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# The Objectives of the Earth Science Curriculum Project; An Evaluation of Their Achievement

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## *Introduction*

The textbook *Investigating the Earth* and its companion two-volume Teacher's Guide were conceived, written, and tested by a group of scientists and educators brought together for that specific purpose. A primary objective was to produce an earth science course that could replace the increasingly unsatisfactory and outdated general science program.

The three main themes outlined for the program were behavioral, conceptual, and historical. Its major objective was to offer the ninth-grade students an interdisciplinary earth science course that would provide a view of our dynamic planet through the use of scientific concepts, such as space, time, energy, motion, and matter, presented through an investigative approach (Roy 1964). One gains an appreciation of the magnitude of the task from the fact that among the authors were geochemists, geophysicists, geologists, meteorologists, oceanographers, astronomers, geographers, and science educators, each an expert in his own field.

## *Statement of the Problem*

At the outset the ESCP writing conference considered that at the junior high school level many students were exposed to their first organized science program, and, therefore, it should provide orientation for the science courses to be taken in higher grades (Roy 1964).

1. The course content should contain materials that would help the students develop an understanding of scientific principles and concepts.
2. The materials prepared for students should take advantage of the student's background in mathematics and science gained in earlier schooling.
3. The course content should have a unifying theme that would provide a

pattern for a number of investigations designed to introduce students to the process of science.

4. The course should contain materials that would encourage the development of a positive attitude toward undertaking further science courses in high school.

5. The course should contain investigations about the dynamics of the earth in order to assist students in gaining an understanding of science concepts such as matter, energy, space, time, forces, and motion.

6. The Earth Science Curriculum Project (ESCP) should provide a Teacher's Guide that would aid in teaching earth science by using the investigative approach with emphasis on unsolved problems.

The purposes of this investigation were: (1) to determine whether the conceptual objectives outlined in the ESCP Teacher's Guide were achieved in the textbook; and (2) to evaluate the teacher's reactions to the recent edition (1967) of the textbook and its supplements.

### *Methods of Procedure*

In order to obtain the background information on which to base an evaluation of *Investigating the Earth*, two types of investigations were conducted. The first, which served as the major source of information, involved obtaining teacher opinions through the use of a questionnaire. The second involved personal visits to five junior high schools in central Iowa to interview students and teachers for opinions about the ESCP textbook and its supplements.

The questionnaire consisted of two parts. It was mailed to 500 randomly selected teachers in the United States and Canada. The teachers were identified as those using ESCP materials. Their addresses were obtained from the Earth Science Curriculum Project office in Boulder, Colorado. The first section contained twenty questions that sought the teacher's reaction to the 1967 edition of the textbook. The second section asked the teachers to rate the achievements of the conceptual objectives that are outlined for each chapter in the 1967 edition of the Teacher's Guide.

The Dale-Chall (1948) formula was used to determine the reading level of the textbook, *Investigating the Earth*.

The textbook, and the Teacher's Guide—parts 1 and 2 were subjectively read and evaluated by the teachers who responded to the questionnaire. Furthermore, the conceptual objectives set forth for each chapter were evaluated in terms of the content of the textbook, that is, whether they were covered in the chapter for which they were outlined or in other chapters. The ESCP feedback reports (1964-1967) concerning the textbook and the teacher's guide were reviewed in this study. These feedback reports were done by test center teachers.

Interviews with educators both in the fields of education and earth science have aided in the findings and conclusions of this investigation.

## Summary of the Questionnaire

The questionnaire consisting of two sections was mailed to 500 teachers across the nation and Canada selected at random from those who have been using ESCP materials. The return from 394 teachers in 47 states and Canada constitutes a 79 per cent return and serves as a basis for this study. The following is a summary of the questionnaire given in per cent, based on the returns.

### Part One

#### Question Number:

1. Name of teacher

2. Name of school

3. Average number of students in class

	<i>Per cent</i>
a. 20-25	10%
b. 25-30	82%
c. 35-40	7%
d. 40-45	3%
e. more	0%

4. Educational Background:

a. Degree	
(1) B.S. or B.A.	35%
(2) M.S. or M.A.	65%
(3) Ph.D.	0%

5. Major:

a. Biology	70%
b. Chemistry	10%
c. Physics	5%
d. Geology	13%
e. Others	2%

6. How many years did you participate in the ESCP testing program?

a. One year	21%
b. Two years	19%
c. Three years	0%
d. None	60%

7. Do you favor standardized national testing?

a. Yes	11%
b. No	89%

8. Have you used the suggested evaluation tests in the hard back (1967) edition of the teachers guide?

a. Yes	55%
b. No	45%

9. If no, why?

a. Because they do not evaluate the objective	
b. They are unclear or pointless	
c. They are difficult to grade	
d. All of the above	35%
e. For reasons other than the above	10%

10. Which chapters and/or investigations could be eliminated without significantly decreasing the value of the text?	a. Chapters 13 and 21	5%
	b. Chapters 1 and 3	3%
	c. Chapters 2 and 5	5%
	d. Chapters 7 and 8	4%
	e. Combine chapter 11 with others	2%
	f. Investigations 1-9, 4-1, 417	2%
	g. Investigations 9-9	3%
	h. Investigations 7-1	5%
	i. Investigations 19-5, 5-1, 19-10, 3-9	4%
11. Did you notice any glaring omissions in the chapters?	a. Yes	2%
	b. No	98%
12. Briefly comment on the hardback cover as compared to previous editions, i.e.,	a. Is it better because the investigations are included in the textbook?	98%
	b. Is its reduced size a favorable factor?	100%
	c. Are illustrations suitable?	87%
13. Did you notice any repetition in it?	a. Yes	20%
	b. No	80%
14. Did the ESCP writers succeed in introducing science concepts from physics, astronomy, meteorology, oceanography, geology and chemistry?	a. Yes	94%
	b. No	6%
15. In your opinion, what purpose do the investigations in the textbook serve?	a. They illustrate the concepts and principles	30%
	b. They teach skills, stimulate interest, make the student think	60%
	c. Practice in inductive and deductive reasoning	5%
	d. Others	5%
16. Does the teacher's guide serve your needs?	a. Yes	100%
	b. No	0%
17. Do you take your students on field trips?	a. Yes	49%
	b. No	51%
18. Do you think that the experience of a field trip would be of much benefit to the students as an aid to understanding the investigative approach?	a. Yes	95%
	b. No	5%
19. Do your students find any difficulty in the reading level of "Investigating the Earth?"	a. Yes	78%
	b. No	22%
20. If yes, what have you done to help them?	a. Spent more time reading orally, summarizing and explaining difficult parts	45%
	b. Get the better readers to help the slow readers	20%
	c. Use more experiments, films, pictures, illustrations and film loops	10%
	d. Use other texts for difficult parts	3%

## Part Two

Please refer to the conceptual objectives (major ideas) as outlined for each chapter in the hardcover teacher's guide, beginning with Chapter 1, 1-4, Chapter 2, 5-9, Chapter 3, 10-16, etc., covering the 119 major ideas. Please rate, on the IBM card enclosed, for each of these objectives as covered in the content of the text (Investigating the Earth). The objectives are listed in numerical order and identified as to consecutive chapters. The rating should be as follows:

POOR	FAIR	AVERAGE	GOOD	EXCELLENT
A-0%	B-1%	C-6%	D-75%	E-18%

## Discussion

Under this heading the authors would like to present their opinions on the following: Why the ninth grade was chosen as the level at which the ESCP materials would be taught; reading ability to students; mathematics in the text; and teachers' rating of the conceptual objectives of the program.

Educators across the nation overwhelmingly suggested that ESCP materials be taught at the ninth grade (Roy 1969). The students using ESCP materials reportedly have a problem with the reading (see question 19 in the questionnaire).

The reading level is uniform throughout the text. Samples taken from every tenth page of the book, according to the Dale-Chall (1948) formula, were used to calculate the reading level of the book by the following process:

- The total number of words in each sample were counted.
- The number of sentences were counted.
- The number of unfamiliar words, i.e., words that didn't appear on the Dale list of 3,000, were counted. All unfamiliar words were listed even though they appeared more than once.
- The average sentence length was computed. (Number of words in each sample divided by number of sentences.)
- The Dale score was computed. (Number of words not on Dale list divided by number of words in sample multiplied by 100.)
- An average of each of the above items for all the samples was computed. It was determined that the textbook is suitable for grades 9-10.

In deciding whether or not the textbook is appropriate for students at a selected educational level, additional factors have to be considered. They include: the interest of the student, the student's acquired background in reading, the types of ideas expressed, and the motivation of the reader.

The reading level improvement of the student will never be achieved unless each classroom teacher from K-12 accepts responsibility for building the students' reading ability (Smith 1964). So long as that responsibility is charged to only the English teacher, the student will continue to regard reading as of importance only in the English class.

The mathematics used in the textbook is not too sophisticated for the ninth-grade student. It is at this level that the students receive their first instruction

in Algebra. It is here, too, that the ESCP materials are designed to be studied. Therefore, it is essential that the earth science teachers explain the mathematical concepts and formulas used in the textbook. It is equally important that the mathematics teachers in the lower grades be made aware of what the student will need to know when he reaches the ninth grade so that he can understand the math in the ESCP investigations (Qutub 1969).

Twenty per cent of the teachers reported that some repetition is found in the textbook, such as the concept of change which is emphasized in chapters 1, 6, 12, and 16, and throughout the textbook for that matter. Such repetition is desired, because concepts need to be repeatedly emphasized in order to show their relationship with others.

According to the ratings of the teachers who tested the ESCP materials, the conceptual objectives (major ideas) outlined for each chapter in the Teacher's Guide are well covered in the content of the book. The authors agree with the teachers' ratings and further wish to point out that the flow of energy in shaping the land surface as well as the role of energy in the various other processes is emphasized throughout the textbook. Also, material that is related to the water cycle (chapters 7-12) and the rock cycle (chapters 13-21) which are the books unifying themes is presented in such a way as to arouse the student's curiosity and to make him inquisitive (ESCP 1965-1968). The necessity for using quantitative data is stressed in many of the investigations. Emphasis is placed on understanding and developing concepts and on making observations of earth processes and their products. The various concepts related to the two cycles were found to be presented in a sequential and continuous manner.

The ESCP writers have also succeeded in integrating science concepts from physics, chemistry, geology, oceanography, meteorology, and astronomy in the content of the textbook. For example, the concept of matter is discussed in Chapter 2 (Earth Materials), the concept of forces is discussed in Chapter 5 (Fields and Forces), the concept of motion in Chapter 4 (Earth Motions) and Chapter 7 (Energy and Air Motions), the concepts of time and space are discussed occasionally in chapters 7-21 (Qutub 1969). The concepts of energy are stressed throughout the book. The source of energy for the water cycle is determined to be the sun, whereas a different source of energy, that generated beneath the crust, is also established as being responsible for part of the rock cycle. The concepts are stressed in the investigations and activities as well as in the questions and problems.

The investigations presented in the textbook may be grouped into three categories (Qutub 1969):

1. Those in which the student is asked to make observations directly without any data, as investigations 1-4 and 2-4.

2. Those in which the student learns how to collect and use data quantitatively through the use of laboratory equipment, such as in investigations 5-2 and 6-2.

3. And finally, those which employ models for teaching the student how to use and interpret data that are already given to him. Examples of such investigations are in exercises 3-9 and 9-9.

Some of the investigations begin in one chapter and end in another, an example being the Sky and Weather Watches which begins in Chapter 1 (The Changing Earth) and are completed in Chapter 4 (Earth Motions) and Chapter 8 (Water in the Air) respectively. In investigation P-2 the student learns how to calculate density, then he uses that knowledge for further investigations that deal with density, as in section 3-8 (What's Inside the Earth).

In brief, the investigations were found by the authors to serve the following:

1. They reinforce the concepts developed in the textbook.
  2. They provide the student with incentive to tackle the unknown.
- They emphasize the importance of models and a scientific method.

### *Summary*

In summary, it is concluded that the ESCP writers have achieved their goal in preparing for the ninth-grade student an interdisciplinary earth science course, using the investigative method, where the student employs a scientific method to inquire about our dynamic planet. They succeeded in tying together concepts from chemistry, physics, meteorology, oceanography, geology, geophysics, astronomy, and soil science, to explain to the ninth-grade student that the earth is a dynamic spheroid of matter in which processes operate to produce cycles of continuous change, controlled by the shifting distribution of energy. The excellent two-volume Teacher's Guide, prepared as a supplement to the textbook, was a further commendable achievement of the ESCP writers.

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