphasis at this level is on the selection of an appropriate learning to solve a problem or to deal with a new situation. This area differs from that of comprehension in that the pupil must select from past learnings the appropriate understanding and process to resolve a problem when no mode of solution is specified.

Level IV: Analysis. Analysis emphasizes the breakdown of materials into constituent parts, the detection of relationships, and the organization of parts.

Level V: Synthesis. This level emphasizes creative behavior in the organization of elements from a number of sources into a new structure. In each case of synthesis there is some new way to communicate and it is this element which distinguishes synthesis from the other levels.

Level VI: Evaluation. The evaluation level involves the making of value judgments about purposes, ideas, works, solutions, methods, and materials. It employs the use of criteria or standards for appraising the extent to which particulars are accurate, effective, economical, or satisfying. The judgments may be qualitative or quantitative, and the
criteria may be either those determined by the pupil or those which are provided for him. Evaluation is regarded as requiring to some extent all the other levels of behavior. However, it is not necessarily the last step in thinking or problem solving.

HYPOTHESIS

Test questions employed by eighth grade science teachers in Louisiana do not cover the higher mental skills emphasized in the modern science curriculum projects.

IMPORTANCE OF THE STUDY

This study is important for the following reasons:

1. The teachers' test questions reflect the teaching methods and kinds of skills development emphasized in the classroom. Further, today's modern science programs stress the development of higher cognitive skills among students. These newer science projects are designed to provide the student with rich experiences in defining problems, critical thinking, evaluations, systematic observations, analysis of data and other skills in meaningful scientific investigations. This study will provide evidence on the extent to which the public schools of Louisiana are meeting the challenge of modern science curriculum projects at this level.

2. The findings can serve as a guide for educators in planning workshops, conferences, evaluative school
visitations, and other in-service teacher training sessions designed to strengthen science teaching methods.

3. The information gained from this study can assist teacher training institutions. The data will focus on factors these institutions need to consider as methods courses are planned and existing programs for science teachers are evaluated.

PROCEDURES USED IN THE STUDY

1. The identity and location of the middle and junior high schools involved in the study were obtained from the Louisiana School Directory (1971-72) issued by the Louisiana State Department of Education. With cooperation and assistance from State Department personnel, a thorough search of all the appropriate Annual Reports on file in the Department was conducted to obtain the identity of teachers in the state-wide population encompassed by the study. Seven hundred and eighty-nine teachers were identified as teaching one or more eighth-grade classes of physical and/or biological sciences for the 1971-72 school year.

2. A sample of two hundred teachers' names, or approximately 25 percent of the total population, was selected by randomization. The name of each teacher in the total population, along with the name and address of his school, was typed on a small, rectangular sheet of paper. Each sheet of approximately equal size was folded in a similar pattern and placed in a large container. After thorough shuffling and
mixing, the sample of two hundred names was drawn to represent the total population.

3. A letter was mailed to each teacher in the sample population giving essential information concerning the nature and professional use of the study (See Appendices A & B). In addition, each teacher was provided with a large, stamped, self-addressed envelope and requested to forward copies of two different unit, six weeks, semester, or final tests which had been constructed and administered to any science class within the past year. It was explained that these teacher-made tests could be in any combination of the above, and that they could be either used copies with student responses on them or blank copies from the teacher's file. Teachers were given assurance that the names of schools, teachers or pupils would not be identified and that all tests, except those from teachers requesting that the tests be returned, would be destroyed at the completion of the study.

4. A six-item questionnaire was also mailed to each teacher in the sample (See Appendix C). The teachers were asked to check the appropriate spaces on this questionnaire and to return it along with the tests. This provided the information related to the college degree, area of certification and teaching experience of each teacher. In addition, the questionnaire provided for the identification of the kind of science curriculum each teacher had been using during the year.

5. Follow-up letters were mailed to those teachers who failed to respond within two weeks following the initial request.
When teachers' responses were not received within two weeks following the second request, each principal was contacted by telephone. A 95 percent response was obtained from the sample.

6. Two questions were selected from each of the two tests received from the one hundred and ninety teachers who responded. The items on each test were re-numbered consecutively to eliminate lettered items and separate numbering of items in different sections. Items were selected through the use of random-number tables provided by Mouly (1963). Seven hundred and sixty questions formed the state-wide question sample for the present study.

7. A five-member panel was chosen to classify each sample question. The qualifications for selection to the panel were: (1) recognition in the field of science education and (2) thorough knowledge of Bloom's Taxonomy.

The following persons formed the panel: (1) Dr. Sam Adams, Professor of Education in Science and Statistics, Louisiana State University; (2) Dr. Fred M. Smith, Professor of Education and Director of the Bureau for Educational Research, Louisiana State University; (3) Dr. Barbara M. Strawitz, Associate Professor of Education and Supervisor of student teachers in science, University High School, Louisiana State University; (4) Dr. Stanley Shaw, State Supervisor of Science and Conservation, Louisiana State Department of Education; and (5) Dr. Clarence Nelson, Professor of Science Education and Educational Evaluation, Office of Evaluation Services, Michigan State University.
8. Each panel member was provided with a copy of the state-wide sample of test questions. Using the six levels of mental skills set forth in Bloom's *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain* as the structure for classification, panel members working individually categorized each item. The panelists entered a number in the blank space to the left of each item according to the following scheme: (1) Knowledge; (2) Comprehension; (3) Application; (4) Analysis; (5) Synthesis; and (6) Evaluation. No further sub-classification was required (See Appendix D). Thus, each question was classified into one of the broad levels of mental skills in the hierarchy. Final classification of each test item, however, was made on the basis of a simple majority (three out of five) of the panel classifications. If there were less than a majority agreement on an item, it was indicated in the treatment of the data.

9. Appropriate tables were used to show comparative emphasis on the various mental skills revealed by the classification of the sample test items. Further, separate tables were used to indicate the comparative emphasis on mental skills based upon the degree held by the teachers, area of certification, years of teaching experience, years of teaching in the sciences, and science curriculum used in courses.

10. Some sample test questions representative of each of the six levels of learning were presented (See Appendix E).
ORGANIZATION OF THE STUDY

Chapter 1: Introduction

A discussion of the important role of questioning in teaching and learning was presented. A definition of the problem, delimitation of the problem, the hypothesis, definition of terms, importance of the study and procedures used were also given.

Chapter 2: Review of Literature

A review of available research findings was presented under three areas: (1) Evidence to support the procedure and use of the Taxonomy in the study; (2) recognition of needed changes in science teaching and testing; and (3) related studies on teachers' oral questioning practices, teachers' written test questions and questions appearing in textbooks.

Chapter 3: Presentation of Data

Appropriate tables were used in this chapter to show the emphasis on mental skills reflected in the state-wide sample of questions. Tables showing comparative emphasis on the cognitive skills based on the factors of teaching experience, area of certification, experience teaching science, type of science curriculum, and college degrees held by the teachers were also presented.

Chapter 4: Summary of Findings and Conclusions

The important findings indicated by the data from each category of the study were summarized. Conclusions were stated
only on those points where data from the study seemed to offer substantial evidence.
Chapter 2

THE REVIEW OF THE LITERATURE

Evidence Supporting the Procedure and Use of the Taxonomy in This Study

Educational researchers agree that tests constructed by teachers are a major factor in the evaluation of students' achievement. Test questions reflect the kinds of objectives held by the teacher constructing them, whether those objectives are stated or not (Pfeiffer and Davis, 1965). Thus, since teacher-made tests are directly related to the objectives of a course, an analysis of the items composing the tests by a panel of science educators, working individually, should reveal the mental skills emphasized by the tests.

In a study replicated by Clegg and others (1969), it was shown that a high level of agreement could be obtained within and between several groups of raters in classifying teacher questions into categories or levels of mental skills. This evidence suggested that the Taxonomy could be used as a common language in education for the classification of cognitive skills required of students when answering teachers' test questions.

One of the major criticisms of teaching and testing procedures in education has been the placement of great emphasis on those achievements which are easiest to measure. In recent years several articles have been published on the subject of educational outcomes in terms of behavior, rather than abstractions,
as proposals to overcome this criticism. One such committee of specialists in evaluation, Bloom and associates, has provided a classification system for organizing educational objectives within the cognitive domain which has produced evidence that it can be applied to actual test construction (Ebel, 1969).

Although there have been other approaches devised for analyzing and classifying test items, Bloom's Taxonomy has received the greatest attention and expression of confidence from researchers. Pfeiffer and Davis (1965), in a study of cognitive objectives in ninth grade science examinations, used the Taxonomy "...to demonstrate the usefulness of a powerful analytic system." Lombard (1965:33) in a discussion of better classroom testing, concluded that, "even though there may be many ways to prepare good science tests, few seem to offer as clear guidance as the objectives in the cognitive domain as outlined in the Taxonomy of Educational Objectives."

Sanders (1966) used the levels of mental behavior in Bloom's Taxonomy in proposing a "taxonomy of questions." In support of this cognitive approach in classifying questions, Sanders (1966:5) wrote:

A teacher who has mastered the taxonomy of questions can use it in a number of ways to improve the intellectual climate of his classroom. It offers a means for him to answer this question: 'Am I offering all appropriate intellectual experiences in my classroom or am I over-emphasizing some and neglecting others?' The answer can easily be found by classifying the questions asked on examinations, homework, and orally.

In an analysis of the existing systems for classifying educational objectives, Gall (1970:713) concluded, 'Bloom's
Taxonomy best represents the commonalities that exist among
the systems."

Sylvester (1971:68) also supported the use of the
Cognitive and Affective Domains as useful systems in the
following statement:

These two taxonomies of educational objectives comprise
only eleven major categories, and yet many of the activities
in our society's formal and informal educational process can
be subsumed within these categories.

In a discussion of constructing tests to measure
intellectual skills, Smith and Adams (1966:131) chose to use
the terminology and the structure found in the Taxonomy. Their
confidence in the Taxonomy as an adequate approach to classifi-
cation of educational objectives is expressed in the following
statement:

We feel that order and consistency (one of the original
purposes of the Taxonomy group) are desirable ends to be
promoted. Second, we feel that the Taxonomy satisfactorily
meets the criterion of completeness. Practically all
intellectual skills that teachers want their students to
acquire can be classified here.

The Taxonomy and other cognitive approaches, however,
have not received full acceptance from every researcher in
education. Gall (1970) was critical of the systems on several
points. She found that at least eleven classifications systems
had been proposed in recent years and that most of these were
composed almost completely of categories based on the type of
cognitive process required to answer the question. Specifically,
Gall (1970:710) indicated the following points as weaknesses of
the cognitive approaches which gives a succinct but complete
summary of criticism appearing in the literature:
(1) These processes are inferential constructs and they cannot be observed directly. Thus, it is not always possible to know whether a student answered a particular question by using a high or low level cognitive process. (2) The existing taxonomies classify questions which cover only a few important educational objectives. These are the types of questions that teachers ask to test the students' recall of information or to cultivate their critical thinking processes. Yet, there are several other worthwhile oral question types which are treated scantily, if at all, in existing taxonomies. (3) The present classification systems are designed primarily to investigate the types of questions which teachers actually use in the classroom, not the types of questions which they should use. (4) These systems stress general question types rather than to identify questions which are effective for a specific curriculum and classroom setting. (5) Today's question-classification systems do not consider the significance of question sequences or 'follow-up' questions.

Although Gall pointed out some limitations of the Taxonomy and other cognitive approaches, only one of these was relevant as a factor affecting the validity of the present study. As she indicated, these are inferential constructs which cannot be observed directly. It is not always possible to know what level of cognitive process is required of the student to answer a particular question. To minimize the possible effects of this factor, the researcher took the following measures: (1) selected members for the classification panel who had extensive experience in the area of science and a thorough knowledge of the Taxonomy; and (2) instructed panel members to base classification on the highest cognitive skill required of the student implied in the question. Thus, without knowing the kind of teaching which preceded the testing, classifications were based on the nature and implication of each question as judged by the majority of panel members.
Recognition of Needed Changes in Science Teaching and Testing

For several decades many educators have expressed the desirability for the kind of science education that would provide for the development of more flexible mental skills among students. The following statement by Davis (1939:371) reflected that desire:

The past years have seen a determined attempt by the leaders in the field of education toward the substitution of certain broad aims other than the traditional teaching of memorization of isolated facts. Teachers in training and teachers in the field have alike expressed their ideas as to the desirability of measuring these new outcomes.

However, only since the launching of Russia's Sputnik I in 1957, has a vigorous examination of the status of science teaching in the United States spurred the writing of numerous articles on the subject by both educators and laymen alike. Much of this writing was concerned with new science curriculum projects that had been proposed. The projects attempted to provide a thrust toward the development of science studies as systems and processes of inquiry. Seventy-seven major projects emerged for levels from kindergarten through the graduate school. New curriculum projects were developed in biology, chemistry, earth science, physical science, elementary science, physics, and computer science and technology (Wolfe, 1970).

Wolfe (1970:72) explained that many of the new projects represented a fundamental departure from the traditional approach in science teaching:
A guiding principle is to treat the sciences not as bodies of knowledge but as systems of inquiry, and to present phenomena directly through experiences in the laboratory, in the field, in the classroom, and by film and television.

Characteristic of the newer science projects has been the emphasis on how to locate information and investigate problems, a shift from science as something to be learned from books to something that grows out of experimental discoveries.

Lombard (1965) reported that classroom tests are probably the most important factors in determining the image of science that students take away from their respective courses. He reasoned that if successful performance on tests depends only on the mastery of the subject matter, teachers are probably defeated in attempting to make science a growing, exciting, highly speculative, and individual enterprise. To quote Lombard (1965:33):

It is of little value to discuss the evidence giving the advantages and disadvantages of the wave versus the particle model of light if the students realize that on the next quiz they will only be expected to 'know the facts,' such as the speed of light, how to calculate wavelengths, and so on. Since we are far more likely to realize those objectives that we consistently reward and evaluate, it is essential to make them the ones we prize most highly.

Lombard (1965:33) also pointed out that most lists of science objectives have shown broad statements such as "development of a scientific attitude" or "development of an appreciation of science." He explained that these objectives must be broken down into more specific terms before they will become functional. Furthermore, to evaluate the extent of attainment, students must be presented with tasks the solutions of which require the stated objectives. "We must ask,"
stated Lombard (1965:33), "if he has attained this objective, what sort of things will the student now be able to do or what sort of questions will he be able to answer?"

Postman and Weingartner (1969:19) were extremely critical of teachers' questions and questioning techniques. They reported that students are primarily required to believe in authorities, or at least pretend to such belief when they take tests:

Mostly they are required to remember. They are almost never required to make observations, formulate definitions, or perform any intellectual operations that go beyond repeating what someone else says is true. Examine the types of questions teachers ask and you will find that most of them are what might technically be called 'convergent questions,' but what might more simply be called 'Guess-what-I'm-thinking questions.'

Postman and Weingartner (1969:19) concluded, "The student is constantly trying to supply the 'Right Answer' and it doesn't seem to matter if the subject is English, history, or science, the students do the same thing."

Commenting on the lack of emphasis in the cognitive areas at the elementary level Sylvester (1971:68) observed:

Unfortunately, the elementary school program often expends so much effort in meeting the tremendous demands of the first two levels of cognitive objectives that it gives only lip service to the four succeeding levels in the hierarchy. Yet, it is this latter kind of intellectual activity that gives meaning to knowledge and comprehension. It's a challenging concern for elementary teachers.

Related Studies

Gall (1970:710) reviewed studies in the area of oral questioning by teachers in the classroom. She found that teachers' questioning practices are fairly consistent:
It is reasonable to conclude that in a half-century there has been no essential change in the types of questions which teachers emphasize in their classrooms. About 60 percent of teachers' questions require students to think; and the remaining 20 percent are procedural.

A study by Pfeiffer and Davis (1965) involved semester examinations for all ninth grade courses during the 1963-64 school year from a junior high school in Northeastern Ohio. The tests had been prepared by teachers as individuals or as members of committees. Test items were analyzed according to Bloom's Taxonomy of Educational Objectives: Cognitive Domain.

Each item on each test was categorized into the highest appropriate class or subclass; item frequencies were tabulated and percentages were calculated.

Pfeiffer and Davis (1965) found that in the area of general science, where most students were enrolled in non-college preparatory programs, about 75 percent of the test items required the task of application, while the remaining 25 percent asked for knowledge. However, the college-preparatory students taking biology were asked questions 100 percent of which required the skill of knowledge only. To these investigators, it seemed probable that the percentages indicated a significant difference in teaching methods among the science teachers in this school. However, just as significant was their observation that no questions were asked that required cognitive skills in comprehension, analysis, synthesis, or evaluation in the general science or biology courses:

The overall lack of concern for the objective in the areas of analysis, synthesis, and evaluation, while not unusual, is surely depressing. In a sense, these junior high school
students were intellectually deprived, not having the opportunity, at least on examinations, to deal with much of the basic nature of the courses. Thus, these students academically able and potential dropouts, were treated to a steady diet of bits-upon-pieces, specific-upon-specific. Only in English and, for a limited group in world history, did students have the intellectual challenge of the higher cognitive processes (Pfeiffer and Davis, 1965:2).

Tinsley and Davis (1971) reasoned that if questions used by teachers can be significant in developing the cognitive powers of students, and if a primary aim of the social studies is to develop critical thinking abilities, an analysis of the questions social studies student teachers plan and compose for instruction could be an important first step in helping teacher candidates become more fully aware of what they are doing.

These researchers conducted an experiment in planning cognitive objectives for instruction in given learning situations and grade levels. The project involved sixty-seven secondary student teachers in social studies at the University of Texas at Austin. Student teachers were randomly assigned to one of four groups in which they received written instructions for the experiment. Group One (N=15) was instructed to compose at least five questions to guide class discussion in an eighth grade American history class; Group Two (N=17), five questions for a test in eighth grade American history; Group Three (N=18), five or more questions to guide discussion in an eleventh grade American history class; and Group Four (N=17), questions for a test in eleventh grade American history (Tinsley and Davis, 1971:60). A system was developed for rating the questions submitted by the groups in six categories: Memory, convergent thinking, logical thinking, divergent thinking, and evaluation.
The results of the foregoing study showed the questions planned by the student teachers placed greatest emphasis on memory and evaluation. Questions were characterized by little variety in opportunity for student practice in the other high-level cognitive areas; nor did they demonstrate a difference in the opportunities provided in class discussion and tests. Moreover, no significant differences existed in opportunities for exercising mental skills between junior and senior high school students (Tinsley and Davis, 1971:62). With the exception of evaluation, the dominant emphasis on memory found in the experiment was similar to the results revealed by other related studies.

Curtis (1943:60) conducted a study of thought questions found in high school science textbooks. With the assistance of six teachers in secondary school science, the investigator formulated a classification system based upon sixteen question types: Comparison and contrast; decision for or against; application of facts or principles already learned in new situations; classification; relationships involving cause and effect; example or illustration; statement of authors' aims or purpose in the selection or arrangement of materials; criticism of the adequacy, correctness, or relevancy of a situation; statement or diagram; inference from data; discussion; outline; explanation or definition; simple recall; summary; observation; and formulation of new questions (Curtis, 1943:62-63).

Each of the six teacher-investigators classified the thought questions appearing in recently published textbooks or
workbooks in his field of specialization. A total of 44,722 thought questions in forty-three books representing four common fields of high school science were analyzed and classified. Classification of a question was determined when four of the six teacher-investigators, working individually, gave the question the same type designation. The study revealed that the types of questions most frequently found in the thirty textbooks analyzed were those demanding recall of facts; those requiring the pupil to give an explanation or a definition; and, those involving relationships. The three types constituted more than half the questions in the thirty books. Other types represented in the textbooks involved application of fact or principle in a new situation, decision, discussion, observation, comparison, and example. The author of this study also found that a considerable number of valuable types of thought questions were employed sporadically or not at all. Curtis (1943:67) concluded:

The evidence here presented would seem to justify the conclusion that authors of textbooks and workbooks in the various fields of high school science are failing to make sufficient use in their books of a considerable number of valuable types of questions which stimulate reflective thinking.

Davis and Hunkins (1966:285) classified textbook questions according to Bloom's Taxonomy. One-third of the chapters in each of three recently published fifth grade social studies textbooks were randomly selected. All questions found at the ends of chapters were listed. Questions from Textbook A, emphasizing a history approach, totaled 139; from Textbook B, having geography emphasis, numbered 350; and from Textbook C, described as having a fused approach, 243 questions.
This study revealed that 87 percent of the questions came under the area of knowledge or recall. About 9 percent of the questions were classified in the category of comprehension, and approximately 4 percent called for some level of analysis to be made. Only three questions or less than 1 percent of the more than seven hundred questions included in the study, could be classified in the synthesis and evaluation categories combined. To quote the researchers:

Perhaps the most surprising finding of all is that the three books, written along different approaches, were so similar in the cognitive emphases of their questions. Not only were they alike with respect to an emphasis on knowledge, their questions revealed a rather uniform neglect of the higher mental operations (Davis and Hunkins, 1966:287).

The foregoing study showed a large percentage of questions in the general category of knowledge which did not reveal the impact of the overall emphasis. Probably more significant was that of all 732 questions, 78 percent dealt with knowledge of specifics, while most of the questions in all books required only knowledge of specific facts; a smaller number demanded knowledge of terminology. Still within the knowledge category, questions emphasizing trends and sequences represented only 5 percent of the total questions, and questions demanding knowledge of universals and abstractions amounted to only 4 percent of all questions. The result was a heavy concentration of questions in the lowest class of the knowledge category (Davis and Hunkins, 1966:288).

Similar results were reported by Hedges in a study that included midyear examinations constructed by selected high school science teachers in Virginia (Hedges, 1966:21).
of fourteen thousand items analyzed, 78 percent were concerned with recall of facts. Further analysis showed that 64 percent of the recall items required only the simplest form of recall in the hierarchy of classification.

SUMMARY

The review of available related literature provides evidence for at least four general observations: (1) educators have for many years expressed a desire for the kind of science instruction that would emphasize the development of higher mental skills among students; (2) a large number of new science curriculum projects have been developed in recent years to promote the higher skills of scientific investigation and inquiry among students; (3) although a number of approaches have been presented as systems for categorizing questions and educational objectives into various cognitive levels, Bloom's Taxonomy has received the widest acceptance from researchers in education; and (4) the types of oral questions and test questions asked by teachers, and questions appearing in textbooks, have continued to place greatest emphasis on the memorization of subject matter.
Chapter 3

PRESENTATION OF DATA

The central problem of this study was to answer two questions: (1) what cognitive skills are emphasized by written test items constructed by eighth grade science teachers?; and (2) are there differences of emphasis on the cognitive skills when comparisons are made among test questions from teachers based on the following teacher-variables: (a) teaching experience; (b) area of certification; (c) college degree; (d) science teaching experience; and (e) user or non-user of modern science curriculum projects?

The following enumerations and data were presented in this chapter to provide information relative to the stated problem: (1) review of procedures used to obtain state-wide question sample; (2) review of methods used to obtain question classifications; (3) present tables giving the number and percentage of questions at each cognitive level as determined by individual members of the classification panel and the levels of agreement on classification by the panel as a group; (4) present separate tables showing comparative data on the number and percentage of questions at each cognitive level for each of the five teacher variables; and (5) present data on the number and percentage of questions classified at each cognitive level from the total sample of test questions.
OBTAINING THE TEST QUESTIONS

The questions were taken from teacher-made tests obtained from a state-wide sample of science teachers. Data on file in the Louisiana State Department of Education revealed that 789 teachers were teaching one or more eighth grade classes in the science area during the 1971-72 school year. A sample of two hundred teachers, or approximately 25 percent of the population, was chosen by randomization to be representative of the total population.

Appropriate letters and other informative materials were mailed to each teacher in the sample. Each teacher was requested to check the items on the questionnaire and to forward this and copies of two different science tests they had constructed and administered to any of their science classes within the past year. They were instructed to forward only major tests (i.e. unit, six weeks, semester, or final). Suitable envelopes and adequate postage was provided for each teacher's return mail. By sending follow-up letters and contacting principals by telephone, a 95 percent response was obtained from the teacher sample.

Two questions were randomly selected from each of the two tests obtained from each of the 190 respondents. Thus, 760 questions formed the state-wide question sample for the present study.
CLASSIFICATION OF QUESTIONS

A five-member panel was chosen to classify the sample test items. The requirements for participation on the panel was that each must have experience and recognition in science education and have an understanding of Bloom's Taxonomy of Educational Objectives, Handbook I: Cognitive Domain.

Each panel member was provided with a copy of the sample test items and instructed to classify each item into one of the six levels presented in the Taxonomy. The members, working individually, were instructed to classify each item into the highest level possible. Final classification of an item was made where three or more of the five members were in agreement.

Classification by Individual Panelists

An analysis of question classifications revealed that all panelists placed the great majority of questions at the knowledge level. As shown in Table 1, classification of questions at the recall level by individual members ranged from a low of 563 questions, or 74.1 percent by panelist B, to a high of 635 questions, or 83.6 percent submitted by panelist C. Other panelists classified recall questions as follows: A, 612 questions (80.5 percent); D, 564 questions (74.2 percent); and E, 601 questions (79.1 percent). Table 1 also shows that B placed 129 questions (17.0 percent) in the comprehension category for the highest percentage at this level, and C had fifty-one questions (6.7 percent) for the lowest. Panelist E classified ninety-six questions (12.7 percent) at the comprehension level, followed by D with ninety-four
Table 1

Number and Percentage of Questions Classified at Each Cognitive Level by Individual Panel Members

<table>
<thead>
<tr>
<th>Cognitive Levels</th>
<th>Panel Members</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Knowledge</td>
<td></td>
<td>612</td>
<td>80.5</td>
<td>563</td>
<td>74.1</td>
<td>635</td>
</tr>
<tr>
<td>Comprehension</td>
<td></td>
<td>75</td>
<td>9.9</td>
<td>129</td>
<td>17.0</td>
<td>51</td>
</tr>
<tr>
<td>Application</td>
<td></td>
<td>53</td>
<td>7.0</td>
<td>51</td>
<td>6.7</td>
<td>37</td>
</tr>
<tr>
<td>Analysis</td>
<td></td>
<td>18</td>
<td>2.4</td>
<td>13</td>
<td>1.7</td>
<td>32</td>
</tr>
<tr>
<td>Synthesis</td>
<td></td>
<td>2</td>
<td>.2</td>
<td>3</td>
<td>.4</td>
<td>4</td>
</tr>
<tr>
<td>Evaluation</td>
<td></td>
<td>0</td>
<td>.0</td>
<td>0</td>
<td>.0</td>
<td>1</td>
</tr>
<tr>
<td>Unclassified</td>
<td></td>
<td>0</td>
<td>.0</td>
<td>1</td>
<td>.1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>760</td>
<td>100%</td>
<td>760</td>
<td>100%</td>
<td>760</td>
</tr>
</tbody>
</table>

*Panel member D classified these questions as 1 or 2, or 1 or 3. These were considered unclassified.
questions (12.4 percent), and A with seventy-five questions (9.9 percent). The number of questions classified at the application level are shown as follows: Panelist A, fifty-three questions (7.0 percent); E, fifty-two questions (6.8 percent); B, fifty-one questions (6.7 percent); D, thirty-eight questions (5.0 percent); and panelist C, thirty-seven questions (4.9 percent).

Easily observed in Table 1 is a sharp drop in the number of questions classified at the three highest levels of the cognitive domain. Panelist C placed thirty-two questions (4.2 percent) of the sample questions in the analysis category for the highest number at this level. Panelist A judged eighteen questions (2.4 percent) in the analysis level, followed by panelist B with thirteen questions (1.7 percent), E with ten questions (1.3 percent), and D with six questions (.8 percent). Panelist C placed four questions (.5 percent) at the synthesis level for the highest number in this category, and only one question was judged to call for evaluation.

The individual panelists made specific classifications of all questions with one major exception. Panelist D failed to make specific classifications of fifty-eight items. These items are shown in Table 1 in the unclassified category.

Levels of Agreement on Question Classification

A simple majority agreement from the five panel members determined the classification of each test item. Table 2, however, shows the agreement on classifications at three levels: (1) unanimous (five-of-five); (2) four-of-five; and (3) three-of-five.
Table 2
Levels of Agreement on Question Classifications by Panel Members

*Levels of Agreement

<table>
<thead>
<tr>
<th>Cognitive Levels</th>
<th>Five-of-Five Agreed</th>
<th>Four-of-Five Agreed</th>
<th>Three-of-Five Agreed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Knowledge</td>
<td>458</td>
<td>74.3</td>
<td>128</td>
</tr>
<tr>
<td>Comprehension</td>
<td>4</td>
<td>6.1</td>
<td>24</td>
</tr>
<tr>
<td>Application</td>
<td>6</td>
<td>12.3</td>
<td>18</td>
</tr>
<tr>
<td>Analysis</td>
<td>0</td>
<td>.0</td>
<td>0</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0</td>
<td>.0</td>
<td>0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0</td>
<td>.0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>468</td>
<td>100%</td>
<td>170</td>
</tr>
</tbody>
</table>

*Twelve questions (1.6 percent of total) received less than a majority agreement from the classification panel.
Classifications of questions in the knowledge category had the highest level of agreement from the panel. Of the 617 questions classified in the knowledge level, 458 questions (74.3 percent) received unanimous agreement; 128 questions (20.9 percent) received the same classification from four out of five panelists; and thirty-one questions (4.8 percent) were classified in the knowledge category by three of the five panel members. Thus, in over 95 percent of the cases where questions were classified in the knowledge category the level of agreement among the panelists was four of five or better.

As shown in Table 2, agreement on classification of questions at the other cognitive levels was lower than at the recall level only. Four questions (6.1 percent) were judged to be in the comprehension category and received unanimous classification; twenty-four questions (36.3 percent) were classed as the comprehension type by four of the five panelists; and thirty-eight questions (57.6 percent) received a three-of-five majority. At the application level, unanimous agreement was made on six questions (12.3 percent), a four-of-five agreement was made on eighteen questions (36.7 percent), and twenty-five questions (51.0 percent) were categorized as the application type by a three-of-five majority. The fifteen questions (100 percent) placed in the analysis category were classified at the three-of-five level of agreement. Three members of the classification panel agreed on one question at the synthesis level. There were no questions recognized at the evaluation level.

Twelve questions (1.6 percent of the total sample) received less
than a majority agreement from the classification panel and were placed in the unclassified section of Table 2.

QUESTION CLASSIFICATIONS AND TEACHER VARIABLES

The questionnaires received from the state-wide sample of teachers were used to identify and separate questions on the basis of five teacher variables: teaching experience, area of certification, college degree, science teaching experience, and science curriculum used in courses (See Appendix B). Appropriate tables were used to make comparisons of the number and percentage of questions classified into each cognitive level of the Taxonomy within each teacher-variable category.

Question Types and Teaching Experience

The area of teaching experience was divided into five levels: 0-3 years; 4-7 years; 8-12 years; 13-16 years; and over 16 years. Following the final phase of classification, each question was counted and grouped into the appropriate category of teaching experience for the teacher who prepared it and the cognitive level for which it was classified. Table 3 presents the complete data on the number and percentage of questions at the various cognitive levels in each category of teaching experience. As shown, the 4-7 years category had 191 (85.3 percent) questions classified at the knowledge level for the highest percentage of items at this level. This was followed by the over 16 years group with sixty-eight questions (82.9 percent), the 0-3 years category with ninety-six questions (80.0 percent), the 8-12 years group with eighty-two questions
Table 3

Number and Percentage of Questions at Each Cognitive Level Based on Years of Teaching Experience

<table>
<thead>
<tr>
<th>Years Teaching Experience</th>
<th>0 - 3 yrs.</th>
<th>4 - 7 yrs.</th>
<th>8 - 12 yrs.</th>
<th>13 - 16 yrs.</th>
<th>Over 16 yrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cognitive Levels</strong></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Knowledge</td>
<td>96</td>
<td>80</td>
<td>191</td>
<td>85.3</td>
<td>82</td>
</tr>
<tr>
<td>Comprehension</td>
<td>15</td>
<td>12.5</td>
<td>15</td>
<td>6.7</td>
<td>5</td>
</tr>
<tr>
<td>Application</td>
<td>5</td>
<td>4.2</td>
<td>10</td>
<td>4.4</td>
<td>15</td>
</tr>
<tr>
<td>Analysis</td>
<td>1</td>
<td>.8</td>
<td>5</td>
<td>2.3</td>
<td>0</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0</td>
<td>.0</td>
<td>0</td>
<td>.0</td>
<td>0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0</td>
<td>.0</td>
<td>0</td>
<td>.0</td>
<td>0</td>
</tr>
<tr>
<td>Undetermined</td>
<td>3</td>
<td>2.5</td>
<td>3</td>
<td>1.3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>120</td>
<td>100%</td>
<td>224</td>
<td>100%</td>
<td>104</td>
</tr>
</tbody>
</table>
(78.8 percent), and the 13-16 years category with 180 questions (78.3 percent) classified at the knowledge level. The 13-16 years teachers had the lowest percentage of knowledge questions in the teaching experience category.

As shown in Table 3, teachers with 0-3 years teaching experience had fifteen questions (12.5 percent) classified in the comprehension category for the highest percentage of questions at this level. The number and percentage of comprehension questions in the other experience categories were as follows: 4-7 years, fifteen questions (6.7 percent); 8-12 years, five questions (4.8 percent); 13-16 years, twenty-five questions (10.9 percent); and over-16-years, six questions (7.3 percent).

The group of teachers with 8-12 years teaching experience contributed fifteen questions at the application level for the highest percentage (14.5 percent) in this category. The 13-16 years group had fourteen questions (6.1 percent) in the application category, followed by the over-16-years group with five questions (6.1 percent), the 4-7 years group with ten questions (4.4 percent), and the 0-3 years group with five questions (4.2 percent).

At the cognitive level of analysis, the over-16-years group contributed three questions, or 3.7 percent of their questions in this category. This was followed by the 13-16 years group with six questions (2.6 percent); the 4-7 years experience category with five questions (2.3 percent); the 0-3 years group with one question (0.8 percent); and the 8-12 years category which had none classified at the analysis level. The 13-16 years group contributed the single question classified at the synthesis
level, and none of the questions in the test sample was placed at the evaluation level by a majority of the classification panel members. However, twelve test items did not receive a majority agreement on classification from the panel. These items are presented in Table 3 at the "undetermined" level of classification.

**Question Types Based on Teacher Certification**

The area of teacher certification was divided into five levels: lower elementary, upper elementary, secondary, temporary (T-certificate--not certified), and others. The sample test items were identified and grouped in the appropriate area of teacher certification based on data from the questionnaire (See Appendix B). As shown in Table 4, test questions were further grouped according to cognitive levels within each division of teacher certification. However, later investigation revealed that the state-wide sample involved teachers in only three areas--upper elementary, secondary, and temporary certification. Therefore, all questions were necessarily grouped into those three areas in Table 4.

The upper elementary group contributed a total of 309 questions. Two hundred and fifty-four (82.2 percent) of those questions were classified at the knowledge level. In comparison, Table 4 shows that secondary teachers contributed 415 questions, of which 329 (79.3 percent) were placed at the knowledge level. Thirty-four questions, or 94 percent of those constructed by teachers with a T-certificate, were judged to be in the knowledge category.
Table 4

Number and Percentage of Questions at Each Cognitive Level
Based on Area of Teacher Certification

<table>
<thead>
<tr>
<th>Areas of Certification*</th>
<th>Lower Elementary</th>
<th>Upper Elementary</th>
<th>Secondary</th>
<th>Temporary (T-Certificate)</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0</td>
<td>.0</td>
<td>254</td>
<td>82.2</td>
<td>329</td>
</tr>
<tr>
<td>Comprehension</td>
<td>0</td>
<td>.0</td>
<td>23</td>
<td>7.5</td>
<td>41</td>
</tr>
<tr>
<td>Application</td>
<td>0</td>
<td>.0</td>
<td>18</td>
<td>5.8</td>
<td>31</td>
</tr>
<tr>
<td>Analysis</td>
<td>0</td>
<td>.0</td>
<td>7</td>
<td>2.3</td>
<td>8</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0</td>
<td>.0</td>
<td>1</td>
<td>.3</td>
<td>0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0</td>
<td>.0</td>
<td>0</td>
<td>.0</td>
<td>0</td>
</tr>
<tr>
<td>Undetermined</td>
<td>0</td>
<td>.0</td>
<td>6</td>
<td>1.9</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0</td>
<td>.0</td>
<td>309</td>
<td>100%</td>
<td>415</td>
</tr>
</tbody>
</table>

*Highest level was used where a teacher was certified at more than one level.
Secondary teachers had forty-one questions (9.9 percent) in the comprehension category, compared to twenty-three questions (7.5 percent) from the upper elementary teachers, and two questions (6.0 percent) from those with temporary certificates. The secondary group had thirty-one questions (7.5 percent) in the application category compared to eighteen questions (5.8 percent) for the upper elementary group. There were no application-type questions in the other areas of certification. At the analysis level, the secondary group had eight questions, or 1.9 percent of the total number of questions, and seven items (2.3 percent), were submitted by the upper elementary group. As noted in other sections of this paper, none of the questions was classified at the evaluation level, and only one item was placed in the synthesis category. Six test items from the upper elementary group and six from the secondary group are shown in the "undetermined" category of Table 4. These twelve questions did not receive a majority agreement on classification from the panel members.

Question Types Based on the Teachers' College Degrees

Data from each of the questions provided the information needed to identify the college degrees held by teachers in the state-wide sample. The following six levels or categories were provided on the questionnaire to insure that each teacher could adequately identify his college degree: Bachelor of Science or Bachelor of Arts, Masters (M.A., M.S., or M.Ed.), Masters + 30, Doctor of Philosophy of Doctor of Education, Education Specialist, and Others. However, later investigation revealed that college
degrees held by teachers in the sample population were confined to just four levels: B.S. or B.A., Masters, Masters + 30, and Others. Thus, as shown in Table 5, the test items were grouped under those four categories at the appropriate cognitive levels of classification.

Table 5 shows that the great majority of questions were contributed by teachers with a Bachelors degree. Of the five hundred and eleven questions that came from this group, 418 or 81.8 percent were classified at the knowledge level. Teachers holding a Masters degree submitted 176 questions of which 141 (80.1 percent) were the knowledge type. The Masters + 30 group provided fifty-three questions (76.8 percent) for the lowest percentage of questions at this level. Only four questions came under the Others category, and 100 percent of those were judged to be at the recall level. None of the questions was submitted by teachers with a Education Specialist, Doctor of Philosophy or Doctor of Education degree.

At the comprehension level, the Masters + 30 group had seven questions, or 10.2 percent for the highest percentage. Forty-five questions, or 8.8 percent of those contributed by teachers with a Bachelors degree, and fifteen questions, or 8.5 percent of those submitted by teachers with the Masters degree, were judged to be in the comprehension category. Six questions (8.7 percent) from the Masters + 30 group, twelve questions (6.8 percent) from the Masters group, and thirty-one questions (6.0 percent) from the Bachelors degree group made up the total number of questions classified at the application level.
<table>
<thead>
<tr>
<th>Cognitive Levels</th>
<th>B.S. or B.A.</th>
<th>Masters (M.A., M.S., or M.Ed.)</th>
<th>Masters + 30</th>
<th>Ph.D or Ed.D</th>
<th>Education Specialist</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
<td>Percent</td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>418</td>
<td>141</td>
<td>53</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>81.8</td>
<td>80.1</td>
<td>76.8</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Comprehension</td>
<td>45</td>
<td>15</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>8.8</td>
<td>8.5</td>
<td>10.2</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>Application</td>
<td>31</td>
<td>12</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>6.8</td>
<td>8.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Analysis</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>2.9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Synthesis</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>.2</td>
<td>.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>.0</td>
<td>.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Undetermined</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1.2</td>
<td>1.7</td>
<td>4.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>511</td>
<td>176</td>
<td>69</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 5

Number and Percentage of Questions at Each Cognitive Level
Based on the Highest College Degree Held by the Teacher
The Master's degree teachers had five questions (2.9 percent) at the analysis level followed by the Bachelors group with ten questions (2.0 percent). None of the test items was placed at the evaluation level and only one question from the total sample was classified in the synthesis category. None of the sixty-nine questions from the Masters + 30 group was classified in the levels of analysis, synthesis, or evaluation.

**Question Types Based on Science Teaching Experience**

Data from the questionnaires provided the information necessary to identify questions from teachers with various years of experience teaching science (See Appendix B). This category was divided into five levels: 0-3 years, 4-7 years, 8-12 years, 13-16 years, and over-16-years. As shown in Table 6, the number and percentage of questions from the state-wide sample were grouped under each of the five categories according to the appropriate cognitive level of classification. The over-16-years category had forty-eight out of fifty-six questions (85.7 percent) placed at the knowledge level. This was followed closely by the 0-3 years group which had 157 out of 184 questions, or 85.3 percent, in the knowledge category. The number and percentage of knowledge questions in each of the other three categories were as follows: 8-12 years group, 174 questions (80.5 percent); 4-7 years group, 186 questions (78.8 percent); and the 13-16 years group, fifty-one questions (75.0 percent). The latter group had the lowest percentage of questions in the category of science teaching experience.
Table 6

Number and Percentage of Questions at Each Cognitive Level
Based on Teachers Experience Teaching Science

<table>
<thead>
<tr>
<th>Cognitive Levels</th>
<th>0 - 3 yrs.</th>
<th>4 - 7 yrs.</th>
<th>8 - 12 yrs.</th>
<th>13 - 16 yrs.</th>
<th>Over 16 yrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Knowledge</td>
<td>157</td>
<td>85.3</td>
<td>186</td>
<td>78.8</td>
<td>174</td>
</tr>
<tr>
<td>Comprehension</td>
<td>16</td>
<td>8.7</td>
<td>20</td>
<td>8.5</td>
<td>14</td>
</tr>
<tr>
<td>Application</td>
<td>7</td>
<td>3.8</td>
<td>15</td>
<td>6.4</td>
<td>20</td>
</tr>
<tr>
<td>Analysis</td>
<td>1</td>
<td>.6</td>
<td>9</td>
<td>3.8</td>
<td>5</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0</td>
<td>.0</td>
<td>0</td>
<td>.0</td>
<td>1</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0</td>
<td>.0</td>
<td>0</td>
<td>.0</td>
<td>0</td>
</tr>
<tr>
<td>Unclassified</td>
<td>3</td>
<td>1.6</td>
<td>6</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>184</strong></td>
<td><strong>100%</strong></td>
<td><strong>236</strong></td>
<td><strong>100%</strong></td>
<td><strong>216</strong></td>
</tr>
</tbody>
</table>
Table 6 shows that eleven of the sixty-eight questions (16.2 percent) contributed by teachers in the 13-16 years category were classified as the comprehension type. In the same category, the over-16-years group had six questions (10.7 percent) followed by the 0-3 years group with sixteen questions (8.7 percent), the 4-7 years group, twenty questions (8.5 percent), and the 8-12 years group, fourteen questions (6.5 percent) for the lowest percentage in the comprehension category. In the application category, the 8-12 years group had twenty questions (9.3 percent), followed by the 13-16 years group with six questions (8.8 percent), the 4-7 years category with fifteen questions (6.4 percent), the 0-3 years group with seven (3.8 percent), and the over-16-years group with only one application-type question (1.8 percent). Only three categories in the science teaching experience area had questions on the analysis level. The 4-7 years group had the highest percentage of analysis questions with nine, or 3.8 percent. The 8-12 years group had five questions (2.3 percent), and the 0-3 years category had one item (0.6 percent). None of the questions was classified in the evaluation level, and only one item qualified for the synthesis category. Twelve questions failed to receive a majority agreement of classification. These test items are shown in Table 6 in the unclassified section.

Question Types from Users and Non-Users of Modern Science Curriculum Projects

Teachers in the sample population were identified as users or non-users of modern science curriculum projects using data from the questionnaire (See Appendix B). The names of newer
science curriculum projects were provided in section six of the questionnaire. Teachers were required to identify the program they were using in any of their eighth grade science courses by placing a check mark in the appropriate space. In section five of the questionnaire, teachers were required to respond to the question: Do you use a science curriculum developed by yourself, your local science department, or a local curriculum committee? Teachers identified as using any one of the newer curriculum projects were classified as "users". The "non-users" were identified as those teachers using a science curriculum developed by themselves or some local group.

As shown in Table 7, the great majority of teachers in the sample was classified in the non-users category. This group contained 173 of the 190 teachers, or 91 percent of those involved in the study. The large group of non-users had 581 of their 692 questions, or 84.0 percent, classified at the knowledge level. Seventeen teachers (9.0 percent of the total sample) were identified as users of modern science projects. This group had thirty-six of sixty-eight (52.9 percent) of their questions placed in the knowledge category for a much lower percentage. The users group contributed eight questions (11.8 percent) at the comprehension level compared with the non-users group which had fifty-eight questions (8.4 percent). Table 7 shows another marked difference between the two groups in the percentage of questions classified at the application level: The users had eighteen questions (26.5 percent) compared with the non-users group which had thirty-one questions (4.5 percent). A similar
Table 7

Number and Percentage of Questions of Each Cognitive Level From Users and Non-Users of Modern Science Curriculum Projects

<table>
<thead>
<tr>
<th>Cognitive Levels</th>
<th>Users</th>
<th>Non-Users</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
</tr>
<tr>
<td>Knowledge</td>
<td>36</td>
<td>52.9</td>
</tr>
<tr>
<td>Comprehension</td>
<td>8</td>
<td>11.8</td>
</tr>
<tr>
<td>Application</td>
<td>18</td>
<td>26.5</td>
</tr>
<tr>
<td>Analysis</td>
<td>5</td>
<td>7.3</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0</td>
<td>.0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0</td>
<td>.0</td>
</tr>
<tr>
<td>Unclassified</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>68</td>
<td>100%</td>
</tr>
</tbody>
</table>
pattern was observed at the cognitive level of analysis. The users had five questions, or 7.3 percent of the total questions taken from this group, classified in the analysis category. The non-users had ten questions or 1.4 percent. None of the questions was classified in the evaluation category, and only one item was identified by a majority of the panel as calling for synthesis. Eleven items in the non-users section, and one in the users section did not receive a majority classification at any cognitive level. These items are shown in the unclassified section of Table 7.

Question Types From the State-Wide Test Sample

The number and percentage of questions classified at each of the six cognitive levels are presented in Table 8. Each item in the state-wide test sample was given a final classification based upon a majority agreement from the five-member classification panel. Of the 760 questions in the total sample, 617, or 81.2 percent, were classified at the lowest cognitive level, knowledge. Sixty-six questions, 8.7 percent of the total number, were placed in the comprehension category. The number and percentage of questions classified at the higher cognitive levels were as follows: application, forty-nine questions, or 6.4 percent; analysis, fifteen questions, or 2.0 percent; synthesis, one question, or .1 percent; and the evaluation category had none. Twelve questions, or 1.6 percent of the total sample, failed to receive a majority agreement on classification from the panel. These items are shown in Table 8 at the unclassified level.
Table 8

Number and Percentage of Questions at Each Cognitive Level
From the State-wide Test Sample

<table>
<thead>
<tr>
<th>Cognitive Levels</th>
<th>Number of Questions</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>617</td>
<td>81.2</td>
</tr>
<tr>
<td>Comprehension</td>
<td>66</td>
<td>8.7</td>
</tr>
<tr>
<td>Application</td>
<td>49</td>
<td>6.4</td>
</tr>
<tr>
<td>Analysis</td>
<td>15</td>
<td>2.0</td>
</tr>
<tr>
<td>Synthesis</td>
<td>1</td>
<td>.1</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0</td>
<td>.0</td>
</tr>
<tr>
<td>Unclassified</td>
<td>12</td>
<td>1.6</td>
</tr>
<tr>
<td>Total</td>
<td>760</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Less than a majority agreement on classification at any level from the panel.

Chapter 4 contains a summary of findings and conclusions drawn from the data presented in this chapter.
Chapter 4

SUMMARY AND CONCLUSIONS

The purpose of this study was twofold: (1) to determine the mental skills emphasized by written test questions constructed and administered to students by eighth grade science teachers; and (2) to determine if there were differences of emphasis on cognitive skills in questions where comparisons were made within each of the following teacher-variable categories: (1) teaching experience; (2) area of certification; (3) college degree; (4) science teaching experience; and (5) type of curriculum used in science classes.

The study included a random sample of two hundred teachers from the total population who were teaching one or more classes of eighth grade science in the public junior high and middle schools of Louisiana. Samples of two major science tests were obtained from each of one hundred and ninety participants. Random tables were used to select two questions from each test in the state-wide sample. The participating teachers also completed a questionnaire designed to secure the information needed for comparison purposes and to identify questions based on five teacher variables.

The six cognitive levels presented in Bloom's Taxonomy of 
Educational Objectives: Handbook I, Cognitive Domain were the criteria upon which question classification were made. A five-member
panel, working individually, classified each sample test item on the basis of the highest cognitive skill observed or implied in each item and required of the student to correctly answer it. Final classification was based on a simple majority agreement from the classification panel.

**SUMMARY OF FINDINGS**

*Question classification by individual panelists.* A high level of agreement in the number and percentage of questions at each cognitive level was observed among the classifications by individual panelists. At the knowledge level, the range in percentages of questions was from a high of 83.6 percent to a low of 74.1 percent. The greatest variation in percentage of questions was found at the comprehension level. The range in percentage of questions classified in the comprehension category among the panel members was from 17.0 percent to 6.7 percent. Generally, a narrow range was found in the percentage of questions classified at the higher levels of cognition. This was shown by the following variations in percentages at each level: application, 7.0 percent to 4.9 percent; analysis, 4.2 percent to .8 percent. One question was classed in the evaluation category by one panelist.

*Levels of agreement on question classifications.* The highest level of agreement was observed in the classification of individual items at the knowledge level from the panel as a whole. The panel was in unanimous agreement on 74.3 percent of the items placed in the knowledge category; four of the five panelists
agreed in 20.9 percent of the cases; and three of the five agreed on 4.8 percent of the items to be placed at the knowledge level. Thus, at the knowledge level, classifications by four or five panelists were in agreement on 95.2 percent of the items.

A different pattern of agreement was evident in classifications at the higher cognitive levels. In the comprehension, application, and analysis categories, questions received a final classification based on a simple majority (three of five) in 57.6 percent, 51.0 percent, and 100 percent of the instances respectively. Conversely unanimous agreement was noted in 6.1 percent of the comprehension questions, 12.3 percent of the application type, and none of the analysis items.

**Question types and teaching experience.** A comparison of questions from teachers in each of the five categories of teaching experience showed no consistently wide difference of emphasis on any particular mental skill. Each group yielded high percentage of questions at the knowledge level with a range of 85.3 percent to 78.3 percent. However, in some instances noticeable differences in the percentage of questions at the higher levels were observed. In the area of comprehension, the 0-3 years experience group had 12.5 percent compared to 4.8 percent in the 8-12 years group. Yet, the 13-16 years teachers submitted questions 10.9 percent of which were the comprehension type. At the application level, the 8-12 years group had 14.5 percent, or a percentage three times that of the application questions submitted by the 0-3 years group or the 4-7 years group. Yet, the 4-7 years teachers had five questions
(2.3 percent) in the analysis category, while the over-16-years group had 3.7 percent, and the 8-12 years teachers had none.

**Question types and teacher certification.** Questions in the sample were received from teachers in three areas of certification--upper elementary, secondary, and temporary, (T-certificate). The great majority of teachers was certified at the upper elementary and secondary levels. Nine teachers were identified as holders of T-certificates.

Upper elementary and secondary teachers had similarly high percentages of questions at the knowledge level, with 82.2 percent and 79.3 percent respectively. Teachers with T-certificates showed a higher percentage with 94 percent. Among questions from secondary teachers there was a slightly higher percentage (approximately two percentage points) of questions in both the comprehension and application categories. Teachers with T-certificates did not have any questions classified beyond the comprehension level. The upper elementary group had 2.3 percent of their questions placed in the analysis category, and the secondary group had a similar percentage with 1.9 percent. The two highest cognitive levels, synthesis and evaluation, were completely neglected except for one question.

**Question types based on teachers' college degrees.** The random sample involved teachers primarily in three college degree categories--Bachelors, Masters and Masters + 30. The Masters + 30 teachers had a slightly lower percentage of questions (76.8 percent) of knowledge type questions compared to the Bachelors group.
with 81.8 percent and the Masters teachers with 80.1 percent. Percentages of comprehension questions among the three major college degree categories showed a narrow range of 6.0 percent to 8.7 percent. Close similarity in percentages of analysis questions was also evident in the Bachelors and Masters degree groups with 2.0 percent and 2.9 percent respectively. The synthesis and evaluation levels were completely neglected by all groups except for one synthesis question.

**Question types and science teaching experience.** Over 80 percent of the teachers in the sample had under twelve years experience teaching science. Questions from teachers in each of the five categories of science teaching experience reflected the pattern of great emphasis on knowledge questions found in most of the other teacher-variable areas. The range in percentage of questions at the recall level was from 75.0 percent in the 13-16 years group to 85.7 percent in the over-16-years category. Percentages in the other groups, however, were rather uniformly distributed within that range at 78.8, 80.5, and 85.3 percent. The 16.2 percent of comprehension questions in the 13-16 years category was conspicuously high compared to the 10.7, 8.7, 8.5, and 6.4 percentages in the other groups for the same cognitive level. A wide variation was found among the various groups in percentages of questions at the application level. The 8-12 years and 13-16 years teachers submitted 9.3 and 8.8 percent application questions respectively. These were followed by the 4-7 years group with 6.4 percent, the 0-3 years teachers with
3.8 percent, and the over-16-years group with a low 1.8 percent. Thus, the range in percentage of application questions was from 9.3 to 1.8 percent. The category of analysis was largely neglected except for nine questions (3.8 percent) from the 4-7 years teachers and five questions (2.3 percent) from teachers with 8-12 years science teaching experience. The areas of synthesis and evaluation were totally neglected except for a single question.

Question types from users and non-users of modern science curriculum projects. Only seventeen teachers in the total sample were identified as users of modern science curriculum projects in their teaching. However, from a percentage comparison, the data indicated a marked difference of emphasis on the various mental skills between the two groups. At the knowledge level, the users had 52.9 percent compared to 84.0 percent for the non-users. The users had 11.8 percent of their questions classified in the comprehension category compared to 8.4 percent for the non-users. A striking difference was noted in the percentage of application questions with 26.5 percent and 4.5 percent for the users and non-users respectively. A similar pattern was noted at the analysis level. The users had 7.3 percent compared to 1.4 percent for the non-users. However, the highest cognitive levels, synthesis and evaluation, were neglected by both groups except for a single question in the synthesis category.
Question types from the total test sample. Six hundred seventeen questions, or 81.2 percent of the sample test items, were classified at the knowledge level by a majority of the classification panel members. Easily observed was a drastic and continuous reduction in the number and percentage of questions in each of the successively higher levels of cognitive behavior. Sixty-six questions (8.7 percent) were placed in the comprehension column; forty-nine questions (6.4 percent), application; fifteen questions (2.0 percent), analysis; one question (.1 percent), synthesis; and evaluation, .0 percent. Twelve questions, or 1.6 percent of the total, were unclassified since they did not receive at least a majority agreement in classification from the panel.

CONCLUSIONS

An analysis of data in this study provided evidence which seemed sufficient to warrant the following conclusions:

(1) Approximately 100 percent of the questions in a statewide sample was classified by a panel of trained, objective observers when working individually and when the basis of classification was a simple majority agreement.

(2) Knowledge type questions were easiest to identify. A lower level of agreement was observed in the classification of questions at each successively higher level of cognition beyond that of knowledge.

(3) A high level of agreement was observed in the percentage of questions classified at each cognitive level by trained individuals working individually as objective observers.
(4) No consistent evidence was observed to indicate that the questions from more experienced or less experienced teachers place greater or lesser emphasis on the higher mental skills. Teachers in all categories of total teaching experience placed similarly great emphasis on the lowest cognitive level, knowledge. In isolated instances, however, questions from certain experienced groups indicated a relatively high or low percentage in a given category.

(5) Approximately four-fifths of the science test questions constructed by teachers with either upper elementary or secondary certificates required the students to exercise only the mental skill of recalling various forms of information. Further, T-certificate teachers placed even greater emphasis on memory type questions, and they neglected to employ questions beyond the comprehension level.

(6) Teachers with secondary certificates asked slightly more comprehension and application-type questions (two percentage points) than did teachers with upper elementary certification. However, science tests from both upper elementary and secondary teachers failed to challenge students at the highest cognitive levels of synthesis and evaluation.

(7) There were only minor differences in the kinds of test questions asked by the science teachers when comparisons were made of questions from teachers holding Bachelors, Masters, and Masters + 30 degrees. Regardless of college degree, teachers gave tests in which 75-80 percent of the items stress simple recall. Although there were far fewer questions at these levels,
close similarity was also observed in the percentages of comprehension and application questions from teachers with different college degrees. Further, teachers neglected the skills of synthesis and evaluation in each college degree category.

(8) Eighth-grade science teachers, regardless of the number of years they have taught science courses, employed tests in which 75-85 percent of the questions stress memory, and practically none of their questions demanded the two highest levels of cognition from the students. However, teachers in the intermediate ranges of science teaching experience (4-7 and 8-12 years) seemed to place more emphasis on application and analysis-type questions than did teachers in the 0-3 years category.

(9) Approximately 91 percent of the eighth-grade science teachers in Louisiana's public schools used a science curriculum designed for themselves or one developed by the local science department or curriculum committee. Thus, only 9 percent of the teachers used one of the modern science curriculum projects that have been recognized in professional publications.

(10) Eighth-grade science teachers who used one of the newer curriculum projects in their teaching asked more questions in the comprehension, application, and analysis categories than did teachers who used a curriculum developed by themselves or by a local group. However, regardless of the kind of curriculum used, teachers did not provide opportunities in the questions they use for their students to exercise mental skills at the highest cognitive levels.
The hypothesis of the study was accepted. However, without offering a value judgment on what percentage of questions would be considered adequate at each cognitive level, the study did show that at least some science teachers in Louisiana asked a noticeable number of comprehension and application-type questions and a few questions which called for analysis.
REFERENCES CITED

BOOKS


PERIODICALS


OTHER SOURCES


Teacher's Name
Name of School
Address

Dear (Teacher's Name):

The Science Section of the Louisiana State Department of Education, in cooperation with Louisiana State University, is very interested in a study that is being made by Mr. Guy Von Schilling on Test Questions Employed by Science Teachers in the Public Junior High and Middle Schools of Louisiana.

We are asking for your cooperation in returning the questionnaire along with tests requested by Mr. Schilling. It is my understanding that this information is needed no later than May 1, 1971.

Your consideration to this request is greatly appreciated.

Sincerely,

Stan Shaw
State Supervisor of Science and Environmental Studies

W. R. Eglin, Director
Student Teaching
Louisiana State University

Attachments: Letter from Mr. Schilling
Questionnaire
APPENDIX B

April 9, 1971

Dear (Teacher's Name)

I am a candidate for the Doctor of Education degree at Louisiana State University. One of the requirements for this degree is a dissertation. One phase of my study requires the collection of a random sample of test questions from teachers who teach one or more classes of eighth grade science. To accomplish this, I need your help on two matters:

(1) Take two different science tests that you have constructed and administered to any of your eighth grade level science classes within the past year and forward them to me in the enclosed envelope that is stamped and addressed. This should be no problem because these can be six-weeks tests, nine-weeks tests, unit tests, mid-semester (mid-term) tests, final tests, or any other tests you might have used to measure student progress over several weeks' period of time. These tests can be in any combination (i.e. two six-weeks tests, one six-weeks test and one mid-term test, two unit tests, one unit test and one final test, etc.), but each must be different. The tests can be blank extra copies you have on file or they may be used student copies with answers on them. Either type is satisfactory.

(2) Respond to the six questions on the attached sheet which is to be returned along with the tests in the enclosed self-addressed envelope.

I know you are so very busy and that you may be reluctant to release copies of your tests. However, this will take just a few minutes of your time and you can be sure that your name, the name of your school, your school system or your students will not be identified or used in any way. The tests will be destroyed unless you request they be returned to you.

I trust that you will honor this request. I must have your response if the study is to continue.

Please accept my sincere thanks for your help in this endeavor.

Respectfully yours,

Guy Von Schilling
Graduate Student
Louisiana State University
NOTE: After you have checked the appropriate space(s) in each item, please detach this sheet and return with the tests.

1. Counting the present year, how many years have you been teaching?

______ 0 - 3 years
______ 4 - 7 years
______ 8 - 12 years
______ 13 - 16 years
______ over-16-years

2. Counting the present year, how many years have you taught one or more science courses on a regular basis?

______ 0 - 3 years
______ 4 - 7 years
______ 8 - 12 years
______ 13 - 16 years
______ over-16-years

3. Place a check mark in the space by your area(s) of teaching certification.

______ 0 - 3 years
______ 4 - 7 years
______ 8 - 12 years
______ 13 - 16 years
______ over-16-years

4. Place a check mark in the space by the highest college degree you hold at present.

______ B.S. or B.A.
______ Masters (M.S., M.A., or M.Ed.)
______ Masters + 30
______ Education Specialist
______ Ph.D. or Ed.D
______ Others

5. In your eighth grade science class(s), do you use a science program developed by yourself, your local science department of local curriculum committee?

______ Yes
______ No
6. In recent years a number of new science curriculum projects or teaching approaches have been developed for use at the elementary and junior high school levels. Below is a partial list of these projects. If you have been using one of the programs in your science class(s) during the past year, please identify it by placing a check mark in the appropriate space. Use the bottom line to identify your curriculum if it is not listed.

- Earth Science Curriculum Project (ESCP)
- Elementary Science Project (ESP)
- Inquiry Development Program (IDP)
- Elementary School Science Project (ESSP)
- Elementary Science Study (ESS)
- Intermediate Science Curriculum Study (ISCS)
- Minnesota Mathematics and Science Testing Project (MinneMast)
- School Science Curriculum Project (SSCP)
- Science Curriculum Improvement Study (SCIS)
- Intermediate Physical Science
- Other project not listed (please identify by writing name of program in the following space) _______________
APPENDIX D

INSTRUCTIONS TO MEMBERS OF THE CLASSIFICATION PANEL

This is a list of questions taken through the use of random-number tables from state-wide test samples. You are to classify each question into one of the six levels of mental skills as presented in Bloom's Taxonomy: Cognitive Domain. A blank space is provided at the left of each question in which you are to place the number representing your classification according to the following scheme: (1) Knowledge; (2) Comprehension; (3) Application; (4) Analysis; (5) Synthesis; (6) Evaluation. No further sub-classification is necessary.

You are asked to determine the highest level of mental behavior to be exercised by the student in successfully answering each question. Thus, your classification is to be based on the highest mental skill that you find expressed or implied in the individual question.

The following is a brief description of the levels of mental behavior recognized by the Taxonomy.

**Level I: Knowledge.** This includes those behaviors which emphasize what a pupil remembers, either by recognition or recall of ideas, materials, or phenomena. This level is basic to working at any other level.

**Level II: Comprehension.** This level emphasizes a grasp of the meaning and intent of a "material" (i.e., a communication
in oral or written form, in verbal or symbolic form, or in concrete form). It includes a pupil's ability to translate, interpret, or extrapolate.

Level III: Application. The emphasis at this level is on the selection of an appropriate learning to solve a problem or to deal with a new situation. This area differs from that of comprehension in that the pupil must select from past learnings the appropriate understanding and process to resolve a problem when no mode of solution is specified.

Level IV: Analysis. Analysis emphasizes the breakdown of materials into constituent parts, the detection of relationships, and the organization of the whole.

Level V: Synthesis. This level emphasizes creative behavior in the organization of elements from a number of sources into a new structure. In each case of synthesis there is some new way to communicate and it is this element which distinguishes synthesis from the other levels.

Level VI: Evaluation. The evaluation level involves the making of value judgments about purposes, ideas, works, solutions, methods, materials, etc. It employs the use of criteria or standards for appraising the extent to which particulars are accurate, effective, economical, or satisfying. The judgments may be qualitative or quantitative, and the criteria may be either those determined by the pupil or those which are provided him. Evaluation is regarded as requiring to some extent all the other levels of behavior. However, it is not necessarily the last step in thinking or problem solving.
If you should have a question concerning classification procedures or the sample test items, please telephone me at one of these numbers: Home - 342-5894 or Office - 388-2760.

A reference copy of the *Taxonomy* will be provided for panel members where needed.
APPENDIX E

SAMPLE TEST QUESTIONS CLASSIFIED
AT VARIOUS COGNITIVE LEVELS BY THE PANEL

KNOWLEDGE

When gas is subjected to added pressure it becomes

What are the three basic types of soil?

What is the formula for angular momentum?

Define kinetic energy.

The first man to make a cell that produced electricity by chemical action was (a) Henry, (b) Faraday, (c) Galvani, (d) Volt.

Rocks which have been changed by heat and pressure are called (a) volcanic, (b) igneous, (c) metamorphic, (d) sedimentary.

(True-False) Green plants make their own food while animals cannot.

The lighted parts of the moon seen at different times are called ____________________________ of the moon.

(Matching descriptive phrases with one-word terms)

____________ A kind of lens that is thinner in the middle and spreads light rays.

In what direction does the current of a dry cell battery flow when the two poles are connected to a 1.5 volt lamp?
COMPREHENSION

What is the difference between reflection and refraction?

How does soil differ from rock?

According to the contraction theory, why does the earth's outer crust wrinkle?

How is wave length determined?

All of the following are solutions except (a) a dime, (b) soda pop, (c) tincture of iodine, (d) mercuric oxide.

An example of a descriptive classification is (a) a red rock, (b) a hard rock, (c) both of these, (d) none of these.

Which of the following is a scalar quantity? (a) force, (b) temperature, (c) velocity.

List the components of these compounds: Ag, NO₃, etc.

APPLICATION

Why can we say color depends on light?

An element has an electron arrangement of 2, 7. The element needs (a) 1, (b) 2, (c) 3, (d) 4 electrons to complete its orbit.

To help reduce loss by fire you should do all of the following except (a) handle fire carefully, (b) remove all fire hazards, (c) store oily rags in the closet, (d) know what to do in case a fire actually breaks out.

Why is the binary system of numbers suitable for use in electronic computers?

How many KM is it from Philadelphia to the North Pole?
Philadelphia is located 40 degrees north latitude.
Mars has an equatorial radius of 3,360 kilometers.

What is the distance of one degree at the equator of Mars?

How much work is done in lifting a five pound gas tank four feet off the ground? (a) no work is done, (b) 25 ft. lbs., (c) 15 ft. lbs., (d) 20 ft. lbs., (e) 27 ft. lbs.

ANALYSIS

Why isn't Polaris a valuable aid to worldwide navigation?

The four diagrams above illustrate the weathering process.

Which diagram or diagrams illustrate mainly physical weathering?

How is the loudness of a sound related to the inverse squared law?

The most important factor effecting the carrying capacity of a stream is the volume of water. (True-False).

The earth is like a merry-go-round because (a) it rotates on its axis, (b) the moon revolves around it, (c) it revolves around the sun, (d) it is round.

Which one of the next two statements comes closer to being a hypothesis? (a) The tires on this sting ray bicycle wear out faster because the wheels are small, (b) small tires wear out faster than large tires. Give reasons for your answer.

Why is it unlikely that the earth's kind of life exists on any of the other planets?

Give some evidence that might indicate that sedimentary rocks in mountains were once part of a geosyncline.
SYNTHESIS

Re-define your notion of an energy system then relate it to clouds.

EVALUATION

None
VITA

Guy Von Schilling was born in New Orleans, Louisiana on May 27, 1936. He received his elementary and secondary education in the public schools of Washington Parish. He graduated from Thomas High School, Franklinton, Louisiana in the spring of 1954.

In the summer of 1954, he enrolled at Louisiana State University in Baton Rouge, Louisiana. Upon the completion of student teaching in general science at the University Laboratory School, he received a Bachelor of Science Degree in Education from Louisiana State University in May, 1957.

The writer joined the faculty of Westdale Junior High School, Baton Rouge, Louisiana, in September, 1957. There he taught Biological Sciences for one year. The following year, 1958, he moved to Bogalusa, Louisiana, where he was employed to teach Life Sciences at Bogalusa Junior High School where he served as chairman of the science department for four years. He remained in that position until the summer of 1968. He was selected as Bogalusa's Outstanding Young Teacher for 1965.

During his tenure in Bogalusa, Louisiana, he served in the Louisiana Army National Guard and the United States Army Reserve. In 1964, he attended the Louisiana National Guard Officers School at Camp Bureaguard, Pineville, Louisiana. Upon graduation he received the Adjutant Generals' Sword as the
Outstanding Graduate, the Erickson Silver Trophy for Leadership, and the Scholastic Trophy for the highest grade average in the graduating class. The writer attended the National Science Foundation's Earth Science Institute at Kansas State University in 1967. He also served as Activities Director and Camp Director at the Bogalusa Y.M.C.A. for a number of years.

In June, 1968, he enrolled as a graduate student at Louisiana State University. He received a Master of Education Degree in Educational Supervision from that institution in August, 1969. In 1969, he was awarded a graduate assistantship in the Educational Media Department, College of Education, Louisiana State University. He also served as an instructor in that department, a position he now holds.

In September, 1958, he married the former Glenda Nell Branch, and they are the parents of two children, Randall Tyrone and Amy Lorraine.
EXAMINATION AND THESIS REPORT

Candidate: Guy Von Schilling

Major Field: Education

Title of Thesis: Test Questions Employed By Science Teachers In Public Junior High And Middle Schools Of Louisiana

Approved:

[Signature]
Major Professor and Chairman

[Signature]
Dean of the Graduate School

EXAMINING COMMITTEE:

[Signature]
Jesse J. Barker

[Signature]
Alain J. Bertrand

[Signature]
Berton Lemillion

[Signature]
Charles W. Roberts, Jr.

Date of Examination: April 10, 1972