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.

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## ABSTRACT

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# 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