

An investigation of the development of life science concepts in selected elementary school science textbooks and laboratory programs
by Rhodora Joy Kent Lucas

A thesis submitted in partial fulfillment of the requirements for the degree of DOCTOR OF EDUCATION
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Abstract:
The purpose of this study was to: examine and identify the development of life science concepts in grades one through six in selected elementary school science textbooks and laboratory programs. Specifically, the study was to investigate (a) what particular life science concepts were developed in six science programs; (b) how many life science concepts were developed in six science programs; (c) what method: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) graphic illustration with or without textual reference, captions, or labels; 5) example in the environment illustrating them, was used most frequently in the development of life science concepts in each of the six science programs. What method was second most used? third? fourth? fifth? d) What method was used most frequently in the development of life science concepts in all six science programs? What method was used second? third? fourth? fifth?, and (e) what life science concepts were developed across grade levels of 1-6 in each of six science programs? The problem was investigated by: (a) a review of literature related to the problems, (b) an investigation of the life science content of six elementary science programs, (c) a tabulation, analysis and comparison of data gathered.

The major conclusions of the study indicated that: (a) there was a marked discrepancy in the number of concepts presented in six programs; (b) methods, sentence inference and graphic illustration, were utilized highly by the writers of two science textbooks examined; (c) specific concepts in life science were omitted from at least five of the six science programs; (d) method utilization varied greatly among the six programs; (e) the method, sentence inference, was used most commonly among the six science programs; graphic illustration was used second most; example in the environment was used third; experiment demonstration fourth; and statement of concept fifth.

The major recommendations of the study were (a) personnel who are evaluating science texts for use with elementary students should be aware of the predominance of the methods inference and illustrations since present research in science teaching emphasizes the importance of the experimental method, (b) elementary school science personnel who are involved in adopting science materials should be discerning in their judgment as to the appropriateness of the number of concepts presented in a program, and (c) since the life science concept load was found to be high in science textbooks, any attempt to describe reading level of a science text should take this finding into account. Most reading formulas do not utilize concept load as a factor.

# AN INVESTIGATION OF THE DEVELOPMENT OF LIFE SCIENCE CONCEPTS IN SELECTED ELEMENTARY SCHOOL SCIENCE TEXTBOOKS AND LABORATORY PROGRAMS

by

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# ABSTRACT

The purpose of this study was to: examine and identify the development of life science concepts in grades one through six in selected elementary school science textbooks and laboratory programs. Specifically, the study was to investigate (a) what particular life science concepts were developed in six science programs; (b) how many life science concepts were developed in six science programs; (c) what method: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) graphic illustration with or without textual reference, captions, or labels; 5) example in the environment illustrating them, was used most frequently in the development of life science concepts in each of the six science programs. What method was second most used? third? fourth? fifth? d) What method was used most frequently in the development of life science concepts in all six science programs? What method was used second? third? fourth? fifth?, and (e) what life science concepts were developed across grade levels of 1-6 in each of six science programs?

The problem was investigated by: (a) a review of literature related to the problems, (b) an investigation of the life science content of six elementary science programs, (c) a tabulation, analysis and comparison of data gathered.

The major conclusions of the study indicated that: (a) there was a marked discrepancy in the number of concepts presented in six programs; (b) methods, sentence inference and graphic illustration, were utilized highly by the writers of two science textbooks examined; (c) specific concepts in life science were omitted from at least five of the six science programs; (d) method utilization varied greatly among the six programs; (e) the method, sentence inference, was used most commonly among the six science programs; graphic illustration was used second most; example in the environment was used third; experiment demonstration fourth; and statement of concept fifth.

The major recommendations of the study were (a) personnel who are evaluating science texts for use with elementary students should be aware of the predominance of the methods inference and illustrations since present research in science teaching emphasizes the importance of the experimental method, (b) elementary school science personnel who are involved in adopting science materials should be discerning in their judgment as to the appropriateness of the number of concepts presented in a program, and (c) since the life science concept load was found to be high in science textbooks, any attempt to describe reading level of a science text should take this finding into account. Most reading formulas do not utilize concept load as a factor.

# Chapter 1

## THE DEVELOPMENT OF THE PROBLEM

Prior to 1950, nationally accepted science programs in the elementary schools that emphasized the importance of student manipulation of materials were virtually non-existent. The advent of Sputnik aroused American attention to science education and the Federal Government allocated funds for the improvement of instruction and materials. By the 1960's, scientists working with science curriculum specialists developed laboratory-centered programs. These programs were activity-based and inquiry oriented (Simpson, 1974:340), and they de-emphasized the reading component. The writers of the Science Curriculum Improvement Study laboratory centered program stated that their program would develop observing, inferring, and hypothesizing students -- or scientifically literate students (SCIS, 1975).

Serious criticism, however, was soon forthcoming. In the sense that textbooks hampered the process of science, laboratory programs eliminated any knowledge beyond what was directly observable:

> Since science was only what you could observe directly, areas of potentially imaginative treatments that could transport older children intellectually out in space or deep into the ocean or back in time to the dinosaurs were gone from the curriculum (Dyrli, 1976:32).

Advocates of the laboratory programs contended that the absence of a reading component was a positive factor (Dyrli, 1976:32). He further noted that authors of these programs suggested that children who are

motivated by the science activity will also be motivated to go to a library and read eagerly. But an examination of actual library resources available to a child revealed the limited and poor quality of available materials. Dyrli (1976:32) stated that "The field abounds with hacks whose writing ineptness is matched only by their subject-matter knowledge."

Babikian, (1975:457) suggested that the advocates of the laboratory programs were being too harsh on modern science textbooks:

> Modern science textbooks portray a different picture of science, presumably a better one. They interpret science as a verb--processes of scientific investigation. Consequently, they present a variety of performance activities to inculcate skills of scientific inquiry. Students ostensibly behave as scientists while they are in school.

Advocates of textbooks acknowledged, however, that there were weaknesses in the textbook approach. Brakken (1968:95) emphasized that enthusiasm may be stifled by a textbook approach when all the students in a class are given identical pieces of textual material. Incorrect information also existed in science textbooks (Iona, 1974:53).

Partly due to some of these criticisms, science curriculum innovation took a new direction and the individualization of instruction became the most wide spread of the current innovations (Johnson, 1974:22). Individualization of instruction did not, however, demand the creation of new materials but instead required the incorporation of many existing resources. O'Toole (1968:388)

pointed out that educators could use existing elementary science programs:

> The new science curriculum study materials such as Science a Process Approach, Science Curriculum Improvement Study and Elementary Science Study, with modifications lend themselves well to an individualized approach.

Rydzewski (1974:40) suggested that individualization could also be accomplished by using components from several textbooks. He further stated that the ideal situation was one in which the teacher chooses units and or modules from laboratory programs and supplements them with parts from innovative science textbooks.

Criticism toward individualization, again, was forthcoming. Newport (1970) explicitly stated that teachers did not have the time nor expertise to develop curriculum for science programs. This task should be left to the national curriculum centers. Dyrli (1971) suggested that a school system should adopt a laboratory program, but have a critical eye toward textbook programs. This was to alleviate the difficult task of developing curriculum. Whether or not a decision was made to adopt a textbook series, a laboratory program, or an integration of both, teachers and supervisors continued to rely on already published science materials. McCurdy (1969) stressed that many teachers were not cognizant of the resources available to them. He pointed out that teachers must rely on resource units or curriculum guides in which objectives are indicated.

Even though there was disagreement among science teachers and

curriculum developers in regard to what specific materials should be used when teaching science, there was agreement among this group as to a basic goal of science education. The Curriculum Committee of the National Science Teachers Associations (NSTA) in 1964 stated that science teaching must result in scientifically literate citizens (Agin, 1974:450). In 1971, the NSTA's Committee on Curriculum Studies reiterated: "The major goal of science is to develop scientifically literate and concerned individuals with a high competence for rational thought and action" (Agin, 1974:405).

Numerous writers in the field of science (Shamos, 1963; Johnson, 1962; Hurd, 1975) have defined scientific literacy by describing the essential role of concept development. Pella (1966:206) stated that:

> The scientifically literate individual presently is characterized as one with an understanding of the (a) basic concepts in science, (b) nature of science, (c) ethics that control the scientist in his work, (d) interrelationships of science and society, (e) interrelationships of science and humanities and (f) differences between science and technology.

Authors of one laboratory-centered program (SCIS, 1975) pointed out that:

> Scientific literacy is a blend of knowledge, skills, and attitudes. . . . Content is built around major scientific concepts that lead children to a basic understanding of science.

Billeh and Pella (1972:5) viewed science ". . . in terms of conceptual schemes, each of which is analyzable into a hierarchy of concepts of

different levels of complexity, abstractness, and domain of application." The consistency of these statements emphasizes that the goal of science education is the development of scientific literacy and the content of science is built around major scientific concepts. One author, (Brakken, 1968), observed that the goal of science teaching becomes the development of the capability of conceptualization. Agin (1974:409), in agreement with the view, stated:

> The activities of science (process) are supported and nourished by previously generated concepts (product). The concepts of science--its classification, laws, theories, etc.--are generated or revised by scientific activities and become the basis for additional activities.

This idea of conceptualization has been defined by Brakken (1968:98) as children's ability to ". . . thoroughly understand an idea and communicate that idea meaningfully in their own terms." Furthermore, the up-to-date science teacher (Esler, 1973-22) intentionally provided for the development of concepts among students by 1) attempting to isolate three to five big ideas or concepts for each unit or chapter of a textbook, 2) structuring inquiry lessons to permit the children in her class to achieve understanding of the desired concepts, and 3) furnishing the children with appropriate experiences for learning the factual material of the topic. Additionally, the science teacher has the responsibility to develop concepts in two major scientific disciplines: physical science and life science (SCIS, 1975).

Walcott (1967:181) stated that biology concept development was

important in leading the child toward a greater understanding of the living world. Beauchamp and Challand (1961) noted that one step in the development of a science textbook was the determination of concepts to be included and at what grade level these concepts would be introduced. Through examination of science programs, this writer has noted differences in concepts that are developed at various grade levels. A determination of the concepts developed in specified textbooks and laboratory centered programs would help educators make decisions regarding the relative appropriateness of a specific program.

## Statement of the Problem

The earliest and most persistent forms of research in science education have been attempts to identify appropriate principles or concepts to be included in science courses (Thompson and Pella, 1972: 251). In addition, Thompson and Pella (1972) found that biology texts were the primary source of such concepts. They (1972:252) noted that:

> The fact that past procedures utilized textbooks, literature and previous studies essentially limited their scope to existing printed concepts, hindered the introduction of new concepts, and involved biased interpretations of the printed materials.

Thompson and Pella (1972:252) conducted a study wherein the design was not limited to existing printed concepts. The writers made use of scientists at the front of knowledge and educators with a variety of orientations.

This resulted in a free flow of new information, evaluation

> of each statement by panels of colleagues for precision, credibility, completeness, importance, and judgment by educators and teachers as to their importance to the education of youth (Thompson and Pella, 1972:252).

The study produced a list of 114 credible life science concepts. An important goal in the evaluation of modern elementary science programs then would be the determination of the extent to which the concepts in Thompson and Pella's study have been developed. A crucial prerequisite to the accomplishment of this would be to operationally define "development of concepts" and examine the curricula in light of such a definition. The problem of this study was to examine selected elementary science laboratory and textbook programs with regard to the operational definition for development of concepts. The determination of the extent to which science concepts are developed would be important to material publishers, national committees, curriculum supervisors, administrators, and classroom teachers. The purpose of this study was to identify the development of specific life science concepts in grades one through six in selected elementary school science textbooks and laboratory programs and determine the methodology utilized for the presentation of these concepts.

## Need for Study

Novak (1965:72) noted that "major concepts in a discipline can be interpreted as providing the principal structure for the discipline." It was pointed out in Chapter 1 that teachers relied on resource units

or curriculum guides. Therefore, the life science curriculum in a school will be the textbook or laboratory program that is adopted and will thereby provide the structure of the life science curriculum. Those who select science programs for use in schools have a serious responsibility and should make selections on sound basis. This involves being cognizant of the content (concepts) and methods (processes) utilized. "The teacher must recognize the need for and understand the generalizations prior to guiding pupils in their abstracting them (McAnarney, 1972:87).

When a teacher is aware of the concepts that are developed in a particular program this enables him or her to supplement that program with other materials or programs. For example, a laboratory program or textbook may be deficient or completely lacking in the area of health, environmental education, or a particular topic such as birds. Research in science education has revealed a trend toward supplementing present adopted science programs in school systems. This can only be done systematically and appropriately if teachers are aware of the specific concepts a program develops. Scott (1972:154) stated that our present urgency in science education is to find ways of doing this job of assimilation.

There appears to be an agreement among science educators that scientific literacy is the development of the capability of conceptualization. This involves not only the identification of concepts to be

taught but also the provision of inquiry lessons in order to permit children to achieve understanding of the concepts. McAnarney (1972:86) noted that ". . . giving attention to process actually enhances the probability of pupil success in learning concepts." Identifying the method of development of concepts in a particular textbook or laboratory program will enable the teacher to assess whether a laboratory program or textbook is concurrent with present trends in elementary science education. For example, process implies that students participate in a lesson or "act" as a scientist in solving problems. If a laboratory or textbook program presents a concept once by a statement or inference it is not particularly developing that concept in terms of present trends in science education.

Weaver (1965:378) noted that:

> As science educators increasingly seek to teach for the major principles of biology regarded as important, it is vital to discover the extent to which textbook writers are producing biology texts which stress these principles in their texts.

But there are inconsistencies in the determination of major concepts and how they are stated by textbook and laboratory program publishers. For example, the laboratory program SCIS list "life cycle" as a concept. The science textbook Science Understanding Your Environment, states the following as a concept: "Different groups of cells perform different functions." Both are examples of concepts yet very different in context. This study examined life science concepts in terms of a specific definition establishing a consistency of the term concept. It

also utilizes a list of concepts carefully generated initially by scientists in the discipline. Programs or textbook publishers will provide the consumer with scope and sequence charts, list of behavioral objectives, and specific concepts throughout the text. But this information does not identify the methods by which concepts are developed. This information is also limited in terms of the publisher's definition of concept and their pre-determined list of concepts.

Unavailable to the consumer in science programs is whether a concept is introduced at one grade level and dropped or revisited in a later grade level.

Admittedly, the development of a concept in a program does not imply that a student will master the concept.

> To be sure, understanding a given discipline requires more than memorization of statements summarizing concepts in the area; a student must discover how the concepts are derived and elaborated in order to understand the concepts and to grasp the structure of the discipline (Novak, 1965:72).

Novak emphasized discovery and understanding which implies active student involvement or methodology emphasis. Yet he stated:

> . . . in general method comparison studies (i.e., lecture only versus lecture lab) probably will not advance our knowledge of how pupils learn or consequently how to improve instruction (Novak, 1965:82).

His involvement has been centered around the need for a conceptual framework that might guide science teaching and lead to successively better development of children's understanding as they progress through

the grades (1965:73). The awareness of the specific concepts that a program develops provides a conceptual framework from which teachers and science adoption committees can make decisions.

Questions to be Answered

1. What life science concepts are developed in each of three major elementary science laboratory programs and three major elementary science textbooks according to grade level?

2. How many life science concepts are developed in each of three major elementary science laboratory programs and three major elementary science textbooks?

3. What method: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) example in the environment illustrating them; 5) graphic illustration with or without textual references, captions, or labels, was used more frequently in the development of life science concepts in each of the three major elementary science laboratory programs and three major elementary science textbooks? What method was second most used? third? fourth? fifth?

4. What method: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) example in the environment illustrating them; 5) graphic illustration with or without textual references, captions, or labels, was used most frequently in the development of life science concepts in all three laboratory science

programs and all three elementary science texts combined? What method was second most used? third? fourth? fifth?

5. What life science concepts are developed across grade levels 1-6 in each of the three major elementary science laboratory programs and three major elementary science textbooks?

General Procedures

The study was developed in the following manner. An extensive review of literature has been made to provide background for the study. From the review of literature, a list of relevant biological concepts was identified. A list of analysis criteria was identified to enable this researcher to examine the development of life science concepts in the textbooks and programs.

The researcher read and examined the life science content of three elementary science laboratory programs and three elementary science textbooks: Science Curriculum Improvement Study, Elementary Science Study, Science A Process Approach, Science Understanding Your Environment, Modular Activities Program in Science, and Concepts in Science. Each program or textbook was examined in terms of the development of life science concepts. In order for a concept to be considered as developed it must have been presented in the materials by at least three of the following methods: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) example in the environment illustrating them; and 5) graphic illustration.

From this investigation the research was able to determine how many life science concepts were developed in each program. In addition, the researcher was able to identify what concepts were developed and at what grade level. The researcher also was able to establish the method used most in elementary science materials in the development of concepts. Tables and charts were prepared to facilitate the reporting of this information.

## Limitations

The study was limited in the following ways:

1. The study was constructed to consider only three elementary science laboratory programs and three science textbook series.

2. The study was restricted to 114 life science concepts agreed upon by biologists, science educators, and secondary school biology teachers to be important for use in K-12 curricula.

3. The study was constructed to consider the development of life science concepts in only grades one through six.

4. The majority of sources for this paper were from the Montana State University Library, a personal library, other libraries through inter-library loan, and ERIC resources.

## Definition of Terms

In order to provide clarity of meaning, the following items were defined:

Biological Science. An organized knowledge about living things; includes botany, zoology, and related sciences; description of living things in terms of origin (evolution), structure (morphology), function of operation (physiology), interrelations with environmental components (ecology), and areas of specialization derived from these (Good, 1973:517).

Concept. A summary of essential characteristics of a group of ideas and/or facts that epitomize important common features of factors from a larger number of ideas.

Concept Load. Distribution of concepts within a particular passage of narrative material; a reflection of the number of ideas compressed; being an index to the difficulty and complexity of the reading material.

Examples in the Environment. The act of applying a concept to different occurrences or situations in the environment. Many times this involves solving a problem situation in the environment. For example, the concept, "Deficiencies of essential nutrients usually lead to manfunctions in organisms" may be demonstrated by withdrawing a nutrient from a live organism and noting the results. Also, it could be having a student react to an environmental picture and responding in a verbal or written form. Examples in the environment may be teacher presented or presented in the text.

Experiments. a) teacher demonstration: The trial of a

planned procedure accompanied by control of conditions and or controlled variation of conditions together with observation of results for the purpose of discovering relationships and evaluating the reasonableness of a given hypothesis (Good, 1973:227). b) Student, Laboratory: an experiment performed with apparatus either a qualitative or quantitative answer to a problem through procedures deliberately designed to produce the interaction of some agency under our control with the system or object we are studying (Good, 1973:228).

Facts--Scientific. A statement of existence or of performance that is identifiable in experience (Good, 1973:233).

Generalization--Theoretical. A statement defining the characteristic features of a given class, relations among classes, or between two or more variables (Good, 1973:259).

Graphic Materials. Instructional materials conveying meaning largely through line representations or symbols that are nearer to reality than verbal symbols, such as maps, charts, diagrams, posters, cartoons, and graphs (Good, 1973:266).

Graphic Illustration. ". . . By illustration we mean any form of exposition or elucidation. The degree it elucidates or reveals is the degree of its goodness or badness. It can exist on its own, or it may need to be amplified by words. Or it can in itself amplify a text" (Gill and Lewis, 1964:34).

Sentence Inference. . . . a collection of statements giving

conditions under which logically valid conclusions can be drawn. The act of obtaining a judgment or logical conclusion (Good, 1973:299-300).

Laboratory Method. The instructional procedure by which the cause, effect, nature, or property of any phenomenon, whether social, psychological or physiological or physical, is determined by actual experience or experiment under controlled conditions (Good, 1973:327).

Life Science. It is sometimes used synonymously with biological science (Good, 1973:517).

Statement. 1) Setting forth in words, 2) specified or said; account or declaration (Guralnik, 1964:1424).

Textbooks. 1) any manual of instruction; 2) a book dealing with a definite subject of study, systematically arranged, intended for use at a specified level of instruction and used as principle source of study material for a given course (Good, 1973:605).

Chapter 2

# REVIEW OF LITERATURE

The purpose of the review of literature was to develop a greater understanding of the nature of concepts and conceptual development. The emphasis was on defining the term concept and examining the formation of, the development of, and the need for concepts. The theories of three prominent psychologists, Bruner, Piaget and Ausubel, were reviewed. This was done to relate how children develop cognitively and the implications this has for the development of concepts in materials.

A review of science education literature revealed the role conceptual development presently has in science education. Three elementary laboratory-centered science programs and three elementary science textbooks series were investigated in terms of their objectives of science education.

Contained in the review of literature significant research regarding the inclusion of reading components and illustrations in educational materials were reported. In addition, significant research regarding the use of experiments and examples from the environment were reported in the section on cognitive development: Piaget, Bruner, and Ausubel.

## History of Science Education

The major purpose of the schools during the colonial period

(early seventeenth century to end of eighteenth century) was to teach children to read the Bible in order to prevent their eternal damnation (Hillway, 1964:5). During the national period (nineteenth century) the primary purpose of education was to instill in the student a feeling of national pride (Tyack, 1967:85). There was no need for analytical thinking. Knowledge was derived from already accepted conceptual schemata. Not until the latter nineteenth century did Harvard accept science courses as a pre-requisite to entrance in their college. Not until the latter nineteenth century was attention given to include science as part of the elementary curriculum (Ebel, 1969:1193). In 1893, the Committee of Ten established that the elementary curriculum would include nature study (Ebel, 1969:1193). It would draw subject matter from the botany and zoology disciplines. The approach to teaching science from 1850 to 1879 was factual and environmental; from 1880 to 1899 the approach was factual and practical (DelDiorno, 1969: 192). The following is taken from the book Nature Study for the Common Schools, written by Wilbur S. Jackman in 1891. It emphasized the importance of the inclusion of well-planned lessons:

> Science teaching for a few years past has been gradually working itself downward from the colleges and high schools into those of lower grades, but, in most cases, the plans followed, while fairly well adapted to the demands of advanced pupils, have been but poorly fitted to the needs of beginners.
>
> It is not intended that the science work outlined in the following pages should be incidental, as ordinarily understood, but that it shall be assigned a regular place in the daily programme with other lessons. Regularity and frequency of the

> exercises are of primary importance, while the absolute amount of time devoted to them is secondary.
>
> By 'lessons' it is meant that at regular times in general exercises the results of the pupils' observations will be gathered at such time general experiments may be performed or other observations made (Jackman, 1891:iii-1).

Until 1930, the purpose of elementary science was to instill in the child an aesthetic value and moral commitment to his world (Ebel, 1969:1193). Science was not a subject but an attitude. The curriculum was a direct result of the massive urbanization that was occurring in America. The schools hoped to instill the desire for future Americans to turn to farming and rural living. DelGiorno (1969:192) labeled this period (1900 to 1919) as a useful and descriptive approach to science teaching. Trofton (1918) suggested that the term science be used in place of nature study. The theme of practicality was quite obvious in his article:

> The part that science plays in modern life is so vital that the science teaching must inevitably have an important place in the school curriculum. There has been some confusion regarding the term to be used to cover the work in science in the elementary school. 'Nature-study' has been the word in most common usage. But there is considerable misunderstanding as to what is included under this term. In recent years it has been used in an ever-broadening sense till now the word is used by many educators to include all phases of science adapted to the elementary school. . .
>
> It is a fundamental principle of teaching that the child should be educated in terms of his environment. His daily life is to be the guide for the school. The underlying reason why the child needs science is because science plays such a vital part in his everyday life. This is a scientific age, when science dominates our life; and it will continue to dominate it with ever-increasing power in the future. In order that the child may play his part efficiently in this scientific environment, it is necessary that he should be educated regarding it in the schools (Trafton, 1918:vii-4).

Between the years 1925-1935, science and technology became synonymous (Ebel, 1969:1193). The purpose of education was for the student to recognize the impact science was having on their lives. The approach to science teaching was technical and personal (DelGiorno, 1969:192).

From 1930 to 1950, the purpose of science education was primarily based on the writings of Dewey. Dewey emphasized the fact that "It is not whether the schools shall or shall not influence the course of future social life, but in what direction they shall do so and how" (Dewey in Rich, 1966:109-110). Dewey pointed out that the manner in which they exercise their influence will result in different ends:

> Educators may act so as to perpetuate the present confusion and possibly increase it. That will be the result of drift and under present conditions to drift is in the end to make a choice. Or they may select the newer scientific, technological and cultural forces that are producing change in the old order; may estimate the direction in which they are moving and their outcome if they are given freer play, and see what can be done to make the schools their ally. Or, educators may become intelligently conservative and strive to make the schools a force in maintaining the old order intact against the impact of new forces (Dewey in Rich, 1966:110).

In 1932, the National Society to Study Education stated in their yearbook that generalizations rather than facts were the content of science (Ebel, 1969:1193). In 1938, the Progressive Educators Association introduced social utility as the underlying theme to prevade every content area. According to Dewey, subject matter was

variable, but scientific method and social cooperation were constants. Problem solving teaching was considered innovative and expository teaching was considered disasterous. The six steps of scientific investigations were emphasized (Ebel:1193). As early as 1937, concern for the development of concepts was emphasized--but as a basis for social thought:

> In spite of the fact that science exerts an almost overwhelming influence in our lives, elementary education has taken little notice of it. Children are growing up to play new roles without understanding. They are not introduced to science as a way of life and to its external manifestations. The obligation of the schools to bring to the masses the greatest of all the contributions of science--a method of thought and approach--is not being realized. If we consider other desired outcomes of education in science at the elementary level, we find little more cause for satisfaction. . .
>
> We cannot stop at glibly reciting the general aims of education. Neither can we longer credit science education with accomplishing a host of obstruse ends. If our science program in the schools is to be effective, we must know definitely what we are trying to accomplish and must set about directly to achieve it (Croxton, 1937:37-38).

During the 1950's some thoughts began which still prevail in the 1970's. The contributions of scientists had erased the magic and invisible spirits of science. An attack on the science-technology ideas was begun. Nevertheless, the struggle for the development of a scientific literate people continued. Blumenfeld (1974:86) found cause to criticize the science of the 1950's:

> 1) Science was being taught predominantly through technological application, 2) Science courses were predominantly fact-oriented, 3) Science courses did not develop unifying concepts, 4) Laboratory work was not open-ended, that is, not inquiry-

oriented, and 5) Modes of instruction were authoritarian, primarily teacher-centered.

It was in this decade that scientists and science educators recognized the importance of science education in helping a student understand science, in relation to himself, his society, and his natural environment (Ebel, 1969:1194). This implied more than the mastery of facts but an insight into the relationship of facts. Blough and Huggett (1951:12-17) emphasized this philosophy in an excerpt from their text Science for the Elementary School Teacher:

> Traditionally we seem always to ask first what subject matter children should learn in science. There is no question that the subject matter of science is important. We do need persons who are well informed about the world in which they live. An informed person is likely to be an interesting one, we should probably agree. But let us not consider a person educated scientifically just because he can tell us how many legs a cricket has, knows that a pair of pliers is an example of a first-class lever, recognizes a tufted titmouse when he sees one, or can define chemical change. The facts of science are important, but how these facts are put together into meaningful ideas is far more important. We say, then that the study of science should help girls and boys come to know some generalizations or big meanings or science principles which they can use in solving problems in their environment.
>
> We also say that a study of science should help pupils to grow in ability to solve problems effectively.
>
> We also say over and over again that the study of science should develop in children a scientific attitude.

It was not until the early 1960's that science educators initiated the first concentrated effort to improve science education. Millions of dollars were spent in bringing together outstanding psychologists, scientists, and educators to create several curricula

(Simpson, 1974:340). Three of the prominent curriculum projects--Science--A Process Approach (SAPA), Elementary Science Study (ESS), and Science Curriculum Improvement Study (SCIS) emerged during this time. Simpson, in an examination of the three programs, noted that all three programs emphasized:

> (i) discovery of fundamental concepts in science, (ii) development of scientific processes, and (iii) stimulation and curiosity in science. All three programs are activity-based and inquiry-oriented (1974:340).

The National Science Teachers Association Curriculum Review Center at the University of Georgia revealed that textbooks were concerned with the development of concepts and processes (Science and Children, 1977:36).

The interpretation of how to develop a scientifically literate citizenship in terms of science teaching, has recently brought about statements concerning appropriate strategies of teaching. Collins (1972:34) suggested rejecting nationally developed curriculum because it 1) was rigid in approach, requiring same activity of all students; 2) did not meet needs of a specific school; and 3) was an expenditure of large sums of money. Donovan (1976:34) suggested that activity-oriented science programs demanded an inordinate amount of preparation time. Riechard (1976:303) noted that there has not been any major increase in classroom adoption and use of new elementary science projects. He further noted that the new science project

materials and ideas have been incorporated into individualized school science curricula. New science lives on "not so much in terms of vitality of individual projects but in the legacy of knowledge, attitudes, and influence they have contributed to elementary science" (Riechard, 1976:304).

O'Toole (1968) listed seven science educators who were presently developing individualized science programs. He noted that regardless of what approaches and ideas were used, the teacher found a greater need for a wide range of materials and equipment, more time for planning instruction, and a higher degree of organization. Rydzewski (1974:40) stated that in an individualized approach to science teaching, teachers "cut across lines to show biological, physical, and ecological aspects of the concepts developed. Scientific literacy and unity result." She listed better classroom presentations, fulfillment of student needs, and the consideration of the financial aspect of purchasing textbooks as some of the advantages of an individualized approach to science teaching.

Akenson (in Kuhn, 1973:350) in a paper presented to the National Social Studies Convention in New York stated:

> History must not record that science teachers ignored the value issues and stuck to facts and concepts. To do so would be to remain crudely prescientific and prevent us from having a future at all.

Simon (1968) emphasized the urgent need to make subject matter more relevant; relevancy meant that the subject matter illuminated student's

values. Blumenfeld (1974:87) noted that the findings of the 1970's President's Task Force on Science Policy indicated that the citizen's confidence in science has eroded in part because of a lack of understanding concerning how science improves the quality of their lives. Hurd (1975:27) suggested that conceptual bridges are needed to connect the natural sciences and social sciences. He noted that "while science does not directly improve values, it creates conditions which demand the reinterpretation of old values or the formation of new ones" (1975:28). Hurd summarized:

> Science provides knowledge; technology provides ways of using this knowledge and our value concepts guide what we ought to do with both (1975:29).

Kuhn (1973:350) echoed Hurd's words in his statement:

> An understanding of appropriate science concepts and processes provide a sound undergirding for our values. But instruction in processes and concepts regardless of its pedagogical soundness, will not clarify student values.

Kuhn cited an example of using values in instruction:

| Fact Level (Ecology) | Concept | Values |
|---|---|---|
| 1. What is a herbivore? | 1. population | 1. Do you feel population growth should be halted? What means would you advocate? |

Kuhn noted some value games--The Pollution Game, The Redwood Controversy and programs--Man and the Environment, Environmental Studies, that have been developed in order to develop skills in the use of the valuing process.

Regardless of the strategies for science teaching, there existed an underlying message in the seventies: to examine closely underlying principles that give structure to a subject (Blumenfeld, 1974:86); to establish a teacher oriented educational environment (Blumenfeld, 1974:89); to not only inform the learner of underlying principles and processes in a discipline but also give him some of the "flesh" of the discipline, i.e., some of the important information and subordinate ideas which the person should acquire to be considered knowledgeable in the discipline (Kuhn, 1972:189).

Kuhn noted that a review of curriculum patterns in science revealed a cyclic pattern. He suggested that ". . . it is essential that science teachers transcend periodic change; one that relates pedagogy to the nature of concept formation and learning theory" (1972:189). Cooley (1961:384) emphasized the importance of examining conceptual learning in children:

> Another basic difficulty is that we often attempt to attack our issues or problems head on without sufficient attention to the framework underlying them. We ask specific questions such as whether or not the laboratory experience should precede, or accompany or follow class discussions. . . rather than ask questions about how children learn science concepts. Our behavior is somewhat like that of the alchemist who wanted to turn lead into gold. All their time and energy was expended on repeated head-on empirical collisions. Today, by making use of the knowledge about the nature of matter, the alchemist dream is quite feasible. Similarly our own advances in science education will not come from a direct attack upon the obvious issues and problems, but by slowely teasing out more basic relationships which will become useful, general operating principles.

Ehrle (1971:22) in a speech delivered to science educators, feared that educators will not listen to the message of the seventies:

> Many will read the new books, hear the new message, but follow the ostrich. With their head securely buried in the content of one subject or another, they will continue to treat the symptoms rather than the disease.

Gerald S. Craig (1972:1-2) in an excerpt from the fourth edition of his text Science for the Elementary School Teacher, identified his priorities for science education:

> It is easy for the specialists to become enamored of their own special fields, and to lose sight of the learner. But the elementary school, with its great purpose, is no place for the specialist to 'strut' his specialization. Rather it is an institution in which a specialist must walk in true humility, for he has been permitted to live with, to teach, and to learn with children--the adults of tomorrow.
>
> The question in the study of the curriculum can never be, 'What is best for science?' Rather the question must be 'What is best for children?' The teacher must recognize always that children are greater than science.
>
> Science in elementary education should be considered from a developmental point of view--a point of view that is sound both with regard to the fundamental nature of children and that of science. The fundamental characteristic that is common to both children and science is that both are actively involved in interpreting the objects and events of the environment.

Kuhn (1972:195) emphasized the need to look at the total process of learning when he summarized that one should consider the stage of the intellectual development of the learner, the objective of instruction and the content, techniques, or science processes to be acquired. He further stated that "Cognitive learning theory affords the best type of viable vehicle for marked improvement of the teaching-learning

process" (Kuhn, 1972:195).

Concepts

Contemporary efforts have redefined knowledge in terms of emphasis on basic concepts and methods which scholars use as intellectual tools to analyze and order their data (Bellack in Rich, 1966:260). Bruner (1962:120), a leading psychologist primarily responsible for introducing the concept of structure into education stated:

> Knowledge is a model we construct to give meaning and structure to regularities in experience. The organizing ideas of any body of knowledge are inventions for rendering experience economical and connected. We invent concepts such as force in physics, the bond in chemistry, motives in psychology, style in literature as means to the end of comprehension. . . . The power of great organizing concepts is in large part that they permit us to understand and sometimes to predict or change the world in which we live. But their power lies also in the fact that ideas provide instruments for experience.

Since this redefinition of knowledge, numerous terms have arisen that have been used interchangeably all denoting the same meaning as concept: conceptual scheme, theme, organizational thread, major generalization, major concept, major principle, and fundamental idea are examples of some of these terms (Kuhn, 1972).

The learning of concepts was noted as an important educational objective at all school levels (Klausmeier and Ripple, 1971). Teachers, curriculum experts, and the designers of instructional materials have been involved in identifying the concepts that students may learn as they progress to higher levels and as they work on the development of

materials and procedures to teach concepts.

Novak (1965:72) stated that "concepts in science are broad generalizations regarding some aspect of the physical or biological world." Pella (1966:31) noted that "concepts are important not only because they are the warp and woof of science, but also because they provide the possessor with a means of coping with the development of knowledge in the future."

Gallagher (1971:330) stated that if concept learning occurs, it will provide the learner with tools for better understanding of their natural environment, a manifold gain in intellectual economy similar to that which results from organizing facts into concepts, and an insight into the nature of the scientific enterprise, in terms of its continual movement toward increased abstraction and generality. Arnone (1971) noted that concepts are essential for comprehension, are shortcuts to communication, are aids in the transfer of learning, and are promoters of recall.

Cognitive Development: Piaget, Bruner, Ausubel

In recent decades several psychologists have studied how students learn concepts. One of the most influential theorists of intellectual development was the Swiss psychologist Jean Piaget (Klausmeier and Ripple, 1971:405). Piaget identified qualitative changes that occur in cognitive development from infancy to maturity.

Changes were heavily dependent on maturational factors (Klausmeier and Ripple, 1971:431). According to Piaget, processes were divided into four stages. Although each stage is defined within age ranges, this does not bind one age with one group. Cognitive development is continuous and a child may progress or remain in one stage regardless of chronological age. Piltz and Sund (1974:43) reported that a child from a high socio-economic background may evolve through the four stages more quickly, while a child from a lower socioeconomic background may be slower. The National Assessment of Educational Progress stated

> If the young American parents did not have the advantages of much education. . . or if he the child lives in the inner city. . . or if he is black. . . he, or she, as the case may be, knows less about science than the nation as a whole (Piltz and Sund, 1974:43-44).

Throughout a child's life, he is constantly assimilating data from the world around him, accommodating to the world around him, and organizing his experiences and knowledge in a structure (Klausmeier and Ripple, 1971:407). Piaget calls this process of organizing one's own intellectual development equilibration. This organized system is constantly changing, growing and reorganizing as the child assimilates and accommodates new experiences. Maturation and direct teaching by people are important in this organizing process.

The four main stages of intellectual development that operates as he organizes this system are 1) Sensori-motor; 2) Preoperational; 3) Concrete operations; and 4) Formal Operations (Klausmeier and

Ripple, 1971:407-413).

The sensorimotor period occurs in the first two years of the child's life. During this period the child progresses from a "reflex stage in which he and the world around him are entirely undifferentiated: to a point that "physical responses are sufficiently coordinated so that the child begins to smooth out sequences of physical motion" (Klausemier and Ripple, 1971:407). Around the ninth month a child begins to view the world as a relatively permanent place (Piltz and Sund, 1974:42). He beings to realize that an object such as a ball may continue to exist even if it is removed from his vision. He begins to use simple means to get to an end such as pushing a door to get from one room to another.

The pre-operational stage (ages 2-7) is a transitional period where the child continuously adds to his repertoire of labels and names for objects. He beings to "form ideas of the sameness of things and to make some general categories of objects. Also, the child begins to form gross relational concepts such as bigger, older, taller, and too much" (Klausmeier and Ripple, 1971:408). A child at this stage is still operating on perceptual experience rather than logical thinking to judge relations. For example, a child will agree that two balls of clay are equal in amount. When one ball of clay is formed into the shape of a donut, the child will change his mind and state that there is more clay in the solid ball. Conceptual thinking,

stated Piaget, lies in the "construction of mental images and symbolic processes" (Klausmeier and Ripple, 1971:409). Constructing mental images is an internal process. Images at this stage are quite specific, i.e., a boy who picks up his toy lunch box for work. Piaget felt that just because a child may use a specific word at this stage it does not indicate conceptualization has occurred. A car may stand for any moving vehicle. Lahedeme (1968) found in a survey that children when asked for explanations of science concepts, knew the "right" words to use but the words were meaningless to them. At this stage the child cannot consider more than one characteristic of an object at one time. A bead may be brown or white but not wooden and brown or wooden and white.

During the third stage, concrete-operational (7-11 years) the child begins to form mental operations and becomes more logical in his thought processes (Sund and Piltz, 1974:41). He begins to consider consequences of his actions. Toward the end of this period he understands conservation principles (i.e., clay ball), concepts of time, space, quantity, and number (Klausmeier and Ripple, 1971:410). For example, a young child at stage II believes there are more marbles in a cluster if they are spread further apart. A child at stage III realizes just because they are further apart does not make any difference concerning number of marbles. However, a child at this stage is still limited mainly to concrete objects, things he can perceive and manipulate (Klausmeier and Ripple, 1974:413).

The most advanced stage, formal operations (11-15 years) is the period of development of abstract and reflexive thinking (Sund and Piltz, 1974:41). Children improve their problem-solving and scientific reasoning abilities. They no longer rely on concrete objects but are capable of conceiving possibilities existing only in the mind.

> In other words, the adolescent is now carrying out hypothetical thinking in which he can mentally (without relying on real world representations) consider all possibilities or combinations, hypothesize the results, and establish an organized and logical sequence of procedures (Klausmeier and Ripple, 1971:413).

Based on Piagetian theory Piltz and Sund (1974:45) suggested that two general principles should be abided by:

> 1. In the elementary school, children should be often involved in learning through physical (concrete) involvement. This is particularly true in science. They can learn best about magnets, sound, or seeds by being actively involved with them. Through such involvement they develop mental actions and operations. Piaget says the basis of all learning is experience. In this he includes both physical and mental experience.
> 2. Only the child himself can develop his cognitive abilities and creative potential--he cannot be told to order but must be involved in activities that give him opportunities to place things in order so that some day he will be able to order things in his mind without manipulating them physically.

Piaget's theories have been tested and retested in scientific research. Not all research has been in agreement. Novak (1975:560) stated that studies done by the Research and Development Center at the University of Wisconsin indicated students can acquire simple and asbtract concepts at ages younger than would be suggested from narrow interpretations of the work of Piaget and co-workers.

Bruner and Piaget closely approach each other theoretically as they trace changes in the conceptual development of children. Bruner and Piaget's theories correspond in that both have determined stages through which a person progresses. Bruner (Bruner, et al., 1966:6-7) stated "We can talk of three ways in which somebody 'knows' something; through doing it, through a picture or image of it, and through some such symbolic means as language." Bruner's three stages are enactive, ikonic, and symbolic (Klausmeier and Ripple, 1971:416). The enactive stage corresponds to Piaget's sensorimotor stage. The person is involved in doing something. The ikonic stage corresponds to Piaget's pre-operational stage where learning occurs by seeing a picture or image of something. Piaget's concrete and formal stage are represented by Bruner's symbolic stage where learning occurs through symbolism such as language. Bruner and Piaget's theories differ as to how and when a person progresses through these stages. Piaget asserts that a child moves from one stage to another. Bruner feels a child can operate at more than one stage at a time. He states "that human beings represent experiences enactively and ikonically throughout their lives, not just during certain earlier years or stages" (Klausmeier and Ripple, 1971: 416).

Bruner's learning theory may be described as a theory of conceptualization (Lefrancois, 1975:90). He prefers to refer to conceptualization or the process of thinking as categorization.

Categories and concepts, according to Bruner are synonomous (Lafrancois, 1975:9). By definition, a category is a representation of objects or events that have similar properties. If two objects are put in the same category this implies that there are similarities between them.

> To categorize is to render discriminably different things equivalent, to group the objects and events and people around us into classes, and to respond to them in terms of their class membership rather than their uniqueness (Bruner, et al. 1958:1).

Bruner also distinguished between attributes and values within a category.

> An attribute is a property or characteristic of an object or event. . . . values are the variations that are possible for an attribute (Lefrancois, 1975:90).

Bruner assumed that interaction with the world always involves categories (Lefrancois, 1975:91). Bruner described what role categorization plays in this interaction process. Categorization reduces the complexity of the environment. Secondly, it permits the recognition of objects. Bruner emphasized that an object is recognizable because it is "like" other objects. Thirdly, it reduces the necessity for constant learning. This reduction in constant learning permits an individual to go beyond information given. It involves recognition of an object by its similarities among other objects not just information received from the object itself. When an object is placed in a category, inferences can immediately be made about that object. Fourthly, categorization provides direction for instrumental activity.

This simply means that recognizing an object as a shoe dictates what you will do with it. And lastly, categorization permits individuals to relate objects and classes of events (Lefrancois, 1975:91-93).

Bruner saw man growing by the "process of internalizing the ways of acting, imaging, and symbolizing that exist in his culture" (Bruner et al, 1966:320-321). His growth will depend on the nature of his life and the demands placed on him. Therefore Bruner placed a heavy emphasis on the role of schooling (Klausmeier and Ripple, 1971:419). He felt children could learn content at an earlier age if it were experienced nonverbally. ". . . Bruner's viewpoint has led to an increase in the attempt to use nonverbal or nonsymbolic instruction to teach concepts to children at a younger age than previously" (Kalusmeier and Ripple, 1971:419-420). Therefore Bruner is an advocate of discovery learning or "learning that takes place when the student is not presented with subject manner in its final form, but rather is required to organize it himself" (Lefrancois, 1975:121).

Another theorist, Ausubel, is also concerned with the organization of cognitive material that have specific educational implications. Bruner supported discovery learning or learning where the teacher does not present materials in any final form. Ausubel's theory dictates different implications for teaching than Bruner's. He contended that reception learning, or learning "where the content of the learning task (what is to be learned) is presented rather than

independently discovered by the learner" (Novak, et al, 1971:484), is the dominant form of learning in schools; therefore, we should be concerned with how we can make this learning more meaningful.

Ausubel stated that a concept acquires real or psychological meaning when it is equivalent to an idea that is already present in the mind (Lefrancois, 1975:97). It is therefore necessary for a learner to already possess something (or a cognitive structure) in his consciousness in order for a concept to have meaning.

Aspects of Ausubel's cognitive structure are also important in the consideration of concept development. Ausubel (Lefrancois, 1975: 97) viewed the cognitive area as consisting of organized and stable concepts in a learner's consciousness. The organization of these concepts is hypothesized as being hierarchial with the most "inclusive concept at the apex and the more specific concepts at the base" (Lefrancois, 1975:97). "Ausubel contends that material is ordinarily organized from the apex downward--that is from the most inclusive to the most specific" (Lefrancois, 1975:97). One may see that this view supports the principle that instruction should begin in a general way and move to specific details. This is in contradiction to Bruner and Piaget's claim that a student should be presented specifics first.

Some specific terms that Ausubel employed include subsumer and subsumption. A subsumer has been defined as a concept but the term includes a concept which incorporates or includes other concepts.

Ausubel then defined learning and forgetting in terms of a process that is labeled subsumption (Lefrancois, 1975:88-89).

> Concepts can be related to each other or to some larger concept. For example, the concepts of mass and force can be related to acceleration. As a learner acquires new knowledge, prior concepts can be gradually subsumed into larger, more inclusive concepts. . . . This hierarchial subsumption process increases further the facility with which new knowledge bits result, subconcepts may become progressively less dissociable as distinct entities (Novak, et al, 1971:485).

Ausubel (Novak, et al, 1971:484) made a distinction between two kinds of learning: rote reception learning and meaningful reception learning. In the former, ". . . new knowledge learned is not associated to form some kind of conceptual base or is not associated with prior concepts. . ." (Novak, 1971:484). In the latter, ". . . new knowledge is associated with ideas or concepts in the learner's cognitive structure" (Novak, et al, 1971:484). Novak, et al (1971:484) stated that Ausubel directs his attention to the planning of instruction so that new material can be learned meaningfully. "For young learners, e.g., elementary school pupils, new learning may be rote until enough information is acquired that subsuming concepts can be formed" (Novak, et al, 1971:486). This new information is called advance organizers. "Organizers are introduced in advance of the material to be learned and are presented at a higher level of abstractness, generality, and inclusiveness than the content to be learned" (Novak, et al, 1971:486). Ausubel also contended that high ability students can provide their

own subsumers whereas low ability students rely on the ordering presented in the instruction (Novak, et al, 1971:490).

Novak, Ring and Tamir (1971:500) found in their analysis of available studies in the field of science education that the following hypotheses (which were formulated on the basis of Ausubel's theory) could be supported:

> (1) Degree of existing knowledge of subject matter at one level of educational attainment influences performance at subsequent educational levels.
> (2) General ability, personality, and interest measures as well as biographical data are less effective predictors of academic success than specific (index of relevant cognitive structure) measures.
> (3) Predictive validity of educational attainment decreases as the lapse of time between the two levels of related learning increases.
> (4) In most cases pre-tests have little predictive validity of academic success since they fail to reveal the potentialities of cognitive structure.
> (5) Prior learning is beneficial to the extent it builds subsuming concepts and that the new learning draws upon these concepts.

Programs

In the last two decades three prominent curriculum projects, Science Curriculum Improvement Study (SCIS), Science a Process Approach (SAPA), Elementary Science Study (ESS), have evolved which actively addressed the relationships between science teaching and learning theory (Simpson, 1974:340). In regard to SCIS, ESS, and SAPA, Simpson (1974:340) stated that "some of the most sophisticated and exciting pedagogy found anywhere lies in these three programs". Elementary

teachers are very interested in the abundance of activities that relate to biology; secondary teachers can glean numerous creative ideas to the teaching of biology from these programs; and college teachers in biology "should be familiar with the content and processes of these elementary curricula" (Simpson, 1974:340).

Under the direction of Robert Karplus, a theoretical physicist, SCIS was begun at Berkley, California in 1962 (Stefanich, 1973:21). Learning, in the life science program, progresses from simple concepts, laboratory observations, and manipulation of materials to more complex concepts and generalizations (Educational Product Report, 1971:6). Each year builds on the experiences of the previous year. By providing the elementary student with a "tangible biological framework" in which to work, they will be able to better analyze complex and precise processes of life in their high school courses (Simpson, 1974:342). Following is the structured sequence of life science topics in SCIS:

| | | |
|---|---|---|
| Organisms--Level 1 | | |
| Organism | Death | Food web |
| Birth | Habitat | Detritus |
| Life cycles--Level 2 | | |
| Growth | Genetic identity | Plant and animal |
| Life cycle | Generation | Metamorphosis |
| | Biotic potential | |
| Populations--Level 3 | | |
| Population | Community | Food chain |
| Predator | Plant-eater | Food web |
| Prey | Animal-eater | |

Environments--Level 4

| | | |
|---|---|---|
| Environment | Range | |
| Environmental factor | Optimum range | |

Communities--Level 5

| | | |
|---|---|---|
| Producer | Photosynthesis | Food transfer |
| Consumer | Community | Raw material |
| Decomposer | | |

Ecosystems--Level 6

| | | |
|---|---|---|
| Ecosystem | Oxygen--carbon dioxide cycle | |
| Water cycle | Pollutant | |
| | Food-mineral cycle | |

(Simpson, 1974:342).

In Unit one by observing aquariums with different organisms the students draw conclusions concerning basic processes necessary to maintain an ecosystem. In Unit two, students study individual lives of plants and animals. In Unit three they study populations of organisms. This enables them to understand the relationships of organisms to the physical environment contained in Unit four. During Unit five they study the nature of operations of biotic communities. Unit six is the culminating unit--the ecosystem. This concept represents the major direction of the content (Simpson, 1974:342); "all the experiences of the first five years repeated and integrated into the conceptual scheme of the ecosystem" (Lawson, 1975:277).

Subsequent to joining the SCIS project in 1965 Lawson (1975: 277), a biologist from Michigan State University stated:

> As I understand the SCIS program, the intent is to help the child to develop literacy in science; to become knowledgeable in the area of science; and to appreciate the viewpoint of the

> scientist. This task is to be achieved by creating situations where the child, through his own observation and response, discovers the concepts. The child is not told directly, but rather is to be led step by step along the path of discovery.
>
> To achieve this goal, the teacher needs to know first exactly what concepts he wants the child to learn. Secondly, he needs to structure the child's experience so that, given a normal child, the child will observe (perceive) the significant relationships and be able to develop the proper ideas from them.

Two directions were utilized in developing materials (Lawson, 1965:185). The first direction consisted of laboratory testing the materials and a second crucial strategy involved taking the materials to students in elementary classrooms. Their reactions to the materials resulted in alterations which shaped the final units of study.

A three-phase teaching strategy--exploration, invention and discovery--is utilized which enables students to carry out their own investigations:

> By explorations we mean the initial direct physical and mental contact with the natural world. This experience is essential if something more than verbal behavior is to be learned. If real understanding is to be achieved, real contact with the world has to be provided. An example of exploration was the observation of fresh water and marine aquaria, the investigation of the stuff on the bottom of the aquarium, and the resultant recognition that some organisms live in fresh water and others in salt water. After this the teacher invented the concepts 'habitat.' Sometimes after the invention of a new concept, the teacher presents new and different examples of the concept. These are discovery lessons. From the new examples the child is expected to recognize that the new concept has applications to situations other than the initial one. The discovery experiences reinforce, refine, and enlarge upon the content of the concept (Lawson, 1975:280).

The life science program in SCIS consists of six units for grades one through six. The program takes advantage of the natural

attraction of students to organisms by using live organisms throughout the six units (Cunningham, 1966:181). Students also go outdoors during their course of study to observe the diversity and interactions of plants, animals, soil, atmosphere, and sun.

A second lab program, Elementary Science Study, was initiated in Cambridge, Massachusetts, 1960, under the direction of Christopher Hale (Piltz and Sund, 1974:132). Since the beginning of the project hundreds of educators and children have participated in the design of its units of study. ESS writers feel there is no distinct set of study topics which will work in all situations with all children; therefore, they have generated a variety of independent units rather than a sequenced curriculum (Walcott, 1967:180). ESS does not begin with a discussion of basic concepts but rather it attempts to confront students with central themes of biology and "provide opportunities for these ideas to grow into meaningful concepts as the students accumulate additional experiences" (Simpson, 1974:341). The development of inquiring children is as an important objective as developing particular scientific concepts (Cunningham, 1966:182). Walcott, 1967:184) stated:

> . . . we want him to have an attitude about living things--a curiosity, a sympathy, and an appreciation for the living world. We feel very strongly that all these goals can be reached only by exposing children to an environment that is very rich in biological materials and not by feeding them neatly encapsulated statements about it.

Specifically, students are given physical materials from the start to investigate. For example, in the unit Pond Water, students examine

microscopic and macroscopic plants and animals found in fresh-water ponds.

> The fantastic variety of life in a pond can serve as the basic of an almost endless study. POND WATER has three main components: a field trip to a pond, classroom observation of the water and mud brought back, and experimentation. The teacher's guide suggests ways of dealing with the problem of 'which animals are the same' and offers a number of questions that have interested children (Romney, 1971:370).

Pond Water is recommended primarily for Grades 1-7 although it is best utilized in grades 3-7. ESS writers include suggestions on how to adapt to the various grade levels. For example, in the Pond Water unit they suggest focusing attention on the larger animals in grades 1-3 and using microscopes with smaller animals in the upper grades.

Although primarily recommended for grades K-4, Animals in the Classroom serves as a resource book to help teachers keep animals in their classrooms. The guide includes a checklist of things to consider when bringing animals to the room, such as the construction of inexpensive cages and the selection of handbooks on animal care.

In the unit Bones, students examine real skeletons to note similarities and differences among them.

> This unit capitalizes on children's natural interest in skeletons by engaging them in activities with real bones. They can assemble a skeleton from a pile of loose bones or even prepare a set of bones for themselves. Such experiences help students to become familiar with a variety of bones, to notice the similarities and differences among them, and to experience the satisfaction (and frustration) of making skeletons. In addition, they should learn many important facts about the skeletal system, and gain some sense of their own body structure and the way it functions (Romney, 1971:14).

A book entitled How to Make a Chicken Skeleton is included as a student booklet. This booklet explains how a child can cook a chicken and assemble the skeleton.

Following is a list of life science topics in ESS:

| | |
|---|---|
| Growing Seeds (K-3) (1-2)* | Mosquitoes (3-9) |
| Life of beans and peas (K-4) | Bones (4-6) |
| Butterflies (K-5) | Small things (4-6) |
| Eggs and tadpoles (K-6) | Tracks (4-6) |
| Animals in the classroom (K-9) (K-4)* | Budding twigs (4-6) |
| Brine shrimp (1-4) | Crayfish (4-6) |
| Changes (1-4) (2-4)* | Earthworms (4-6)* (4-8) |
| Pond water (1-7) (3-7)* | Microgardening (4-7)* (4-9) |
| Starting from seeds (3-7) (5-6)* | Behavior of mealworms (4-8) |

*Second paranthèses designates preferred grade level for unit. (Simpson, 1974:341).

Specific unit objectives are listed for each of the 17 ESS life science units. Because of the nature of the units (i.e., wide grade span) the unit objectives do not have to be in any specific order nor is it necessary to develop all objectives at every grade level (Aho, et al, 1974:V). According to ESS writers, teachers should determine which unit objectives are applicable to the ESS unit activities going on in their own classroom.

> As every ESS unit is appropriate for more than one grade level, a student may be exposed to a specific ESS unit several times during the elementary school years. Also, a given student may far surpass grade level expectations in working through a specific ESS unit. Because of the multiage design and provisions for individualizing instruction in each ESS unit, evaluation objectives are designated by levels:
>
> A. Basic (B)

Evaluation objectives at a lower level of achievement. Almost every student in the class should be able to achieve at this level.

B1. Intermediate (I)

Evaluation objectives at a higher level of achievement. The majority of the students in the class should be able to achieve at this level.

C. Advanced

Evaluation objectives at a still higher level. Students achieving at this level will have out-performed the majority of their classmates (Aho, et al, 1974:V).

Teachers and students may select those units that fit their preference, locality, and available materials.

Science A Process Approach (SAPA) was initially funded by the American Association for the Advancement of Science in 1962, under the direction of John R. Mayor. Over a six year period more than 100 scientists and teachers worked together on its development. SAPA differs from other science programs in that procedures of scientific inquiry are emphasized rather than facts (Simpson, 1974:341). SAPA writers felt that all citizens should develop certain process skills and a basic knowledge of the world around them (Stefanich, 1973:14). Instead of studying "ecology" students are given tasks in which they observe, infer, and classify. Emphasis is on developing a basic process rather than on a body of content. SAPA felt that "Children will eventually synthesize their own concepts about basic biologic mechanisms" (Simpson, 1974:341). For example, a lesson may be called "Classifying" rather than "Biology" although they will be classifying living and nonliving materials in an aquarium. "While students learn

how to control variables and interpret data, they necessarily are exposed to the primary functions of life" (Simpson, 1974:341). SAPA also differs from other programs in its hierarchial structure. Certain competencies are a pre-requisite for later lessons (Stefanich, 1973:15). Advanced lessons many times are dependent upon concepts in previous lessons. Therefore, SAPA includes an appraisal section which the teacher uses to determine if material is mastered.

Of all three programs SAPA is more teacher-centered. For each unit of study the teacher has an exercise booklet that contains clearly stated objectives, rationale, vocabulary, related materials, instructional procedure, generalizing experiences, and competency measures. The teacher is still a planner of learning rather than a source of knowledge (Stefanich, 1973:16). Learning occurs as students manipulate and have experiences with equipment. Following is a list of processes that are developed in the SAPA life science program.

| Basic processes (K-3) | Integrated processes (4-6) |
|---|---|
| Observing | Controlling variables |
| Using space-time relationships | Interpreting data |
| Using numbers | Defining operationally |
| Measuring | Formulating hypotheses |
| Classifying | Experimenting |
| Predicting | |
| Inferring | |

(Simpson, 1974:342).

The noticeable emphasis in 'Content' in SAPA is physiologic. Pratically all of the major organismic functions are dealt with, in the course of activities centering on nutrition and energetics.

development and taxonomy (Classification) (Simpson, 1974:343). Within each unit there are four or five activities. There may be only one activity that deals with a life science concept or biologic phenomena.

Following is a list of the modules that contain life science topics in SAPA:

Ecology

4 Leaves, Nuts and Seashells
11 Listening to Whales
16 Living and Nonliving Things
Trees in Our Environment
19 Soils
21 Weather
28 Molds and Green Plants
31 Life Cycles
32 Terrarium
47 A Tree Diary
50 The Clean Up Campaign
55 The Bean - It Came Up
71 Seeds and Soap
74 Biotic Communities
76 Limited Earth
85 Contour Maps
88 Environmental Protection
90 Streams and Slopes
91 Flowers
100 Plant Nutrition

Plants

43 A Plant Part that Grows
52 Plants Transpire
89 Plant Parts
102 Plants in Light

Animals

14 Animals and Familiar Things
20 Counting Birds
36 Animal Responses
63 Maze Behavior
79 Animal Behavior

Human Body

1 Perception of Color
7 Perception of Taste
15 Perception of Odors
18 Using the Senses
58 Liquids and Tissues
66 Learning and Forgetting
68 Field of Vision
72 Heart Rate
82 Changes Are
97 Optical Illusions
98 Eye Power
101 Mental Blocks
105 Membranes
(Chase, 1977)

Modules 16-30 are recommended for use in Grade 1. Modules 31-45 are recommended for use in Grade 2. Modules 46-60 are recommended for use in Grade 3. Modules 61-75 are recommended for use in Grade 4. Modules 76-90 are recommended for Grades 5. Modules 91-105 are recommended for Grade 6.

Textbooks: Modular Activities Program in Science (MAPS), Concepts in Science, and Science Understanding Your Environment

DelGirono (1969) investigated science textbooks from 1850 to 1954. He summarized:

> On the whole, the impact of new developments on science education lagged behind some ten to thirty years; that is current developments in science did not appear in the science textbooks until ten to thirty years after they had been first announced (Delgiorno, 1969:192).

He further noted that, in general, a textbook contained far more information than could be covered in a course. As a result most classes never will reach the "exciting scientific frontier." "You would graduate from high school or college without learning about new developments in science and the effect these advances have on democratic

citizens" (DelGiorno, 1969:192).

Carter (1967) suggested, however, that modern science textbooks portray a better and different picture of science. The emphasis is on the processes of science rather than on the content of science.

One of the science textbooks, Modular Activities Program In Science (MAPS), was strongly influenced in style, format, sequence and pupil activities by three laboratory programs, SCIS, SAPA, and ESS (Science and Children, 1976:25). The twenty-five modules are designed for grades K-8. MAPS utilizes the cognitive development theory of Piaget.

> MAPS makes available for these children a carefully designed progression of preoperational and concrete operational experiences in science that permit them to develop their own thinking processes as they are encouraged to explore and discover within the framework of four conceptual systems and four basic science processes stated behaviorally (Berger, et al, 1974:T1).

Patterns of Life is the life science conceptual scheme. Blocks of related material or subordinate concepts are built around this "organizer concept" (Berger, et al, 1974:T3). MAPS is also concerned with the development of the following science-related processes: (1) observing and describing; (2) investigating and manipulating; (3) organizing and quantifying; and (4) generalizing (Berger, et al, 1974:T2).

MAPS writers noted that the emphasis is not on reading:

> MAPS is not a 'read about' program. The child develops understanding of concepts and process skills by working with

> real materials and with visual representations of real materials. The text is the source of instructions and commentary, not of information. The child's growth in science is not inhibited by reading ability (Berger, et al, 1974:T1).

Minimal reading, inclusion of poetry, and a high level of student involvement are characteristic of the program (Stefanich). MAPS writers contend that "The major learnings of this program emerge from the experiences of the children; the major processes evolve as the children participate in the activities" (Berger, et al, 1974:T1).

Each teacher's edition contains an overview (clear statement of the purpose of the module), background information (can appear at beginning of module, before a group of activities, or with description of an activity), concept process chart, materials (listed at beginning of every cluster and each activity within cluster), behavioral patterns, and teaching suggestions (Berger, et al, 1974:T4).

Concepts in Science is based on six conceptual schemes (Science Teacher, 1974:20). The four life science conceptual schemes are as follows:

> When energy changes from one form to another, the total amount of energy remains unchanged.
> Living things are interdependent with one another and with their environment.
> A living thing is the product of its heredity and environment.
> Living things are in continuous change (Brandwein, et al, 1975:F-17).

Within each one of these conceptual schemes is a hierarchy of concepts from simple to complex.

> 'Simple' is used here in the sense that the experience provided should be easily recognizable (Brandwein, et al, 1975:F-14).

Within each concept there is a number of subconcepts whose development, according to the writers of Concepts in Science, depends on the judgment of the teacher (Brandwein, et al, 1975:F-15).

The writers of Concepts in Science referred to the book as "a sourcebook of situations in which children participate and perceive objects and events" (Brandwein, et al, 1975:F-15).

> . . . They observe; they investigate relationships; they collect relevant data; they describe and discuss their results; they confirm one another's results (through collaborating in an investigation); they invent; they report their results in a kind of colloquium. Note the processes--observation, investigation, collection of relevant data, description of results, discussion of findings, confirmation of findings, exercising inventiveness, reporting of work, and experimentation, among others. Children are engaged in valid operations leading to concept attainment (Brandwein, et al, 1975:F-15).

The core to concept seeking is investigation (Brandwein, et al, 1975:F-15). Concepts in Science includes six types of investigations: Unit Opening, Apprentice, Search on Your Own, Investigating Further, Long Term Search, and Verifying Progress.

> We have attempted to give structure to the teaching of science during the first ten years of schooling by reinforcing the processes of science with an understanding of the concepts of science. We have, in short, sought to identify and define a structure that is not only verifiable but also viable, that is, practical and productive in teaching children (Brandwein, et al, 1975:F-11).

The teacher's edition contains a teaching background (precedes each unit), concept statements, basic behaviors sought, view of the

unit, lesson cluster background (more extensive science background), teaching aids, and teaching notes (Brandwein, et al, 1975:F-23-24).

Concepts in Science major focus is on scientific foundation and has little emphasis on the history of science or present day social issues (Stefanich).

Science instruction, according to the writers of Science Understanding Your Environment, should have two main aims: (1) the development of a knowledge dimension and (2) the development of a performance dimension. The knowledge dimension refers to the biological concepts. The performance dimension refers to the inquiry skills of observing, measuring, describing, comparing, classifying, ranking information, collecting information, experimenting, and drawing conclusions (Mallinson, 1972:T4). In order to develop these two dimensions the writers felt that pupils must be actively involved in collecting information, teachers must conduct open-inquiry demonstrations, and pupils must be provided with paper-pencil activities (Mallinson, 1972:T4).

The life science program is based on four major topics: The Living World (Levels 1, 3, 4, and 6); Plants (Levels 1, 3, 4, and 5); Animals (Levels 1-6); and Human Growth and Development (Levels 1, 2, 4, 5, 6) (Mallinson, 1973:T6). The authors and editors of Science Understanding Your Environment claimed that they developed a plan in which the approach to the preceding basic topics varies in accord with

the maturity of students involved.

> For children at the primary level, the approach to science is mainly on the characteristics of the objects and scientific phenomena that are studied. At this level, children focus their efforts around the elements of science in their environment, in terms of describing, comparing, and ranking information about the characteristics of these elements.
>
> At the middle level, students evidence curiosity about the relationships between themselves and their environment, and between various elements of the environment. Consequently, the emphasis in science instruction should be on relationship and utilization, or the 'use and value' aspects of objects, materials, and phenomena of science.
>
> At the upper elementary level, students are capable of a degree of abstract thinking not apparent earlier. The science program in the upper levels emphasizes the operational, or functional approach (Mallinson, 1972:T5-T6).

The teacher's edition includes in each lesson the concepts, behavioral objectives, vocabulary, lesson materials, marginal questions, summing up section, picture descriptions, and science background (additional information for teacher).

## Importance of Science Reading Materials

Blough (1973:21) pointed out that it is still all right to read. Emphasis has been so strong on observation, experimentation, and other processes that teachers have been reluctant to use any reading resource in a science program.

In a summary of research in science education, Rowe (1975:64) stated that middle and upper class children benefit little from the programs as they now stand: "Probably the heavy emphasis on sorting, categorizing, and ordering that marks the early programs makes up for

deficits among the poor and handicapped but adds little to what the environment already supplies to the well-to-do."

As Kline (1963:233) pointed out, today as never before, teachers of upper elementary and secondary levels should not be content with vicarious learning alone but should include broad types of material. Both teachers and class will benefit from a meaningful and productive experience. Knowledge, stated Selsam (1973:19), is not gathered from observation alone.

Blough (1973:21) recognized that adults do not discover everything first hand. Adults rely on books to answer solutions to problems:

> It suggests that an educated person depends on reading for information, inspiration, and appreciation and that early satisfying experiences with reading to discover are important for children.

Shade (1953:637) claimed that student experience with the scientific method can be gained in two ways: 1) by observing and manipulating, and 2) by examining the observations and manipulations of original investigators. He further stated that there exists the misconception that only new is important. It is a result of the failure to recognize that new developments have an earlier and more fundamental background. Dyrli (1976:32) pointed out that knowledge that transcends vicarious experience is lost in the curriculum when children are limited to their physical experience.

Silva (1974:225) emphasized that not all students become

scientists. She suggested that science programs could be improved by helping students acquire an appreciation of science and literature as two related components of our culture (1974:228). Students would be able to relate science to other areas of knowledge.

Importance of Illustrations

One of the important ways of "knowing" according to Bruner (Bruner, et al, 1966:6-7) is through a picture or image of something. Piaget (Klausmeier and Ripple, 1971:413) also emphasized that children need concrete objects or things they can perceive. It can be inferred that Piaget and Bruner see the importance of illustrations in science materials. Ausubel stated that a concept acquires real or psychological meaning when it is equivalent to an idea that is already present in the mind (Lefrancois, 1975:97). Obviously children today are acquiring real or psychological meaning through visual stimuli.

> Today's pupils live in an extraordinarily visual world: TV, magazines, newspaper, books, city streets, museums, department stores, advertisements--all struggle for visual attention (Weiss, 1973:4).

Flannigan and Boone (1977:7) emphasized the importance of learning through illustrations:

> Children take to pictures quickly because they are familiar and do not require the additional learning to understand that print demands.

Huck (1976:112) noted that illustrations are one media by which a message is conveyed. She further noted that "The basic function of

illustrations in informational books is to clarify and extend the text" (Huck, 1976:539). Illustrations can clarify size relationships (Huck, 1976:539). The perspective size of a Tyrannosaurus is understood when a boy is shown standing next to one. Illustrations can provide the bulk of information (Huck, 1976:340). Arbuthnot (1972:589) stated that photographs and other illustrations can be informative and motivating. The style of illustration, too, can contribute to a child's acceptance of informational material.

## Conclusion

Man's most distinctive characteristic is his ability to form abstract concepts and thus to grasp relationships between things. There is little evidence that the full quantity and quality of mental activity that is called concept formation occurs in animals other than man (Simpson, 1965:514). When and how this concept formation occurs has been interpreted differently by psychologists. Science educators recognize their inevitable task of adopting science materials and teaching techniques that will permit the student to search for meaning on their level. Ultimately, meaning in science is the establishment of generalizations and explanations for observed facts.

# Chapter 3

## PROCEDURES

The contents of this chapter will describe the procedures that were utilized in organizing the data collected for this study.

### Research Questions

1. What life science concepts are developed in each of three major elementary science laboratory programs and three major elementary science textbooks according to grade level?

2. How many life science concepts are developed in each of three major elementary science laboratory programs and three major elementary science textbooks?

3. What method: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) example in the environment illustrating them; 5) graphic illustration with or without textual references, captions, or labels, was used most frequently in the development of life science concepts in each of the three major elementary science laboratory programs and three major elementary science textbooks? What method was second most used? third? fourth? fifth?

4. What method: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) example in the environment illustrating them; 5) graphic illustration with or without textual references, captions, or labels, was used most frequently in the

development of life science concepts in all three laboratory science programs and all three elementary science texts combined? What method was second most used? third? fourth? fifth?

5. What life science concepts are developed across grade levels 1-6 in each of the three major elementary science laboratory programs and three major elementary science textbooks?

Selection of the Laboratory Programs and Textbooks

In order to determine which three elementary science laboratory programs and elementary science textbooks were representative of those used throughout the United States, the researcher sent an inquiry to Market Data Retrieval. It was believed that information from Market Data Retrieval would identify the three major elementary science laboratory programs and major elementary science textbooks by national sales. Since Market Data Retrieval had not done a survey of elementary science programs since 1973, this information was unavailable. A copy of this letter can be found in Appendix D.

The writer then randomly selected twenty school districts from throughout the United States that were listed in Patterson's American Education. In order to corroborate the findings in science education literature as to what are currently major elementary science materials, large school districts were intentionally chosen to receive a questionnaire concerning the science programs presently in use. Following is a list of the school systems selected: San Francisco

United District (California), Denver District (Colorado), Atlanta, Culton Co. (Georgia), Champaign District (Illinois), Indianapolis Public Schools (Indiana), Lexington Public Schools (Kentucky), Springfield District (Massachusetts), Detroit Wayne Co. (Michigan), Atlantic City District (New Jersey), Rochester Public School District (New York), Charlotte-Mecklenberg District (North Carolina), Columbus City District (Ohio), Tulsa School District (Oklahoma), Portland School District (Oregon), Pittsburgh City District (Pennsylvania), Knoxville School District (Tennessee), Houston School District (Texas), Seattle School District (Washington), Milwaukee District (Wisconsin), and Providence District (Rhode Island).

A letter was written to solicit information regarding what science program or programs the preceding school systems were presently using. A postcard with a typed list of the prominent science programs now in use was enclosed in the letter for convenient return. A copy of the letter and postcard can be found in Appendix B. The letter was forwarded to each school system requesting that they check on the enclosed postcard the science programs they were presently using. Contained in Table 1 is the information received from this questionnaire after four weeks duration.

Sixteen out of twenty districts returned the postcard after four weeks. The data from the returns revealed that six school districts were using the laboratory program Science A Process Approach (SAPA);

seven school districts were using the laboratory program Elementary Science Study (ESS); and six school districts were using the laboratory program Science Curriculum Improvement Study (SCIS). The textbook program, Concepts in Science, was being used by seven school districts. The textbook programs, Science Understanding Your Environment and Modular Activities Program in Science (MAPS), were used by five school districts. The textbook program, Modern Elementary Science, was used by three school districts. The textbook programs, Elementary Science Learning by Investigation, Basic Science Program Series, Ginn Science Program, Heath Elementary Science, and Modern Science were all being used by two school districts. The Young Scientist and Discovering Science textbook programs were used by one district.

After reviewing available textbook series, literature on science programs (Aho, 1974; Garigliano, 1975; Lawson, 1975; Walcott, 1967; Simpson, 1974; Cunningham, 1966; Gallagher, 1977; and Science and Children, 1977), and the returns from sixteen school districts regarding science programs in use, the following textbooks and laboratory programs were chosen to be reviewed in this study: Science Curriculum Improvement Study (SCIS), Science a Process Approach (SAPA), Elementary Science Study (ESS), Science Understanding Your Environment, Modular Activities Program in Science (MAPS), and Concepts in Science.

Table 1

Surveyed School Districts

| | |
|---|---|
| San Francisco United District | No Response |
| Denver District | No Response |
| Atlanta, Culton Co. | SAPA, SCIS, ESS Concepts in Science, Elementary Science Learning by Investigation, Science Understanding Your Environment, Modular Activities Program in Science, Science: People, Concepts, Processes, Elementary School Science, Ginn Science Program, Modern Science |
| Indianapolis Public Schools | ESS |
| Lexington Public Schools | SCIS |
| Springfield District | No Response |
| Detroit Wayne Co. | Discovering Science, Heath Elementary Science |
| Atlantic City District | Elementary Science Learning by Investigation, MAPS, Modern Elementary Science |
| Rochester Public School District | ESS, Modular Activities Program in Science |
| Charlotte-Mecklenberg District | Elementary School Science, Ginn Science Program, ESS |
| Columbus City District | Science Understanding Your Environment |
| Tulsa School District | SAPA, ESS, SCIS, Concepts in Science Modular Activities Program in Science, Elementary School Science, Modern Science |
| Portland School District | ESS, SCIS, Concepts in Science, Science Understanding Your Environment, Modern Elementary Science |
| Pittsburgh City District | Heath Elementary Science |

Table 1 Continued

| | |
|---|---|
| Knoxville School District | SAPA, Science Understanding Your Environment, Ginn Elementary Science, The Young Scientists |
| Houston School District | Concepts in Science, Science Understanding Your Environment |
| Seattle School District | SAPA, ESS, SCIS, Concepts in Science |
| Milwaukee District | SAPA, ESS, SCIS, MAPS, Modern Elementary Science, Concepts in Science |
| Providence District | SAPA, Concepts in Science |
| Champaign School District | No Response |

Selection of 114 Life Science Concepts

In order to determine an appropriate list of life science concepts the writer investigated the related literature. This investigation revealed a study done in 1972, that identified current credible concepts in life science considered to be important for inclusion in K-12 curricula. Three steps were utilized in determining the list:

> Step 1: development of an initial list of concepts by a panel of scientists,
> Step 2: evaluation and revision of the initial list by scientists to form second list,
> Step 3: evaluation and revision of the second list by a national panel of science educators, biology teachers, and other scientists to form final list (Thompson and Pella, 1972:252).

The initial list was generated by asking a panel of 87 scientists what they believed to be the five to seven most important concepts in their

speciality and biology in general. This list of 151 concepts was viewed by a Wisconsin Panel, made up of a botanist and zoologists for precision, credibility, completeness and importance to K-12 curriculum. The final derived list contained 114 concepts. The list of these 114 concepts can be found in Appendix A.

A list that includes K-12 concepts in contrast to a K-6 list was chosen because an initial examination of elementary programs by this writer revealed that some concepts considered seventh and eighth grade concepts were included in fifth and sixth grade materials. A K-6 list would have eliminated many of the more difficult concepts included in elementary science materials.

Criterion Analysis

The writer turned to literature in the field of education to determine methods by which concepts are taught in elementary materials. An examination of science literature in the field of education revealed that the following five methods are utilized in concept development: (1) Sentence Inference, 2) Statement of Concept, 3) Experiment Demonstration, 4) Example in the Environment illustrating them, and 5) Graphic Illustration.

Collection of Data

In order to facilitate the examination of the laboratory programs and textbooks the writer classified the 114 concepts into 15

categories. The categories were as follows: ecological growth and change, organisms, plant and animal behavior, reproduction, plant and animal classification, communities, ecosystem: environment, living systems, environmental change, energy, natural resources, pest control and diseases, evolution, cells, genes, heredity, and health. This enabled the writer to organize the concepts into workable groups which facilitated the examination of the various laboratory programs and textbook series. For example, if a page dealt with a health concept, the writer examined the concepts contained in the category "health". Table 2 depicts the categories and specific concepts contained within each category.

Table 2. The Categorization of Concepts Presented and Developed in Elementary Science Programs.

| Categories | Concepts |
|---|---|
| Ecological growth and change | 1, 2, 3, 4, 5, 6, 8, 9, 10, 11 |
| Organisms | 12, 13, 14, 15, 16, 17, 104 |
| Plant and Animal Behavior | 18, 19, 20 |
| Reproduction | 21, 22, 23 |
| Plant and Animal Classification | 24, 25, 44, 45, 103, 109 |
| Communities | 7, 26 |
| Ecosystem: environment, living systems, environmental change | 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 99, 106 |
| Energy | 38, 39, 40, 41, 42, 43 |
| Natural Resources | 46, 47 |
| Pest Control and Diseases | 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59 |
| Evolution | 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72 |
| Cells | 37, 73, 74, 75, 76, 77, 78, 79, 107 |
| Genes | 80, 81, 82, 83, 84, 85, 86, 87, 112 |
| Heredity | 88, 89, 90, 112, 114 |
| Health | 91, 92, 93, 94, 95, 96, 97, 98, 100, 101, 102, 102, 108, 110, 113 |

The writer examined each elementary science textbook series at each grade level (1-6) to determine on which pages specific concepts taken from the identified 114 life science concepts were found and the method that was utilized in presenting the concepts. Each teacher's manual of the laboratory programs was examined to determine on which pages specific concepts taken from the identified 114 life science concepts were found and the method that was utilized in presenting that concept. Each page of a textbook or teacher's manual on which a concept was found was entered on a raw data chart which corresponds to the criteria in the analysis key.

Once the concepts were identified in context and the methods of presentation were identified, the researcher was able to determine what concepts were developed. In order for a concept to have been considered developed, at least three of the five methods (1) Sentence Inference, (2) Statement of Concept, (3) Experiment Demonstration, (4) Example in the Environment illustrating them, or (5) Graphic Illustration must have been utilized in presenting the concept. The five methods that were utilized in the presentation of concepts were discussed in the review of literature. Each individual method was rationalized as being a viable means for presenting science material, although student participation was supported by all publishers as being essential for student conceptualization. In order to establish that students were participating in an activity (experiment demonstration) or whether they

were primarily using reading materials (sentence inference or statement of concept) at least three methods of presentation had to be utilized in concept development. This assured that student went beyond simply reading science materials and were involved in at least one other method.

If a concept was found on a page twice but developed by the same method both times (i.e., statement) the page number was recorded only once. If the concept was found two times on a page and each time was developed by a different method (i.e., statement and illustration) the page number was recorded twice.

Because of the complexity of some concepts, if part of the concept was found on a page it was recorded as occurring on the page. For example, the concept "Behavioral patterns can be described in terms or one or more of the following: their functional significance, evolutionary history, developmental roots in the individual's experiences, and physiological mechanism" includes four ways in which behavior patterns are described. If one of these ways were discussed on a page then the page number of the concept was recorded. If one experiment or one example in the environment extended over two pages, the first page was recorded.

The researcher was able to determine the method that was used most often in the development of concepts by tabulating the total number of pages that depicted the method in concept presentation.

Laboratory programs and textbooks were identified by the letters A B C D E F; these programs were respectively Elementary Science Study, Science Curriculum Improvement Study, Science A Process Approach, Science Understanding Your Environment, Modular Activities Program in Science, and Concepts in Science. Concepts were numbered 1 through 114. The analysis criteria were identified as follows: 1) sentence inference, 2) statement of concept, 3) experiment demonstration, 4) example in the environment illustrating them, and 5) graphic illustration. Analysis criteria labels were condensed in the tables as follows: 1) inference, 2) statement, 3) experiment, 4) example in the environment, and 5) illustration.

## Analysis of Data

Tables were constructed from the raw data to organize the findings that answer the research questions. Following is a list of the tables that were constructed.

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration for each teacher's manual of three laboratory programs.

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, for each

book level of three textbook series.

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series.

Table 4. Concepts developed in each of the three laboratory programs and each of the three textbook programs, according to grade level.

Table 5. Concepts developed in each of the three laboratory programs and each of the three textbook programs across grade levels.

Table 6. Frequency of methods used in the development of life science concepts in three textbook series and teacher's manuals of each of the three laboratory programs.

Figure 1 depicts the logical progression of data collection necessary to answer the research questions. Table 4 answers question one. Table 5 answers questions two and five. Table 6 answers question 3 and question 4.

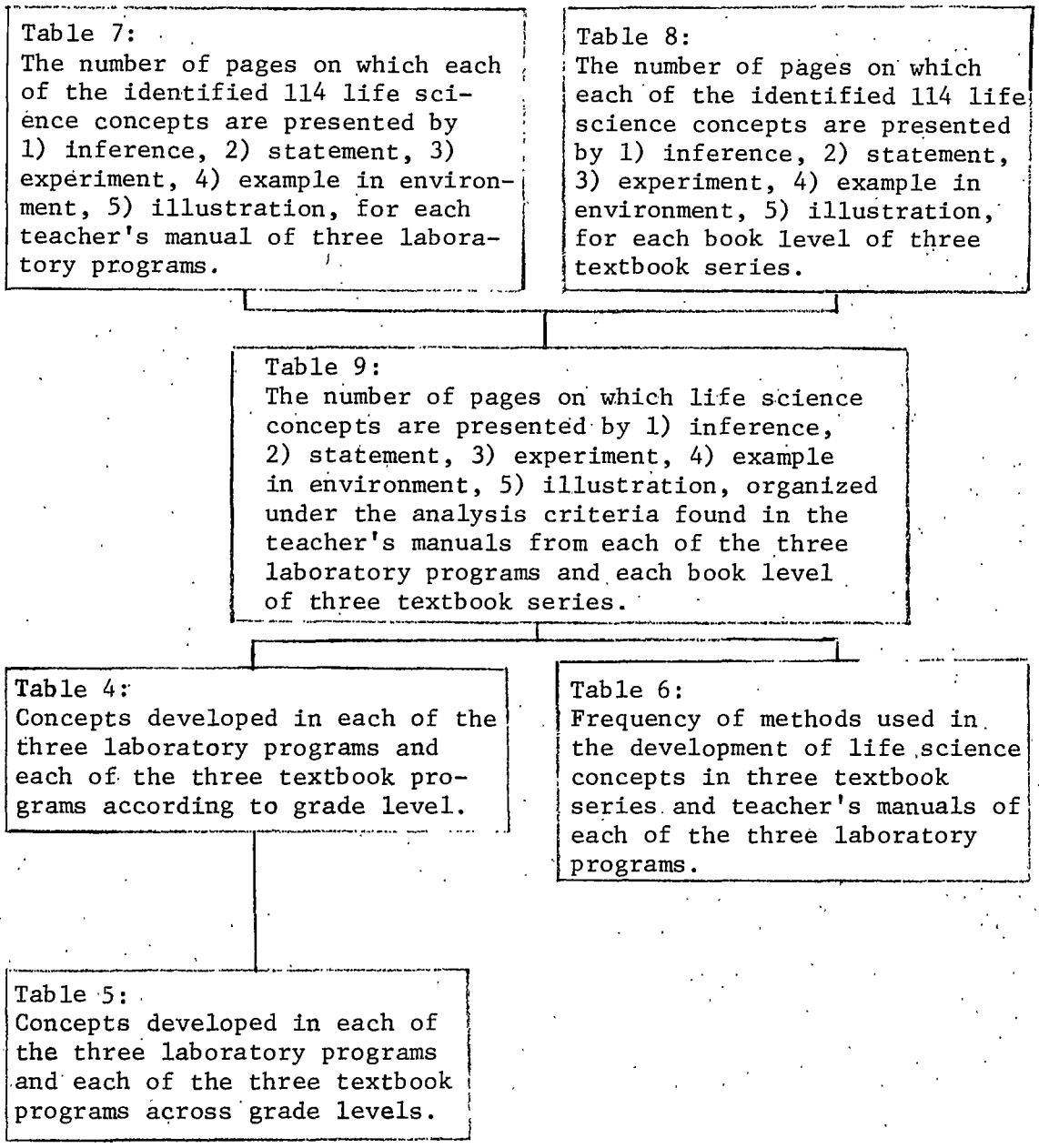



Figure 1. Analysis Schedule

Evaluation by Panel of Science Educators

In order to determine if the researchers' identification of concepts and designation of methods of presentation in the science texts and laboratory programs were accurate, an evaluation by a panel of science educators[1] was conducted.

Sample pages from the following science programs were chosen for examination: Elementary Science Study, Science A Process Approach, Concepts in Science, Science Understanding Your Environment.

The panel members were sent a letter that explained the procedures for the evaluation. They were asked to read the selected sample pages from the respective science programs that were labeled A-D and identify appropriate concepts presented and designate the method or methods of presentation utilized by the publishers. They were asked to organize their observations on a chart that was included in the evaluation packet. The evaluation packet can be found in Appendix C.

Table 3 contained information on the science educator's evaluations and the researcher's evaluation.

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[1]Assistance in the evaluation of the sample sections was provided by Dr. Paul Markovits, Montana State University, Dr. Thomas Crumbaugh, Berea College, Dr. Greg Stefanich, Northern Iowa University, Ms. Joan Anderson, Northern Iowa University.

Table 3. Science Educators/Researcher Panel Evaluation

| Program | Concept | Methods | | | | |
|---|---|---|---|---|---|---|
| | | Statement | Inference | Experiment | Example in Environment | Illustration |
| A (ESS) | 1 | | X, $Y_2$, $Y_4$ | X, $Y_1$, $Y_2$, $Y_3$, $Y_4$ | | |
| B (SAPA) | 2 | | X, $Y_2$, $Y_3$, | X, $Y_1$, $Y_2$. $Y_3$, | | |
| B* (SAPA) | 1 | | $Y_4$ | $Y_4$ | | |
| C (Concepts in Science) | 2 | X, $Y_1$, $Y_2$ $Y_3$, $Y_4$ | $Y_1$ | | | X, $Y_1$, $Y_2$, $Y_3$, $Y_4$ |
| D (Science Understanding Your Environment) | 4 | $Y_1$, $Y_3$ | X, $Y_1$, $Y_4$ | | $Y_1$ | X, $Y_2$, $Y_3$, $Y_4$ |

KEY: X = Researcher, Science Educator
$Y_1$ = Panel Member #1
$Y_2$ = Panel Member #2
$Y_3$ = Panel Member #3
$Y_4$ = Panel Member #4

*There was one disagreement on concept designation in SAPA.

On Program A, ESS, four of the science educators agreed with the researcher on selecting the appropriate concept. On Program B, SAPA, three science educators agreed with the researcher. On Program C, Concepts in Science, four of the science educators agreed with the researcher. On Program D. Science Understanding Your Environment, four of the science educators agreed with the researcher.

In Program A, ESS, science educators agreed with the researcher on the two methods, inference and experiment. One science educator listed only one (experiment) of the two methods. On Program B, SAPA, science educators agreed with the researcher on the methods, inference and experiment. One science educator listed only one method (experiment) of the two methods selected by the researcher. On Program C, Concepts in Science, three science educators agreed with the researcher on the method, statement and four science educators agreed with the method, illustration. One science educator chose the method inference which did not agree with the researcher's selection. On Program D, Science Understanding Your Environment, two educators agreed with the researcher on the method, inference and three science educators agreed with the researcher on the method, illustration. Three educators chose the method, statement and one science educator chose the method, example in the environment which were in disagreement with the researcher.

Analysis of the data obtained from the panel of science

educators when compared with the researcher's analysis demonstrated that in almost all cases the same concept and method of presentation was agreed upon. Specifically, all science educators agreed with the researcher on concept selection in three programs of the four science programs and three out of four science educators agreed with the researcher on the remaining science program. There was a majority of agreement among the science educators and researcher on methods of presentation. The few disagreements between the researcher and science educators occurred in two programs. The discrepancies occurred between the methods statement and inference which are closely related and thus susceptible to various interpretations. The remaining discrepancy occurred with one science educator choosing example in the environment.

Chapter 4

# ANALYSIS OF DATA AND FINDINGS

The purpose of this study was to examine and identify the development of life science concepts in grades one through six in selected elementary school science textbooks and laboratory programs. Specifically three elementary science textbooks and three elementary science laboratory programs were examined to determine the manner and extent that a predetermined list of 114 life science concepts were developed.

The six laboratory programs and textbook series were labeled as follows: A - Elementary Science Study (ESS); B - Science Curriculum Improvement Study (SCIS); C - Science A Process Approach; D - Science Understanding Your Environment; E - Modular Activities Program in Science (MAPS); F - Concepts in Science.

This chapter presents the findings for the five questions posed in this study. For each question investigated, data were collected for the specific items under investigation and are presented in table form. Various tables display concept development by grade level in each of the programs and the programs combined.

## Relevant Data and Findings

Question 1. (What life science concepts are developed in each of three major elementary science laboratory programs

and three major elementary science textbooks according to grade level?) was answered by conducting a number of essential observations of the identified texts and laboratory programs. The first step was to determine the number of pages on which each of the identified 114 life science concepts were presented in the textbooks and laboratory programs. This information is depicted in Tables 7 and 8. Information gathered from Tables 7 and 8 were essential for the construction of Table 9 which displays the methods utilized for each concept by number of pages. Tables 7, 8, and 9 can be found in Appendix E. Table 9 then led to the construction of Table 4. Table 4 depicts the concepts developed in each of the three laboratory programs and each of the three textbook programs according to grade level and specifically presents data that allows question 1 to be answered.

Table 4

Concepts Developed in Each of the Three Laboratory Programs and Each of the Three Textbook Programs According to Grade Level

| Program or Textbook Series | Concept | Grade Level |
|---|---|---|
| A - ESS | 9 | 1, 2, 3, 4, 5, 6, |
| | 13 | 1, 2, 3, 4, 5, 6 |
| | 20 | 1, 2, 3, 4, 5, 6, |
| | 21 | 1, 2, 3, 4, 5, 6 |
| | 27 | 1, 2, 3, 4, 5, 6, |
| | 34 | 1, 2, 3, 4, |
| | 57 | 4 |
| | 73 | 4 |
| | 74 | 4, 5, 6 |
| | 104 | 4, 5, 6 |
| | 109 | 1, 2, 3, 4, 5, 6, |
| B - SCIS | 1 | 6 |
| | 2 | 2 |
| | 7 | 5 |
| | 8 | 4 |
| | 9 | 2, 4, 6 |
| | 13 | 1, 5 |
| | 19 | 4 |
| | 20 | 4 |
| | 21 | 2, 5 |
| | 26 | 5, 6 |
| | 27 | 1, 3, 5, 6 |

Table 4 Continued

| Program or Textbook Series | Concept | Grade |
|---|---|---|
| | 28 | 1, 6 |
| | 44 | 2 |
| | 109 | 3 |
| C - SAPA | 9 | 1, 6 |
| | 13 | 4, 6 |
| | 19 | 4, 5, 6 |
| | 20 | 2, 4, 6 |
| | 21 | 2, 5 |
| | 27 | 4 |
| | 29 | 2 |
| | 72 | 3 |
| | 80 | 5 |
| | 109 | 2, 3, 5, 6 |
| D - Science Understanding Your Environment | 4 | 3 |
| | 7 | 3 |
| | 8 | 2, 3, 4 |
| | 9 | 2, 3, 4 |
| | 10 | 1, 5, 6 |
| | 13 | 1, 2, 3, 4, 6 |
| | 15 | 1 |
| | 16 | 4 |
| | 17 | 1 |
| | 19 | 6 |
| | 20 | 2, 3, 6 |
| | 21 | 1, 3, 5 |

Table 4 Continued

| Program or Textbook Series | Concepts | Grade |
|---|---|---|
| D - Science Understanding Your Environment | 26 | 1, 3 |
| | 27 | 1, 2, 3, 6 |
| | 28 | 1, 2, 4, 5 |
| | 29 | 2, 6 |
| | 30 | 6 |
| | 34 | 1, 3, 4, 6 |
| | 36 | 4, 6 |
| | 38 | 3, 4 |
| | 44 | 2 |
| | 45 | 4 |
| | 46 | 4 |
| | 47 | 4, 5 |
| | 53 | 6 |
| | 55 | 3 |
| | 56 | 4 |
| | 58 | 4, 5, 6 |
| | 70 | 3, 5 |
| | 73 | 6 |
| | 76 | 6 |
| | 77 | 1, 4, 6 |
| | 78 | 6 |
| | 91 | 5 |
| | 93 | 1, 6 |
| | 94 | 6 |
| | 98 | 6 |
| | 109 | 2, 3, 4, 5 |

Table 4 Continued

| Program or Textbook Series | Concepts | Grade |
|---|---|---|
| E - MAPS | 1 | 3, 6 |
| | 2 | 3, 6 |
| | 3 | 6 |
| | 4 | 6 |
| | 7 | 3, 4, 6 |
| | 8 | 2, 3, 4, 5, 6 |
| | 9 | 2, 3, 5, 6 |
| | 10 | 3, 5, 6 |
| | 13 | 2, 3, 6 |
| | 20 | 2, 4, 5 |
| | 21 | 2, 3, 4, 5 |
| | 26 | 3, 4, 6 |
| | 27 | 3, 4, 6 |
| | 28 | 2, 3, 4, 6 |
| | 31 | 4 |
| | 34 | 1, 2, 3 |
| | 35 | 1, 3 |
| | 40 | 6 |
| | 44 | 1, 2, 5, 6 |
| | 46 | 3, 6 |
| | 47 | 1, 6 |
| | 55 | 6 |
| | 62 | 6 |
| | 73 | 5 |
| | 77 | 5 |
| | 103 | 2 |

Table 4 Continued

| Program or Textbook Series | Concepts | Grade |
|---|---|---|
| F - Concepts in Science | 2 | 4 |
| | 8 | 2, 3, 4, 5 |
| | 9 | 3, 4 |
| | 13 | 1, 2, 3, 4, 6 |
| | 19 | 4, 6 |
| | 20 | 4, 6 |
| | 21 | 1, 2, 3, 4 |
| | 25 | 3 |
| | 27 | 4, 6 |
| | 28 | 3, 4 |
| | 29 | 3 |
| | 34 | 4, 5 |
| | 38 | 2, 3, 4, 6 |
| | 40 | 2, 3, 6 |
| | 44 | 2 |
| | 56 | 6 |
| | 58 | 6 |
| | 60 | 5 |
| | 67 | 5 |
| | 70 | 1, 2, 5 |
| | 72 | 5 |
| | 73 | 5 |
| | 74 | 4, 5 |
| | 75 | 5 |
| | 76 | 5 |
| | 77 | 5 |

Table 4 Continued

| Program or Textbook Series | Concepts | Grade |
|---|---|---|
| F - Concepts in Science | 78 | 6 |
| | 80 | 6 |
| | 88 | 5 |
| | 90 | 5 |
| | 91 | 5 |
| | 93 | 1, 2 |
| | 99 | 4 |
| | 104 | 4, 5, 6 |
| | 114 | 6 |
| | 109 | 2, 3, 5 |

Question 5. (What life science concepts are developed across grade levels 1-6 in each of the three major elementary science laboratory programs and three major elementary science textbooks?) was answered by taking the concepts developed according to grade level in each specific program from Table 4 and combining them in order to depict all concepts developed in each total program (Table 5). Information in Table 5 specifically presents data which allows question 5 to be answered.

Question 2. (How many life science concepts are developed in each of three major elementary science laboratory programs and three major elementary science textbooks?) was answered by totaling

the number of concepts developed by grade level from Table 4. This information led to the development of Table 5 which depicts the specific concepts that were developed in each of the three laboratory programs and each of the three textbook programs across grade level. Table 5 also displays the number of concepts developed in each laboratory program and each textbook series. This information from Table 5 specifically presents data that allows question 2 to be answered.

Table 5

Concepts Developed in each of the Three Laboratory Programs and each of the Three Textbooks Programs Across Grade Level

| Program or Textbook Series | Concept |
|---|---|
| A - ESS | 9, 13, 20, 21, 27, 34, 57, 73, 74, 104, 109<br>Total: 10 |
| B - SCIS | 1, 2, 7, 8, 9, 13, 19, 20, 21, 26, 27, 28, 44, 109<br>Total: 13 |
| C - SAPA | 9, 13, 19, 20, 21, 27, 29, 72, 90, 109<br>Total: 9 |
| D - Science Understanding Your Environment | 4, 7, 8, 9, 10, 13, 15, 16, 17, 19, 20, 21, 26, 27, 28, 29, 30, 34, 36, 38, 44, 45, 46, 47, 53, 55, 56, 58, 70, 73, 76, 77, 78, 91, 93, 94, 98, 109<br>Total: 37 |
| E - MAPS | 1, 2, 3, 4, 7, 8, 9, 10, 13, 20, 21, 26, 27, 28, 31, 34, 35, 40, 44, 46, 47, 55, 62, 73, 77, 103, 109<br>Total: 27 |
| F - Concepts in Science | 2, 8, 9, 12, 19, 20, 21, 25, 27, 28, 29, 34, 48, 40, 44, 56, 58, 60, 67. 70, 72, 73, 74, 75, 76, 77, 78, 80, 88, 90, 91, 93, 99, 104, 109, 114<br>Total: 36 |

Question 3. (What method: 1) sentence inference; 2) statement of concept, 3) experiment demonstration, 4) example in the environment illustrating them, and 5) graphic illustration with or without textual references, captions, or labels, was used most frequently in the development of life science concepts in each of the three major elementary science laboratory programs and three major elementary science textbooks? (What method was second most used? third? fourth? fifth?) was answered by examining data in Table 9 and adding the number of pages utilized for each specific method of presentation of each concept in the respective programs. This computation yielded a grand total of pages for each method. This information is presented in Table 6. Table 6 depicts the frequency of methods used in the development of life science concepts in three textbook series and teacher's manuals of each of the three laboratory programs and specifically presents data that allows question 3 to be answered.

Question 4. (What method: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) graphic illustration with or without textual references, captions, or labels; and 5) example in the environment illustrating them, was used most frequently in the development of life science concepts in all three laboratory science programs and all three elementary science texts combined? What method was second most used? third? fourth? fifth?)

was answered by adding the frequency of methods of presentation in each of the programs. The computation yielded totals for each method across programs and specifically presents data that allows question 4 to be answered.

Table 6. Frequency of Methods Used in the Development of Life Science Concepts in Three Textbook Series and Teacher's Manuals of Each of the Three Laboratory Programs.

| Program | Inference | Statement | Experiment | Illustration | Example in Environment |
|---|---|---|---|---|---|
| A | 550 | 3 | 246 | 450 | 297 |
| B | 143 | 17 | 99 | 117 | 39 |
| C | 71 | 3 | 59 | 31 | 45 |
| D | 375 | 53 | 83 | 343 | 131 |
| E | 255 | 16 | 126 | 303 | 219 |
| F | 635 | 39 | 127 | 555 | 96 |
| TOTAL | 2029 | 131 | 740 | 1801 | 827 |

Key: A - ESS
B - SCIS
C - SAPA
D - Science Understanding Your Environment
E - MAPS
F - Concepts in Science

# Chapter 5

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Science education has taken at least three directions in the last two decades. By the 1960's, activity-based and inquiry oriented programs such as SAPA, SCIS, and ESS were dominating federal fund allocations in science education. Enthusiasts of these programs were criticized because the programs eliminated knowledge that was unobservable such as dinosaurs and planetary motion; in short, there was no reading component in the programs. Rather than turning back to textbooks which were also considered inadequate, science educators suggested an individual approach utilizing textbooks and programs. But science educators questioned whether teachers had the time or expertise for this difficult task of developing science curricula. Amid this dissention, however, there was agreement as to the goal of science education; science teaching must result in a scientifically literate populus. Scientific literacy and conceptual development were considered synonymous. The individual science teacher was considered responsible for developing the capability of conceptualization in the discipline of science.

In 1972, Thompson and Pella conducted a study that produced a list of 114 life science concepts for grades one through twelve. The extent to which these life science concepts are developed in elementary science programs should be a concern of material publishers, national

committees, curriculum supervisors, administrators and classroom teachers. The problem of this study was to examine selected elementary science laboratory and textbook programs with regard to the operational definition for the development of concept. The purpose of this study was to identify the development of life science concepts in grades one through six in selected elementary school science textbooks and laboratory programs and determine the methodology utilized for the presentation of these concepts.

The need for this study was based on several points. Teachers need to be cognizant of the concepts developed in a program. Awareness of the concepts developed in a program would enable a teacher to supplement that program with other materials or programs thus avoiding overlap of concepts. Secondly, research in science education has shown that inquiry lessons are necessary for conceptualization. Identification of the method of development of concepts in a particular textbook or laboratory program would enable the teacher to determine whether a laboratory program or textbook is consistent with present trends in science education. This study examined science materials in terms of a standard definition of concept rather than a definition prescribed by each individual program. It also utilized a concept list that was determined by scientists in the discipline of life science. Even though the development of a concept in a particular program does not ensure that a child will have the ability to conceptualize, it

does provide a conceptual framework that might guide science teaching and lead to successively better development of children's understanding as they progress through the grades.

Questions in this study as posed were: 1) what life science concepts were developed in three major elementary science programs and three major elementary science textbooks according to grade level; 2) how many life science concepts were developed in three major elementary science laboratory programs and three major elementary science textbooks; 3) what method (sentence inference, statement of concept, experiment demonstration, example in the environment illustrating them, graphic illustration with or without textual references, captions, or labels) was used most frequently in the development of life science concepts in each of the three major elementary science laboratory programs and three major elementary science textbooks? What method was used second most? third? fourth? and fifth? 4) what method (sentence inference, statement of concept, experiment demonstration, example in the environment illustrating them, graphic illustration with or without textual references, captions, or labels) was used most frequently in the development of life science concepts in all three laboratory science programs and all three elementary science textbooks combined? What method was second most used? third? fourth? fifth? 5) what life science concepts were developed across grade levels one through six in each of the three

major elementary science laboratory programs and three major elementary textbooks?

General procedures for the study were presented which included a review of literature that was conducted for the purposes of providing background for the study; the identification of a list of life science concepts; the identification of a list of analysis criteria that enabled the researcher to record methods utilized in textbooks and programs; the categorization of concepts; and the examination of three elementary science laboratory programs and three elementary science textbooks in terms of the development of life science concepts. A concept was considered developed if it was presented by at least three of the following methods: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) example in the environment illustrating them; 5) graphic illustration. Tables and charts were prepared to facilitate the reporting of this information.

Recognized limitations of the study were that 1) the study considered three elementary science laboratory programs and three science textbook series, 2) the study used 114 life science concepts, 3) grades one through six were considered, 4) the majority of sources for the paper were taken from the Montana State University Library, a personal library, available sources through interlibrary loan, and ERIC materials for the periods of July 1969 to October 1976.

A review of literature was made to provide information regarding the nature of concepts and conceptual development. In order to relate how children develop cognitively and to describe the implications which cognitive growth have on the development of concepts within materials, the theories of psychologists, Bruner, Piaget, and Ausubel were reviewed. A review of science education literature revealed the role conceptual development has had in science education. Three elementary laboratory centered science programs and three elementary science textbook series were reviewed. The importance of a reading component and illustrations in science materials was reported.

The review pointed out that not until the nineteenth century was science included in the elementary curriculum. At that time the national science programs were entitled Nature Study and content was drawn from botany and zoology disciplines. Until 1930, the goal of science teaching was to instill in the children aesthetic value and moral commitment to the world. Science and technology were synonymous terms during the years 1925-1935. From 1930 to 1950, Dewey's educational attitudes prevailed in science teaching. One of these attitudes was that science subject matter changed, but that scientific method and social cooperation never changed. The first half of the sixties saw the first concentrated effort to improve science education. Activity-based inquiry oriented science programs and textbooks were

concerned with the development of concepts and processes. Rejection of nationally developed curriculum, support of individualized science programs, advocation of value development in science education were some of the actions taken by science educators. By 1970, science educators were focusing their concern on developing underlying principles that gave structure to a subject, on teacher-oriented educational environments, and on giving the learner the important information and subordinate ideas of a discipline. One science educator suggested we transcend the cyclic patterns in science curriculum and focus attention on the nature of concept formation and learning theory.

It is reported in the review of literature that knowledge has been redefined in terms of emphasis on basic concepts and methods which scholars use as intellectual tools to analyze and order their data. Since the learning of concepts was an important educational objective at all school levels, teachers, curriculum experts, and the designers of instructional materials have been involved in identifying the concepts that students need to learn as they progress to higher levels. A concept was defined as broad generalizations regarding some aspect of the physical or biological world. It was noted that if concept learning occurs it provides the learner with tools for better understanding of the natural environment, a manifold gain in intellectual economy similar to that which results from organizing

facts into concepts, and an insight into the nature of the scientific enterprise in terms of its continual movement toward increased abstraction and generality.

In the review of literature, Piaget's research on qualitative changes that occur in cognitive development from infancy to maturity was identified. According to research findings the four stages (Sensori-motor, preoperation, concrete operations, and formal operations) were found dependent on socio-economic background. Piaget emphasized that throughout his or her life, a child is constantly assimilating data from the world around him/her, accommodating to the world around him/her, and organizing his/her experiences and knowledge in a structure. This process is called equilibration. Based on Piagetian theory, two general principles were applied: Children should learn through physical involvement and only the child can develop his or her cognitive ability and creative potential. Bruner's theory was described as a theory of conceptualization. Conceptualization was defined as a process of thinking or categorization. According to Bruner a child progresses through three stages of knowing: enactive, ikonic, and symbolic. Thus, in order for a child to know or learn he must be presented subject matter in a manner that requires him to organize it himself. It was noted that psychologist Ausubel felt that since reception learning is the dominant form of learning in schools then more time should be spent in making reception learning

more meaningful. Ausubel contended that there was a hierarchy of concepts. Concepts can be related to form one concept. Children should be presented with general concepts and move to specific details. A child must be able to relate new knowledge to something he/she has already in his/her consciousness. Ausubel made a distinction between rote reception learning and meaningful reception learning.

The review of literature also contained reports on three laboratory programs: SCIS, SAPA, and ESS. Organisms, life cycles, populations, environments, communities and ecosystems structure the life science sequence in SCIS. Students explore live organisms, teachers "invent" concepts after student's exploration, and finally students discover new concepts by using their new knowledge. The second laboratory program reviewed, ESS, also emphasized the manipulation of physical materials to develop basic concepts. The writers of ESS picked a variety of topics to confront students with central themes of biology and to provide opportunities for ideas to grow into meaningful concepts. Each ESS unit is appropriate for a range of grade levels which enables teachers and students to select particular ESS units. The third program reviewed, SAPA, is unique because of its emphasis on procedures of scientific inquiry rather than on a body of content. Students are given tasks in which they use basic processes such as observation, classification, and inference as well as processes. SAPA was reported as being more teacher-

centered and hierarchial in structure.

It was reported that even though textbooks contained far more information than could be covered in a course, textbook's emphasis is on the processes of science rather than the content of science. The impact of the three laboratory programs, SCIS, SAPA, and ESS was evident in the textbook Modular Activities Program in Science (MAPS). Students become involved in experiences that permit them to develop their own thinking processes. Characteristics of the textbook MAPS included minimal reading, poetry inclusion, and student involvement. The textbook Concepts in Science was reported as being based on four conceptual life science schemes. Within each scheme was a hierarchy of concepts from simple to complex. Writers of Concepts in Science also emphasized that their textbook has students observe, describe, collect, investigate, discuss, report, and invent. The third textbook series reviewed, Science Understanding Your Environment, had two main aims: 1) the development of a knowledge dimension which referred to biological concepts and 2) development of a performance dimension which referred to inquiry skills. The writers again emphasized that in order to develop these dimensions students must be actively involved in collecting information, they must be exposed to open-inquiry demonstrations, and they must be provided with paper-pencil activities. The life science program is based on four major topics: The Living World, Plants, Animals, and Human Growth and Development.

The importance of including reading materials and illustrations in science materials was reported. Students need more than just vicarious learning. Even adults depend on reading for learning. The research of Piaget and Bruner emphasized the importance of illustrations in science materials.

The three textbooks and three laboratory programs were partially determined by sending an inquiry to twenty large school districts throughout the United States. The inquiry requested information regarding what science program the school system was presently using. This information was tabulated to determine the six leading science programs. After reviewing available textbook series, literature on science programs, and the returns of 16 of the 20 large school districts, the following textbooks and laboratory programs were chosen: Science Curriculum Improvement Study (SCIS), Science A Process Approach (SAPA), Elementary Science Study (ESS), Science Understanding Your Environment, Modular Activities Program in Science (MAPS) and Concepts in Science. From a study done in 1972, 114 life science concepts were determined. This list included concepts for grades one through twelve. A review of literature in science education revealed five methods that are utilized in concept development: 1) sentence inference, 2) statement of concept, 3) experiment demonstration, 4) example in the environment illustrating them, and 5) graphic illustration. Each elementary science textbook series

and teacher's manual of the laboratory programs were examined to determine on which pages specific concepts from the 114 life science concepts were found and the method utilized in presenting the concept. A concept was considered developed if at least three of the five methods were utilized in presenting the concept. Number of pages determined the method most commonly used. Laboratory programs and textbooks were identified by letters. Concepts were numbered 1-114 and analysis criteria were numbered 1-5. Seven tables were constructed to organize the findings that answered the five research questions.

To ensure that the researcher's analysis of the programs were reliable, an evaluation by a panel of science educators was conducted.

## FINDINGS AND CONCLUSIONS

The examination of three elementary science programs and three elementary science textbook programs and the analysis of the data of this study made possible the following findings from which conclusions were drawn.

Question 1. What life science concepts are developed in each of three major elementary science laboratory programs and three major elementary science textbooks according to grade level?

Findings: Program A, ESS, in first grade developed the following concepts: 9, 20, 21, 27, 34, and 109. In second grade concepts 9, 21, 27, 34, and 109 were developed. In third grade

concepts 9, 20, 21, 27, 34, and 109 were developed. In fourth grade concepts 9, 20, 21, 27, 34, 57, 73, 74, 104, and 109 were developed. In fifth grade concepts 9, 20, 21, 27, 73, 74, and 109 were developed. In sixth grade concepts 9, 20, 31, 27, 73, 74, and 109 were developed. Program B, SCIS, first grade developed the following concepts: 27 and 28. In second grade concepts 2, 9, 21, and 44 were developed. In third grade concepts 27 and 109 were developed. In fourth grade concepts 8, 9, 19, and 20 were developed. In fifth grade concepts 7, 21, 26, 27, and 28 were developed. Program C, SAPA, developed concept 9 in first grade. Concepts 20, 21, 29, and 109 were developed in second grade. Concepts 72 and 109 were developed in third grade. In fourth grade concepts 19, 20, and 27 were developed. In fifth grade concepts 19, 80, and 109 were developed. In sixth grade, concepts 9, 19, 20, and 109 were developed. Program D, Science Understanding Your Environment, developed the following concepts in grade one: 10, 13, 15, 17, 21, 26, 27, 28, 34, 77, and 93. In second grade concepts 8, 9, 13, 20, 27, 28, 29, 44, 45, and 109 were developed. In third grade concepts 4, 7, 8, 9, 13, 20, 21, 26, 27, 34, 38, 55, 70, and 109 were developed. In fourth grade concepts 8, 9, 13, 16, 28, 34, 36, 38, 46, 47, 53, 58, 77, and 109 were developed. In fifth grade concepts 10, 21, 28, 47, 58, 70, 91, and 109 were developed. Concepts 10, 13, 19, 20, 27, 29, 30, 34, 36, 53, 58, 73, 76, 77, 78, 93, 94, and 98 were developed in grade six. In Program E, MAPS, concepts

35, 44, 47, and 109 were developed in grade one. In grade two, concepts 8, 9, 13, 20, 21, 28, 34, 44, 103, and 109 were developed. In grade three concepts 1, 2, 7, 8, 9, 10, 13, 21, 26, 27, 28, 34, 35, and 46 were developed. In grade four concepts 7, 8, 20, 21, 26, 27, 28, 31, 34, and 109 were developed. In grade five concepts 8, 9, 10, 20, 21, 44, 73, 77 and 109 were developed. Concepts 1, 2, 3, 4, 7, 8, 9, 10, 13, 26, 27, 28, 40, 44, 46, 47, 55, 62, and 109 were developed in grade six. The following concepts were developed in the first grade of Program F, Concepts in Science; 13, 21, and 93. In second grade concepts 8, 13, 21, 38, 40, 44, 70, 93, and 109 were developed. In third grade concepts 8, 9, 13, 21, 25, 28, 29, 38, 40, and 109 were developed. In fourth grade concepts 2, 8, 9, 13, 19, 20, 21, 27, 28, 34, 48, 74, 99, and 104 were developed. In fifth grade concepts 8, 34, 60, 67, 70, 72, 73, 74, 75, 76, 77, 88, 90, 91, 104, and 109 were developed. In grade six concepts 13, 19, 20, 27, 38, 40, 56, 58, 78, 80, 104, and 114 were developed.

Conclusions: The individual concepts were examined and classified in terms of category types (1-15) they represented. This classification procedure made it possible to identify which broad areas in life science were addressed in the respective programs and at what particular grade level.

Program A, ESS, developed concepts in the following categories across grade levels 1-6: ecological growth and change, plant and

animal behavior, reproduction, ecosystem, plant and animal classification, and organisms. In grade 4 concepts in the following category were developed: pest control and diseases. In grades 4,5, and 6 concepts in the following category were developed: cells. In program B, SCIS, concepts in the following categories were developed in grade 1: organisms and ecosystems. In grade 2 concepts ecological growth and change, reproduction, and plant and animal classification were developed. In grade 3 the concepts plant and animal classification and ecosystem emerged as developed. In grade 4 concepts in the following categories were developed: plant and animal behavior and ecological growth and change. In grade 5 concepts in the following categories were developed: organisms, reproduction, communities, and ecosystem. In grade 6 concepts in the following categories were developed: ecosystem, communities, and ecological growth and change. In program C, SAPA, concepts in the following category were developed in grade 1: ecological growth and change. In grade 2 concepts in the following categories were developed: plant and animal behavior, reproduction, plant and animal classification, and ecosystem. In grade 3 concepts in the following categories were developed: plant and animal classification, and evolution. In grade 4 concepts in the following categories were developed: organisms, plant and animal behavior, and ecosystem. In grade 5 concepts in the following categories were developed: plant and animal behavior, reproduction,

plant and animal classification, and genes. In grade 6 concepts in the following categories were developed: ecological growth and change, organisms, plant and animal behavior, and plant and animal classification. In program D, Science Understanding Your Environment, concepts in the following categories were developed in grade 1: ecological growth and change, organisms, reproduction, communities, ecosystem, cells, and health. In grade 2 concepts in the following categories were developed: ecological growth and change, organisms, plant and animal behavior, plant and animal classification, and ecosystem. In grade 3 concepts in the following categories were developed: ecological growth and change, organisms, plant and animal behavior, reproduction, plant and animal classification, communities, ecosystem, energy, pest control and diseases, and evolution. In grade 4 concepts in the following categories were developed: ecological growth and change, organisms, plant and animal classification, ecosystem, energy, natural resources, pest control and diseases, and cells. In grade 5 concepts in the following categories were developed: ecological growth and change, reproduction, plant and animal classification, ecosystem, natural resources, evolution, and health. In grade 6 concepts in the following categories were developed: ecological growth and change, organisms, plant and animal behavior, ecosystem, pest control and diseases, cells, and health. In program E, MAPS, concepts in the following categories

were developed in grade 1: plant and animal classification, ecosystem, and natural resources. In grade 2 concepts in the following categories were developed: ecological growth and change, organisms, plant and animal behavior, reproduction, plant and animal classification, and ecosystem. In grade 3 concepts in the following categories were developed: ecological growth and change, organisms, reproduction, communities, ecosystem, and natural resources. In grade 4 concepts in the following categories were developed: ecological growth and change, plant and animal behavior, reproduction, plant and animal classification, communities and ecosystem. In grade 5 concepts in the following categories were developed: ecological growth and change, plant and animal behavior, reproduction, plant and animal classification, and cells. In grade 6 concepts in the following categories were developed: ecological growth and change, organisms, plant and animal classification, communities, ecosystem, energy, natural resources, pest control and diseases, and evolution. In program F, Concepts in Science, concepts in the following categories were developed in grade 1: organisms, reproduction, and health. In grade 2, concepts in the following categories were developed: ecological growth and change, organisms, reproduction, plant and animal classification, energy, evolution, and health. In grade 3 concepts in the following categories were developed: ecological growth and change, organisms, reproduction, plant and animal classification, energy, and ecosystem.

In grade 4 concepts in the following categories were developed: ecological growth and change, organisms, plant and animal behavior, reproduction, ecosystem, energy, cells, and health. In grade 5 concepts in the following categories were developed: ecological growth and change, organisms, plant and animal classification, ecosystem, evolution, cells, heredity, and health. In grade 6 concepts in the following categories were developed: plant and animal behavior, organisms, ecosystem, energy, pest control and diseases, cells, genes and heredity.

In program A, ESS, there was a total of 8 categories developed in grade 4 which was the highest number of categories developed in a grade. Seven categories were developed in grades 5 and 6, and 6 categories were developed in grades 1, 2, and 3. ESS developed six categories throughout six grades. In program B, SCIS, there was a total of 4 categories developed in grade 5 which was the highest number of categories developed in a grade. Three categories were developed in grades 3 and 6, 2 categories were developed in grades 1, 3, and 4. In program C, SAPA, there was a total of 6 categories developed in grades 2, 5, and 6 which was the highest number of categories developed in a grade. Three categories were developed in grade 4, 4 categories were developed in grade 3 and one category in grade 1. In program D, Science Understanding Your Environment, there was a total of 11 categories developed in grade 3 which was the highest

number of categories developed in a grade. Nine categories were developed in grade 4, 7 cateogires were developed in grades 1, 5, and 6, and 5 categories were developed in grade 2. In program E, MAPS, 9 categories were developed in grade 6 which was the highest number of categories developed in a grade. Seven categories were developed in grade 4, 6 categories were developed in grades 2, and 3, 5 categories were developed in grade 5, and 3 categories in grade one. In program F, Concepts in Science, 8 categories were developed in grades 4, 5, and 6, which was the highest number of categories developed in a grade. Seven categories were developed in grades 2 and 3, and 3 categories were developed in grade 1.

Question 2. How many life science concepts are developed in each of three major elementary science laboratory programs and three major elementary science textbooks?

Findings: Program A, ESS, presented 19 concepts and 10 of the 19 were developed. Program B, SCIS, presented 24 concepts and 13 were developed. Program C, SAPA, presented 18 concepts and 9 were developed. Program D, Science Understanding Your Environment, presented 57 concepts and 37 were developed. Program E, MAPS, presented 39 concepts and 27 were developed. Program F, Concepts in Science, presented 62 concepts and 36 were developed.

Conclusion: Program C, SAPA, presented and developed fewer concepts than the other programs. Program F had the largest range

between the number of concepts presented and the number developed. Program A, ESS, and Program C, SAPA, each presented nine more concepts than they developed. When all six science programs were examined, this was the smallest margin between concepts presented and concepts developed. Program B, SCIS, presented eleven more concepts than they developed. This placed program B, SCIS, third in order among the six programs in terms of the difference in concepts presented and developed. Program E, MAPS, presented twelve more concepts than they developed. This placed program E, MAPS, fourth in order among the six programs in terms of the difference in concepts presented and developed. Program D, Science Understanding Your Environment, presented twenty more concepts than they developed. This placed program D, Science Understanding Your Environment, fifth in order among the six programs in terms of the difference in concepts presented and developed. Program F, Concepts in Science, presented twenty-six more concepts than they developed. This placed program F, Concepts in Science, sixth among the six programs in terms of the difference in concepts presented and developed. As the preceding discussion indicates, the laboratory programs SCIS, SAPA, and ESS, and the textbook series, MAPS, were closer in number of concepts presented and developed than the two textbooks series, Science Understanding Your Environment and Concepts in Science. There was a marked discrepency in the number of concepts presented and concepts

developed in the two latter textbook series, Science Understanding Your Environment, and Concepts in Science.

Question 3. What method: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) example in the environment illustrating them; and 5) graphic illustration with or without textual references, captions, or labels, was used most frequently in the development of life science concepts in each of the three major elementary science laboratory programs and three major elementary science textbooks? What method was second most used? third? fourth? fifth?

Findings: Program A, ESS, used the method, sentence inference first, graphic illustration second, example in the environment illustrating them third, experiment demonstration fourth, and statement of concept fifth. These numbers are a result of considering each unit in program A, ESS, as being utilized at every suggested grade level. This skews the data because it assumes that if a unit in Program A, ESS, is recommended for grades 1-4 it will be taught all four years. For example, one unit in program A, ESS, consisted of a book of illustrations totaling 99 pages. This single book is recommended for each of three grades, thus, totaling 297 illustrations. This is possible because each unit includes suggestions for use with each grade level. Also, one unit in program A, ESS, may present concept 13 by two methods which would not develop that concept. But combined

with another unit which may use a third method in presenting concept 13, it would be considered developed. A particular unit in program A, ESS, does not develop a concept, but a combination of units will develop a concept. This practice is consistent with the recommendations of the writers of the material. Concept 109 is an example of this. Concept 109, when presented in the various grade levels recommended by the publishers used 99 inferences, 6 experiments, 22 examples in the environment, and 350 illustrations. In comparison program B, SCIS, used the method sentence inference first, graphic illustration second, experiment demonstration third, example in the environment demonstrating them fourth, and statement, fifth. There were 26 more pages utilizing inference than illustration and 18 more pages of illustration than experiment. Program C, SAPA, used the method sentence inference first, experiment demonstration second, example in the environment illustrating them third, graphic illustration fourth, and statement of concept fifth. There were 14 more pages of example in the environment illustrating them than graphic illustrations. Program D, Science Understanding Your Environment, used the method sentence inference first, graphic illustration second, example in the environment illustrating them third, experiment demonstration fourth, and statement of concept fifth. There were 32 more pages of inference than illustration. Inference was used on 292 more pages than experiment. There were 20 more pages of experiment than state-

ment. Program E, MAPS, used the method graphic illustration first, sentence inference second, example in the environment illustrating them third, experiment demonstration fourth, and statement of concept fifth. There were 48 more pages of illustrations than pages of inferences. There were 129 more inferences than experiments. Program F, Concepts in Science, used the method sentence inference first, graphic illustration second, experiment demonstration third, example in the environment illustrating them fourth, and statement of concept fifth. There was a margin of 524 pages between experiment and inference.

Conclusion: The publishers of the six science programs emphasized the importance of student manipulation of materials in order for conceptualization to occur. Writers of the program, ESS, stated in their unit on Eggs and Tadpoles: "The overall purpose of this unit is to help children understand how they can find things out for themselves by observing living materials--not just to teach them a specific set of facts about frogs and tadpoles" (1974:viii). ESS writers emphasized the fact that the development of inquiring children was just as important as the development of particular scientific concepts. SCIS writers claimed that a child, through his own observation and responses, will discover the concepts. SAPA's complete emphasis was on developing a basic concern rather than a body of content. MAPS' writers noted that their emphasis was not

reading; a child will develop an understanding of concepts by working with real material and visual stimuli representations of real materials. Concepts in Science writers claimed that the core to concept seeking was investigation. Writers of Science Understanding Your Environment stated that pupils must be actively involved in collecting information, and teachers must conduct open inquiry demonstrations.

The predominance of the method, experiment demonstration revealed the manner in which a student would be involved in a particular program. This method implies that students will be acting as scientists by handling materials while they solve problems. High usage of the methods, sentence inference, statement of concept, and graphic illustration implies that students are predominately reading.

When examining all six programs in terms of method utilization, the method, inference, was utilized most often by each program. This would be expected since reading is a primary means of introducing experiments, illustrations, and examples in the environment. In the following analyses the terminology high utilization, refers to an abundant number of occurrences of a method when compared to the occurrences of the method, inference; hence the number of inferences serves as a point of reference. If, for example, the number of inferences was 143 and the number of experiments was 99, one could

say that the method, experiment was highly utilized.

Because ESS writers recommend that each of their units can be used at various grade levels, any particular unit extended across these levels makes occurrences of methods look greater than if they were just tied to one grade level. In order to view the laboratory program, ESS, in proper perspective regarding method utilization, each unit of ESS in this discussion is treated as if it were taught at only one grade level. The occurrence of each method in all of the ESS units combined is as follows: sentence inference, 145; statement of concept, 1; experiment demonstration, 77; graphic illustration, 174; and example in the environment illustrating them, 85. Two ESS units, Bones and Tracks, are picture books which include 39 pages and 99 pages of illustrations respectively. The preceding two books include 138 pages of the 174 pages of illustrations occurring in all ESS materials. The method, experiment demonstration, was highly utilized in this program which supports the claims of the writers.

SCIS employs a three phase teaching strategy--exploration, invention, and discovery; the invention phase involves teacher's introducting "new" concepts to the students. This accounted for the 17 times SCIS utilized the method, statement of concept. SCIS highly utilizes the method, experiment demonstration throughout their program, thus supporting the claims of the writers.

In program C, SAPA, the method, experiment demonstration is

highly utilized throughout the program, thus supporting the claims of the writers. In program D, Science Understanding Your Environment, the method, experiment demonstration, is not highly utilized in comparison to the method, sentence inference.

Program F, Concepts in Science, utilizes the method, experiment demonstration, considerably less than the methods, sentence inference and graphic illustration, which implies that students are primarily involved in reading. Program E, MAPS, utilizes methods, experiment demonstration, and example in the environment highly, which agrees with the writer's claim that students will develop an understanding of a concept by working with real materials (experimentation) and visual stimuli representations of real materials (example in the environment). Of the three textbook programs, MAPS is the only one that utilizes the method, experiment demonstration, as highly in comparison with the method, sentence inference. All three laboratory programs, SCIS, SAPA, and ESS, highly utilize the method, experiment demonstration which supports the claims of the writers of these science programs. The writers for the textbooks, Concepts in Science and Science Understanding Your Environment made claims that the core to concept seeking was through investigation and that pupils must be actively involved in collecting information. As this study indicates, the low utilization of the method, experiment demonstration, in these two textbooks does not support this claim.

Question 4. What method: 1) sentence inference; 2) statement of concept; 3) experiment demonstration; 4) example in the environment illustrating them; 5) graphic illustration with or without textual references, captions, or labels, was used most frequently in the development of life science concepts in all three laboratory science programs and all three elementary science texts combined? What method was second most used? third? fourth? fifth?

Findings: The most frequently used method in all six programs combined was sentence inference; graphic illustrations was used second; example in the environment illustrating them third; experiment demonstration fourth; and statement of concept fifth. There were 228 more pages of inference than illustration; there were 974 more pages of illustration than example in the environment; there were 87 more pages of example in the environment than experiment; and there were 609 more pages of experiment than statement.

Conclusions: In order for an elementary science program to be consistent with recent developments in elementary science education, students must actively participate in a lesson or "act" as scientist in solving problems. The theories of two prominent psychologists, Piaget and Bruner, support the importance of learning through physical involvement in the elementary grades. The high frequency of the methods, sentence inference and graphic illustration, utilized in the development of life science concepts in all six science programs,

indicates that students are primarily reading science. This is not supportive of the reported present trend in elementary science education nor does it support the learning theories of Piaget and Bruner. However, the high frequency of the method, sentence inference, and graphic illustration, were mostly contributed by the textbooks, Concepts in Science and Science Understanding Your Environment. Therefore, the laboratory programs, SCIS, ESS, SAPA, and the textbook MAPS, cannot be considered inconsistent with the present reported trends in science education and the theories of Piaget and Bruner.

Question 5. What life science concepts are developed across grade levels 1-6 in each of the three major elementary science laboratory programs and three major elementary science textbooks?

Findings: In program A, ESS, concepts 9, 20, 21, 27, 34, 57, 73, 74, 104, and 109 were developed. In program B, SCIS, concepts 1, 2, 7, 8, 9, 19, 20, 21, 26, 27, 28, 44, and 109 were developed. In program C, SAPA, concepts 9, 19, 20, 21, 27, 29, 72, 90, and 109 were developed. In program D, Science Understanding Your Environment, concepts 4, 7, 8, 9, 10, 13, 15, 16, 17, 19, 20, 21, 26, 27, 28, 29, 30, 34, 36, 38, 44, 45, 46, 47, 53, 55, 56, 58, 70, 73, 76, 77, 78, 91, 93, 94, 98, and 109 were developed. In program E, MAPS, concepts 1, 2, 3, 4, 7, 8, 9, 10, 13, 20, 21, 26, 27, 28, 31, 34, 35, 40, 44, 46, 47, 55, 62, 73, 77, 103, and 109 were developed. In program F, Concepts in Science, concepts 2, 8, 9, 12, 19, 20, 21, 25, 27, 28,

29, 34, 38, 40, 44, 56, 58, 60, 67, 70, 72, 73, 74, 75, 76, 77, 78, 80, 88, 90, 91, 93, 99, 104, 109, and 114 were developed.

Once the individual concepts were identified, they were examined in terms of the broad categories they could be classified into: Program A, ESS, developed concepts in the categories, ecological growth and development, plant and animal behavior, reproduction, plant and animal classification, ecosystem, pest control and diseases, organism, and cells. No concepts in the categories, communities, energy, natural resources, evolution, genes, heredity, and health were developed. Program B, SCIS, developed concepts in the categories, ecological growth and change, plant and animal behavior, reproduction, plant and animal classification, communities, ecosystems, and organisms. No concepts were developed in the categories, energy, natural resources, pest control and diseases, evolution, cells, genes, heredity, and health. Program C, SAPA, developed concepts in the categories, ecological growth and change, plant and animal behavior, reproduction, plant and animal classification, ecosystems, pest control and diseases, organisms, and cells. No concepts in the categories, communities, energy, natural resources, evolution, genes, heredity or health were developed. Program D, Science Understanding Your Environment, developed concepts in the categories, ecological growth and change, organisms, plant and animal behavior, reproduction, plant and animal classification,

communities, ecosystems, energy, natural resources, pest control and diseases, evolution, health, and cells. Concepts in the categories, genes and heredity, were not developed. Program E, MAPS, developed concepts in the categories, ecological growth and change, organisms, plant and animal classification, communities, ecosystem, energy, natural resources, pest control and diseases, evolution, and cells. Concepts in the categories, genes, heredity, and health were not developed. Program F, Concepts in Science, developed concepts in the categories, ecological growth and change, organisms, plant and animal behavior, reproduction, plant and animal classification, ecosystem, energy, pest control and diseases, evolution, cells, genes, heredity, and health. Concepts in the categories, communities and natural resources, were not developed.

Conclusions: ESS writers claim that there is no distinct set of study topics in the elementary science curriculum which work for all children. For this reason the writers of ESS have generated a variety of independent units, which are not sequenced according to concepts. Therefore, the lack of development of concepts in the categories, communities, energy, natural resources, evolution, genes, heredity, and health, are not in conflict with the writer's claim that there is no distinct set of study topics in the elementary science curriculum.

SCIS materials dealt with components of the ecosystem.

Concepts that were concerned with ecological phenomena were developed and thus the claims of the writers that SCIS' major direction of the content is in the development of the concept ecosystem were supported by the findings of this study.

Out of the 41 life science units in the program, SAPA, only 23 of the units dealt with any of the 114 concepts. For example, in the unit, Seeds and Soap, there was no presentation of the effect soap and detergents have on the environment even though the rationale at the beginning of the unit suggested it. This unit emphasized the processes of science rather than the development of life science concepts. This is not in conflict with the claims of SAPA writers since they contended that their emphasis is on developing processes rather than a body of knowledge. However, the rationale in the teachers guide implies that a life science concept will be presented.

Science Understanding Your Environment was the only science program of the six programs examined that developed several concepts in the category, health.

Examination of the categories developed in MAPS supported the claims of the writers that their material was drawn from the three laboratory programs, SCIS, SAPA, and ESS. In addition to the ecological approach of SCIS, MAPS developed concepts in the additional categories, natural resources, pest control and diseases, evolution, and cells. MAPS did not include concepts in the category, health,

and therefore could not be considered for use as a health science program.

Concepts in Science presented more categories than the other five science programs investigated in this study. Concepts in Science was the only science program that developed concepts in the categories, genes, and heredity. Concepts in Science dealt with only one concept in the category, health, and therefore should not be considered for use as a complete health science program.

## RECOMMENDATIONS

1. The methods, inference and illustrations, in comparison to the method, experimentation, were utilized highly by the writers of the textbooks, Concepts in Science and Science Understanding Your Environment. Personnel who are evaluating science textbooks for use with elementary students should be aware of the predominance of these methods in the materials, since present research in science teaching emphasized the importance of the experimental method.

2. Since the life science concept load was found to be high in science textbooks, any attempt to describe reading level of a science text should take this finding into account. Most reading formulas to not utilize concept load as a factor.

3. Parallel studies should be conducted utilizing a physical science concept list.

4. Based upon the findings of this study, certain specific topics in life science such as ornithology and environmental education, received little attention commensurate to the present demand for these. Should life science teachers see these topics as a necessary part of the curriculum, other science materials should be examined in order to determine appropriate supplementary materials to purchase.

5. Based upon the findings of this study, only one program (Science Understanding Your Environment) of the six programs examined, included more than one health concept. Should school district personnel desire a complete health program, additional health materials should be purchased.

6. Elementary school science personnel who are involved in adopting science materials should be discerning in their judgment as to the appropriateness of the number of concepts developed in a program. As suggested in the findings of this study, there is a marked discrepancy in the number of concepts developed in the six programs. If it were important for the science program of a school system to have a large number of concepts developed, then the school system should consider the adoption of the textbooks, Science Understanding Your Environment and Concepts in Science.

However, school science personnel who are adopting science materials should be careful in that in the number of concepts developed

in a program does not guarantee their mastery.

7. Adoption committees should be discerning as to whether they want to adopt a science program that would deal with a complex concept such as "The phenomenon of heredity in all living things thus far investigated is attributable to the replication and transmission of the genetic materials DNA or RNA." The textbook, Concepts in Science, Developed this concept. Any adoption committee should examine the concepts developed in any program under consideration for this phenomena.

8. Adoption committees should make a decision concerning whether they desire a spiral or hierarchial curriculum in science. A hierarchial curriculum such as SAPA and Concepts in Science, implies complex concepts could be first introduced in the intermediate grades without any previous experience of the children with that concept. A spiral curriculum, such as SCIS, implies a revisiting of concepts throughout the grades.

9. If ESS were to be adopted as a complete science program and the categories, communities, energy, natural resources, evolution, genes, heredity, and health were deemed necessary, experiences for the children with these topics would have to be provided for through supplementary materials.

10. Since SCIS materials examined dealt with components of the ecosystem, members of an adoption committee who want a science

program more diversified than an ecological approach would have to supplement the SCIS program.

11. Minimal reading was utilized in the three laboratory programs SCIS, SAPA, and ESS. Personnel responsible for the development of a complete science program should consider supplementing these programs with a reading component.

12. Those who use or wish to adopt the program, SAPA, should be aware of what specific concepts are developed in the units. Titles of the units may be misleading because they may imply that life science concepts are presented which have not been shown to be developed through this study.

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PLEASE NOTE:

Appendices contain small print.
Filmed as received.

UNIVERSITY MICROFILMS INTERNATIONAL

# APPENDIX A

CONCEPT LIST

1. Livings things tend to increase in numbers to the level the environment will permit. Man's ability to modify his environment does not make him an exception. His success in bypassing some environmental barriers is now challenged by new barriers.

2. The earth's carrying capacity is finite for one and all species. Its space, materials, and available energy are limited mainly by surface area, the rate of cycling of water, gases, and materials, and the efficiency of photosynthesis.

3. Population growth in animals is solely a function of the relationship between birth rates, death rates, and migration. Where egress is not possible, continued increase can only be stopped by reduced birth rates and/or increased death rates.

4. Man as an ecological force has been able to change some populations of organisms to suit his needs through selection and differential reproduction rates.

5. When plants and animals alter the environment by their presence, they may adversely affect conditions for their own survival while improving conditions for the survival of other plants and animals thus allowing a succession of changes to occur.

6. After a slow phase, population growth from relatively low to relatively high levels usually tends to occur exponentially, then to decline as numbers approach environmental capacity.

7. Serious disturbance within a biotic community usually result in the increase of some species and the decrease of others. The fluctuations may abate in time and a new community will be established.

8. Plants and animals have a limited but varied ability to adjust to the environment. Survival in a given place is determined primarily by the genetically specified morphology and physiology of the individual.

9. The variability of environmental factors influences the growth and distribution of plant and animal life at all levels; from the small scale (microcosm) to the large (biome).

10. Most plant and animal species possess the ability to survive in a variety of environments. If not restricted by physical barriers, they occupy any natural environmental niche where they can successfully compete with other species.

11. Environmental factors which influence and in turn are influenced by a population, tend to stabilize the population's size. Those factors which influence populations but are independent of them may cause instability.

12. The development of an organism results from the interaction of the organism's genetic endowment with its environment.

13. The survival and well-being of an organism depends in part upon the availability of water, energy or energy-yielding substances, minerals, and in some cases certain essential organic compounds that cannot be synthesized by the organism.

14. Organisms cannot be completely understood in terms of present physical and chemical laws. For example, the behavior of an organism cannot be predicted from the activities of its cells. New laws may emerge on the organismal level.

15. Deficiencies of essential nutrients usually lead to malfunctions in organisms.

16. The more constant the internal environment of an organism, the freer it can be of external environmental restrictions.

17. Some higher plants, and a few higher animals, seem capable of continuous growth during their life span.

18. Animal behavior has evolved just as structure and biochemical processes have. The behaviors of man and many other animals have much in common.

19. The development of behavior is the product of both genetic and environmental interactions; purely genetic or fully learned behavior is highly improbably.

20. Behavioral patterns can be described in terms of one or more of the following: their functional significance, evolutionary history, developmental roots in the individual's experience and physiological mechanisms.

21. Different species may have different methods of reproducing themselves. Some reproduce by fission or spores, others through sex cells, and some use several methods.

22. The process of reproduction in higher animals is, in part, initiated and regulated by the action of those hormones which control primary and secondary sexual development and influence behavior.

23. In many animal species the opportunities for mating depend upon socially determined interactions such as position in a dominance hierarchy or possession of territory. Individuals who are able to survive physically may not contribute their genetic material to the next generation due to lack of territory or social dominance.

24. A species is the basic classificatory unit into which biologists divide both plants and animals. By one definition species may be thought of as an assemblage of individuals capable of interbreeding.

25. Hereditary differences and similarities form the basis for the classification of plants and animals.

26. Diversification and specialization in species both lead to communities of living things characterized by interdependence, sharing and mutual tolerance, relative density, complexity, and the efficient use of space, matter, and energy.

27. All living things are interdependent with one another and with their environment.

28. No one major ecological factor but a combination of them determines the environment; soil, water, air, energy, plants and animals (including man) all contribute.

29. Four basic attributes of living systems are: (1) the capacity to make copies of themselves; (2) the capability for change; (3) the capacity to store information and; (4) the ability to translate this information for use in complex activities.

30. All living systems--from cells to biomes--are in a dynamic steady-state which may be altered when a component in a system is changed.

31. Order is a constant theme in biology. Life is organized from the molecular and intracellular level to the community and biosphere.

32. When internal disturbances occur in organisms as a result of various stresses, adjustments occur through regulatory mechanisms or adaptations that tend to move the system toward a normal state or one compatible with survival.

33. While many biological events appear to be random, these events can often be described or predicted statistically.

34. All things--physical as well as biological--change through time.

35. Although individual reactions in biological systems tend to be reversible, the sum total of such reaction usually leads to stable predictable and generally irreversible changes.

36. With individual higher animals, the survival in and adaptation to a changing environment depends to a large extent upon the interaction of the nervous and endocrine system.

37. Cellular and tissue interactions are basic components of the processes required to effect differentiation.

38. With minor exceptions, living things obtain their energy directly or indirectly from the sun through the process of photosynthesis.

39. In a biochemical reaction there is no loss or gain of energy, only a transformation of energy from one form to another.

40. Energy passes through a network of organisms beginning with green plants--the food producers--then to animals which eat plants, then to animals that eat those animals and so on. At each transfer energy is dissipated and less life can be sustained.

41. The general mechanisms for the utilization, storage, and transfer of energy appears to be basically similar in all organisms. All organisms employ ATP as the universal energy carrier.

42. During their life span, living organisms can accumulate energy to maintain a dynamic steady-state positive energy balance.

43. Ecosystems, such as inland bodies of water, with measurable energy inputs, outputs and determinable transfer functions, can be

partially modeled. Appropriate computer programs can then aid in solving ecological problems.

44. While no single characteristic differentiates all plants from all animals, differences between them do exist. These differences become more pronounced in the higher form.

45. One factor limiting the size of a terrestrial animal is the type of skeleton it has. An internal skeleton is able to support a much larger animal than an external skeleton of the same weight.

46. To meet future needs, the use of biological resources must be governed by the role these resources play in the ecosystem.

47. The natural environment is being so altered through the effects of technology and the rapid expansion of wealth and population that man must make drastic changes in his behavior or consider his extinction probable.

48. The control of plant and animal pests by factors such as disease, natural enemies and competitors is less harmful to the environment (in some cases) than many of the chemicals synthesized for that purpose by man.

49. Infectious diseases are controlled by excluding the pathogen from the host's environment, eradicating it from this environment, and by preventing or limiting its growth within the host.

50. In higher animals resistance to some disease-producing microorganisms can be induced in the absence of the disease by stimulating the host's immune response to the specific pathogen.

51. Varieties of plant and animal species as well as individual organisms differ in their susceptibility to diseases, as pathogen organisms also differ in their ability to induce diseases. This variation is hereditary but its expression is dependent on the environment.

52. The dispersal of most pathogenic organisms is primarily passive. However, vectors such as insects and other organisms do account for the transmission of some pathogens.

53. Diseases are a byproduct of the metabolism and reproduction of pathogenic microorganisms, reflecting the interaction of the pathogen with a susceptible host.

54. Diseases are due to natural causes. All physical and possibly all mental diseases are based on molecular interactions.

55. Organisms become troublesome to man when his own activities alter or upset the existing steady-state. In this respect many organisms have become better adjusted to man than he has to them.

56. Diseases are ideally controlled within populations, as well as individuals, by prevention rather than cure.

57. Most species of microorganisms in their natural habitat are not dangerous to man and are essential components of the ecosystem.

58. Diseases in plants and animals may result from such factors as genetic constitution and physiological dysfunction, and/or may be caused by living agents such as viruses, bacteria, fungi, parasitic higher organisms, and insects.

59. Following recovery from a disease caused by microorganisms, a second contact may produce no illness in higher organisms. Immunity occurs if a high level of antibodies and an increased capacity to produce specific antibodies results from the first exposure.

60. Evolution of all life, including that of man, is not toward a hypothetically perfect form of organism, but towards the most effective adaptation in a particular environment and niche.

61. The enormous variety of organisms, past and present, is thought to be the result of evolution.

62. Man, like all other animals, has evolved in response to his physical, chemical, and biotic environment. This environment in part control's him, and in part is controlled by him.

63. Evolutionary specialization of long duration has resulted in morphological and physiological difference among the cells of an organism.

64. Individuals who survive to reproduce, contribute their genetic material to the next generation. The genetic material of those who fail to reproduce is lost to future generations.

65. Theoretically, man can be modified by a system of selective breeding as have plants and other animals.

66. In sexually reproducting organisms, many new species arise when a segment of a population is isolated under conditions where it is free to evolve along different lines until it can no longer interbreed with descendents of the original population.

67. The first land plants and animals may have evolved from aquatic ancestors who became adapted to life outside the water environment by the gradual development of specialized structures for support, exchange of gasses, and reproduction.

68. There is no scientific evidence that the origin, evolution, and continuation of life on this planet is dependent on other than natural phenomena.

69. One theory states that life began in an oxygen-free atmosphere. The atmosphere changed when primitive cells developed a photosynthetic capacity and released oxygen. Present atmospheric oxygen is predominantly of photosynthetic origin.

70. Fossils represent ancient one-living organisms and populations. Much of our information about them is derived in part from principles based on the study of modern organisms and populations.

71. One theory concerning the origin of life on earth proposes that it arose spontaneously in an aquatic environment by the action of energy on nonliving material that became self-reproducing.

72. Fossels of algae-like organisms and bacteria provide evidence of the earliest life on earth. These organisms are found in sedimentary formations believed to have been deposited more than three billion years ago.

73. By and large living things are composed of a fundamental unit of structure and function known as the cell.

74. Present living cells are seen to arise from pre-existing cells.

75. Cell membranes provide a selective barrier which maintains the intracellular environments suitable for the biological reactions occurring within cells.

76. The activities of living cells result essentially from chemical and physical processes in which the reactants are supplied by nutrients that must be replenished.

77. Associations of specialized cells performing the same function form tissue, groups of different tissues combined in characteristic patterns form organs, and collections of functionally related organs constitute systems within the organism.

78. All chemical reactions occurring within cells are controlled by regulating the amount, type, and specificity of the enzymes present. Complex living systems would not be possible without this control.

79. As a zygote divides and develops into an embryo and eventually into an adult, different groups of cells lose different parts of the potential toward differentiation.

80. Genes direct the process of development by imposing a species specific control on the developing embryo and also regulating the general processes of differentiation.

81. Genes are arranged in a single file on chromosones. Genes on a chromosone are usually inherited together.

82. Most organisms carry harmful recessive genes which, if brought together by inbreeding or chance, may express themselves as abnormalities in the offspring of such a union.

83. Genetic mutation on the molecular level occurs as the alteration, addition, rearrangement, or omission of nucleotides in the mucleotide sequence of a gene.

84. The universal genetic code is based on various combinations of four different nucleotides. A single coding unit consisting of three such nucleotides usually specifies a particular amino acid. Another may initate or terminate synthesis or a polypeptide.

85. At times the genetic materials of two homologous chromosomes may be exchanged. This leads to greater variation in offspring and allows one to map the chromosomes.

86. The specificity of an antibody or enzyme is based on its unique capacity to unite preferentially with a definite chemical substance or configuration. Such a capacity reflects the genetic endowment of the cells producing the antibody or enzyme.

87. Most species alternate between the haploid and diploid state.

88. The phonomenon of heredity in all living things thus far investigated is attributable to the replication and transmission of the genetic materials DNA or RNA.

89. The DNA in a cell determines the type of RNA made, and the RNA in turn specifies the types of proteins which will be formed. Some of these proteins become structural components while others become enzymes. In this way genetic material determines characteristics of living organisms.

90. The process of nuclear division in which chromosomes separate after replication, insures the presence of identical genetic material in each of the two daughter nuclei and in each cell resulting from cell division.

91. Those chemical elements, which are basic building blocks of all life, are constantly cycled on our planet by chemical, biological, and geological processes.

92. All drugs (medicine) and many other substances (such as table salt) should be considered potentially harmful to the people who use them. Judicious use tends to minimize the danger.

93. Human health is promoted by moderation in things such as cleanliness, exercise and food consumption.

94. The nutritional requirements of an organism are determined by the composition and physiological activities of its tissues and constitutent cells. Genetic make-up, stress, and developmental stage may cause the needs to differ from time to time and from individual to individual.

95. Curing or preventing some human diseases in the population may not lessen the total need for medical care--it may increase it.

96. The occurrence of epidemics has been a factor influencing the evolution of all species including man.

97. Upon contact with some foreign agents, the immune response of higher animals is activated by a variety of cells which possess a specific immunological capacity.

98. The endocrine system is a feedback system which not only regulates many of the activities of higher animals, but their physical development as well. A malfunction of this system may result

in physiological disorder.

99. The complexity and diversity of living matter as we know it depends largely on the unique properties of the element carbon and the compound water.

100. Frequently biochemical and physiological processes have more than one function in metabolic activities.

101. Altering the chemical mediators at junctions between nerve cells can alter the behavior or state of an animal. This accounts for the action of many medicines, drugs, and other substances.

102. Some enzymes are solely protein, others only function in combination with another type of substance (called a coenzyme or prosthetic group).

103. The early embryonic stages of different animals may show gross morphological similarities. These similarities become less evident with further development.

104. Unicellular organisms (paramecia, amoeba) perform the major functions of multicellular organisms such as: ingestion, respiration, digestion, exretion, locomotion and reproduction. Such organisms are considered to have a cellular organization.

105. In animals, rejection of a transplanted tissue by a graft recipient may be the result of an immune reaction by the recipient against the foreign constituents present within the graft.

106. The conservative nature of living systems is exemplified by cyclic progresses that have evolved, from the metabolic activities within a single cell to cycles occurring on a world-wide scale.

107. Ionizing radiation generally has its greatest effect on proliferating and/or relatively undifferentiated cells.

108. The indefinite extension of a human life may not be a desirable goal because of the personal and social problems it could create.

109. Some structures and associated processes are common to all living things while others are unique to particular types of organisms.

110. Ionizing and ultraviolet radiation affects biological systems by

causing cell damage and genetic mutation.

111. Some functions of man's brain set him apart from all other animals.

112. The fundamental unit of heredity, the gene, consist of numerous separable components.

113. An embryo is subjected to many environmental influences. Some birth defects are caused by abnormal internal conditions related to nutrition, antibiotics, radiation, drugs, hormones, and other factors.

114. Mutation in a population is essentially random; selection converts this randomness into a pattern.

# APPENDIX B

msu
COLLEGE OF EDUCATION

DEPARTMENT OF ELEMENTARY EDUCATION

MONTANA STATE UNIVERSITY, BOZEMAN 59717

March 30, 1977

I am presently a doctoral student at Montana State University. I am seeking information on what science programs are being used throughout the United States. This information will be used in a dissertation entitled "An Investigation of the Development of Life Science Concepts in Selected Elementary School Science Textbooks and Laboratory Programs."

Please indicate on the enclosed postcard the science program your system is presently using.

Thank you in advance for your attention to this.

Sincerely,

R. Joy Lucas

TELEPHONE (406) 994 4744

Science a Process Approach (SAPA)_____
Elementary Science Study (ESS)_____
Science Curriculum Improvement Study (SCIS)_____
Concepts in Science (Harcourt Brace)_____
Elementary Science, Learning by Investigation
(Rand McNally)_____
Science Understanding Your Environment (Silver Burdett)__
Modular Activities Program in Science (Houghton Mifflin)_
Science: People, Concepts, Processes (McGraw-Hill)_____
Modern Elementary Science_____(HOLT)
Elementary School Science (Addison Wesley)_____
Basic Science Program Series (Scott Foresman)_____
Ginn Science Program_____
Modern Science (Laidlaw)_____
Other_____

# APPENDIX C

Joy Lucas
CPO 1125
Berea College
Berea, Kentucky

April 24, 1978

Dear Science Educator:

I am presently working on a dissertation entitled "An Investigation of the Development of Life Science Concepts in Selected Elementary School Science Textbook and Laboratory Programs." Your help would be appreciated in providing a reliability check of the procedures used in the study.

Enclosed please find pages from four published elementary science materials. Attached to each of these selection is a "concept list." The science material contained therein covers one of the concepts attached to the pages.

On the form provided select the concept that is presented on the pages and determine by what method or methods the writers of the text used to present that particular concept. Definition of the methods utilized in science materials is enclosed. Record this information on the form provided. Also included is the collection of data section of the dissertation. Your attention to this matter is greatly appreciated.

Sincerely,

R. Joy Lucas

| Program | Concept | Methods | | | | |
|---|---|---|---|---|---|---|
| | | Statement | Inference | Experiment | Example/ Environment | Illustration |
| A | | | | | | |
| B | | | | | | |
| C | | | | | | |
| D | | | | | | |

CONCEPT LIST

1. By and large living things are composed of a fundamental unit of structure and function known as the cell.

2. Present living cells are seen to arise from preexisting cells.

3. Cell membranes provide a selective barrier which maintains the intracellular environments suitable for the biological reactions occurring within cells.

4. The activities of living cells result essentially from chemical and physical processes in which the reactants are supplied by nutrients that must be replenished.

5. Associations of specialized cells performing the same function form a tissue, groups of different tissues combined in characteristic patterns form organs, and collections of functionally related organs constitute systems within the organism.

6. All chemical reactions occurring within cells are controlled by regulating the amount, type, and specificity of the enzymes present. Complex living systems would not be possible without this control.

INVESTIGATION 2

A

# 2. A NEW LOOK AT AN ONION

## INTRODUCTION

The pupil uses his microscope to see the cellular structure of a plant, the onion. He begins by dissecting an onion bulb, which he examines first with his naked eye and then with a hand lens. Hopefully, the intermediate step of the hand lens will help the student to realize that things seen through the microscope do not really get bigger; they just appear bigger. Using the microscope, the pupil examines the cells of the onion and compares their size with a hair or other measuring device of his choice.

## MATERIALS—*(*New Item)*

**PER CLASS**

- lens paper
- facial tissue
- detergent solution
- bottles of water
- scissors
- *cutting boards (cardboard)
- *paring knives (for cutting onions)
- *onions
- *paper towels
- *large photographs of onion cells

**PER PUPIL**

- hand lens
- microscope
- microscope slides
- cover slips
- medicine dropper
- tweezers

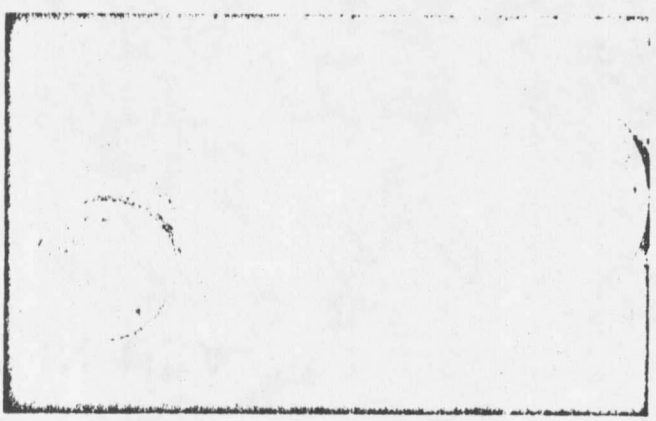
## TEACHING SUGGESTIONS FOR INVESTIGATION 2

- Pupils should be able to proceed with the suggestions on the worksheets for this investigation with a minimum of teacher direction, but some may need individual help with their microscopes. Also the children will need to be reminded about careful handling and use of knives.

- Blotting the onion cross section with a paper towel before examining it with the hand lens may somewhat reduce nose and eye irritation.

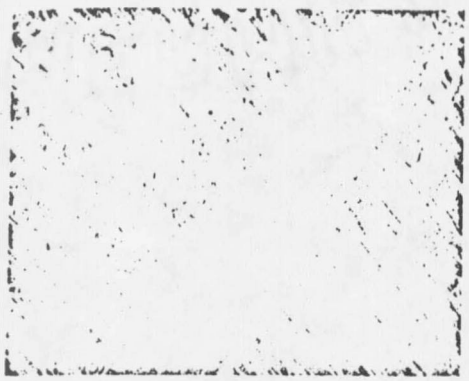
- The piece of onion tissue used under the microscope should be very small and almost transparent. The thin skin between the layers of the onion is ideal. If children have trouble finding this thin skin, you should help them find it. One easy trick is to slice the onion as if for a hamburger and then peel the skin from between the onion rings.

- In preparing a specimen of onion skin for viewing, care should be taken not to allow it to become folded over on the slide. Also, children should make sure that no pulpy material is attached to it. Otherwise, observation of individual cells becomes difficult. Sometimes air bubbles are mistaken for cells.

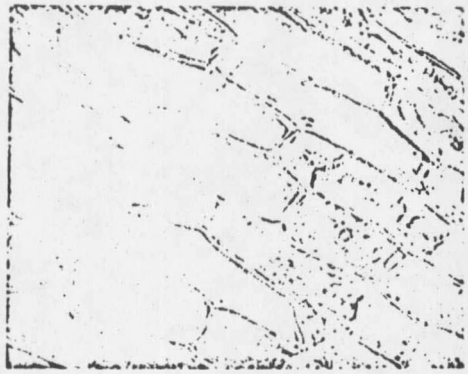


Two air bubbles on a slide

- The section on measuring the cells is intended to help the children remember that the units which they are seeing are not really as big as they look, and that the *microscope* is not *changing the actual size of the units*, just the appearance. If the cell walls were a distinct color, it would be possible to see an individual onion cell with the naked eye. All cells will not be the same size or shape. The difference between length and width may have to be pointed out to some of the children.



Onion cells from the inner part of the onion bulb seen with a hair laid across them. These cells are about ½ hair width wide and 2 hair widths long.



Cells from an onion bulb.

- It would be better not to introduce the word *cell* yourself. Let the children come upon it independently. It is included in the quotation from Robert Hooke on Worksheet, Area Two, page 2, of Investigation 2. (See page 39 of this guide.)

- After the children have completed the investigation and have read about Robert Hooke's discovery of cells, you may want to introduce them to the book *The Faithful Eye of Robert Hooke* (see page 7). Superior readers will read this book with ease. Your slow readers will enjoy the pictures but you should plan to read this book to them or have it read aloud to them.

- You may want to bring out now or later when the children themselves examine a specimen of cork, that the units in cork which Robert Hooke called *cells* are actually merely the empty cell walls which formerly surrounded the living cells.

- Students should be encouraged to move around the classroom looking at one another's slides. For students having difficulty, this is especially helpful.



Onion cells as photographed with an AS&E microscope.

# INVESTIGATION 2



## A New Look At An Onion

*YOUR NAME:*

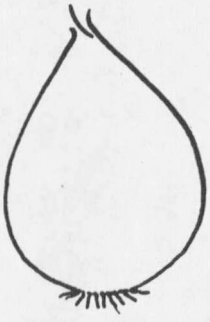
**WHAT'S INSIDE AN ONION?**

No doubt you have seen onions often.
But have you really looked at an onion? Look at an onion carefully. What do you see?

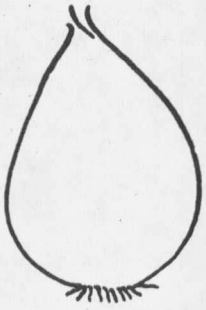
Perhaps you see the dried remains of rootlets and the messy end where the leaf blades died off. Did you notice the outer skin? Peel off some outer skin. Think about what the onion might look like inside.

1. Sketch what you *think* you would see if you cut the onion lengthwise from the leaf end to the root end.

2. Now slice the onion lengthwise and sketch what you *see*.



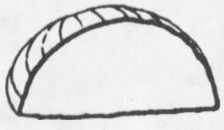
I THINK



I SEE

3. Next sketch what you *think* you would see if you cut one of your onion slices in half across the roundest part.

4. Cut through the roundest part and sketch what you *see*.



I THINK



I SEE

CONCEPT LIST

1. Animal behavior has evolved just as structure and biochemical processes have. The behaviors of man and many other animals have much in common.

2. The development of behavior is the product of both genetic and environment interactions; purely genetic or fully learned behavior is highly improbable.

3. Behavioral patterns can be described in terms of one or more of the following; their functional significance, evolutionary history, developmental roots in the individual's experience, and physiological mechanisms.

B

## INSTRUCTIONAL PROCEDURE

### *Introduction*

Give each child a copy of *Cindy and the Raccoons* to read. After everyone has read the story, discuss the questions that follow the story. You may want to begin by asking if cats, dogs, and birds learn. The children will probably give examples of things their pets have learned.

Lead the students to a discussion of whether guinea pigs can learn. Explain that everyone is going to investigate this question by using a maze. Explain the term *maze*, preferably by displaying the one that will be used in *Activity 1*.

Give each child a copy of *Maze Pattern 1*. Discuss the various paths the guinea pig might use to reach the food. Ask the students to draw arrows to indicate these paths. Next have the group suggest what they might observe, measure, or infer about the guinea pigs during the investigation. You might ask questions such as the following:

- What might we observe to determine if a guinea pig can learn?
- What might we measure to determine if a guinea pig can learn?
- Do you think that the guinea pig will run the maze faster each time?
- Will the guinea pig make fewer mistakes each time?
- How can we make sure that the guinea pig will run through the maze?

MATERIALS

*Cindy and the Raccoons*, 30 booklets, *(Module 63)*
*Maze Pattern 1*, 1 spirit duplicating master, *(Module 63)*

Module numbers in parenthesis identify the location of supplied items.

### *Activity 1*

Ask the students to plan an investigation to see if guinea pigs can learn to locate food in a maze. Encourage everyone to formulate specific questions that they would like to have answered. Help them plan the investigation so that the number of trials is the manipulated variable, and the time required for each trial, the maze-time, is the responding variable. Introduce the term *maze-time* as the amount of time between the starting time and the time when the guinea pig reaches the food. All other variables should be held constant. Some of these variables are—

1. the time of day the guinea pigs are placed in the maze,
2. the amount of time since the guinea pigs were last fed,
3. the kind of food used in the maze,
4. the person who puts the guinea pigs and the food in the maze, and
5. the conditions such as light, location, and noise in the room.

Give the students most of the responsibility for planning and conducting the investigation. Several hints follow that will help to assure the success of the investigation. Introduce these suggestions subtly if the children do not think of them.

1. Before beginning the trials, be sure that the guinea pigs are accustomed to being handled, to noises, and to children moving around in the room. Be as quiet as possible during the trials so that the animals do not become frightened.

2. Before the trials begin, the guinea pigs should associate the maze with food. To accomplish this, make temporary sections in the maze by placing dividers across passageways, and feed the guinea pigs in a different section each day for several days prior to the trials. Use apples or other food with a scent in the maze.

3. Do not feed the guinea pigs for at least twelve hours before each day's trials. A suggested schedule is to remove the food from the cage late one afternoon when school closes and conduct the trials early the next day.

4. If the food deprivation begins on Monday afternoon, the trials can begin on Tuesday and can run for four consecutive days.

CONCEPT LIST

1. Diversification and specialization in species both lead to communities of living things characterized by interdependence, sharing and mutual tolerance, relative density, complexity, and the efficient use of space, matter, and energy.

2. All living things are interdependent with one another and with their environment.

3. No one major ecological factor but a combination of these determines the environment; soil, water, air, energy, plants, and animals (including man) all contribute.

4. Four basic attributes of living systems are: 1) the capacity to make copies of themselves; 2) the capability for change; 3) the capacity to store information and; 4) the ability to translate this information for use in complex activities.

**Unit Concept-Statement:** Man is the product of his heredity and environment.

**EXTENDING THE LESSON**

Have students consider how the environment is changed when materials are returned to it that are not useful or that are harmful to plant and animal life. What are some effects on living things of pollution of the air with harmful gases? of the water with harmful chemical substances? of the land with solid wastes and other matter? Children may wish to survey their environment for evidence of pollution.



What is true of plants is true of animals as well. Animals ❶ make use of their environment. Can you see how this crocodile is doing so? Animals need food, oxygen, water, and shelter. They feed on plants, or on other animals. And ❷ they return materials to the environment.

Living things take from their environment and give back to their environment. In other words, living things and ❸ their environment are **interdependent.** Living things take matter and energy from the environment. They return matter and energy to the environment.

❹ Man also is interdependent with his environment. He takes matter and energy from the environment. He returns matter and energy to the environment. In this he is like other living things.

However, there is one way in which man is different. Other living things do not change their environment the way man does. True, some animals, such as locusts, can lay waste whole crops. Mice and rats can do great damage. But this destruction is a fairly simple change. Man is different. *Man is not only adapted to the environment. He changes his environment in complex ways. This is part of man's kind of interdependence.*

40

**Continuing Lesson Cluster 5**

❶ How do animals change their environment? (take oxygen from air, eat plants and animals as food, drink water, occupy living space, make homes, produce wastes)

❷ What do animals return to the environment? (carbon dioxide, water, undigested wastes, some heat, minerals when they die and decay) Do animals, like plants, have special habitats? What examples can you give? (camels on deserts, penguins in the Antarctic, deer in forests, fishes in tropical waters, etc.)

❸ What is the difference between dependence and interdependence? You may wish, with the children's help, to develop and discuss these diagrams:

living things → environment
living things ↔ environment

Explain that the arrows mean "depend on." How is the second diagram different from the first? Which shows interdependence? How? (Living things take substances from the environment and renew the environment by returning them.)

❹ What evidence do we have that man depends on his environment? You may wish to place on the board two headings and have children elaborate under each heading as in these examples:

| ENVIRONMENT | MAN |
|---|---|
| plants, animals | food |
| Sun, fuels, food | energy |
| air | oxygen |
| lakes, wells, atmosphere | water |

CONCEPT LIST

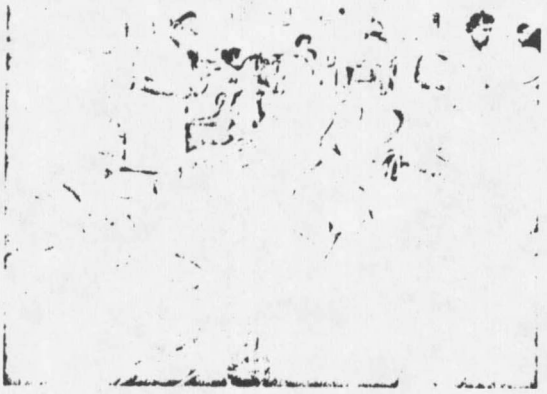
1. Diseases are a byproduct of the metabolism and reproduction of pathogenic microorganisms, reflecting the interaction of the pathogen with a susceptible host.

2. Diseases are due to natural causes. All physical and possibly all mental diseases are based on molecular interactions.

3. Organisms become troublesome to man when his own activities alter or upset the existing steady-state. In this respect many organisms have become better adjusted to man than he has to them.

4. Diseases are ideally controlled within populations, as well as individuals, by prevention rather than cure.

5. Most species of microorganisms in their natural habitat are not dangerous to man and are essential components of the ecosystems.



**This is a public health clin** People come to these clinics protection against disease. Fi out if there are any public hea clinics in your town.

person to another person living far away?

Almost all plants and animals can have communicable diseases. But disease often spreads faster among men. Sometimes people live close to each other. Much garbage collects in this environment. Why are communicable diseases a big problem in large cities? Why do these diseases spread more slowly in the country?

Suppose you have a communicable disease. Other members of your family are likely to get it. You can keep from spreading it to your neighbors and friends. Why should you stay home when you have such a disease? What else can you do? How does keeping yourself and your home clean help you to stay healthy?

**Conditions like this** can cau many problems. What could happ if this garbage was left for a lo time? How can communicable ease be spread here?



## TESTING WATER

Water can be tested to see if it is polluted. The testing is done in much the same way as you tested water for yeast. Food for bacteria is mixed with some of the water to be tested. It is kept in a warm place for several hours. If gas forms, the water is polluted.

Collection of Data

The writer will examine each elementary science textbook series at each grade level (1-6) to determine on which pages specific concepts taken from the identified 114 life science concepts are found and the method that is utilized in presenting that concept. Each teacher's manual of the laboratory programs will also be examined to determine on which pages specific concepts taken from the identified 114 life science concepts are found and the method that is utilized in presenting that concept. Each page of a textbook or teacher's manual on which a concept is found will be entered on a raw data chart which corresponds to the criteria in the analysis key.

Once the concepts have been identified on context and the methods of presentation are identified, the researcher will be able to determine what concepts are developed. In order for a concept to be considered developed, at least three of the five methods (1) Sentence Inference, (2) Statement of Concept, (3) Experiment Demonstration, (4) Example in the Environment illustrating them, or (5) an Illustration must be utilized in presenting the concept.

If a concept is found on a page twice but developed by the same method both times (i.e., statement) the page number will be recorded only once. If the concept is found two times on a page and both times is developed by a different method (i.e., statement and illustration) the page number will be recorded twice.

Because of the complexity of some concepts, if part of the concept is found on a page then it will be recorded as occurring on the page. For example, the concept "Behavioral patterns can be described in terms of one or more of the following: their functional significance, evolutionary history, developmental roots in the individual's experiences, and physiological mechanisms" includes four ways in which behavioral patterns are described. If one of these ways were discussed on a page then the page number of the concept would be recorded. If one experiment or one example in the environment extends over two pages, the first page will be recorded.

The researcher will be able to determine the method that is used most often in the development of concepts by tabulating the total number of pages that depict concept presentation.

Laboratory programs and textbooks will be identified by the letters A B C D E F. Concepts will be numbered 1 through 114. The analysis criteria will be identified as following: 1) inference, 2) statement, 3) experiment, 4) example in environment, and 5) illustration.

Concept. A summary of essential characteristics of a group of ideas and/or facts that epitomize important common features of factors from a larger number of ideas.

Examples in the Environment. The act of applying a concept to different occurrences or situations in the environment. Many times this involves solving a problem situation in the environment. For example, the concept, "Deficiencies of essential nutrients usually lead to malfunctions in organisms" may be demonstrated by withdrawing a nutrient from a live organism and noting the results. Also, it could be having a student react to an environmental picture and responding in a verbal or written form. Examples in the environment may be teacher presented or presented in the text.

Experiments. a) teacher demonstration: The trial of a planned procedure accompanied by control of conditions and or controlled variation of conditions together with observation of results for the prupose of discovering relationships and evaluating the reasonableness of a given hypothesis (Good, 1973:227). b) Student, Laboratory: an experiment performed with apparatus either a qualitative or quantitative answer to a problem through procedures deliberately designed to produce the interaction of some agency under our control with the system or object we are studying (Good, 1973:228).

Facts--Scientific. A statement of existence or of performance that is identifiable in experience (Good, 1973:233).

Generalization--theoretical. A statement defining the characteristic features of a given class, relations among classes, or between two or more variables (Good, 1973:259).

Graphic Materials. Instructional materials conveying meaning largely through line representations or symbols that are nearer to reality than verbal symbols, such as maps, charts, diagrams, posters, cartoons, and graphs (Good, 1973:266).

Illustration. ". . . By illustration we mean any form of exposition or elucidation. The degree it elucidates or reveals is the degree of its goodness or badness. It can exist on its own, or it may need to be amplified by words. Or it can in itself amplify a text" (Gill and Lewis, 1964:34).

Inference. . . . a collection of statements giving conditions under which logically valid conclusions can be drawn. The act of obtaining a judgement or logical conclusion (Good, 1973:299-300).

Laboratory Method. The instructional procedure by which the cause, effect, nature, or property of any phenomenon, whether social, psychological or physiological or physical, is determined by actual experience or experiment under controlled conditions (Good, 1973:327).

Life Science. It is sometimes used synonymously with biological science (Good, 1973:517).

Statement. 1) Setting forth in words, 2) specified or said; account or declaration (Guralnik, 1964:1424).

Textbooks. 1) any manual of instruction; 2) a book dealing with a definite subject of study, systematically arranged, intended for use at a specified level of instruction and used as principal source of study material for a given course (Good, 1973:605).

# APPENDIX D

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. Laboratory programs were identified as follows: A - ESS; B - SCIS; C - SAPA.

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 1. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | 1 | | 2 |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. A | 1 | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 | | | | |
| B | | | | | | 3 | | | 2 | 10 | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | | | | | | |
| 3. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | 2 | | 2 | | 2 | | | | | | | | | | | 1 | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | |
| 4. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | 1 | | | | | | | | | 1 | | 1 | 1 | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | 1 | 1 | | | | 1 |
| C | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 8. A | 1 | | 1 | | | 1 | | 1 | | | 1 | | 1 | | | 1 | | 1 | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | 14 | 2 | 20 | 2 | 29 | | | | | | 1 | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9. A | 7 | | 3 | 6 | | 7 | | 3 | 6 | | 7 | | 3 | 6 | | 18 | | 21 | 8 | | 14 | | 17 | | 6 | 13 | | 17 | 5 | |
| B | 1 | | 1 | | | 2 | | 1 | | 2 | 2 | | 1 | | | 14 | 2 | 20 | 2 | 29 | 1 | 1 | | | | 1 | | 2 | | 6 |
| C | 3 | | 3 | 3 | | | | | | | 1 | | 1 | | | | | | | | 1 | | | 2 | | 3 | | 2 | 2 | 1 |
| 10. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13. A | 7 | | 6 | 8 | 2 | 7 | | 6 | 8 | 2 | 13 | | 6 | 9 | 2 | 18 | | 12 | 9 | 2 | 15 | | 12 | 7 | 2 | 12 | | 10 | 5 | 1 |
| B | 2 | | 2 | | 2 | | | 1 | | | 2 | | 3 | | | 1 | | 1 | | | 1 | | 1 | | 1 | | | | | |
| C | 4 | | 3 | 1 | | | | | | | | | | | | 1 | | 1 | 1 | 1 | 1 | | 1 | | | 3 | | 3 | 3 | |
| 14. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 15. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 2 | | |
| 16. A | 1 | | | 1 | | 1 | | | 1 | | 1 | | | 1 | | 1 | | | 1 | | 1 | | | 1 | | 1 | | | 1 | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | 2 | | 3 | | 1 | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | 1 | | 1 | | 1 | 2 | 1 | 3 | 3 | | 1 | | 2 | | 1 |
| 20. A | 6 | | 1 | 4 | | | | | | | 6 | | 1 | 3 | 1 | 12 | | 8 | 4 | 2 | 11 | | 7 | 3 | | 11 | | 7 | 3 | |
| B | | | | | | | | | | | | | | | | 2 | | 3 | | 1 | | | | | | | | | | |
| C | | | | | | 3 | | 3 | | 3 | | | | | | 4 | | 3 | 1 | 4 | 1 | | 1 | | | 6 | | 5 | | 2 |
| 21. A | 22 | | 1 | 14 | 1 | 22 | | 1 | 14 | 1 | 17 | | 1 | 12 | 1 | 29 | | 6 | 17 | 1 | 21 | | 5 | 12 | 1 | 14 | | 5 | 9 | 1 |
| B | 2 | | | 2 | | 11 | | 5 | 1 | 2 | 1 | | | 1 | | 1 | | 1 | | | 3 | | 2 | | 1 | | | | | |
| C | 1 | | | 1 | | 6 | | 7 | | 2 | | | | | | | | | | | | | | | | 1 | | 1 | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 22. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | 1 | | | 1 | | | | | | | 2 | 1 | | 3 | 2 | 4 | 1 | 1 | 1 | 2 |
| C | | | | | | | | | | | | | | | | 1 | | | 1 | | | | | | | | | | | |
| 27. A | 1 | | | 1 | 1 | 1 | | | 1 | 1 | 3 | | | 1 | 1 | 5 | | | 3 | 1 | 5 | | | 3 | 1 | 5 | | | 3 | 1 |
| B | 4 | | 3 | 2 | | | | | | | 10 | | 3 | | 2 | | | | | | 7 | 1 | 8 | 1 | 7 | 6 | | 11 | 2 | 5 |
| C | 2 | | | 1 | | | | | | | 1 | | 3 | | | 1 | | | 1 | | | | | | | | | | | |
| 28. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | 2 | | | 3 | 1 | | | | | | 2 | | | 2 | | | 1 | 1 | | | | | | | | 2 | | 2 | | 1 |
| C | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 29. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| C | 2 | | | 2 | | 2 | | | 2 | 1 | | | | | | | | | | | | | | | | | | | | |
| 30. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | | 2 | | 1 |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 33. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34. A | 8 | | 3 | | 1 | 8 | | 3 | | 1 | 8 | | 3 | | 1 | 8 | | 3 | | 1 | | | | | | | | | | |
| B | 2 | | | | 2 | 1 | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | 1 | | | 1 | | | | | | | | | | | | | | | | |
| 35. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 36. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 37. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 38. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | 1 | | | 1 | | | | | | | | | | | | | | | | | | 3 | 2 | 1 | | | | | | |
| C | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 39. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 41. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 43. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 44. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | 2 | | | 3 | | 1 | 1 | | | | 1 | | 1 | | | 1 | | 1 | | | 1 | | 1 | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45. A | 2 | | | 2 | | | | | | | 2 | | | 2 | | 4 | | | 4 | | 3 | | | 3 | | 2 | | 2 | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 46. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 47. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 48. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 49. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 50. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 51. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 52. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 53. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 54. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 55. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 56. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 57. A | | | | | | | | | | | | | | | | 2 | | 1 | 1 | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | 2 | | 2 | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 58. A | | | | | | | | | | | 1 | | | | | 4 | | 3 | | | 4 | | 3 | | | 4 | | 3 | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 59. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 60. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 61. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 62. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 63. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 57. A | | | | | | | | | | | | | | | | 2 | | 1 | 1 | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | 2 | | 2 | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 58. A | | | | | | | | | | | 1 | | | | | 4 | | 3 | | | 4 | | 3 | | | 4 | | 3 | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 59. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 60. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 61. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 62. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 63. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 64. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 65. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 66. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 67. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 68. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 69. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 70. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 71. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 72. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | 1 | | 4 | | 1 | | | | | | | | | | |
| 73. A | | | | | | | | | | | | | | | | 3 | | 6 | | 9 | 3 | | 6 | | 9 | 3 | | 6 | | 9 |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 74. A | | | | | | | | | | | | | | | | 1 | 1 | 1 | | | 1 | 1 | 1 | | | 1 | 1 | 1 | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 75. A | | | | | | | | | | | | | | | | 1 | | 1 | | | 1 | | | | 1 | 1 | | | | 1 |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 76. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 77. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 78. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 79. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 80. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | 1 | | | 4 | 6 | 2 | | | | |
| 81. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 82. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 83. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 84. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 85. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 86. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 87. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 88. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 89. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 90. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 91. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 92. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 93. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 94. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 95. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 96. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 97. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 98. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 99. A | 4 | | 1 | | | 4 | | 1 | | | 4 | | 1 | | | 5 | | 2 | | | 1 | | 1 | | | 1 | | 1 | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 100. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 101. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 102. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 103. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 104. A | | | | | | | | | | | | | | | | 4 | | 4 | | 15 | 4 | | 4 | | 15 | 4 | | 4 | | 15 |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 105. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 106. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 107. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 108. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 109. A | 8 | | | 6 | 2 | 8 | | | 6 | 2 | 12 | | | 9 | 1 | 26 | | 6 | 27 | 115 | 24 | | 6 | 25 | 115 | 21 | | 6 | 22 | 115 |
| B | 2 | | | | 2 | 2 | | | 2 | | 3 | | 4 | 3 | | | | | | | 1 | 2 | 4 | | 2 | | | | | |
| C | 2 | | | 1 | | 4 | | 3 | 3 | | 1 | | | 1 | 8 | | | | | | 1 | | 1 | 4 | 2 | 3 | | | 5 | 4 |
| 110. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 111. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 112. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each teacher's manual of three laboratory programs. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 113. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 114. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. Textbook series were identified as follows: D - Science Understanding Your Environment; E - MAPS; F - Concepts in Science.

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 1. D | | | | | | | | | | | | | | | | | | | | | 2 | | | | | 2 | | | | 1 |
| E | | | | | | | | | | | 5 | | 3 | 2 | 3 | | | | | | | | | | | 2 | | | 2 | 1 |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. D | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | |
| E | | | | | | | | | | | 2 | | 2 | | 1 | | | | | | | | | | | 2 | | 2 | | 2 |
| F | | | | | | | | | | | | | | | | 4 | | 2 | | 2 | | | | | | | | | | |
| 3. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | 3 | 1 | 1 |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4. D | | | | | | | | | | | 2 | | | 1 | 3 | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 3 | 2 |
| F | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | |
| 5. D | | | | | | | | | | | 1 | | | | 1 | 2 | | | 1 | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | 2 | 1 |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | |
| 7. D | | | | | | | | | | | 3 | | | 1 | 2 | 1 | | | | | 1 | | | | | | | | | |
| E | | | | | | | | | | | 2 | | | 2 | 2 | 3 | | | 2 | 2 | | | | | | 1 | | 1 | | 1 |
| F | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | 1 | | | | 1 |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 8. D | 2 | | | | 2 | 5 | | | 1 | 7 | 5 | | 1 | 3 | 4 | 4 | | 1 | 2 | 3 | 5 | | | | 1 | | | | | |
| E | | | | | | 3 | | 2 | 3 | 1 | 2 | | | 2 | 2 | 3 | | | 3 | 3 | 18 | | 7 | 20 | 26 | 9 | | 2 | 7 | 8 |
| F | | | | | | 9 | | 6 | 1 | 11 | 20 | | 3 | 2 | 20 | 17 | 2 | 3 | 4 | 14 | 1 | 1 | 1 | 1 | 1 | 1 | | | | |
| 9. D | 3 | | | | 3 | 1 | | | 1 | 2 | 2 | 1 | 1 | 2 | 6 | 2 | 2 | 2 | | 4 | | | 2 | | | | | | | |
| E | | | | | | 3 | | 2 | | 3 | 5 | | 3 | 5 | 8 | | | | | | 1 | | 1 | 1 | 1 | 2 | | 5 | 1 | 3 |
| F | 3 | | | | 3 | | | | | | 6 | | 2 | 2 | 6 | 7 | | 2 | | 7 | | | | | | | | | |
| 10. D | 1 | | | 1 | 2 | | | | | | | 3 | | 1 | 5 | | | | | | 5 | | 1 | | 2 | 1 | | 1 | 2 | 1 |
| E | | | | | | | | | | | 3 | | | 3 | 2 | | | | | | 1 | | | 1 | 1 | 2 | | | 2 | 2 |
| F | | | | | | | | | | | 3 | | | | 2 | 1 | | | | | | | | | | | | | | |
| 11. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | 4 | | | | 6 | | | | | | | | | | | | | | | | | | | | | 4 | | | 1 | 2 |
| 13. D | 4 | | | 1 | 4 | 3 | 2 | 1 | 2 | 8 | 2 | 1 | 1 | 1 | 2 | | 4 | | 1 | 2 | 2 | | | 1 | 2 | 2 | | 1 | 2 | |
| E | | | | | | 3 | | 3 | 1 | 4 | 4 | | 2 | 2 | 5 | | | | | | | | | | | 2 | 1 | 3 | 3 | 3 |
| F | 7 | | 2 | | 10 | 4 | | 5 | | 6 | 5 | | 3 | | 4 | 5 | 5 | 2 | 1 | 4 | 4 | | | | | 7 | 3 | 1 | 1 | 4 |
| 14. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 15. D | 2 | | 2 | | 2 | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16. D | | | | | | | | | | | | | | | | 2 | | 1 | | 2 | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17. D | 3 | | | 2 | 3 | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| F | | | | | | 1 | | | | 1 | 1 | | | | 1 | 1 | | | | 1 | | | | | | | | | | |
| 18. D | 2 | | | | 2 | | | | | | | | | | | | | | | | | | | | | 2 | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | 1 | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| 19. D | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | 1 | 1 | 2 | 1 |
| E | | | | | | | | | | | | | | | | | | | | | 2 | | 1 | | | | | | | |
| F | | | | | | | | | | | | | | | | 2 | 2 | | 1 | 2 | | | | | | 10 | 1 | 2 | 2 | 10 |
| 20. D | | | | | | 2 | | | 1 | 2 | 4 | | 1 | | 3 | | | | | | 2 | | | | | | 1 | 1 | 2 | 1 |
| E | | | | | | 1 | | | 1 | 1 | | | | | 10 | | 4 | 7 | 10 | | 3 | | 5 | 3 | 6 | | | | | |
| F | | | | | | | | | | | | | | | 3 | 1 | 1 | 2 | 2 | | | | | | | 14 | | 5 | 3 | 13 |
| 21. D | 10 | 1 | 1 | 5 | 12 | | | | | | 3 | | 2 | | 2 | | | | | | 8 | 1 | 5 | 4 | 7 | | | | | 1 |
| E | | | | | | 1 | | | 1 | 1 | 2 | | 1 | 1 | 4 | 2 | | 1 | 1 | 3 | 8 | | 7 | 1 | 11 | 1 | | | | 1 |
| F | 27 | | 1 | 1 | 29 | 12 | | 3 | 1 | 16 | 8 | | 1 | 5 | 8 | 3 | 1 | | | 2 | 3 | | | | 2 | 2 | | | | 2 |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 22. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25. D | | | | | | | | | | | | | | | | | | | | | 3 | | | | | 2 | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | 17 | | 2 | 4 | 18 | | | | | | 4 | | | 2 | 4 | | | | | |
| 26. D | 4 | | | 1 | 4 | | | | | | 2 | | 1 | 3 | 3 | 2 | | | 1 | 1 | | | | | | 1 | | | | |
| E | | | | | | | | | | | 5 | | 3 | 2 | 4 | 6 | 1 | | 9 | 6 | | | | | | 4 | 1 | 1 | 6 | 5 |
| F | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | 2 | | | | 2 |
| 27. D | 2 | | | 1 | 2 | 4 | | 1 | 1 | 7 | 4 | | | 1 | 3 | | 1 | | | | 4 | | | | | 8 | | 1 | 2 | 3 |
| E | | | | | | | | | | | 3 | | 1 | 2 | 3 | 18 | | 10 | 16 | 18 | | | | | | 7 | | 1 | 5 | 8 |
| F | 4 | | | 1 | 4 | | | | | | 14 | | | 1 | 12 | 25 | 2 | 4 | 4 | 24 | 1 | | | | | 6 | 2 | | 1 | 6 |
| 28. D | 8 | | 4 | 6 | 8 | 4 | | | 1 | 5 | | | | | | 1 | | | 1 | 1 | 2 | | 2 | | 1 | 1 | | | | |
| E | | | | | | 2 | | 1 | 2 | 2 | 6 | 1 | 3 | 12 | 12 | | | 2 | 2 | 3 | | | | | | 2 | | 1 | 1 | 1 |
| F | | | 1 | | 3 | | | | | | 4 | | 6 | | 7 | 3 | 1 | 1 | | 2 | | | | | | 1 | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 29. D | | | | | | | | | | | 2 | | | | 3 | | | | | | | | | | | | | | | |
| E | | | | | | 4 | | 1 | 3 | 4 | | | | | | | | | | | | | | | | 1 | | 1 | 1 | 12 |
| F | | | | | | | | | | | 4 | | 1 | 1 | 4 | 1 | | | | | | | | | | | | | | |
| 30. D | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 8 | | 13 | 3 | 12 |
| F | | | | | | | | | | | | | | | | 4 | | | | 2 | | | | | | 1 | | | | 2 |
| 31. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | 2 | | | 1 | 1 | | | | | | | | | | |
| 32. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 33. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34. D | 1 | 1 | 3 | | 5 | | | | | | 9 | 3 | 9 | 6 | 13 | 7 | | 1 | | 4 | | | | | | 5 | | | 4 | 6 |
| E | 4 | | | 3 | 4 | 3 | | 2 | 4 | 2 | | 1 | 2 | 1 | 2 | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | 26 | 2 | 9 | 8 | 20 | 15 | 3 | 5 | 3 | 13 | | | | | |
| 35. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | 2 | | | 2 | 2 | | | | | | 1 | | | 1 | 1 | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 36. D | | | | | | | | | | | | | | | | 1 | | | 1 | 2 | | | | | | 1 | 1 | | 2 | 2 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | |
| 37. D | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | |
| 38. D | | | | | | | | | | | 1 | 2 | 1 | 1 | 2 | 2 | | | | 1 | | | | | | 1 | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 2 | | 1 |
| F | | | | | | 1 | 2 | | | 1 | 6 | | 1 | 1 | 3 | 2 | | 2 | | 1 | 1 | | | | | 8 | 2 | 2 | 1 | 4 |
| 39. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40. D | | | | | | | | | | | 3 | 1 | | | | 1 | | | | | 1 | | | | | 1 | | | | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 4 | 2 | 4 | 3 |
| F | | | | | | 13 | | 1 | 2 | 18 | 2 | 2 | | | 2 | 2 | 2 | | | | | | | | | 4 | | | 1 | 2 |
| 41. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 2 | | | | 2 | | | | | |
| 42. D | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 2 | | | | 1 | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 43. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 44. D | 1 | | | | | 2 | | | 1 | 3 | | | | | | | | | | | | | 1 | | | 2 | | | | |
| E | 3 | | | 3 | 3 | 3 | | | 3 | 3 | | | | | | | | | | | 2 | | 1 | 1 | 1 | 1 | | | 1 | 1 |
| F | | | | | | 1 | | | 1 | 2 | 2 | | | | | 2 | | | | | | | | | | | | | | |
| 45. D | | | | | | 2 | | | 1 | 4 | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 46. D | | | | | | | | | | | | | | | | 2 | | | 1 | 2 | | | | | | | | | | |
| E | | | | | | | | | | | 1 | | | 1 | 1 | | | | | | | | | | | 1 | | 2 | | 1 |
| F | | | | | | | | | | | 2 | | | 2 | | | | | | | | | | | | | | | | |
| 47. D | | | | | | 1 | | | | 2 | 1 | | | | | 3 | 1 | | 2 | 3 | 11 | | 2 | 4 | 10 | | 1 | | | 1 |
| E | 3 | | | 3 | 3 | | | | | | 1 | | | 1 | 1 | | | | | | | | | | 3 | | 2 | 2 | 1 |
| F | 6 | | | | 6 | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| 48. D | | | | | | | | | | | | | | | | 4 | | | | 1 | 2 | | | | | 2 | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| F | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| 49. D | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 50. D | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | 1 | | | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | | | | 3 |
| 51. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 52. D | | | | | | | | | | | | | | | | | 2 | | | | | | | | | 2 | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 53. D | | | | | | | | | | | | | | | | 1 | | | | | | | | | | 1 | | 1 | 1 | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 54. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 55. D | | | | | | | | | | | 1 | | | 1 | 1 | 1 | | | | | | | | | | 1 | | | | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 2 | 2 |
| F | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | |
| 56. D | | | | | | 1 | | | | 1 | | | | | | 1 | | 1 | | 2 | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | 8 | | 3 | 2 | 4 |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 57. D | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | 1 |
| F | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | 2 | | | | |
| 58. D | | | | | | | | | | | | | | | | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | | 4 | 1 | 1 | 1 | 3 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 1 | 2 |
| 59. D | | | | | | 1 | | 1 | | 1 | | | | | | | | | | | | | | | | | 1 | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | |
| 60. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | 1 | | | | 11 | | 2 | 1 | 5 | | | | | | |
| 61. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| 62. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 2 | 2 |
| F | 4 | | | 2 | 4 | | | | | | | | | | | | | | | 2 | | | | | | 5 | | | | 1 |
| 63. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 64. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 65. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 66. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 67. D | 2 | | | | 2 | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | 5 | | | | 5 | 2 | | | | 1 | | | | | | 14 | | 11 | 1 | 11 | | | | | |
| 68. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 69. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 70. D | 1 | | | | 1 | | | | | | 2 | 1 | | 3 | 3 | | | | | | 5 | 1 | 1 | 1 | 6 | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | 11 | | 1 | | 12 | 8 | | | 1 | 9 | 2 | | | | | | | | | | 7 | 2 | 2 | 2 | 7 | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 71. D | | | | | | | | | | | | | | | | 1 | | | | | | | | | | 2 | 1 | 2 | 1 | 3 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | 2 |
| 72. D | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | 2 | | | | 2 | | | | | | 4 | | | 1 | 3 | | | | | |
| 73. D | | | | | | | | | | | | | | | | 1 | | | | | 2 | | | 1 | 1 | | | 1 | | |
| E | | | | | | | | | | | | | | | | | | | | | | 1 | 4 | | 5 | | | | | |
| F | | | | | | | | | | | | | | | | 1 | | | | 1 | 8 | 2 | 4 | 1 | 7 | | | | | |
| 74. D | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | | | 1 | 2 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | 2 | 1 | 1 | 2 | 4 | 4 | | 2 | 1 | 5 | | | | | |
| 75. D | | | | | | | | | | | | | | | | | | | | | | | | | | 15 | 1 | 4 | 5 | 17 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 1 | | 3 | | 1 | | | | | |
| 76. D | | | | | | | | | | | | | | | | 3 | | | | | | | | | | 1 | 1 | | 1 | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 2 | | 1 | | 2 | 2 | | 1 | 1 | 1 |
| 77. D | 5 | | | 4 | 9 | | | | | | | | | | | 18 | | 6 | 11 | 17 | 1 | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | 4 | | | 4 | 4 | | | | | |
| F | | | | | | | | | | | | | | | | 2 | | | | 2 | 23 | | 1 | 6 | 18 | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 78. D | | | | | | | | | | | | | | | | | | 1 | | | | | | | | 1 | 1 | | 1 | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 2 | | | | 1 | 2 | | 1 | 1 | 1 |
| 79. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 80. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | 10 | | | 3 | 10 |
| 81. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| 82. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 83. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 84. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 85. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 86. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 87. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 88. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 2 | | | 1 | 2 | 3 | | | | 2 |
| 89. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 90. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | 1 | | | | | |
| 91. D | | | | | | | | | | | | | | | | | | | | | 2 | | | 1 | 1 | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 3 | | | 1 | 3 | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 92. D | | | | | | | | | | | | | | | | | 1 | | | 1 | | | | | | 3 | | | | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 93. D | 2 | 2 | | 2 | 6 | | | | | | | | | | | 5 | | | | 1 | | | | | | 2 | | | 1 | 2 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | 4 | | | 3 | 4 | 4 | | | 1 | 4 | | | | | | | | | | | | | | | | 1 | | | | 1 |
| 94. D | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | 1 | 1 | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 95. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 96. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 97. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| 98. D | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | 1 | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 99. D | | | | | | | | | | | | | | | | 2 | | | | 1 | 2 | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| F | | | | | | | | | | | | | | | | 4 | | 1 | | 3 | 1 | | | | | 2 | | | | 2 |
| 100. D | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 101. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 102. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 103. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | 1 | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 104. D | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | 2 | | 1 | | 2 | 3 | | 1 | | 3 | 4 | | 3 | | 2 |
| 105. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 106. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 107. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 108. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 109. D | | | | | | 7 | | 1 | 4 | 9 | 3 | | | 1 | 5 | 1 | | 1 | | 2 | 20 | | 7 | 3 | 14 | | 6 | | | 7 |
| E | 2 | | | 2 | 2 | 3 | | 2 | | 2 | 6 | | | | | 11 | | | 10 | 10 | 14 | | 4 | 17 | 24 | | 2 | | 1 | 2 |
| F | | | | | | 4 | | 2 | 1 | 4 | 15 | | 2 | 2 | 15 | 3 | | | | 2 | 1 | | 1 | | 1 | | | | | |
| 110. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 111. D | | | | | | 1 | 1 | | 1 | 3 | | | | | | | | | | | | 1 | | | | 3 | | | 1 | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 2 | | | | |
| 112. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 8. The number of pages on which each of the identified 114 life science concepts are presented by (1) inference, (2) statement, (3) experiment, (4) example in environment, (5) illustration, for each book level of three textbook series. (Continued).

| Concept and Teacher's Manual | Grade 1 | | | | | Grade 2 | | | | | Grade 3 | | | | | Grade 4 | | | | | Grade 5 | | | | | Grade 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 113. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 114. D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | 12 | | 2 | 1 | 10 |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. Laboratory programs and textbook series were identified as follows: A - ESS; B - SCIS; C - SAPA; D - Science Understanding Your Environment; E - MAPS; F - Concepts in Science.

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 1. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | 2 | 2 | | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | 2 | 2 |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | 2 | 2 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| E | | 5 | | | | 2 | 7 | | | | | | | | | | 3 | | | | 3 | | | 2 | | | 2 | 4 | | | 3 | | 1 | 4 |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 13 | | | | | | | | | | | | | | 4 | | | | | | | 4 | | | | | | 7 |
| 2. A | 1 | 1 | 1 | 1 | 1 | 1 | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | 3 | | | | | 3 | | | | | | | | | | | | | | | | 2 | | | | | 2 | | 10 | | | | 10 |
| C | | | | | 1 | | 1 | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | | | |
| D | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 |
| E | | | 2 | | | 2 | 4 | | | | | | | | | | 2 | | | 2 | 4 | | | | | | | | | 1 | | 2 | 3 |
| F | | | | 4 | | | 4 | | | | | | | | | | | 2 | | | 2 | | | | | | | | | | 2 | | | 2 |
| TOTAL | | | | | | | 19 | | | | | | | | | | | | | | 7 | | | | | | | 2 | | | | | | 16 |
| 3. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | 2 | | | 1 | 3 | | | | | | | | | | 2 | | | | 2 | | | | | | | | | | 2 | | | 2 |
| C | | | | | | | | | | | | 1 | | 1 | | | | | 1 | | 1 | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | 3 | 3 | | | | | | | | | | | | | 3 | 3 | | | | | | 1 | 1 | | | | | 1 | 1 |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 6 | | | | | | | 1 | | | | | | | 6 | | | | | | | 1 | | | | | | 3 |

Table 9. The number of pages on which life science concepts are presented by I) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 4. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | 1 | | | | 1 | | | | | 1 | | 1 | | | | | 1 | | 1 | | | | | | | | | | 1 | | | 1 |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | 2 | | | | 2 | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | 3 | | | | 3 |
| E | | | | | | 2 | 2 | | | | | | | | | | | | | | | | | | | | 3 | 3 | | | | | | 2 | 2 |
| F | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 |
| TOTAL | | | | | | | 6 | | | | | | | 1 | | | | | | | 1 | | | | | | | 4 | | | | | | | 7 |
| 5. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | 1 | 2 | | | 3 | | | | | | | | | | | | | | | | | | 1 | | | 1 | | | 1 | | | | 1 |
| E | | | | | | 3 | 3 | | | | | | | | | | | | | | | | | | | 2 | | 2 | | | | | | 1 | 1 |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 7 | | | | | | | | | | | | | | | | | | | | | 3 | | | | | | | 3 |
| 6. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | |

**Table 9.** The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 7. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | 1 | 1 | 2 | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | | 1 | 1 | 2 |
| C | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | 3 | 1 | 1 | | 5 | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | 2 | | | 2 |
| E | | | 2 | 3 | | 1 | 6 | | | | | | | | | | | | | 1 | 1 | | | 2 | 2 | | | 4 | | | 2 | 2 | 1 | 5 |
| F | | | 1 | | | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | 2 |
| TOTAL | | | | | | | 16 | | | | | | | | | | | | | | 2 | | | | | | | 5 | | | | | | 11 |
| 8. A | 1 | 1 | 1 | 1 | | | 4 | | | | | | | | 1 | 1 | 1 | 1 | | | 4 | | | | | | | | | | | | | |
| B | | | | 14 | | 1 | 15 | | | 2 | | | | 2 | | | 20 | | | | 20 | | | | 2 | | | 2 | | | | 29 | | | 29 |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | 2 | 5 | 5 | 4 | 5 | | 21 | | | | | | | | | | 1 | 1 | | | 2 | | 1 | 3 | 2 | | | 6 | | 7 | 4 | 3 | 1 | | 15 |
| E | | 3 | 2 | 3 | 18 | 9 | 35 | | | | | | | | | 2 | | | 7 | 2 | 11 | | 3 | 2 | 3 | 20 | 7 | 35 | | 1 | 2 | 3 | 26 | 8 | 40 |
| F | | 9 | 20 | 17 | 1 | 1 | 48 | | | | 2 | 1 | | 3 | | 6 | 3 | 3 | 1 | | 13 | | 1 | 2 | 4 | 1 | | 8 | | 11 | 20 | 14 | 1 | | 46 |
| TOTAL | | | | | | | 123 | | | | | | | 5 | | | | | | | 50 | | | | | | | 51 | | | | | | 130 |
| 9. A | 7 | 7 | 7 | 18 | 14 | 13 | 66 | | | | | | | | 3 | 3 | 3 | 21 | 17 | 17 | 64 | 6 | 6 | 6 | 8 | | 5 | 31 | | | | 6 | | 6 |
| B | 1 | 2 | 2 | 14 | 1 | 1 | 21 | | 2 | | 1 | | | 3 | 1 | 1 | 1 | 20 | | 2 | 5 | | | | 2 | | | 2 | | 2 | | 29 | | 6 | 37 |
| C | 3 | | 1 | | 1 | 3 | 8 | | | | | | | | 3 | | 1 | | | 2 | 6 | 3 | | | | 2 | 2 | 7 | | | | | 1 | 1 | 1 |
| D | 3 | 1 | 2 | 2 | | | 8 | | 1 | 2 | | | | 3 | | 1 | 2 | 2 | | | 5 | | 1 | 2 | | | | 3 | 3 | 2 | 6 | 4 | | | 15 |
| E | | 3 | 5 | | 1 | 2 | 11 | | | | | | | | | 2 | 3 | | 1 | 5 | 11 | | | 5 | 1 | 1 | | 7 | | 3 | 8 | | 1 | 3 | 15 |
| F | 3 | | 6 | 7 | | | 16 | | | | | | | | | | 2 | 2 | | | 4 | | | 2 | | | | 2 | 3 | | 6 | 7 | | | 16 |
| TOTAL | | | | | | | 130 | | | | | | | 6 | | | | | | | 95 | | | | | | | 50 | | | | | | 90 |

**Table 9.** The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 10. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | 1 | | | | 5 | 1 | 7 | | 3 | | | | | 3 | | | | | 1 | 1 | 2 | 1 | | | | 1 | 2 | 4 | 2 | | | 5 | 2 | 1 | 10 |
| E | | | 3 | | 1 | 2 | 6 | | | | | | | | | | | | | | | | | 3 | | 1 | 2 | 6 | | | 2 | | 1 | 2 | 5 |
| F | | | 3 | 1 | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | 2 |
| TOTAL | | | | | | | 17 | | | | | | | 3 | | | | | | | 2 | | | | | | | 10 | | | | | | | 17 |
| 11. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | 4 | | | | | 4 | 8 | | | | | | | | | | | | | | | 1 | 1 | 6 | | | | | 2 | 8 |
| TOTAL | | | | | | | 8 | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 8 |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 13. A | 7 | 7 | 13 | 18 | 15 | 12 | 72 | | | | | | | | 6 | 6 | 6 | 12 | 12 | 10 | 52 | 8 | 8 | 9 | 9 | 7 | 5 | 46 | 2 | 2 | 2 | 2 | 2 | 1 | 11 |
| B | 2 | | 2 | 1 | 1 | | 6 | | | | | | | | 2 | 1 | 3 | 1 | 1 | | 8 | | | | | | | | 2 | | | | 1 | | 3 |
| C | 4 | | | 1 | 1 | 3 | 9 | | | | | | | | 3 | | | 1 | 1 | 3 | 8 | 1 | | | 1 | | 3 | 5 | | | | 1 | | | 1 |
| D | 4 | 3 | 2 | | 2 | 2 | 13 | | 2 | 1 | 4 | | | 7 | | 1 | 1 | | | 1 | 3 | 1 | 2 | 1 | 1 | 1 | 2 | 8 | 4 | 8 | 2 | 2 | 2 | | 18 |
| E | | 3 | 4 | | | 2 | 9 | | | | | | 1 | 1 | | 3 | 2 | | | 3 | 8 | | 1 | 2 | | | 3 | 6 | | 4 | 5 | | | 3 | 12 |
| F | 7 | 4 | 5 | 5 | 4 | 7 | 32 | | | | 5 | | 3 | 8 | 2 | 5 | 3 | 2 | | 1 | 13 | | | | 1 | | 1 | 2 | 10 | 6 | 4 | 4 | | 4 | 28 |
| TOTAL | | | | | | | 141 | | | | | | | 16 | | | | | | | 92 | | | | | | | 67 | | | | | | | 73 |
| 14. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | 1 | 1 | | | | | 1 | | 1 | | | | | | 2 | 2 | | | | | | | | | | | | | | |
| D | 2 | | | | | 1 | 3 | | | | | | | | 2 | | | | | | 2 | | | | | | | | 2 | | | | 1 | | 3 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 4 | | | | | | | 1 | | | | | | | 4 | | | | | | | | | | | | | | 3 |

**Table 9.** The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 16. A | 1 | 1 | 1 | 1 | 1 | 1 | 6 | | | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 6 | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | 2 | | | 2 | | | | | | | | | | | 1 | | | 1 | | | | | | | | | | | 2 | | | 2 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 8 | | | | | | | | | | | | | | 1 | | | | | | | 6 | | | | | | | 2 |
| 17. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | 3 | | | 1 | | | 4 | | | | | | | | | | | | | | | 2 | | | | | | 2 | 3 | | | | | | 3 |
| E | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| F | | 1 | 1 | 1 | | | 3 | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | | | 3 |
| TOTAL | | | | | | | 8 | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | 7 |
| 18. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | 2 | | | | 2 | 4 | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | 2 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | 1 | | 1 | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 19. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | 2 | | | 2 | | | | | | | | | | | 3 | | | 3 | | | | | | | | | | | 1 | | | 1 |
| C | | | | 1 | 2 | 1 | 4 | | | | | 1 | | 1 | | | | 1 | 3 | 2 | 6 | | | | | 3 | | 3 | | | | 1 | | 1 | 2 |
| D | | | 1 | | | | 1 | | | | | | 1 | 1 | | | 1 | | | | 1 | | | | | | 2 | 2 | | | 1 | | | 1 | 2 |
| E | | | | | 2 | | 2 | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | | | | |
| F | | | | 2 | | 10 | 12 | | | | 2 | | 1 | 3 | | | | | | 2 | 2 | | | | 1 | | 2 | 3 | | | | 2 | | 10 | 12 |
| TOTAL | | | | | | | 21 | | | | | | | 5 | | | | | | | 13 | | | | | | | 8 | | | | | | | 17 |
| 20. A | 6 | | 6 | 12 | 11 | 11 | 46 | | | | | | | | 1 | | 1 | 8 | 7 | 7 | 24 | 4 | | 3 | 4 | 3 | 3 | 17 | | | 1 | 2 | | | 3 |
| B | | | | 2 | | | 2 | | | | | | | | | | | 3 | | | 3 | | | | | | | | | | | 1 | | | 1 |
| C | | 3 | | 4 | 1 | 6 | 14 | | | | | | | | | 3 | | 3 | 1 | 5 | 12 | | | | 1 | | | 1 | | 3 | | 4 | | 2 | 9 |
| D | | 2 | 4 | | 2 | | 8 | | | | | | 1 | 1 | | | 1 | | | 1 | 2 | | 1 | | | | 2 | 3 | | 2 | 3 | | | 1 | 6 |
| E | | 1 | | | 3 | | 4 | | | | 4 | | | 4 | | | 7 | 5 | | | 12 | | 1 | | 10 | 3 | | 14 | | 1 | 10 | | 6 | | 17 |
| F | | | | 3 | | 14 | 17 | | | | 1 | | | 1 | | | | 1 | 5 | 6 | | | | | | 2 | | 3 | 5 | | | | 2 | | 13 | 15 |
| TOTAL | | | | | | | 91 | | | | | | | 6 | | | | | | | 59 | | | | | | | 40 | | | | | | | 51 |
| 21. A | 22 | 22 | 17 | 29 | 21 | 14 | 125 | | | | | | | | 1 | 1 | 1 | 6 | 5 | 5 | 19 | 14 | 14 | 12 | 17 | 12 | 9 | 78 | 1 | 1 | 1 | 1 | 1 | 1 | 6 |
| B | 2 | 11 | 1 | 1 | 3 | | 18 | | | | | | | | | 5 | | 1 | 2 | | 8 | 2 | 1 | 1 | | | | 4 | | 2 | | | | | 3 |
| C | 1 | 6 | | | | 1 | 8 | | | | | | | | | 7 | | | | 1 | 8 | | | | 1 | | | 1 | | 2 | | | | | 2 |
| D | 10 | | 3 | | 8 | | 21 | 1 | | | | 1 | | 2 | 1 | | 2 | | 5 | | 8 | 5 | | | | 4 | | 9 | 12 | | 2 | | 7 | 1 | 22 |
| E | | 1 | 2 | 2 | 8 | 1 | 14 | | | | | | | | | | 1 | 1 | 7 | | 9 | | 1 | 1 | 1 | 1 | | 4 | | 1 | 4 | 3 | 11 | 1 | 20 |
| F | 27 | 12 | 8 | 3 | 3 | 2 | 55 | | | | 1 | | | 1 | 1 | 3 | 1 | | | | 5 | 1 | 1 | 5 | | | | 7 | 29 | 16 | 8 | 2 | 2 | 2 | 59 |
| TOTAL | | | | | | | 241 | | | | | | | 3 | | | | | | | 57 | | | | | | | 103 | | | | | | | 112 |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 22. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 25. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | 3 | 2 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | 17 | | | 4 | 21 | | | | | | | | | | 2 | | | | 2 | | | 4 | | | 2 | 6 | | | 18 | | | 4 | 22 |
| TOTAL | | | | | | | 27 | | | | | | | | | | | | | | 2 | | | | | | | 6 | | | | | | | 22 |
| 26. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | 1 | | 2 | 4 | 7 | | | | | 1 | 1 | 2 | | | | | | 1 | 1 | | | 1 | | 3 | 1 | 5 | | | | | 2 | 2 | 4 |
| C | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | 1 | | | 1 | | | | | | | |
| D | 4 | | 2 | 2 | | 1 | 9 | | | | | | | | | | 1 | | | | 1 | 1 | | 3 | 1 | | | 5 | 4 | | 3 | 1 | | | 8 |
| E | | | 5 | 6 | | 4 | 15 | | | | 1 | | 1 | 2 | | | 3 | | | 1 | 4 | | | 2 | 9 | | 6 | 17 | | | 4 | 6 | | 5 | 15 |
| F | | | | 1 | | 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 2 | 3 |
| TOTAL | | | | | | | 35 | | | | | | | 4 | | | | | | | 6 | | | | | | | 28 | | | | | | | 30 |
| 27. A | 1 | 1 | 3 | 5 | 5 | 5 | 20 | | | | | | | | | | | | | | | 1 | 1 | 1 | 3 | 3 | 3 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 6 |
| B | 4 | | 10 | | 7 | 6 | 27 | | | | | 1 | | 1 | 3 | | 3 | | 8 | 11 | 25 | 2 | | | | 1 | 2 | 5 | | | 2 | | 7 | 5 | 14 |
| C | 2 | | 1 | 1 | | | 4 | | | | | | | | | | 3 | | | | 3 | 1 | | | 1 | | | 2 | | | | | | | |
| D | 2 | 4 | 4 | | 4 | 8 | 22 | | | | 1 | | | 1 | | 1 | | | | 1 | 2 | 1 | 1 | 1 | | | 2 | 5 | 2 | 7 | 3 | | | 3 | 15 |
| E | | | 3 | 18 | | 7 | 28 | | | | | | | | | | 1 | 10 | | 1 | 12 | | | 2 | 16 | | 5 | 23 | | | 3 | 18 | | 8 | 29 |
| F | 4 | 2 | 14 | 25 | 1 | 6 | 52 | | | | 2 | | 2 | 4 | | | | 4 | | | 4 | 1 | | 1 | 4 | | 1 | 7 | 4 | | 12 | 24 | | 6 | 46 |
| TOTAL | | | | | | | 153 | | | | | | | 6 | | | | | | | 41 | | | | | | | 54 | | | | | | | 110 |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 28. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | 2 | | 2 | | | 2 | 6 | | | | | 1 | | 1 | | | | 1 | | 2 | 3 | 3 | | 2 | | | | 5 | 1 | | | | 1 | 2 |
| C | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | 8 | 4 | | 1 | 2 | 1 | 17 | | | | | | | | 4 | | | | 2 | | 6 | 6 | 1 | | 1 | | | 8 | 8 | 5 | | 1 | 1 | | 15 |
| E | | 2 | 6 | | | 2 | 10 | | 1 | | | | | 1 | | 1 | 3 | 2 | | 1 | 7 | | 2 | 12 | 2 | | 1 | 17 | | 2 | 12 | 3 | | 1 | 18 |
| F | | | 4 | 3 | | 1 | 8 | | | | 1 | | | 1 | 1 | | 6 | 1 | | | 8 | | | | | | | | 3 | | 7 | 2 | | | 12 |
| TOTAL | | | | | | | 42 | | | | | | | 3 | | | | | | | 24 | | | | | | | 30 | | | | | | | 47 |
| 29. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | 1 | | | | | 1 | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | | | | |
| C | 2 | 2 | | | | | 4 | | | | | | | | | | | | | | | 2 | 2 | | | | | 4 | | 1 | | | | 1 |
| D | | | 2 | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | | 3 |
| E | | 4 | | | | 1 | 5 | | | | | | | | | 1 | | | | 1 | 2 | | 3 | | | | 1 | 4 | | 4 | | | 12 | 16 |
| F | | | 4 | 1 | | | 5 | | | | | | | | | | 1 | | | | 1 | | | 1 | | | | 1 | | | 4 | | | | 4 |
| TOTAL | | | | | | | 17 | | | | | | | | | | | | | | 3 | | | | | | | 10 | | | | | | | 24 |
| 30. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | 4 | 4 | | | | | | | | | | | | | 2 | 2 | | | | | | | | | | | | 1 | 1 |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| E | | | | | | 8 | 8 | | | | | | | | | | | | | 13 | 13 | | | | | | 3 | 3 | | | | | 12 | 12 |
| F | | | | 4 | | 1 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 17 | | | | | | | | | | | | | | 15 | | | | | | | 3 | | | | | | | 19 |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 31. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | 2 | | | 2 | | | | | | | | | | | | | | | | | | 1 | | | 1 | | | | 1 | | | 1 |
| TOTAL | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 |
| 32. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 33. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 34. A | 8 | 8 | 8 | 8 | | | 32 | | | | | | | | 3 | 3 | 3 | 3 | | | 12 | | | | | | | | 1 | 1 | 1 | 1 | | | 4 |
| B | 2 | 1 | | | | | 3 | | | | | | | | | 1 | | | | | 1 | 2 | 1 | | | | | 3 | | | | | | | |
| C | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | | |
| D | 1 | | 9 | 7 | | 5 | 22 | 1 | | 3 | | | | 4 | 3 | | 9 | 1 | | | 13 | | | 6 | | | 4 | 10 | 5 | | 13 | 4 | | 6 | 28 |
| E | 4 | 3 | | | | | 7 | | | 1 | | | | 1 | | 2 | 2 | | | | 4 | 3 | 4 | 1 | | | | 8 | 4 | 2 | 2 | | | | 8 |
| F | | | | 26 | 15 | | 41 | | | | 2 | 3 | | 5 | | | | 9 | 5 | | 14 | | | | 8 | 3 | | 11 | | | | 20 | 13 | | 33 |
| TOTAL | | | | | | | 106 | | | | | | | 10 | | | | | | | 44 | | | | | | | 33 | | | | | | | 73 |
| 35. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | 2 | | 1 | | | | 3 | | | | | | | | | | | | | | | 2 | | 1 | | | | 3 | 2 | | 1 | | | | 3 |
| F | | | | | 2 | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 5 | | | | | | | | | | | | | | | | | | | | | 3 | | | | | | | 3 |
| 36. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | 1 | | 1 | 2 | | | | | | 1 | 1 | | | | | | | | | | | 1 | | 2 | 3 | | | | 2 | | 2 | 4 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 2 | | | | | | | 1 | | | | | | | | | | | | | | 3 | | | | | | | 4 |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 37. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| TOTAL | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| 38. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | 1 | | | | | | 1 | | | | | 3 | | 3 | | | | | 2 | | 2 | 1 | | | 1 | | | 2 | | | | | | | |
| C | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | 1 | 2 | | 1 | 4 | | | 2 | | 1 | | 3 | | | 1 | | | | 1 | | | 1 | | | | 1 | | | 2 | 1 | 1 | | 4 |
| E | | | | | | 1 | 1 | | | | | | | | | | | | | 2 | 2 | | | | | | | | | | | | 1 | 1 |
| F | | 1 | 6 | 2 | 1 | 8 | 18 | | 2 | | | | 2 | 4 | | | 1 | 2 | | 2 | 5 | | | 1 | | | 1 | 2 | 1 | | 3 | 1 | 1 | 4 | 10 |
| TOTAL | | | | | | | 25 | | | | | | | 10 | | | | | | | 10 | | | | | | 5 | | | | | | | 15 |
| 39. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 40. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | 3 | 1 | 1 | 1 | 6 | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | 1 | 1 |
| E | | | | | | 2 | 2 | | | | | | 4 | 4 | | | | | | 2 | 2 | | | | | | 4 | 4 | | | | | | 3 | 3 |
| F | | 13 | 2 | 2 | | 4 | 21 | | | 2 | 2 | | | 4 | | 1 | | | | | 1 | | 2 | | | | 1 | 3 | | 18 | 2 | | | 2 | 22 |
| TOTAL | | | | | | | 30 | | | | | | | 9 | | | | | | | 3 | | | | | | | 7 | | | | | | | 26 |
| 41. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | 2 | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | 2 |
| TOTAL | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| 42. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | 2 | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| TOTAL | | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 43. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 44. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | 2 | 1 | 1 | 1 | 1 | 6 | | 1 | | | | | | 1 | | | | 1 | 1 | 1 | 3 | | 3 | | | | | 3 | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | 1 | 2 | | | | 2 | 5 | | | | | | | | | | | | 1 | | | 1 | | 1 | | | | | 1 | | 3 | | | | 3 |
| E | 3 | 3 | | | 2 | 1 | 10 | | | | | | | | | | | | 1 | | | 1 | 3 | 3 | | | 1 | 1 | 8 | 3 | 3 | | | 1 | 1 | 8 |
| F | | 1 | 2 | 2 | | | 5 | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | 2 | | | | | 2 |
| TOTAL | | | | | | | 26 | | | | | | | | 1 | | | | | | | 5 | | | | | | | 13 | | | | | | | 13 |
| 45. A | 2 | | 2 | 4 | 3 | 2 | 13 | | | | | | | | | | | | | 2 | | 2 | 2 | | 2 | 4 | 3 | | 11 | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | 2 | | | | | 2 | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | 4 | | | | | 4 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 15 | | | | | | | | | | | | | | | 2 | | | | | | | 12 | | | | | | | 4 |

**Table 9.** The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 46. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | 2 | | | 2 | | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | 2 | | | 2 |
| E | | | 1 | | | 1 | 2 | | | | | | | | | | | | | 2 | 2 | | | 1 | | | | 1 | | | 1 | | | 1 | 2 |
| F | | | 2 | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | 2 |
| TOTAL | | | | | | | 6 | | | | | | | | | | | | | | 2 | | | | | | | 2 | | | | | | | 6 |
| 47. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | 1 | 1 | 3 | 11 | | 16 | | | | 1 | | 1 | 2 | | | | | 2 | | 2 | | | | 2 | 4 | | 6 | | 2 | | 3 | 10 | 1 | 16 |
| E | 3 | | 1 | | | 3 | 7 | | | | | | | | | | | | | 2 | 2 | 3 | | 1 | | | 2 | 6 | 3 | | 1 | | | 1 | 5 |
| F | 6 | 1 | | | | | 7 | | | | | | | | | | | | | | | | | | | | | | 6 | 1 | | | | | 7 |
| TOTAL | | | | | | | 30 | | | | | | | 2 | | | | | | | 4 | | | | | | | 12 | | | | | | | 28 |
| 48. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | 4 | 2 | 2 | 8 | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 |
| E | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | 1 | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 |
| TOTAL | | | | | | | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |

**Table 9.** The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 49. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | 1 | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| 50. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | 1 | 1 | | | | | | 1 | 1 | 1 | | | | | | | | | | | | | | | | | 1 | | | 1 | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | 3 |
| TOTAL | | | | | | | 6 | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | 4 |
| 51. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 9. The number of pages on which life science concepts are presented by I) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 52. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| D | | | | | | 2 | 2 | | | | 2 | | | 2 | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
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| TOTAL | | | | | | | 3 | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | 1 |
| 53. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | 1 | | 1 | 2 | | | | | | | | | | | | | 1 | 1 | | | | | | 1 | 1 | | | | | | 1 | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 2 | | | | | | | | | | | | | | 1 | | | | | | 1 | | | | | | | 1 |
| 54. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 55. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| D | | | 1 | 1 | | 1 | 3 | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | 1 | | 1 | 2 |
| E | | | | | | 2 | 2 | | | | | | | | | | | | | | | | | | | | 2 | 2 | | | | | | 2 | 2 |
| F | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| TOTAL | | | | | | | 6 | | | | | | | | | | | | | | | | | | | | | 3 | | | | | | | 5 |
| 56. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| D | | 1 | | 1 | | | 2 | | | | | | | | | | | 1 | | | 1 | | | | | | | | | 1 | | 2 | | | 3 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | 8 | 8 | | | | | | | | | | | | | 3 | 3 | | | | | | 2 | 2 | | | | | 4 | 4 |
| TOTAL | | | | | | | 10 | | | | | | | | | | | | | | 4 | | | | | | | 2 | | | | | | 7 |
| 57. A | | | | 2 | | | 2 | | | | | | | | | | | 1 | | | 1 | | | | 1 | | | 1 | | | | | | | |
| B | | | | | 2 | | 2 | | | | | | | | | | | | 2 | | 2 | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | 1 | 1 | | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | 1 | 1 |
| F | | | | | 1 | 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| TOTAL | | | | | | | 9 | | | | | | | | | | | | | | 4 | | | | | | | | | | | | | | 2 |

**Table 9.** The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 58. A | | | 1 | 4 | 4 | 4 | 13 | | | | | | | | | | | 3 | 3 | 3 | 9 | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| D | | | | 1 | 2 | 4 | 7 | | | | 2 | 1 | 1 | 4 | | | | 1 | 1 | 1 | 3 | | | | 1 | 1 | 1 | 3 | | | | 2 | | 3 | 5 |
| E | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| F | | | | | | 2 | 2 | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | 2 | 2 |
| TOTAL | | | | | | | 23 | | | | | | | 4 | | | | | | | 12 | | | | | | | 4 | | | | | | 8 |
| 59. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | 1 | | | | | 1 | | | | | | 1 | 1 | | 1 | | | | | 1 | | | | | | | | | | 1 | | | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 3 | | | | | | | 1 | | | | | | | 1 | | | | | | | | | | | | | 1 |
| 60. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| F | | | | 1 | 1 | | 12 | | | | | | | | | | | | 2 | | 2 | | | | | 1 | | 1 | | | | | 5 | | 5 |
| TOTAL | | | | | | | 12 | | | | | | | | | | | | | | 2 | | | | | | | 1 | | | | | | 5 |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 61 A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 62. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| E | | | | | | 2 | 2 | | | | | | | | | | | | | | | | | | | | 2 | 2 | | | | | | 2 | 2 |
| F | 4 | | | | 2 | 5 | 11 | | | | | | | | | | | | | | | 2 | | | | | | 2 | 4 | | | | 1 | 5 |
| TOTAL | | | | | | | 13 | | | | | | | | | | | | | | | | | | | | 4 | | | | | | | 7 |
| 63. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 64. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Table 9.** The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 67. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | 2 | | 1 | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | 2 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | 5 | 2 | | 14 | | 21 | | | | | | | | | | | | 11 | | 11 | | | | | 1 | | 1 | | 5 | 1 | | 11 | | 17 |
| TOTAL | | | | | | | 24 | | | | | | | | | | | | | | 11 | | | | | | | 1 | | | | | | | 19 |
| 68. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 69. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Table 9.** The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 70. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | 1 | | 2 | | 5 | | 8 | | | 1 | | 1 | | 2 | | | | | 1 | | 1 | | | 3 | | 1 | | 4 | 1 | | 3 | | 6 | | 10 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | 11 | 8 | 2 | | 7 | | 28 | | | | | 2 | | 2 | 1 | | | | 2 | | 3 | | 1 | | | 2 | | 3 | 12 | 9 | | | 7 | | 28 |
| TOTAL | | | | | | | 36 | | | | | | | 4 | | | | | | | 4 | | | | | | | 7 | | | | | | | 38 |
| 71. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| D | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| F | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 72. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | 1 | | | 1 | | | | | | | | | | | 4 | | | 4 | | | | | | | | | | | | 1 | | 1 |
| D | 1 | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | 2 | | 4 | | 6 | | | | | | | | | | | | | | | | | | | 1 | 1 | 2 | | | | 2 | 3 | | 5 |
| TOTAL | | | | | | | 8 | | | | | | | | | | | | | | 4 | | | | | | | 2 | | | | | | | 7 |

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| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 73. A | | | | 3 | 3 | 3 | 9 | | | | | | | | | | | 6 | 6 | 6 | 18 | | | | | | | | | | | | 9 | 9 | 27 |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | 1 | 2 | 2 | 5 | | | | | | 1 | 1 | | | | | | 2 | 2 | | | | | 1 | 1 | 2 | | | | 1 | 3 | 4 |
| E | | | | | | | | | | | | 1 | | 1 | | | | | 4 | | 4 | | | | | | | | | | | 5 | | 5 |
| F | | | | 1 | 8 | 1 | 10 | | | | | 2 | | 2 | | | | | 4 | | 4 | | | | | 1 | | 1 | | | | 1 | 7 | 2 | 10 |
| TOTAL | | | | | | | 24 | | | | | | | 4 | | | | | | | 28 | | | | | | | 3 | | | | | | | 37 |
| 74. A | | | | 1 | 1 | 1 | 3 | | | | 1 | 1 | 1 | 3 | | | | 1 | 1 | 1 | 3 | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | 2 | 4 | | 6 | | | | 1 | | | 1 | | | | 1 | 2 | | 3 | | | | 2 | 1 | | 3 | | | | 4 | 5 | | 9 |
| TOTAL | | | | | | | 10 | | | | | | | 4 | | | | | | | 6 | | | | | | | 3 | | | | | | | 9 |
| 75. A | | | | 1 | 1 | 1 | 3 | | | | | | | | | | | 1 | | | 1 | | | | | | | | | | | | 1 | 1 |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| D | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | 1 | | 1 | | | | | | | | | | | | 3 | | 3 | | | | | | | | | | | | 1 | | 1 |
| TOTAL | | | | | | | 4 | | | | | | | | | | | | | | 5 | | | | | | | | | | | | | | 2 |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 76. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | 3 | | 5 | 8 | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | 2 | 2 |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | 2 | | 2 | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | | 2 | | 2 |
| TOTAL | | | | | | | 10 | | | | | | | | | | | | | | 1 | | | | | | | 1 | | | | | | | 4 |
| 77. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | 5 | | | 18 | 1 | 15 | 39 | | | | | | 1 | 1 | | | | 6 | | 4 | 10 | 4 | | | 11 | | 5 | 20 | 9 | | | 17 | | 17 | 43 |
| E | | | | | 4 | | 4 | | | | | | | | | | | | | | | | | | 4 | | 4 | | | | | 4 | | 4 |
| F | | | | 2 | 23 | | 25 | | | | | | | | | | | | 1 | | 1 | | | | 6 | | 6 | | | | 2 | 18 | | 20 |
| TOTAL | | | | | | | 68 | | | | | | | 1 | | | | | | | 11 | | | | | | 30 | | | | | | | 67 |
| 78. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | 1 | 1 | | | | | | 1 | 1 | | | | 1 | | | 1 | | | | | | 1 | 1 | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | 2 | 2 | 4 | | | | | | | | | | | | | 1 | 1 | | | | | | 1 | 1 | | | | 1 | 1 | 2 |
| TOTAL | | | | | | | 5 | | | | | | | 1 | | | | | | | 2 | | | | | | 2 | | | | | | | 2 |

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| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 79. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| C | | | | | 1 | | 1 | | | | | | | | | | | | 4 | | 4 | | | | | 6 | | 6 | | | | | 2 | | 2 |
| D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | | | | | | 10 | 10 | | | | | | | | | | | | | | | | | | | 3 | 3 | | | | | | 10 | 10 |
| TOTAL | | | | | | | 11 | | | | | | | | | | | | | | 4 | | | | | | 9 | | | | | | | 12 |
| 81. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| F | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| TOTAL | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |

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| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 82. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 85. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 86. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 88. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| F | | | | | 2 | 3 | 5 | | | | | | | | | | | | | | | | | | | 1 | | 1 | | | | 2 | 2 | 4 |
| TOTAL | | | | | | | 5 | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 4 |
| 89. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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**Table 9.** The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 91. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
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| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
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| 99. A | 4 | 4 | 4 | 5 | 1 | 1 | 19 | | | | | | | | 1 | 1 | 1 | 2 | 1 | 1 | 7 | | | | | | | | | | | | | | |
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| F | | | | 4 | 1 | 2 | 7 | | | | | | | | | | | 1 | | | 1 | | | | | | | | | | | 3 | | 2 | 5 |
| TOTAL | | | | | | | 29 | | | | | | | | | | | | | | 8 | | | | | | | | | | | | | | 6 |

**Table 9.** The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
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| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
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| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 109. A | 8 | 8 | 12 | 26 | 24 | 21 | 99 | | | | | | | | | | | 6 | 6 | 6 | 18 | 6 | 6 | 9 | 27 | 25 | 22 | 95 | 2 | 2 | 1 | 115 | 115 | 115 | 350 |
| B | 2 | 2 | 3 | | 1 | | 8 | | | | | 2 | | 2 | | | 4 | | 4 | | 8 | | 2 | 3 | | | | 5 | 2 | | | | 2 | | 4 |
| C | 2 | 4 | 1 | | 1 | 3 | 11 | | | | | | | | | 3 | | | 1 | | 4 | 1 | 3 | 1 | | 4 | 5 | 14 | | | 8 | | 2 | 4 | 14 |
| D | | 7 | 3 | 1 | 20 | | 31 | | | | | | 6 | 6 | | 1 | | 1 | 7 | | 9 | | 4 | 1 | | 3 | | 8 | | 9 | 5 | 2 | 14 | 7 | 37 |
| E | 2 | 3 | 6 | 11 | 14 | | 36 | | | | | | 2 | 2 | | 2 | | | 4 | | 6 | 2 | | | 10 | 17 | 1 | 30 | 2 | 2 | | 10 | 24 | 2 | 40 |
| F | | 4 | 15 | 3 | 1 | | 23 | | | | | | | | | 2 | 2 | | 1 | | 5 | | 1 | 2 | | | | 3 | | 4 | 15 | 2 | 1 | | 22 |
| TOTAL | | | | | | | 208 | | | | | | | 10 | | | | | | | 50 | | | | | | | 155 | | | | | | | 467 |
| 110. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| TOTAL | | | | | | | 7 | | | | | | | 2 | | | | | | | | | | | | | 3 | | | | | | | 4 |

Table 9. The number of pages on which life science concepts are presented by 1) inference, 2) statement, 3) experiment, 4) example in environment, 5) illustration, organized under the analysis criteria found in the teacher's manuals from each of the three laboratory programs and each book level of three textbook series. (Continued).

| Concept and Series Manual | Inference Grade | | | | | | Total | Statement Grade | | | | | | Total | Experiment Grade | | | | | | Total | Example/Environment Grade | | | | | | Total | Illustration Grade | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | | 1 | 2 | 3 | 4 | 5 | 6 | |
| 112. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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