1955

The principles of physical and biological science found in five textbooks of geography for grade eight.

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http://hdl.handle.net/2144/11332

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THE PRINCIPLES OF PHYSICAL
AND BIOLOGICAL SCIENCE FOUND
IN FIVE TEXTBOOKS OF GEOGRAPHY
FOR GRADE EIGHT

by

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A thesis submitted to the School of Education,
Boston University, in partial fulfillment of require­
ments for the degree of Master of Education.

1955
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Second Reader: Helen A. Murphy, Professor of Education
ACKNOWLEDGMENT

The author gratefully acknowledges the valuable suggestions given by Dr. John G. Read for delimiting the problem of this study and for organizing the investigation. Also, the author is indebted to Dr. Helen A. Murphy for her comments, criticisms, and inspiration. Without her understanding and continued encouragement this study could not have been completed.
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CHAPTER I
REVIEW OF LITERATURE AND
RESEARCH IN THE FIELD

INTRODUCTION

On the sands of Alamagordo as the desert trembled before the onslaught of the Atomic bomb, a handful of scientists questioned what they had created. They were awed as they viewed the glass encrusted crater where only shortly before had stood the tower. The tower, a fifty ton steel giant, was now only vapor that was being dissipated in the atmosphere. They had not envisioned their own powers.

Shortly after, as the world observed the gaping ruins of a once great city and reflected on the 100,000 casualties, every intelligent citizen had an awareness of the potentialities of science he had never before considered. Man found himself not merely in the Atom age, but he found himself in a great, stimulating Scientific age. He was surrounded by science.

The children of today know science long before they arrive at kindergarten. They have had their "shots" for colds and possibly polio, vaccination for smallpox, watched space travel on television, and have known the automobile all of their lives. These things are commonplace to them, and they are just awakening to the world in which they live.
It is essential that everyone become familiar with the concepts and uses of science. There is no better place to develop critical thinking, the proper attitudes toward science or the understanding of its principles than in the elementary school.

The importance of early training in this area is shown in Croxton's analysis:

We have come to consider the first few years of the child's life the most important formative period. It is possible that we may discover that they are likewise most important in establishing scientific attitudes. 1

The purpose of this investigation is to determine the principles of physical and biological science found in five textbooks of geography for grade eight.

A BRIEF HISTORY OF THE TEACHING OF SCIENCE IN THE ELEMENTARY SCHOOL

The inclusion of science in the curriculum of the elementary schools of America brought many varied opinions both as to need and to the methods of presentation.

The first schools recognized two chief values. The first

---

was information. The second was a religious value. The student gained an education through acting as a storehouse of facts, and was brought closer to his Creator through his study of living things in the areas of botany, zoology and especially biology.

In the latter half of the nineteenth century the educational philosophy of Pestalozzi found support in Oswego, New York, where the object lesson type recitation was substituted for passive learning from textbooks.

In some cases the object lessons were highly systematized and were regarded as natural science, or at least a preparation for science, which was completely classified knowledge.

As a further effort to avoid the "dry as dust" approach of his predecessors, Agassiz opened a nature school on an island in Buzzards Bay. It was from this school that subsequent curriculum planning in elementary schools gained its philosophy.

Out of the Agassiz School went many of the men who became pioneers in the science movement in colleges and academies. A few carried this


3. Croxton W. C., op. cit. p. 22
inspiration into the teacher-training institutions and the elementary schools.4

Foremost in the field of elementary science at this time was Henry H. Straight, a student of Agassiz. Straight modified the object lesson into a more meaningful learning situation in an integrated study of natural science.

He saw the insufficiency of "object teaching" as an educational process. He sought to overcome these defects by "correlation of subjects of study"... Was undoubtedly the first to correlate natural science with geography and other subjects in the curriculum.5

Other educators of the times were likewise cognizant of the inadequacies of the "object lesson" and through the efforts of Henry Clapp, Arthur C. Boyden, Alpheus Hyath, Lucretia Crocken, Wilbur Jackman and many more, the nature movement got underway.6

Cornell University made a tremendous contribution to the movement beginning in 1893. This work came through the efforts of Liberty Hyde Bailey, Anna B. Comstrock, and John L. Spencer.7 Bailey lectured, wrote articles and established the

4. ibid. p. 23
6. Croxton, op. cit. p. 23
7. Weller, op. cit., p. 738
NATURE STUDY QUARTERLY. Anna B. Comstrock wrote literature for children and "spent all her efforts on developing children rather than subjects of study". 8

Science emerged in the twentieth century with the religious aim modified to the point where it no longer had significance. 9 However, the informational aim still persisted as it has done right down to the present. 10

Laboratory instruction promoted "disciplinary values" which came under such sharp criticism by educational psychologists that "science lost much prestige as a subject of instruction and enrollments in science courses at the secondary level dropped off." 11

As the century developed Weller 12 points out, "Elementary science was a natural outgrowth of Nature Study..... with its emergence about 1925."

Meister 13 in his review of "Recent Educational Research in Science Teaching" concluded that by 1930 general science

8. ibid. p. 740
10. ibid. p. 5
11. ibid. p. 6
12. Weller, op. cit., p. 730
had crystallized to the point where future science teaching would have to be modified. He predicted that by 1940 the replacement of Nature Study by elementary science would be complete.\textsuperscript{14}

His prediction was more than simply a good guess. Early research had pointed the way that elementary science teaching would evolve. Subsequent research has made this guess an accepted fact.

Croxton in evaluating the evolving role of science stated:

\begin{quote}
An elementary science movement is in progress, although it is only beginning to find expression in the public schools. The evidences are unmistakable. Educational periodicals are devoting much space to the subject. Many elementary science readers and textbooks are appearing and are finding ready sale...Marked revisions of courses of study are giving the subject a more prominent place in the school program......courses of study in elementary science constitute sizable books......a number of higher institutions are offering courses in the teaching of science in the elementary school.\textsuperscript{15}
\end{quote}

As the teaching of elementary science evolved, writers differed both to course content and outcomes. Regardless of

\textsuperscript{14} ibid. p. 878.

\textsuperscript{15} Croxton, \textit{op. cit.}, p. 31
The Thirty-First Yearbook of the National Society for the Study of Education states:

It is obvious that all of science can not be taught...the primary purpose of science in the elementary school is...that of assisting boys and girls to become educated laymen.16

Russell17 conducted a poll of fifty-one leading elementary science teachers and proposed several purposes for teaching science. The person polled was asked to check any reason with which he concurred. The following are the purposes which the group unanimously recommended:

- helps children to appreciate their environment and to understand important relationships of living things
- offers good opportunities to develop favorable character and personality traits in children
- aids children to form habits and attitudes of scientific thinking and scientific doing


provides information which children can use in their everyday living

uses subject matter that is naturally interesting and stimulating to children in elementary grades

Blough points out there are many skills to be taught as the objectives of an elementary science program. Among these are:

...skills of reading, writing and arithmetic as essential equipment for gaining information

...the ability to use one's hands

...the skill of seeing things around you and seeing them accurately

...skill of being able to listen intelligently

...skill of speaking effectively so that we can express our ideas coherently and accurately

...skill of sensing problems and solving them in a scientific way, so that the results are dependable

Croxton maintains that in the elementary school "it is not too early to begin the development of scientific attitudes and habits of procedure".


19. Croxton, op. cit., p. 49
He selects for the major aims of teaching elementary science:

To cultivate scientific attitudes and methods of procedure.

To lead to broader concepts, generalizations and outlooks.

To open new avenues of interest and satisfaction.

To enable the individual to meet the problems of existence with the available scientific knowledge and requisite skills.

To develop social attitudes and appreciations

Noll\(^{20}\) in reporting the findings from one hundred thirty sources of teaching science, indicates the aims of science to be:

Knowledge of principles and applications of science

Desirable habits of work and study

Ability to use the scientific method

Scientific attitudes

Interest in science

Appreciation of the beauties of nature and in the commonplace

Appreciation of the work of the scientist

---

20. Noll, op. cit., p. 9
Laughlin\textsuperscript{21} who recognizes that technology avoids stagnation through constant revamping, believes education should do the same. He recognizes that the objectives should be:

\begin{itemize}
  \item developed to build an understanding of man and his world
  \item taught to help man do away with many of his superstitions
  \item to build better understanding of plant and animal life
  \item foundation of well established health practices
  \item to develop an understanding of human development
\end{itemize}

It would thus indicate that while knowledge of factual material has been stressed in the past, it is losing its position of prominence to the development of scientific attitudes and the understanding of scientific principles.

Further emphasis is lent to this conclusion by Blough who states for goals of science teaching:\textsuperscript{22}

\begin{itemize}
  \item help pupils grow in ability to solve problems effectively
  \item develop in children a scientific attitude
\end{itemize}


\textsuperscript{22} Blough, \textit{op. cit.}, p. 18-20
...create in children an interest in and an appreciation for the world in which they live.

This stand was taken by the Forty-Sixth Yearbook when it very candidly stated:

The development of competence in use of the scientific method of problem solving and the inculcation of scientific attitudes transcend in importance other objectives in science instruction. 23

With the emergence of broad concepts as the objectives of science instruction, it became necessary to determine whether or not this was sound pedagogy. The research in this area is interesting and illuminating.

Croxton 24 determined that science teaching in the past has been based upon three pillars. Namely:

1. obtaining rich emotional satisfaction
2. developing interests in nature
3. acquiring a fund of information through environmental contacts

Principles and generalizations have never been considered as the primary aim of instruction. The general feeling was that they belonged at the secondary and college levels. 25


25. Ibid., p. 627
From his experimentation with classes from the upper primary through junior high he concluded:

1. Many children in the higher primary, intermediate, and junior high schools are capable of generalizing.

2. There is little in the experiments to indicate that junior high school pupils possess markedly superior ability to generalize than intermediate pupils possess.\(^{26}\)

Although, admittedly, his samplings were small and, as he pointed out, his correlations would have been higher with more expert teaching, his findings do have significance.

Using the concept of weather, Blough\(^{27}\) has shown how some concepts are "big ideas", and they can be learned a little at a time, beginning in the primary grades.\(^{28}\)

He expanded his "big idea" concept in the following manner:\(^{29}\)

**PRIMARY GRADES: Evaporation-condensation**  
The drying of water colors, drying of wet clothes on a radiator, and

\(^{26}\) Ibid., p. 634  
\(^{28}\) Ibid., p. 120  
\(^{29}\) Ibid., p. 121
the lowering of the water level in the aquarium.

MIDDLE GRADES: Temperature-water vapor ratio
What makes changes in the weather?
What causes rain, snow, sleet and fog?

UPPER GRADES: Weather study
The actual forecasting, construction and interpretation of weather maps.

In working with his groups he determined that each level of development brought a further development of the concept. Each step was dependent upon the preceding one(s).30

Monumental work in the area of generalizations was completed by Haupt31 in 1935. He recognized the existence of two major schools of thought about science teaching and content in the elementary school. The first group supported objectives stated as moral, ethical, civic, vocational, aesthetic and spiritual values. The second group supported objectives stated as broad conceptions, or generalizations indicative of content to be taught or learned.32

The objective of his dissertation was to determine whether or not children were capable of mental activity which

30. Ibid., p. 121
32. Ibid., p. 2
is necessary for the "large generalization" as an objective in science education.

Using concepts of graded difficulty among other things, he concluded: 33

...that these units which by the criteria of this study are classified as simple units were learned on the lower grade levels and those classified as complex were learned on the higher grade levels.

...the difference between the mental operations of the children of the first and sixth grades was not one of ability to generalize but one concerning the complexity of the generalization. Complexity of the elements depends upon:
1. The number of concepts associated
2. The number and immediacy of the experiences which are involved in the concepts associated.

...data indicate the presence of the same kind of mental activity at all grade levels

...an 'understanding of an objective' is not approached or secured through repetition of the same or similar words of the objective, but through the interpretation of numberous and varied learning experiences in such terms of the objective as are possible with the particular grade level.

33. Ibid., p. 94-105
vague and erroneous ideas persisted even after instruction in some cases when teaching for "big ideas".

difficult and complex ideas at the lower levels produced misconceptions rather than vague right ideas.

there is no experimental evidence to show that biological science content is any less difficult than physical content for lower level students.

Martin in a complex study to determine biological science principles as suitable general science course objectives sums up the research with the following:

If the results of surveys and research studies concerned with curricular offerings in science furnish valid indices or trends in this area, then it is evident that eventually our science courses on the elementary, secondary and junior college levels of the public schools will be, for the most part, general courses...Thus the teachers of science...are faced with obligations of determining what are the important principles of science of which an understanding is necessary for the solution of problematic situations which arise in everyday life.

That principles of science are now recognized as essential goals in instruction has been in many studies. That the prin-

ciples must be taught as such is shown by the following three authors.

Noll\textsuperscript{35} found that "Scientific attitudes do not seem to be developed by regular classroom instruction in general science to an extent comparable with that secured by definite instruction in scientific attitudes."

Weller\textsuperscript{36} from her work with sixth-grade pupils deduced "The material of elementary science provides the means of developing desirable attitudes and skills in problem solving if attention is focused on this aim."

Craig\textsuperscript{37} places emphasis on the grade placement of science concepts with this conclusion. "Because of the immaturity of the child, however, there is an unique need in elementary science for specific statements of the meanings to be developed in each grade and also of the broader scientific principles or generalizations toward a later understanding of which the attainment of these specific goals contributes.\textsuperscript{38}

\begin{thebibliography}{9}
\bibitem{35} Noll, op. cit., p. 29
\bibitem{36} Weller, Florence, "Attitudes and Skills in Elementary Science." \textit{Science Education}, 17: 90-97; April, 1933.
\bibitem{37} Craig, Gerald S., Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School, N. Y. Bureau of Publications, Teachers College, Columbia University, No. 276, 1927.
\bibitem{38} Ibid., p. 4
\end{thebibliography}
Russell\textsuperscript{39} reflects a great many studies in this area with the simple statement "Use any method (of teaching science) that gives you results but...a method built around the SCIENCE CONCEPT idea will meet with the approval of prevailing opinion and practice."\textsuperscript{40}

BRIEF HISTORY OF THE DEVELOPMENT OF SCIENCE CONCEPTS

Much of the research on science concepts as objectives of course instruction is to be found only in unpublished Master's theses and Doctoral dissertations. Therefore, the writer would like to make mention of two noteworthy studies in the field. The work of Curtis\textsuperscript{41} and of Martin\textsuperscript{42} gives a worthwhile, objective overview of research which is current to 1945.

It is not this author's purpose to consider all the works of Martin and Curtis, but, rather, he intends to select the more significant studies and to consider more recent material.


\textsuperscript{40} Ibid., p. 42


The research and refinement of science principles began in three independent centers: the University of Chicago under the direction of Elliott Downing; Columbia University, under the combined direction of S. Ralph Powers and Gerald S. Craig; and the University of Michigan, under the guidance of Francis D. Curtis. Recently greater refinement of principles was begun at New York University with Charles J. Piper and Martin L. Robertson as directors and at Boston University under the supervision of John G. Read.

Pioneer work in this area was conducted by Craig at Columbia University in 1927. Craig was concerned with establishing a list of objectives from which a course in elementary science could be organized. For this purpose he made an analysis of textbooks and courses of study in science and of articles and discussions on the objectives of science in the elementary school. That Craig was an early advocate of principles as suitable teaching objectives in science is shown in his statement: "Certain objectives that are selected for elementary school science should conform to those facts, principles, generalizations, and hypotheses of science which are

essential to the interpretation of natural phenomena which commonly challenge children.44

Wilbur,45 at the University of Michigan in 1931, made a scientific approach to the problem of acceptable science principles for inclusion at the ninth grade level. With the help of six graduate students he defined a principle of science as a comprehensive generalization which:

- Is stated positively and definitely
- Is true but with rare exceptions within the limitations set up by the statement
- Clearly states or implies a dynamic process or interaction
- Is demonstrable experimentally
- Is clearly not a part of a larger principle which can be definitely stated
- Is not merely a definition or a description
- Has wide application in the natural environment and is not ruled out by any of the preceding criteria

Fourteen general science textbooks were examined, the principles were tabulated and examined by subject matter specialists in the areas of biology, geology, chemistry and physics for technical correctness and terminology. One hundred

44. Ibid., p. 56-57

seventy principles were determined and these were re-evaluated by ten general science teachers in terms of which were necessary, desirable or undesirable in a general science course.

This was, however, a significant study for both the refinement of the principles and the objectivity of the analysis of the texts.

Robertson, like Wilbur, worked under Curtis at the University of Michigan. His criteria of a science principle was determined by a group of teachers enrolled in a Seminar in the Teaching of Science. To be a principle a statement:

- must be a comprehensive generalization
- must be true without exception within the limitations specifically stated
- must be a clear statement of a process or interaction
- must be capable of illustration so as to gain conviction
- must not be a definition
- must not deal with a specific substance or variety or with a limited group of substances or species

A list of several hundred major and minor principles was developed from the combined resources of ten previous studies. Wilbur's study played a significant role. A team of three specialists evaluated the principles and further refinement was accomplished by a group of subject matter specialists to

ensure they conformed to the established criteria. At this stage the list was reduced to 243 principles and twenty elementary science specialists condensed the list to a working body of 113.

Robertson determined:

1. Many principles were unsuited for objectives of elementary science.

2. There was a wide range of expert opinion as to the suitability of the various principles.

3. There was little uniformity in the statement of a principle.

Wise, 47 also of Michigan, investigated to determine which principles of science are most important for ninth grade general science. A compilation of the work of four predecessors was used in assembling the principles. Two experts judged two hundred fifty-two principles as satisfactory in light of the following criteria of a principle:

- must be a comprehensive generalization describing some fundamental process, constant mode of behavior, or property relating to natural phenomena
- must be true without exception within limitations specifically stated
- must be capable of illustration
- must not be a definition

These principles were re-evaluated in terms of adequacy and correctness by three subject matter specialists and this reduced the list to one hundred ninety-one items. The relative value of each of the principles was determined by ranking the principles in descending order by number of applications within the ninth grade textbooks.

Wise found that "the upper 25 per cent of the principles included fifty-five of those classified as belonging to the field of physics, eight from the field of chemistry and three from the field of geology." He likewise determined that, "no single field of the physical sciences is more important than all materials drawn from other specialized areas."48

Martin,49 in 1944, endeavored to determine the principles of the biological science that had importance for general education. An analysis of 2573 newspaper and magazine articles was made in terms of:

1. was it a literal or direct statement of the principle in the article

2. if not stated directly, was it capable of restatement so that it could

48. Ibid., pp. 67-76

3. if, in the opinion of the reader, a knowledge of the principle is essential for the true biological significance of the principle in the article.

Martin,\(^{50}\) to ensure standardization throughout his work, determined that for a statement to be a principle it must be:

1. a comprehensive generalization which resumes the widest possible range of facts within the domain of facts with which it is directly concerned. The facts resumed in the generalization must denote
   a. objects and/or events and the relations between them, and
   b. properties

2. scientifically true. To satisfy this criterion it must be
   a. verifiable; i.e., it must be stated so that it suggests, either directly or indirectly, a definite operation or observation or experiment whereby its truth value can be tested or verified.
   b. consistent with the body of accepted scientific knowledge, and except for a few limiting or singular exceptions, with all the data relevant to it.

The frequency of occurrence was taken as index of importance. Each principle was rated on a five point scale by qualified personnel to determine the suitability for inclusion in a science course in general education.

\(^{50}\) Martin, op. cit., p. 101
More recently, Fleish, Leonelli, Eastman, Case, and O' Connor at Boston University are among those who have extended the research in the area of science principles.

Fleish, in an effort to determine realistic goals for science teaching at the junior high level, polled students in junior and senior high schools to ascertain their science interests. The student returns revealed that of the six hundred fifty-six questions asked, four hundred seventy-four dealt with science principles. These four hundred seventy-four questions could further be classified under sixty science principles.


The author then evaluated ten general science textbooks to determine a correlation between textual material and student interests. She also made an investigation of the grade placement of the concepts as determined by in-service elementary grade and junior high teachers.

The author concluded that:

1. There was little uniformity among textbook writers as to the importance of the various science concepts.
2. In-service teachers had little accord as to grade placement of the sixty science concepts.
3. Many typical high school students had not fully understood what was considered basic science principles.

Using these, among other conclusions, the author proposed what she considered to be thirty basic principles for future science teaching at the junior high school level.

Eastman sought to determine the extent to which one hundred three principles of physical science were applied in industry in a Massachusetts town. Like Fleish, he concluded that the science curriculum of a given community should be tailored to the local situation when he stated "...physical science in the school could provide more intelligent citizens with respect to local industry by acquainting the pupils with practical applications of the principles of physical science found in local industry."56

56. Eastman, op. cit., p. 103
Case investigated science principles found in four ninth-grade general science texts. He determined that the physical science principles predominated by over the biological science principles in a ratio of 2 to 1. He concluded that many of the principles received but a singular mention in a given text; many authors attempted to present facts that had no relation to the science generalizations; and that much of the science material did not actually meet the needs of a special region.

O'Connor investigated the "principles of physical and biological science found in seven textbooks of general science for grade seven." This study was a companion study of Leonelli's and the techniques were almost identical.

The investigator concluded ....."Although principles of physical science are stressed, biological science principles are not an unimportant part of the textbook content. The number of principles and topics upon which there are agreement provide a nucleus about which seventh-grade science content could be built."57

Leonelli58 investigated those physical and biological science principles found within eighth-grade textbooks of science.

57. O'Connor, op. cit., p. 98
58. Leonelli, op. cit., p. 36
To be a principle for the eighth-grade level of comprehension, a statement:

1. Must be a comprehensive generalization or a part of a comprehensive generalization.

2. Must be true without exception within the limitation specifically stated.

3. Must not be a definition.

4. Must be demonstrable experimentally.

5. Must be stated definitely and/or may be implied in the writings of the author.

6. Must not deal with specific substances.

In general, the criteria agreed with the findings of Robertson, Wise, Martin and others.

His investigation of eight eighth-grade science textbooks determined the content to be distributed in the following twelve areas: Astronomy, Sound, Light, Matter, Energy and Simple Machines, Weather and Climate, Magnetism and Electricity, Earth's Surface and Changes, Fire and Heat, Fluids, Plants and Animals, and Miscellaneous.59

A page by page analysis of the science texts revealed there were one hundred and eighty-six science principles treated at this educational level. Of these, one hundred and forty-four were physical science principles and the remaining forty-two were biological science principles. Only sixteen

59. Ibid., pp. 36-37
physical science principles and only four biological science principles were found to be contained in the majority of texts.

Leonelli concluded that science textbook authors did not generally agree on either the principles to be incorporated at this level or the emphasis to be placed upon those which were used.

SUMMARY OF RESEARCH

The evolution of science teaching in the elementary schools of America in the last century has brought about many significant changes.

The early concepts of information and religion gave way to "object lessons" which lent emphasis to the Pestalozzian theory of "learning by doing". The religious element ceased to remain important, though the information concept has persisted to the present.

Nature study, which was a natural development of the "object lessons", developed from the turn of the twentieth century until it crystallized into elementary school science about 1925.

The Thirty-First Yearbook of the National Society for the Study of Education gave emphasis to the concept of "big ideas". The Forty-Sixth Yearbook published fifteen years later broadened even further this same concept which had been expanding in the interim.
The "big idea" concept of the Thirty-First Yearbook was an outgrowth of the research of such men as Craig and Wilbur who pioneered in the area of science concepts as the goal of science teaching.

Haupt, from his investigations, concluded that upper primary grade children were capable of reaching conclusions through interpreting facts. Weller and Martin determined that students gained a greater appreciation of science principles when they were taught as such.

Robertson, Wise and Martin made notable contributions in the refinement of science principles and in establishing reliable, scientific techniques of investigation. The University of Michigan, Columbia University and New York University were the centers of research. Later, at Boston University, under the direction of Vaden W. Miles and John G. Read, notable refinement in the field was accomplished by Fleish, Leonelli, Eastman, Case and O'Connor.

THE PROBLEM OF THIS INVESTIGATION

Research has shown the importance of science teaching in the Elementary School and need for adequate materials. Therefore, this investigation is an attempt to determine the principles of physical and biological science which are contained within eighth-grade geography textbooks.
SCOPE AND LIMITATIONS OF THIS INVESTIGATION

This investigation is limited to five currently used eighth grade geography textbooks. This level was selected so that correlation with the Leonelli study would be effected.

Only those principles shall be selected which appear to the writer to conform to the criteria established for this investigation.
CHAPTER II
THE RESEARCH
RESTATMENT OF THE PROBLEM

The problem of this investigation is to determine the principles of physical and biological science found in five textbooks of geography for grade eight.

TECHNIQUES EMPLOYED

Selection of Textbooks for Analysis

The author, in determining the textbooks to be analyzed, based their inclusion in the study upon the following criteria:

1. Each textbook must be designated by the publisher as an eighth-grade textbook of geography.
2. Each textbook must have been published by a well known firm with nation-wide distribution.
3. Each textbook must have been published or revised since 1945 to ensure up-to-dateness.
4. Each textbook must have been written by a recognized author in the field.
5. Each textbook must have been available for use at the beginning of the study.

Five textbooks of geography for grade eight that satisfied the above criteria were selected. With the exception of one the geography textbooks selected were from publishers
other than those used in Leonelli's study of science textbooks. They were arranged alphabetically by author and assigned an identification number. The textbooks selected for this study were:


The major units of the textbooks selected for analysis are listed below:

**Book 1.**

- **Unit I** Geography in the Modern World
- **Unit II** Man and Climate
- **Unit III** Man and the Surface of the Lands
- **Unit IV** Man and the Natural Resources
- **Unit V** Life Processes of Civilization
- **Unit VI** The Geography of Nations

---

1. Leonelli, *op. cit.* pp. 29-30
Book 2.

Unit I  This Is a Working World
Unit II  Hunters and Fishermen
Unit III  Farmers and Herdsmen
Unit IV  Lumbermen and Forest Workers
Unit V  Miners and Other Mineral Workers
Unit VI  Power and Man's Work
Unit VII  Makers and Builders
Unit VIII  Transportation and Communication
Unit IX  Merchants and Traders
Unit X  All the World's Workers

Book 3.

Unit I  Looking at one Community
Unit II  The Tools of Geography
Unit III  Man and Resources
Unit IV  Hunters - Trappers - Fishermen
Unit V  Ranchers and Herdsmen
Unit VI  Farmers and Their Work
Unit VII  Forests and Forest Workers
Unit VIII  Miners and Their Work
Unit IX  This is the City
Unit X  Living in North America
Unit XI  Living in South America
Unit XII  Living in Eurasia
Unit XIII  Living in Africa
Unit XIV  Living in Australia and New Zealand
Unit XV  The Continent of Antarctica
Unit XVI  Conservation of Natural Resources
Unit XVII Interdependence

**Book 4.**

Unit I  Understanding Global Patterns
Unit II  A Climate You Wouldn't Choose:
Unit III Tropical Lands of Rain and Drought
Unit IV  Lands of Uncertainty and Danger
Unit V  Sunshine for Sale
Unit VI  The Humid Subtropical Lands Support Many People
Unit VII The Marine Climatic Regions Are Lands of Human Accomplishment
Unit VIII Lands Assuming World Leadership
Unit IX  Lands of Romance and Tragedy
Unit X  Land of Opportunity and Hardship
Unit XI Cold, Long Periods of Light and Darkness, and Few People

**Book 5.**

Unit I  Mathematical Geography in Relation to Everyday Experiences
Unit II  Globes, Maps, and Graphs
Unit III Climates of the Earth in Their Relation to Man
Unit IV  Hunting and Fishing
Unit V  Grazing Regions
Unit VI  Forests and Their Uses
An examination of the subject matter areas disclosed that while the authors used varied approaches, the subject matter content was, in many instances, similar in scope.

Determination of Physical and Biological Science Principles for Grade Eight

Leonelli's² list of "Principles of Physical and Biological Science Found in Textbooks of Science for Grade Eight" was used. The author utilized this list because:

1. Each principle had been determined in light of specific, established criteria.

---

2. Leonelli, op. cit., pp. 41-64
2. Each principle had been validated in terms of technical accuracy.

3. Each principle was written for vocabulary comprehension in grade eight.

4. Each principle had received treatment by science textbook authors.

Leonelli's one hundred eighty-six principles were listed in a column on 8 x 11 sheets under the eleven headings of Astronomy; Sound; Light; Matter, Energy and Simple Machines; Weather and Climate; Magnetism and Electricity; Earth's Surface and Changes; Fire and Heat; Fluids; Plants and Animals; and Miscellaneous. A column for each of the textbooks analyzed was then drawn to the right of the column of principles. Two sheets of paper had to be glued together to accommodate the six columns.

Each textbook of geography was then systematically reviewed in a page by page analysis to determine both the principles treated and also the degree of emphasis placed upon each. As a principle was uncovered in the reading, the page number of the text being used was listed in the appropriate column opposite the principle on the master list. This method was soon discarded in favor of a system of check marks in the margin. By using the check marks it was possible on the second reading to make a more accurate analysis. This second review resulted in the uncovering of added principles
and the deletion of others where the connection was too remote.

In the final stage the textbooks were reviewed a third time and the principles marked were recorded by page number on the original master list.

Through this approach and the use of the indexes for clues it is believed the reliability of the research was enhanced.

Table I which follows shows the total number of different physical and biological science principles which were determined in this study.
<table>
<thead>
<tr>
<th>Principles</th>
<th>Book I</th>
<th>Book II</th>
</tr>
</thead>
<tbody>
<tr>
<td>All the bodies in the solar system travel around the sun.</td>
<td></td>
<td>398</td>
</tr>
<tr>
<td>Almost all the energy on the earth comes from the sun.</td>
<td>237</td>
<td></td>
</tr>
<tr>
<td>The rotation of the earth causes an apparent rotation of the stars.</td>
<td></td>
<td>276, 277, 279</td>
</tr>
<tr>
<td>The length of time it takes for a planet to travel around the sun depends upon its distance from the sun.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nearly vertical rays of radiant energy will produce greater heat on a surface than will the more slanted radiant ones.</td>
<td>27, 28, 29, 30, 31, 146, 147, 56, 60</td>
<td>367, 400</td>
</tr>
<tr>
<td><strong>SOUND</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound travels through matter.</td>
<td>292</td>
<td>294, 296, 297</td>
</tr>
</tbody>
</table>

#Table I is read thus: The principle "All the bodies in the solar system travel around the sun." was found on page 398 of Book II.
TABLE I (CONTINUED)

<table>
<thead>
<tr>
<th>Principles</th>
<th>Book I</th>
<th>Book II</th>
<th>Book III</th>
<th>Book IV</th>
<th>Book V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound is produced by vibrating bodies.</td>
<td>295</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIGHT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark clothing absorbs more heat than it reflects while light clothing reflects more than it absorbs.</td>
<td>43</td>
<td>39,202,292,293</td>
<td>453,456</td>
<td>4,12,35,323,303</td>
<td></td>
</tr>
<tr>
<td>Part of the light striking a surface is reflected from the surface.</td>
<td></td>
<td></td>
<td>17,33,63,72,278,393</td>
<td>49,56,70,105,138,278,424,445,452,454</td>
<td></td>
</tr>
<tr>
<td>The sun is the earth's main source of natural light.</td>
<td>31,43,44,168</td>
<td>202,231,292</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark colored surfaces absorb light better than light colored surfaces.</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rough or unpolished surfaces absorb light better than smooth or polished surfaces.</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The smoother the surface which light rays strike, the better the reflection.</td>
<td>43</td>
<td>39,202,292,293</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATTER, ENERGY AND SIMPLE MACHINES</td>
<td></td>
<td></td>
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<tr>
<td>Force is required to move matter thus doing work.</td>
<td>183,191</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Principles</td>
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</tr>
<tr>
<td>Friction produces heat: no two bodies can be rubbed together without a change of some of the mechanical energy into heat energy.</td>
<td>161,169</td>
<td></td>
<td></td>
<td>58,63,80,290</td>
<td>123,167,196,197,211</td>
</tr>
<tr>
<td>Work is done when a body is moved.</td>
<td></td>
<td>183</td>
<td></td>
<td>196,198</td>
<td>205</td>
</tr>
<tr>
<td>The more energy possessed by a body the greater is its ability to do work.</td>
<td>68,69,134,244,246,184,185,186,189,252,253,254,255,196,198,199,245,255,256,257,255,256,257,265,272,273,283,321,326</td>
<td>290,333,386,410,436</td>
<td>198,199,200,206,210,211</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sliding friction is greater or offers more resistance than rolling friction.</td>
<td>272</td>
<td>71,173,187,216,249,273,274</td>
<td></td>
<td>196,198</td>
<td>205</td>
</tr>
<tr>
<td>The more energy stored due to position the greater the potential energy.</td>
<td></td>
<td>189</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A smooth surface offers less resistance to motion than does a rough surface.</td>
<td>242,269,273</td>
<td>49,123,124,257,318,325</td>
<td>100,129,145,188,194,205,222</td>
<td>327,426,433,435,470</td>
<td>114,196,203,216,238</td>
</tr>
<tr>
<td>Friction is always encountered whenever work is done.</td>
<td></td>
<td>282</td>
<td></td>
<td></td>
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<tr>
<td>The amount of work obtained from a machine is never as much as the amount of work put into the machine.</td>
<td>189,181</td>
<td></td>
<td></td>
<td></td>
<td>205</td>
</tr>
<tr>
<td>Principles</td>
<td>Book I</td>
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<tr>
<td>Matter can be changed in form</td>
<td>24, 44, 52, 67, 82, 88, 6, 41, 45, 47, 49, 62</td>
<td>375</td>
<td>79, 84, 129, 262, 327</td>
<td>23, 30, 49, 71, 118, 119, 14, 15, 35, 37, 39, 39</td>
<td>14, 15, 35, 37, 39, 39, 39</td>
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<tr>
<td></td>
<td>91, 92, 104, 115, 117</td>
<td>92, 110, 125, 128</td>
<td>129, 130, 146, 161, 162</td>
<td>40, 45, 49, 51, 53, 55</td>
<td>40, 45, 49, 51, 53, 55, 55</td>
</tr>
<tr>
<td></td>
<td>145, 154, 165, 183</td>
<td>169, 180, 181, 183</td>
<td>167, 183, 197, 203, 222</td>
<td>60, 61, 70, 78, 79, 90, 100</td>
<td>60, 61, 70, 78, 79, 90, 100</td>
</tr>
<tr>
<td></td>
<td>184, 236, 273, 279, 287</td>
<td>164, 161, 166, 167</td>
<td>276, 277, 279, 304, 318</td>
<td>101, 106, 111, 120, 124</td>
<td>101, 106, 111, 120, 124, 124</td>
</tr>
<tr>
<td></td>
<td>297, 319, 397, 378</td>
<td>217, 203, 224, 226</td>
<td>326, 336, 338, 385, 392</td>
<td>125, 135, 143, 144, 159</td>
<td>125, 135, 143, 144, 159</td>
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<td>250, 255, 266, 324</td>
<td>437, 446, 454, 456</td>
<td>187, 189, 201, 203, 219</td>
<td>187, 189, 201, 203, 219</td>
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<tr>
<td>WEATHER AND CLIMATE</td>
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<tr>
<td>The higher the temperature of the air, the greater is the amount of moisture required to saturate it.</td>
<td>44, 52, 146</td>
<td>82</td>
<td></td>
<td>125, 130, 146, 150, 150</td>
<td>35, 55</td>
</tr>
<tr>
<td>Heat radiates from the ground much more easily into dry air than into moist air.</td>
<td></td>
<td></td>
<td></td>
<td>160, 274, 276, 279, 320</td>
<td></td>
</tr>
<tr>
<td>Ocean temperatures are less variable from time to time in the same place than is the temperature of the land.</td>
<td>43, 44, 58, 63, 68, 123, 139</td>
<td>104</td>
<td>15, 47, 49, 51, 59, 60, 60</td>
<td>148</td>
<td></td>
</tr>
<tr>
<td>When air is cooled sufficiently, the moisture in it condenses.</td>
<td>44, 52, 67, 82, 88, 128, 129, 203, 336</td>
<td>84, 327, 373</td>
<td>40, 71, 118, 130, 161, 14, 15, 35, 38, 39, 40</td>
<td></td>
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</tr>
<tr>
<td>Air moves from points of greater pressure to points of less pressure causing air currents or winds.</td>
<td>56, 59, 60, 61, 62, 280</td>
<td></td>
<td>162, 187, 189, 203, 205</td>
<td>49, 52, 53, 55, 60, 111</td>
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<tr>
<td></td>
<td>63, 115, 116, 118, 149, 150, 151</td>
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<td>276, 277, 279, 334, 366</td>
<td>226, 425</td>
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<tr>
<td>Principles</td>
<td>Book I</td>
<td>Book II</td>
<td>Book III</td>
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</tr>
<tr>
<td>Differences in temperature causes differences in atmospheric pressure and these differences cause winds.</td>
<td>58, 63, 67, 103, 117, 147, 154</td>
<td>280</td>
<td>118, 276, 383, 325, 369, 368, 369, 370</td>
<td>44, 45, 61, 52, 53, 57, 58, 59</td>
<td></td>
</tr>
<tr>
<td>Whenever air is heated, a given volume of it becomes lighter and is then pushed upward by the greater pressure of the cooler, heavier air around it.</td>
<td>44, 52, 67, 91, 103, 118, 154, 185, 283</td>
<td>279</td>
<td>372</td>
<td>22, 30, 71, 135, 203, 321, 457, 461, 469, 36, 38, 40, 45, 47, 51, 52, 53, 62</td>
<td></td>
</tr>
<tr>
<td>The warmer the air the more moisture it can hold; the colder the air the less moisture it can hold.</td>
<td>44, 52, 67, 91, 103, 118, 154, 185, 283</td>
<td>62</td>
<td>72, 80, 108, 113, 118, 127, 221, 277, 369, 370, 49, 51, 53, 55, 60, 111, 228, 338</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat energy tends to move from a body of higher temperature to a body of lower temperature.</td>
<td>27, 28, 29, 30, 31, 55, 50, 146, 147</td>
<td>397, 400</td>
<td>374, 376</td>
<td>64, 79, 97, 117, 128, 10, 11, 12, 13, 15, 35, 45, 53, 128</td>
<td></td>
</tr>
<tr>
<td>The more slanting the rays of the sun, the less heat the rays supply.</td>
<td>24, 40, 55, 62, 63, 67, 75, 84, 90, 151, 168</td>
<td>62, 244, 280, 281</td>
<td>45, 76, 97, 104, 110, 111, 296</td>
<td>71, 84, 104, 113, 118, 129, 135, 162, 165, 167, 181, 189, 192, 207, 266, 274, 275, 278, 305, 320, 355, 357, 369, 409, 427, 457</td>
<td></td>
</tr>
</tbody>
</table>
When water takes up heat, it evaporates to water vapor; and when water vapor cools or loses heat, it condenses to water.

MAGNETISM AND ELECTRICITY

All wires carrying an electric current resist the flow of the current; the greater the resistance the hotter the wire.

An electric current may be produced by: rubbing or friction, by chemical action, or by the use of magnets.

EARTH'S SURFACE AND CHANGES

The surface of the earth has been undergoing constant gradual changes from its very beginning.
### TABLE I (CONTINUED)

<table>
<thead>
<tr>
<th>Principles</th>
<th>Book I</th>
<th>Book II</th>
<th>Book III</th>
<th>Book IV</th>
<th>Book V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running water, wind, glaciers, and other agencies are constantly moving soil and rocks from higher levels to lower levels.</td>
<td>14, 15, 16, 89, 103, 110, 126, 164, 165, 166, 167, 178, 179, 192, 194, 195, 196, 202, 210, 211, 214, 216, 217, 221, 227</td>
<td>29, 42, 63, 86, 89, 96, 97, 135, 146, 147, 166, 244</td>
<td>4, 14, 44, 52, 63, 118, 122, 11, 21, 23, 25, 29, 31, 125, 229, 269, 328, 353, 32, 33, 35, 73, 84, 97, 99, 125, 127, 129, 131, 152, 162, 164, 185, 188, 190, 196, 197, 200, 212, 221, 324, 225, 244, 264, 304, 333, 337, 354, 355, 356, 368, 369, 370, 371, 379, 383, 385, 391, 402, 410, 412, 428, 456</td>
<td>5, 55, 94, 96, 97, 99, 100, 103, 109, 122, 125, 234, 252, 131, 160, 162, 170, 186, 200, 226, 302, 303</td>
<td>44</td>
</tr>
<tr>
<td>Two groups of things are constantly acting on the earth's surface, one building it up and the other tearing it down.</td>
<td>14, 15, 16, 89, 103, 110, 126, 164, 165, 166, 167, 178, 179, 192, 194, 195, 196, 202, 210, 211, 214, 216, 217, 221, 227</td>
<td>29, 42, 63, 86, 89, 96, 97, 135, 146, 147, 166, 244</td>
<td>4, 14, 44, 52, 63, 118, 122, 11, 21, 23, 25, 29, 31, 125, 229, 269, 328, 353, 32, 33, 35, 73, 84, 97, 99, 125, 127, 129, 131, 152, 162, 164, 185, 188, 190, 196, 197, 200, 212, 221, 324, 225, 244, 264, 304, 333, 337, 354, 355, 356, 368, 369, 370, 371, 379, 383, 385, 391, 402, 410, 412, 428, 456</td>
<td>5, 55, 94, 96, 97, 99, 100, 103, 109, 122, 125, 234, 252, 131, 160, 162, 170, 186, 200, 226, 302, 303</td>
<td>144</td>
</tr>
</tbody>
</table>
Principles
All bodies are attracted to the earth by a force called gravity.

Rocks are changed in form and shape by the action of heat, water and pressure.

Only a part of the earth has emerged from the Ice Age.

Soil is composed of small parts of rocks.

FIRE AND HEAT
The sun is the earth’s most important source of heat.

A fuel burns only if heated to its kindling temperature in air.

Dark colored objects absorb radiant heat faster than light colored objects.

Heat increases the speed of evaporation of liquids.

The angle at which the sun’s rays strike the earth affects the amount of heat absorbed.
Principles

Most substances can be changed from one state (solid, liquid or gas) to another by being heated or cooled.

A certain amount of heat must be in matter before matter can be changed from one state (solid, liquid or gas) to another.

Heat can be transferred from one body to another.

Whenever air is heated, a given volume of it becomes lighter and is then pushed upward by the greater pressure of the cooler, heavier air around it.

**TABLE I (CONTINUED)**

<table>
<thead>
<tr>
<th>Principles</th>
<th>Book I</th>
<th>Book II</th>
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</thead>
</table>
### TABLE I (CONTINUED)

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<th>Book III</th>
<th>Book IV</th>
<th>Book V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat is used to destroy bacteria.</td>
<td></td>
<td>211,221</td>
<td>169</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FLUIDS</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Fluids (liquids or gases) that are heated are pushed up by the heavier, colder fluids immediately below and to the side of them.</td>
<td></td>
<td>58,63,67,103,117,279</td>
<td>372</td>
<td>23,30,71,185,203,36,38,40,45,47,321,457,461,469</td>
<td>51,52,53,62</td>
</tr>
<tr>
<td>Dissolving substances in water will raise the boiling point and lower the freezing point.</td>
<td></td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The pressure under water becomes greater as the distance below the surface becomes greater.</td>
<td></td>
<td></td>
<td>197</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air exerts pressure.</td>
<td>58,59,63</td>
<td>278</td>
<td>31,59,69</td>
<td>102,207,206,221,232,196,280,281,290,241,261,337,379,380,297,308,310,311</td>
<td>331,425</td>
</tr>
<tr>
<td>Whenever a confined gas is reduced in volume, the pressure it exerts is increased.</td>
<td></td>
<td>176,193</td>
<td></td>
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</tr>
<tr>
<td><strong>PLANTS AND ANIMALS</strong></td>
<td></td>
<td></td>
<td></td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>Principles</td>
<td>Book I</td>
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</tr>
<tr>
<td>Only a few of the many seeds that are formed actually grow and produce</td>
<td>103, 106, 120, 127,</td>
<td>5, 69, 70,</td>
<td>24, 54, 94, 102,</td>
<td>132, 139, 141, 152,</td>
<td></td>
</tr>
<tr>
<td>plants.</td>
<td>132, 205, 252, 267,</td>
<td>74, 92,</td>
<td>108, 177, 334</td>
<td>156, 158, 199, 260</td>
<td></td>
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<td></td>
<td>356, 359, 399, 396</td>
<td>323</td>
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<tr>
<td>Leaves, with the aid of energy from the sun, make starch from water and</td>
<td></td>
<td>54</td>
<td></td>
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<tr>
<td>carbon dioxide.</td>
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<tr>
<td>All animals are like in that they meet changing seasons in some way.</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>The process of losing water takes place much less rapidly in spiny than</td>
<td>84, 152</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in leafy plants.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate and weather influence the health and energy of man more than</td>
<td>25, 29, 46, 47, 48,</td>
<td>9, 56, 212,</td>
<td>46, 121, 188, 216,</td>
<td>1, 14, 36, 40, 46, 54,</td>
<td></td>
</tr>
<tr>
<td>most other conditions</td>
<td>66, 69, 73, 74, 78,</td>
<td>244</td>
<td>261, 357, 54, 73, 30,</td>
<td>59, 50, 62, 66, 69,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>103, 105, 110, 134,</td>
<td>267, 301</td>
<td>119, 165, 176, 137,</td>
<td>74, 113, 179, 194,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>136, 143, 146, 150,</td>
<td></td>
<td>196, 205, 268, 269,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>159, 164, 155, 187,</td>
<td></td>
<td>273, 279, 297, 204,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>264, 301, 303, 315,</td>
<td></td>
<td>297, 301, 311, 341,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>316, 320, 332, 342,</td>
<td></td>
<td>350, 427</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>346, 350, 355, 413,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>414, 417, 455, 456</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Man cannot live without food.</td>
<td>15, 25, 46, 47, 48,</td>
<td>9, 23, 24,</td>
<td>24, 50, 51, 52, 56, 79,</td>
<td>18, 17, 36, 37, 50, 59,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>49, 50, 79, 97, 101,</td>
<td>26, 77, 81,</td>
<td>154, 155, 156, 162, 169,</td>
<td>57, 64, 66, 70, 71,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>120, 125, 132, 142,</td>
<td>35, 55, 62,</td>
<td>154, 155, 156, 162, 169,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>167, 304, 304, 306,</td>
<td>66, 95, 96,</td>
<td>154, 155, 156, 162, 169,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>210, 260, 284, 295,</td>
<td>115, 131, 132,</td>
<td>154, 155, 156, 162, 169,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>304, 307, 311, 312,</td>
<td>178, 184, 185,</td>
<td>154, 155, 156, 162, 169,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>351, 379, 399, 394,</td>
<td>257, 267, 297,</td>
<td>178, 184, 185, 275, 322,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>396, 449</td>
<td>209, 299, 299,</td>
<td>339, 347, 349, 360, 395</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>297, 330, 342,</td>
<td>390, 406, 417, 421, 242,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>430, 431, 444,</td>
<td>460, 471, 252, 255, 270,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>473, 477</td>
<td>272, 277</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaporation of perspiration occurs faster in dry air than in moist air.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principles</td>
<td>Book I</td>
<td>Book II</td>
<td>Book III</td>
<td>Book IV</td>
<td>Book V</td>
</tr>
<tr>
<td>------------</td>
<td>--------</td>
<td>---------</td>
<td>----------</td>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>New organisms are produced from some part of old organisms.</td>
<td>106, 120, 152, 197</td>
<td>53, 54, 55, 56, 66, 77, 84, 87, 88, 90, 120, 124, 136, 137, 335</td>
<td>53, 58, 61, 82, 107, 120, 124, 136, 137</td>
<td>53, 58, 61, 82, 107, 120, 124, 136, 137</td>
<td>99, 103, 313, 226, 231, 97, 139, 171, 242</td>
</tr>
</tbody>
</table>

TABLE I (CONTINUED)
### TABLE I (CONTINUED)

<table>
<thead>
<tr>
<th>Principles</th>
<th>Book I</th>
<th>Book II</th>
<th>Book III</th>
<th>Book IV</th>
<th>Book V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life comes from life.</td>
<td>40, 44, 47, 108, 107</td>
<td>43, 48, 52, 88, 91, 94</td>
<td>50, 51, 57, 60, 85, 96</td>
<td>54, 77, 80, 127, 128</td>
<td>54, 77, 80, 127, 128</td>
</tr>
<tr>
<td>Living things by their activities</td>
<td>42, 44, 46, 48, 49, 50</td>
<td>42, 44, 46, 48, 49, 50</td>
<td>42, 44, 46, 48, 49, 50</td>
<td>42, 44, 46, 48, 49, 50</td>
<td>42, 44, 46, 48, 49, 50</td>
</tr>
<tr>
<td>the welfare of other living things</td>
<td>75, 77, 89, 90, 95</td>
<td>75, 77, 89, 90, 95</td>
<td>75, 77, 89, 90, 95</td>
<td>75, 77, 89, 90, 95</td>
<td>75, 77, 89, 90, 95</td>
</tr>
</tbody>
</table>

**Note:** The table continues with similar entries for each column.
<table>
<thead>
<tr>
<th>Principles</th>
<th>Book I</th>
<th>Book II</th>
<th>Book III</th>
<th>Book IV</th>
<th>Book V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature tries to maintain a balance.</td>
<td>40, 42, 79</td>
<td>34, 41, 107</td>
<td>84, 354</td>
<td>99, 100, 104, 141, 142</td>
<td>50, 54, 56, 76, 88, 127</td>
</tr>
<tr>
<td>Man cannot live without water.</td>
<td>15, 77, 93, 104, 153, 203, 205, 247</td>
<td>58, 244</td>
<td>23, 41, 43, 48, 49, 50, 54, 99, 118, 158, 208, 336, 384</td>
<td>143, 150, 175, 429</td>
<td>128, 166, 167, 169, 240, 260, 266, 302</td>
</tr>
<tr>
<td>Green plants can be killed by preventing their shoots from reaching the sunlight.</td>
<td></td>
<td>54, 66</td>
<td></td>
<td>48, 283</td>
<td>53</td>
</tr>
<tr>
<td>Decay is usually caused by bacteria, molds or mildews.</td>
<td></td>
<td></td>
<td></td>
<td>350</td>
<td>36</td>
</tr>
</tbody>
</table>

**MISCELLANEOUS**

Air pressure decreases the higher we go.
<table>
<thead>
<tr>
<th>Principles</th>
<th>Book I</th>
<th>Book II</th>
</tr>
</thead>
<tbody>
<tr>
<td>When a gas expands it takes in heat; when a gas contracts it gives off heat.</td>
<td></td>
<td>189</td>
</tr>
<tr>
<td>Friction and inertia must be overcome to move one surface over another.</td>
<td>189, 161, 162, 256</td>
<td></td>
</tr>
<tr>
<td>Objects in fluids are buoyed up by the fluid.</td>
<td>4, 49, 226, 276, 277, 278, 280, 284, 285, 295, 322, 342, 347, 377, 395, 435</td>
<td>13, 15, 40, 43, 49, 50, 123, 124, 125, 201, 214, 224, 245, 249, 271, 274, 275, 276, 282, 288, 289, 302, 303, 304, 310, 314, 318, 321, 323</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Book III</th>
<th>Book IV</th>
<th>Book V</th>
</tr>
</thead>
<tbody>
<tr>
<td>128, 412</td>
<td>189</td>
<td>38, 172</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Book IV</th>
<th>Book V</th>
</tr>
</thead>
<tbody>
<tr>
<td>38, 172</td>
<td>189</td>
</tr>
</tbody>
</table>
### TABLE I (CONCLUDED)

<table>
<thead>
<tr>
<th>Principles</th>
<th>Book I</th>
<th>Book II</th>
<th>Book III</th>
<th>Book IV</th>
<th>Book V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavier objects have a stronger attraction for each other than do lighter objects.</td>
<td>46</td>
<td>46,53,448</td>
<td>48,59,149,241,309</td>
<td>16,136,357</td>
<td>180</td>
</tr>
<tr>
<td>Cloth fibers are poor conductors of heat.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5,18</td>
</tr>
<tr>
<td>Heat loss can be prevented by the use of insulators.</td>
<td>46,53,448</td>
<td></td>
<td></td>
<td>110,296</td>
<td></td>
</tr>
<tr>
<td>The pressure of water at any point below its surface is always equal to the weight of the water and air above that point.</td>
<td>74,117,121</td>
<td></td>
<td></td>
<td>35,53,137,236,357, 371,380,417,424,428, 431,461,469</td>
<td>198,199</td>
</tr>
</tbody>
</table>
Findings Table I. Ninety-one physical and biological science principles were found to be contained within the five textbooks of geography reviewed. Of this number thirty-eight principles were treated to some degree by every author. Twenty-seven principles were physical science concepts, and the remaining eleven were biological science concepts. This would indicate that authors of geography textbooks were in substantial agreement as to the broad science concepts that constitute a part of geography subject matter for grade eight.

Table II which follows shows the number of physical and biological science principles determined from the review of five textbooks of geography for grade eight. Included is the relative percentage of the number of physical and biological science principles found in the textbooks.
TABLE II

TOTAL NUMBER OF DIFFERENT PRINCIPLES OF PHYSICAL AND BIOLOGICAL SCIENCE FOUND IN EACH OF THE GEOGRAPHY TEXTBOOKS

<table>
<thead>
<tr>
<th>Field of Science</th>
<th>Principles in Book</th>
<th>Principles</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5</td>
<td>Number</td>
<td>Per Cent</td>
</tr>
<tr>
<td>*Physical Science</td>
<td>46 52 34 42 54</td>
<td>72</td>
<td>79</td>
</tr>
<tr>
<td>Biological Science</td>
<td>12 14 14 16 17</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>58 66 48 58 71</td>
<td>91</td>
<td>100</td>
</tr>
</tbody>
</table>

*Table II is read thus: Book 1 contained 46 of a total of 72 physical science principles and 12 of a total of 19 biological science principles, etc. Seventy-two or 79 per cent of the 91 different principles were of physical science.

Findings Table II. Table II reveals that there is uniformity among the authors of textbooks of geography in placing emphasis upon physical science concepts rather than upon the biological science concepts. Of the ninety-one principles which were determined in the study, seventy-two concepts or seventy-nine per cent were principles of physical science, and nineteen concepts or twenty-one per cent were principles of biological science.

Table III shows the number of different principles found in each textbook of geography for grade eight.
### TABLE III

**NUMBER OF DIFFERENT PRINCIPLES BY TOPICS FOUND IN EACH TEXTBOOK OF GEOGRAPHY FOR GRADE EIGHT**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Total Number of Different Principles</th>
<th>Book Number</th>
<th>Average Number of Principles Per Book</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Astronomy</em></td>
<td>5</td>
<td>2 3 2 1 4</td>
<td>2.4</td>
</tr>
<tr>
<td>Sound</td>
<td>3</td>
<td>- 3 1 1 2</td>
<td>1.4</td>
</tr>
<tr>
<td>Light</td>
<td>6</td>
<td>5 3 2 4 4</td>
<td>3.6</td>
</tr>
<tr>
<td>Matter, Energy and Simple</td>
<td>10</td>
<td>4 10 4 3 5</td>
<td>5.2</td>
</tr>
<tr>
<td>Machines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weather and Climate</td>
<td>12</td>
<td>12 8 6 8 8</td>
<td>8.4</td>
</tr>
<tr>
<td>Magnetism and Electricity</td>
<td>2</td>
<td>1 2 1 1 2</td>
<td>1.4</td>
</tr>
<tr>
<td>Earth's Surface and Changes</td>
<td>9</td>
<td>7 7 5 7 9</td>
<td>7.0</td>
</tr>
<tr>
<td>Fire and Heat</td>
<td>10</td>
<td>7 8 9 8 10</td>
<td>8.4</td>
</tr>
<tr>
<td>Fluids</td>
<td>5</td>
<td>3 4 2 2 3</td>
<td>2.8</td>
</tr>
<tr>
<td>Plants and Animals</td>
<td>19</td>
<td>14 14 13 16 17</td>
<td>14.8</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>10</td>
<td>4 5 3 5 8</td>
<td>5.0</td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
<td>59 67 48 56 72</td>
<td>60.4</td>
</tr>
</tbody>
</table>

*Table III is read thus: Of the total number of different principles of Astronomy (5), Book 1 contained 2, Book 2 contained 3, etc., and the average number of principles for the five textbooks was 2.4.*
Findings Table III. Table III clearly shows that the four areas of Weather and Climate, Earth's Surface and Changes, Plants and Animals, and Fire and Heat received the greatest emphasis in all the textbooks of geography for grade eight. Also, there is a high correlation among the authors in the remaining seven areas of limited emphasis. It should be noted that, but with a single exception, all of the topics received treatment by all of the authors.

Table IV which follows shows the total number of principles determined after analyzing the five textbooks of geography for grade eight and the number of principles which were found in each textbook. Also included is the relative percentage per textbook of the total number of principles found in the survey.
TABLE IV

TOTAL NUMBER OF DIFFERENT PRINCIPLES FOUND IN FIVE EIGHTH-GRADE TEXTBOOKS OF GEOGRAPHY FOR GRADE EIGHT AND THE NUMBER AND PERCENTAGE OF THE TOTAL FOUND IN EACH BOOK

<table>
<thead>
<tr>
<th>Total Number of Different Principles</th>
<th>Number of Different Principles in Book</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>*91</td>
<td>58  66  48  58  71</td>
<td>60</td>
</tr>
<tr>
<td>Per cent of</td>
<td>64  73  53  64  78</td>
<td>66</td>
</tr>
</tbody>
</table>

*Table IV is read thus: Of the total number of 91 different principles found in all five books, 58 or 64 per cent were found in Book 1, 66 or 73 per cent in Book 2, etc., for an average of 60 different principles per book, or an average of 66 per cent of the total 91 principles.

Findings Table IV. Table IV indicates high accord among authors of textbooks of geography as what constitutes essential science concepts in the study of geography for grade eight. An average of sixty principles or sixty-six per cent of the total number of different principles for each textbook was realized.

Table V which follows shows the degree of emphasis placed upon both the physical and biological science principles as determined by the frequency of mention within the five textbooks analyzed. Included is the relative percentage of frequency of physical and biological principles of science found in the textbooks.
### TABLE V

**FREQUENCY OF MENTION OF PRINCIPLES OF PHYSICAL AND BIOLOGICAL SCIENCE FOUND WITHIN FIVE TEXTBOOKS OF GEOGRAPHY FOR GRADE EIGHT**

<table>
<thead>
<tr>
<th>Field of Science</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Science</td>
<td>422</td>
<td>457</td>
<td>253</td>
<td>595</td>
<td>569</td>
<td>2296</td>
<td>55</td>
</tr>
<tr>
<td>Biological Science</td>
<td>362</td>
<td>335</td>
<td>365</td>
<td>444</td>
<td>345</td>
<td>1851</td>
<td>45</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>784</td>
<td>792</td>
<td>618</td>
<td>1039</td>
<td>904</td>
<td>4147</td>
<td>100</td>
</tr>
</tbody>
</table>

*Table V is read thus: Book 1 contained 422 of a total of 2296 mentions of physical science principles and 362 of a total of 1851 mentions of biological science principles, etc. 2296 or 55 per cent of the 4147 of the different mentions were of physical science.*

**Findings Table V.** Table V discloses that there is greater depth in the area of principles of biological science than it would appear from Table II. The principles of physical science are greater in number by a ratio of approximately 4:1 as disclosed in Table II, but, by number of times mentioned in the textbooks, the ratio of physical science principles approaches that of 1:1. The latter ratio was affected mainly from the three broad principles of "Some living things depend upon each other for getting part of what they need in order to live", Living things by their life activities affect the welfare of other living things," and "Living things cannot exist long without water."

Table VI which follows shows the number of different textbooks of geography in which major subject-matter topics appeared.
TABLE VI
NUMBER OF TEXTBOOKS OF GEOGRAPHY FOR GRADE EIGHT IN WHICH MAJOR SUBJECT-MATTER TOPICS APPEARED

<table>
<thead>
<tr>
<th>Topic</th>
<th>Book Number</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Astronomy</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>Sound and Light</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>Matter, Energy and Simple Machines</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>Weather and Climate</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>Magnetism and Electricity</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>Earth's Surface and Changes</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>Fire and Heat</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>Fluids</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>Plants and Animals</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>x</td>
<td>5</td>
</tr>
</tbody>
</table>

*Table VI is read thus: The topic Astronomy was found in Book 1, Book 2, Book 3, etc., for a total of five books, showing that all books contained the topic of Astronomy.
Findings Table VI. Table VI gives an excellent picture of the unanimity among authors in the field on the relationship between science and geography for grade eight. Without exception every topic received some degree of emphasis in each of the textbooks. This would clearly indicate there is a vital need for teachers of geography and science in the junior high school to be well acquainted with each other's area of study and to work together for increased efficiency in the teaching-learning situation for mutual benefit.

SUMMARY OF FINDINGS

The study disclosed that a total of ninety-one principles of physical and biological science were determined upon analyzing five textbooks of geography for grade eight. Of this number seventy-two were principles of physical science, and nineteen were principles of biological science. Thirty-eight principles appeared in every textbook examined. Of these, twenty-seven were principles of physical science and eleven were principles of biological science.

Book 5 contained the greatest number of principles with fifty-four principles of physical science and seventeen principles of biological science for a total of seventy-one principles. Book 3 contained the least number of principles with thirty-four principles of physical science and fourteen principles of biological science for a total of forty-eight prin-
ciples. The average number of principles determined for the five textbooks of geography reviewed was sixty principles with an average of sixty-six per cent of the total number of principles determined for all five textbooks.

The study also disclosed the ratio of the number of different principles found was four principles of physical science to one principle of biological science. However, the ratio of frequency of mention reduced this ratio to approximately one principle of physical science to one principle of biological science.

The eleven topics treated in the analysis were unanimously covered in all five textbooks reviewed which would indicate accord by the authors as to essential science principles to be incorporated in the study of geography in grade eight.
CHAPTER III
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

RESTATEMENT OF THE PROBLEM

The problem of this investigation is to determine the principles of physical and biological science contained within five textbooks of geography for grade eight.

SUMMARY OF TECHNIQUES EMPLOYED

As the first step in solving this problem, the investigator utilized the criteria for the selection of textbooks set up by a group of teachers in a Seminar in Science Education at Boston University. Five textbooks were selected that conformed to the established criteria.

A review of research in the field disclosed a recent contribution of principles of physical and biological science for grade eight. Because of the excellent elements in its construction, this list was adopted as a master list of valid and appropriate science principles for this investigation. The principles were typed on 8 x 11 sheets and five additional columns were added to accommodate the texts to be analyzed.

In commencing the analyzation the author first read a page of text and noted the page number opposite the appropriate principle under the heading of the book being reviewed. This soon proved unsatisfactory because there was no readily avail-
able way to determine the reliability of the analysis.

Substituted for this approach was the method of actually marking the principles in the margin of the text. This enabled the author on the second reading to ascertain any unmarked concepts or to delete any previously marked principle which, due to the wording, was too remote an idea and required too much inference. This technique proved successful, and in the final analysis the marks in the margin were translated into page numbers beside the appropriate science principle in the proper textbook column. To determine the reliability of the analysis, the indexes also were used for clues to science principles. The final review detected no new principle.

SUMMARY OF THE FINDINGS

Ninety-one different principles of physical and biological science were found in the five textbooks analyzed. Seventy-two of the principles were physical science concepts and nineteen principles were biological science concepts. The principles of physical science constituted seventy-nine per cent of the total; the principles of biological science constituted nineteen per cent of the total.

Of the eleven major topics considered in the analysis, the textbook authors were in accord on the emphasis they placed upon the four areas of Weather and Climate, Earth's Surface and Changes, Fire and Heat and Plants and Animals. Also, there
was uniformity in the degree of emphasis given the other lesser topics.

Bock 5 was found to contain seventy-one of the ninety-one principles. This constituted seventy-eight per cent of the total. Bock 3 was found to contain only forty-eight of the ninety-one principles or fifty-three per cent of the total.

The number of different science principles was divided four to one in favor of physical science. However, the various mentions of concepts within the texts divided the emphasis almost on an equal basis. This was due largely to the tremendous influence of the three broad concepts, "Some living things depend upon each other for getting part of what they need in order to live", "Living things by their life activities affect the welfare of other living things", and "Living things cannot exist long without water."

CONCLUSIONS

Although the approach to geography varies greatly with each author, there is a noteworthy high degree of agreement both as to geography subject-matter and to science concepts for grade eight.

The wording of the principles in some instances gave such wide latitude that there was almost always the possibility for unlimited interpretation when applied to the area of geography.
There are enough principles of physical and biological science common to both geography and science at this level to constitute an excellent core or nucleus from which to build workable and efficient units for either class, and offers tremendous opportunities to the person who teaches both areas to a given class.

Research has shown that units of work built around broad concepts are in harmony with present day pedagogy, and the studies on science principles which are available offer to teacher, administrator, and supervisor excellent source material for keeping abreast of worthwhile investigations.

RECOMMENDATIONS

This appears to be the first investigation of science principles encompassed in the field of geography.

It is recommended that additional studies be made both at the seventh grade and ninth grade levels. This would make it possible to know which principles, if any, are receiving treatment in geography texts. If principles of physical and biological science are encountered, it will be possible to determine which ones are common to both studies, and this will be of value in determining the appropriate level for the study of the broad generalization.

It is also recommended that teachers of both geography and science avail themselves of this material that they may
better plan their instruction and develop current courses of study.

In view of the investigations in the area of science principles *per se* and as science course objectives, it is recommended that teachers, administrators and supervisors make known to their associates the available materials with which they can develop personal files, texts, reference sets, pictures, demonstrations, and experiments which will concretely reinforce those broad concepts which the students need to grasp and understand.
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