



A survey of earth science courses as a discipline in Montana secondary schools
by Richard Leland Mackin

A thesis submitted to the Graduate Faculty in partial Fulfillment of the requirements for the degree of
MASTER OF SCIENCE in EARTH SCIENCE
Montana State University
© Copyright by Richard Leland Mackin (1970)

Abstract:

Earth science, as a discipline, is ideally suited to play a key interdisciplinary role in the study of environmental problems. It can provide an interesting, meaningful, relevant, and continuous type of curriculum in which each student may become actively involved. However the course in secondary school earth science which has enjoyed a resurgence of popularity in the past decade seems to be backsliding toward general science once again. Part of the problem may be a shortage of properly trained teachers. But, this problem is a peculiar one. Recent graduates, well trained in earth science, find it difficult to obtain jobs because the school staffs are filled with tenured teachers trained for general science or the biological sciences who are now teaching earth science. It also seems to be difficult to set up programs for retraining these teachers.

There is presently, very little motivating force in the way of organizations, state or national, to get earth science moving ahead once again. The systems of school financing, the Montana mill levy in particular, seem to be obsolescent forms because there is an insufficient funding for the school districts each year. Other problems are: the extremely small size of many Montana school districts; accreditation requirements that may not be entirely adequate; secondary and college level teacher preparatory requirements that may be unrealistic.

To seek out the answers to these problems a broad search of related literature was made. A three page questionnaire was sent to all Montana earth science teachers. Two smaller questionnaires were devised and distributed to physical geology students at Montana State University to get the students' point of view. Statistical reports related to science teaching and issued by the Montana Superintendent of Public Instruction were also reviewed. This data was examined and analyzed, and conclusions were drawn that seem to verify the recent findings of other workers.

It was found that the trend toward earth science in Montana has indeed slowed down and may even be retrogressing. Apparently there is no concerted program in Montana to retrain those presently teaching out of their fields in earth science nor is there any solution in sight that is capable of solving the financing problems of Montana school districts. There seems to be no publicized planning on the part of state officials to implement a program that will encourage school districts to consolidate, to review accreditation requirements, or to take leadership in improving the approaches to the adult world that our children now stumble through.

It is suggested that earth science professionals continue, and increasingly so, to propagandize with national science organizations over the relative merits of earth science as a beginning high school science course. Educational personnel at all levels should actively seek to discourage general science as a course and as a certifiable teaching major or minor. The obsolescent state-local methods of raising funds should be replaced by a federal-state financing system with a minimum of federal control.

Montana, a state of vast territorial expanse and very small school districts, requires of some teachers that they be knowledgeable in several fields.

Teachers with science majors therefore should be exposed to physics, chemistry, biology, and earth science. A teacher in a small class III district would be more versatile and students would benefit as well. If one teacher were hired by two or more contiguous districts it could provide some of the economic benefits of consolidation. Principals and superintendents should try to effect a program of sharing equipment with neighboring school districts and should also encourage their teachers to take field trips.

In presenting this thesis in partial fulfillment of the requirements for an advanced degree at Montana State University, I agree that the Library shall make it freely available for inspection. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by my major professor, or, in his absence, by the Director of Libraries. It is understood that any copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Signature Richard Loland Meckin

Date 5 August 1970

A SURVEY OF EARTH SCIENCE COURSES AS A DISCIPLINE
IN MONTANA SECONDARY SCHOOLS

by

RICHARD LELAND MACKIN

A thesis submitted to the Graduate Faculty in partial
Fulfillment of the requirements for the degree

of

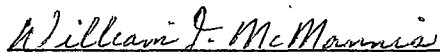
MASTER OF SCIENCE

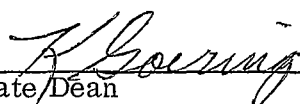
in

EARTH SCIENCE

Approved:


Head, Major Department


Chairman, Examining Committee


Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

August, 1970

ACKNOWLEDGMENTS

I wish to express my appreciation to Dr. William J. McMannis, my graduate committee chairman for providing much assistance, supervision, and many helpful suggestions in the preparation of this report. Special thanks and gratitude are also extended to Dr. Robert A. Chadwick, Dr. Albert Suvak, and Professor Earl H. Fellbaum, who directly or indirectly did much to make this report meaningful.

Professor Milton J. Edie, Head of the Department of Earth Sciences assisted my research by providing encouragement and facilities for the gathering of data.

I also wish to acknowledge the assistance of the other members of the committee in the reading and criticism of this thesis.

TABLE OF CONTENTS

	PAGE
VITA	ii
ACKNOWLEDGMENT	iii
LIST OF TABLES	vi
LIST OF FIGURES	vii
ABSTRACT	viii
CHAPTER	
I.	
Introduction	1
Statement of the Problem	4
Methods and Procedure	6
Limitations	9
Definition of Terms	10
II. REVIEW OF THE LITERATURE	12
Literature Related to Montana	12
Theses Related to a Study of Earth Science Curricula	13
ESCP Related Literature	14
Literature Related to a True Interdisciplinary Approach	16
Literature Related to Environmental Problems	20
Recent Research in Science Teaching	21
A Geologist's View	26

CHAPTER	PAGE
III. ANALYSIS OF DATA	28
The Science Teacher Questionnaire	28
Science Teacher Lists	50
Geology Student Questionnaires	54
IV.	
Summary	63
Conclusions	64
Recommendations	70
Research Topics Beyond the Scope of This Paper .	75
SELECTED REFERENCES	78
APPENDIX	83

LIST OF TABLES

TABLE	PAGE
I. Distribution of Teaching Facilities and Related Teacher Evaluations	33
II. Teacher Cocurricular Involvements	44
III. Earth Science and Related Courses Taken by Nonminors	47
IV. Teaching Combinations	55
V. Distribution of Answers to Question 1 and 2 on Geology Student Questionnaire A	57
VI. Distribution of Answers to Geology Student Questionnaire B	61

LIST OF FIGURES

FIGURE	PAGE
1. Diagram to Illustrate Relationships Among the Fundamental Disciplines from the Standpoint of General Education	17
2. Per Cent Distribution from Teachers Who Take Field Trips	36
3. Changes in the Number of Teachers Teaching Earth Science and General Science 1963 to 1970	52
4. Changes in the Number of Schools Offering Earth Science and General Science 1963 to 1970	52

ABSTRACT

Earth science, as a discipline, is ideally suited to play a key interdisciplinary role in the study of environmental problems. It can provide an interesting, meaningful, relevant, and continuous type of curriculum in which each student may become actively involved. However the course in secondary school earth science which has enjoyed a resurgence of popularity in the past decade seems to be backsliding toward general science once again. Part of the problem may be a shortage of properly trained teachers. But, this problem is a peculiar one. Recent graduates, well trained in earth science, find it difficult to obtain jobs because the school staffs are filled with tenured teachers trained for general science or the biological sciences who are now teaching earth science. It also seems to be difficult to set up programs for retraining these teachers. There is presently, very little motivating force in the way of organizations, state or national, to get earth science moving ahead once again. The systems of school financing, the Montana mill levy in particular, seem to be obsolescent forms because there is an insufficient funding for the school districts each year. Other problems are: the extremely small size of many Montana school districts; accreditation requirements that may not be entirely adequate; secondary and college level teacher preparatory requirements that may be unrealistic.

To seek out the answers to these problems a broad search of related literature was made. A three page questionnaire was sent to all Montana earth science teachers. Two smaller questionnaires were devised and distributed to physical geology students at Montana State University to get the students' point of view. Statistical reports related to science teaching and issued by the Montana Superintendent of Public Instruction were also reviewed. This data was examined and analyzed, and conclusions were drawn that seem to verify the recent findings of other workers.

It was found that the trend toward earth science in Montana has indeed slowed down and may even be retrogressing. Apparently there is no concerted program in Montana to retrain those presently teaching out of their fields in earth science nor is there any solution in sight that is capable of solving the financing problems of Montana school districts. There seems to be no publicized planning on the part of state officials to implement a program that will encourage school districts to consolidate, to review accreditation requirements, or to take leadership in improving the approaches to the adult world that our children now stumble through.

It is suggested that earth science professionals continue, and increasingly so, to propagandize with national science organizations over the relative merits of earth science as a beginning high school science course. Educational personnel at all levels should actively seek to discourage general science as a course and as a certifiable teaching major or minor. The obsolescent state-local methods of raising funds should be replaced by a federal-state financing system with a minimum of federal control.

Montana, a state of vast territorial expanse and very small school districts, requires of some teachers that they be knowledgeable in several fields.

Teachers with science majors therefore should be exposed to physics, chemistry, biology, and earth science. A teacher in a small class III district would be more versatile and students would benefit as well. If one teacher were hired by two or more contiguous districts it could provide some of the economic benefits of consolidation. Principals and superintendents should try to effect a program of sharing equipment with neighboring school districts and should also encourage their teachers to take field trips.

CHAPTER I

INTRODUCTION

The trend toward the teaching of earth science in Montana secondary schools which was advancing noticeably in the early 1960's now seems to be faltering. The purpose of this paper is to examine what has been happening in Montana in this regard. However, before delving deeply into the problem some background pertaining to the relative merits of earth science as opposed to general science would be in order.

Looking back on the twentieth century, future historians may well view our time as a period of transition filled with crisis, unrest, and malaise. Presently, there seems to be an increasing number of well informed persons who view the near future with more than a vague apprehension. However, it is only from the vantage point of the future historian that one can be sure of the answers.

The unrest that is so evident all about us seems to arise from several sources. By far the most overpowering and potentially the most deadly is the problem of mushrooming populations. Unless steps can be taken very soon to control national and global birth rates, all other efforts may be in vain. Another problem, second only because it derives from the first is that of pollution, and again it is of global scale. And finally, there is the problem of rapid technological change and the veritable explosion of available information with its perplexing storage and retrieval problem (Ehrlich, 1968; Lamson, 1969; Pitkin, 1968).

These problems pose great urgency for those who expect to be living twenty years from now. Attitudes of people as private individuals or as part of the corporate power structure may have to undergo considerable revision. Like it or not, these problems are with us and they will not go away. If educators were to form their educational philosophy from an international frame of reference, perhaps more visionary solutions to the problems of our day would be forthcoming (Brameld, 1965, p. 103, 116-119).

It was with this global frame of reference in mind that an inquiry into how earth science was being taught in Montana secondary schools began. Earth science, as a discipline, may be a key educational factor in man's initial efforts to control pollution of his environment. Because earth science is a study of the lithosphere, hydrosphere, and atmosphere, it is ideally suited to a consideration of the urgent problems of our time. A firm grasp of key concepts such as the rock cycle, hydrologic cycle, atmospheric circulation, crustal disturbances, and the constant tendency toward a flattening of the landscape by erosional processes can provide the young people of Montana (and hopefully those elsewhere) with the excellent tools and common purpose that are so vitally needed for the job that is at hand.

Educators and the lay public have recently shown an increased interest in earth science as a beginning science course in secondary education (Shrum and Thompson, 1966, ESCP NL-10, p. 1). Environmental problems may be partly responsible but dissatisfaction with general science is also a strong factor. This is partly because much of the general science subject matter is

being treated in earlier courses and partly because general science courses suffer from a lack of continuity (Bisque, 1966, p. 1; Paull, et al., 1969, p. 50).

Since 1961, when the "Study Guide in Science for Grades 7-9" was issued by the State Superintendent of Public Instruction for Montana, there has been a limited trend, as in surrounding states, to place the study of biology in grade seven, physical science in grade eight, and earth science in grade nine. This trend is consistent with the current educational trend away from teaching of facts (Taba, 1962, p. 211-215) which quickly become obsolete, and toward an increased emphasis on discovery in the laboratory (Bisque, 1966, p. 1; Ladd, 1968, p. 64).

According to Bisque (1966, p. 1) general science courses tend to teach facts rather than concepts; they suffer from a lack of continuity; and the subject matter does not relate to the real world. He states:

The strength of earth science as a discipline is in its presentation of ideas in the context of experience or problems that relate to a unifying theme. This theme, a study of man's environment is the realm of earth science (ibid, p. 2).

Earth science then, properly taught, furnishes the framework for a course of study that provides students with intellectual concepts and principles rather than facts. It teaches them to think (Taba, 1962, p. 215-220). It affords them an overview of the problems they will face in their adult world regardless of their college intentions. The possibility of an interdisciplinary approach to global problems is exciting. Such an approach which emphasizes kinship rather than differences between the disciplines is vital. But scientists and educators must learn to communicate with one another and to work together, for earth

scientists cannot do the job alone. It requires the integration of effort by biologists, physical scientists, social scientists, political scientists, economists, mathematicians, and above all, specialists in the art of communication (Hayakawa, 1964; Lucio and McNeil, 1969, p. 196). So far experience has proven it most difficult to find scientists with the scope and inclination necessary to work with educators in developing a unified approach which adheres to a coherent theme (Bisque, 1966, p. 2; Carter, 1967, p. 2). Earth science and other disciplines need to be integrated in order to present a meaningful, relevant, and continuous educational program to young people.

It is just possible that an integrated approach using learning situations that pertain to the real world, along with a continuing communications program that plays up advantages and benefits of a good education, might provide the interest and motivation that presently seems to be lacking. And it is this very lack of motivation and interest that seems to be at the root of many of our discipline problems (Hoover, 1964, p. 464; Rogers, 1959, p. 157-158; Moustakas, 1956, Ch. 1).

STATEMENT OF THE PROBLEM

During the past decade earth science as an introductory high school science course has tended to replace the former general science curriculum. The latter appears to be receiving decreasing support in enlightened education circles (Henderson, 1969, p. 8; Staff Report, 1963, ESCP NL-1, p. 1; Merrill and Shrum, 1966, p. 24). However, the past few years has seen a slowing down, perhaps even a regression, of the trend toward earth science. The

primary purpose of this paper then is to examine what has been happening in Montana. There was no data available which would indicate what the trend has been or what the status of secondary school earth science in Montana was in 1969.

Part of the problem in Montana is a short supply of trained earth science teachers. But then, what does one do with the over-supply of tenured general science teachers? Shrum and Thompson (1966) and Merrill and Shrum (1966) had discussed the problem; they suggest, among other things, a retraining of those not presently qualified according to legal standards. Howard K. Reith (1969 doctoral thesis, University of North Dakota) reports: "Over one-third of the states have no teacher certification policies in earth science. The subject is being taught, for the primary [sic] part, by unqualified teachers." The difficulties encountered while trying to implement retraining in Montana will be discussed in Chapter III.

One stagnating economic factor may be the mill levy system which is used to raise additional school funds in Montana; another is the extremely small size of many third class school districts.

Accreditation requirements for the secondary schools may not be adequate (Blosser and Howe, 1969, p. 90). Teachers in Montana presently can and do teach out of their major or minor fields without fear of a crackdown from accreditation authorities.

On the national level there seems to be no science organization with the capability, motivation, and initiative to launch a campaign in behalf of earth

science.

Another factor may be the manner in which course offerings are made to teacher candidates in our institutions of higher learning. It would seem to this investigator, that today's students face a scheduling crisis; they cannot schedule enough in depth subject matter material in a four year curriculum.

Many young people arrive at college as prospective teachers and are not at all sure in which field they wish to major (Holmes, 1969, p. 142). They seemed to have gained very little knowledge of teaching career opportunities from their high school experience. After attending a higher level institution for several years their awareness improves and this in turn causes many of them to switch majors.

Finally, but not the least important is the problem of lack of interest and motivation on the part of many students in our secondary schools. Suspect is our continuing failure to provide an interesting, relevant, and continuous type of curriculum in which each student may become involved.

METHODS AND PROCEDURE

The most practical way to secure data for the projected study of earth science teaching in Montana was determined to be by questionnaire. The questionnaire was devised to resemble a previous questionnaire sent out by McMannis and Shenkle (1965). It was the expectation that the returned data could be compared and contrasted to the earlier data. The questionnaire consisted of thirty-one questions and was three pages long (see the Appendix). Names and addresses of earth science teachers were compiled from the "List of Montana Science

Teachers 1968-69" taken from the "Fall Reports" by Clark Fowler in the office of the State Superintendent of Public Instruction. From this list, one hundred nineteen possibilities were selected. A cover letter was included with each instrument. In some instances, where it was not clearly evident that earth science was being taught as such, an additional letter was addressed to the science department head requesting that the questionnaire be forwarded to the applicable teacher.

Seventy-four questionnaires were returned which was 62 per cent of the total distributed. Of these, six said they were not teaching earth science at this time. Please note that hereafter in this report, reference to statistical data will be based on the sixty-eight questionnaires from currently active teachers.

The questions were devised and organized so that, in a general sense, certain groupings of data would show patterns such as the type of teaching conditions encountered, teaching methods, educational background, the type of teaching aids used, and budgetary trends. Some questions called for multiple answers and some for comments. To avoid confusion and to assure accuracy during the processing, the following system was used. The questionnaires were serialized from one to seventy-four and then divided by school districts into class I, class II, and class III categories. In Montana, a community of 8,000 persons or over is rated class I; a class II district has more than 1,000 but less than 8,000 persons; a class III district is composed of less than 1,000 persons (Montana Code, Title 75, Section 1802, p. 155). Montana school

districts are officially set up on an 8-4 or 6-3-3 system. An 8-4 system simply means an elementary school from grade one to eight and a high school from grade nine to twelve. In a 6-3-3 system the grade range is as follows: elementary, one to six; the junior high, seven to nine; the senior high, ten to twelve (Montana Code, Title 75, sections 4138, 4201, pp. 318, 324). Montana provides an incentive for the 6-3-3 system because it will reimburse for junior high school students at the higher senior high student rate. As of this date there are eighteen districts with twenty-five operating junior high schools and 153 districts operating both a 1-8 elementary school and a 9-12 high school (Montana Education Directory, 1969). One would expect the figures to be reversed considering the incentive, but one deterrent apparently is the cost of new school buildings; another is the small size of many school districts. A class III school district, in order to meet minimum requirements for existence must have a taxable valuation of \$75,000 and no less than fifteen students (Montana Code, Title 75, Section 1805, p. 157). A school district, in order to qualify for the higher rate of reimbursement must have a minimum of 150 junior high students, three separate buildings, and three administrators (Montana Code, Title 75, Section 1802, p. 155). Data from the instruments in each school district were then tallied for a total of three tallies. To preserve their value many unclassifiable comments were drawn off in their entirety so that all those pertaining to a particular question in a particular school district could be found on a single sheet of paper. Each sheet was identified by class of the school district, question number, and question. Each comment was identified by the

serial number of the instrument. The tallies of all three districts were then totaled to get overall figures for each question.

In addition to the detailed teacher questionnaire, two shorter questionnaires were devised for the students taking Physical Geology 101 at Montana State University. The first one was distributed through three academic quarters of 1968-1969. It consisted of fifteen questions and was related to their secondary school earth science experience, if any. The second questionnaire was much shorter and was distributed only to spring quarter 1970 Physical Geology 101 students. Its specific aim was to determine how many students had had an Earth Science Curriculum Project (ESCP) course in secondary school and if so what statistical correlations could be determined from the data. Analysis of the data is covered in Chapter III and copies of the questionnaires may be found in the Appendix.

The "List of Montana Science Teachers 1969-1970" was used to make still another statistical analysis pertaining to the trend toward earth science and away from general science. Teaching combinations, that is, other science courses taught by the same teacher were also investigated. Discussion pertaining to the last two analyses are also found in Chapter III.

Where applicable, statistical means, medians and modes were determined. They may be found in Chapter III, Analysis of Data, and in applicable tables and charts.

LIMITATIONS

This survey was limited to junior and senior high schools, both public

and private in the state of Montana. Elementary schools were not involved since the names of earth science teachers were taken from the science teacher list which records data only from junior and senior high schools in the state.

Distribution of the questionnaire was not considered ideal because of the possibility that earth science units were being offered under the guise of general science, senior science, or some other misleading title. In some instances a school district may have been in the process of a change-over from a seventh grade to a ninth grade offering. This survey may have caught them during the transition period. Some districts had begun teaching earth science and then stopped for no apparent reason. Six of the seventy-four questionnaires returned fit this last situation.

DEFINITION OF TERMS

Earth Science Curriculum Project (ESCP). Sponsored by the American Geological Institute (AGI) and supported by the National Science Foundation (NSF). Faced with a rapidly growing earth science curriculum which began in New York State, the AGI felt that up-to-date resource materials had to be developed for teachers of secondary school earth science courses. The AGI also hoped to improve earth science teacher training, and ultimately, to further the improvement of science education in general. The ESCP program evolved from this initial effort (ESCP, 1963, NL-1).

Interdisciplinary approach. This term means different things to different people. The investigator uses this term with meaning in the broadest sense. It means that concepts in a learning sequence are approached so as to encompass

the interrelationships, points of view, and attitudes reflected by all the major disciplines including the humanities. For an example, turn to the Review of the Literature (p. 26) where a geologist's view is given. ESCP committee members use the term usually as it applies to disciplines closely related to earth science, e.g. geochemistry, geophysics, space physics. At times reference is made to a conceptual framework which includes and ties together all areas of science. Here the reference is to biology, chemistry, mathematics, physics, astronomy, geology, geography, oceanography, and meteorology which must be dealt with when discussing the materials and processes which shape our environment (Bisque, 1966, p. 1).

Modular scheduling. A type of flexible scheduling. Time modules of five to thirty minutes are combined in various plans for each subject to suit the needs of different learning activities and different grouping configurations. It is particularly well suited to team teaching situations.

Teacher function. A specified way in which he performs or carries out a role. In so doing certain information or experience is transmitted to the learner. The learner is assumed to acquire immediate meaning which he translates into action for his learning activities.

CHAPTER II

REVIEW OF THE LITERATURE

There is a wealth of literature that relates to the development of science curricula, environmental problems, and interdisciplinary philosophy that is pertinent to this investigation. However, time and space will permit only brief summaries of the most important articles.

LITERATURE RELATED TO MONTANA

Literature related to the teaching of earth science in Montana is relatively sparse. A search turned up the following:

"The Study Guide in Science, Grades 7 to 9, 1961", issued by the State Superintendent of Public Instruction, Helena, Montana.

Results of a questionnaire distributed by McMannis and Shenkle, about December 1964.

"List of Montana Science Teachers", 1963-64; 1966-67; 1967-68; 1968-69; 1969-70. These lists were taken from the "Fall Reports" prepared by Clark Fowler, Science Supervisor in the office of the State Superintendent of Public Instruction.

These reports are reviewed in detail in Chapter III, Analysis of Data.

An article by Rex C. Haight (approximately 1940) discussed the problems that arose while trying to educate the rural youth of the Grass Range school district. This district covered an area estimated by Haight to be about fifteen times the area of the District of Columbia. At that time the only practical solution seemed to be the use of correspondence courses. According to Haight the program met with considerable success. This article proved of interest primarily because it gives some historical insight into the problem of educating the young people of Montana. It also gives the reader an appreciation of the vast expanse

of real estate that is Montana.

THESES RELATED TO A STUDY OF EARTH SCIENCE CURRICULA

Reith (1969) made a study of earth science teachers and practices in North Dakota and came up with some interesting original research data. The situation in North Dakota is somewhat analogous to that in Montana, but, in North Dakota the elementary schools include grades one to eight. Since eighth grade earth science is mandatory this means that all earth science teachers have to be certified as elementary teachers. Reith's purpose was to define the weaknesses of national and state curricula and to make recommendations on the basis of the findings. The results of his investigations showed that earth science procedures on a national and state level were weak. Over one-third of the states had no certification policies in earth science and courses were being taught, for the most part, by unqualified teachers.

According to Reith, the lack of well trained earth science teachers is forcing a trend back to general science, if not in name, in course content. There seems to be no pressure for qualified teachers so that ultimately there may be no need for earth science teachers at all. The situation in North Dakota was grossly inadequate but it seems to be improving since Reith wrote his thesis. The Minot State College has instituted a Cooperative College School Science Project to coordinate the ESCP program with the public schools in the area (DeWayne Martin, 1970, personal communication). Reith recommends that to improve the North Dakota earth science program, the following be done: strengthen teacher certification requirements; the state board should enforce

existing requirements; integrate earth science courses under the responsibility of a single teacher; promote realistic majors at the college level; all science teaching majors should minor in earth science.

Unpublished master's theses by Graham (1968) and Merriman (1965) generally support the findings of Reith (1969), this investigator, and other workers in the profession. Of particular interest was the finding by Graham that the West Virginia teachers surveyed had almost as many credit hours in biology as those earned in all the other science fields combined. Science and mathematics earned totaled 5,146 or an average of twenty-eight credits per respondent. Biology credits reported totaled 4,663 or an average of twenty-six and one half credits per respondent. There were other courses recorded, bacteriology for example, that could be considered related to biology. Addition of these courses to the total would indicate a strong background in the biological sciences for the respondents. Graham stated that the largest number of West Virginia junior high science teachers are qualified to teach biology but very few were well trained in any of the sciences needed to teach earth science. There is no legal certification in earth science, only in general science. She too recommended that earth science be taught as a separate course. These master's theses indicate a common problem, lack of training and promotional programs, with no easy solution in sight.

ESCP RELATED LITERATURE

The ESCP Newsletters provide the history and most recent data on the evolution of the text "Investigating the Earth" (1968, Boston, Houghton Mifflin

Company). Bisque (1966, p. 1) wrote about the superiority of an interdisciplinary earth science course over general science as a relevant, continuous, and meaningful study of our physical environment. In a staff report, Shrum and Thompson (1966, NL-10) discussed the problems involved in training earth science teachers and the future prospects for those thus trained. Helburn (1967, NL-13) reported on the progress of the High School Geography Project (HSGP). He stated that this project does not overlap ESCP, rather, both are complementary. "HSGP's current effort is focused on a 'Settlement Theme Course'. This course is divided into eleven units and represents a systematic coverage of geography through the unifying theme of man's settlement-or-occupancy-of the earth." Carter (1967, p. 2) gave a brief report on the status of the Biological Sciences Curriculum Study (BSCS). He remarked about the noticeable interdisciplinary relationships the ESCP has with BSCS, "Although to my knowledge there has never been a conscious effort by those preparing the ESCP materials to integrate their materials into the BSCS program. Nor was there any conscious effort on the part of those preparing the BSCS materials to integrate their materials into the ESCP program." Eighteen months later, Joseph L. Weitz, ESCP Director, published an article in the May 1969 ESCP Newsletter. In it he called for a true interdisciplinary approach in the handling of environmental factors and effects in the secondary schools. Biology was one of the disciplines mentioned specifically but there were no suggestions as to how such a program might be implemented. As one scans the literature scattered references may be found that link the National Science Foundation to interdis-

ciplinary investigations involving the natural sciences and mathematics. All of the aforementioned are signs that movement is in the right direction, but it is this investigator's impression that progress is much too slow.

LITERATURE RELATED TO A TRUE INTERDISCIPLINARY APPROACH

Holmes (1969), expressed the need for a liberal education in the midst of an era of specialization. Although any discipline may serve, as a geologist he thinks of geology as being the ideal central core of "a synthesizing educational framework wherein any given speciality can be visualized in terms of its relationship to the whole field of knowledge" (Holmes, 1969, p. 142). A major advantage is that the high school and junior college students can be shown the benefits and advantages of such a broad overview before they must make any final career decisions. He says that every specialist needs to see his field of interest in the context of this wider view of our culture. As a counterbalance to this necessary professional specialization, a sympathetic awareness of the main areas of human thought and endeavor should be encouraged. The groundwork for all this should be laid early and constantly reinforced throughout the school years. Figure 1 is a reproduction of the diagram devised by Holmes. His intent was to compress the field of knowledge into the smallest feasible number of major disciplines surrounding geology. Holmes felt the most effective geology teacher is the one who can lead students to see their exciting major field as being vitally involved in all the other fields.

Brameld refers to a study made by the Carnegie Corporation. The findings were that the American student's understanding of international affairs is more provincial than in any comparable country; that graduating seniors have little more knowledge about foreign affairs than they had as freshmen; isolationist attitudes are chronic at all college levels. Brameld suggests that curriculum revision is long overdue. He urges that world civilization serve as the central concept of curriculum integration. We should reconstruct the entire purpose and process of education. Brameld says (1965, p. 118) "man lives in a period fraught with the greatest peril he has ever encountered". At the same time his period of existence is one of such awesome discovery and scientific advance that he has the capability of producing a way of life far more creative and abundant than was ever before dreamed possible. In such a period much of the inherited structure and function of education become outmoded. Education, more than any other cultural institution "has the responsibility and opportunity to bring to all children and adults of all countries the full import of the fearful and promising age in which we live" (Brameld, 1965, p. 119).

Lucio and McNeil (1969, pp. 316-319) discussed the organizational framework needed for curriculum development. Their reasoning provides understanding in depth relative to a true interdisciplinary approach. They say that any plan for instructional organization must consider the problems of sequence and integration. Sequence is defined as "the provision for a cumulative development of an important skill, concept, or value" (Lucio and McNeil, 1969, p. 316). Integration is defined as being "primarily one of overcoming

the charge that schools tend to compartmentalize knowledge into subjects so that the learner cannot see the interrelation of his learnings or use them in new situations (transfer)" (Lucio and McNeil, 1969, p. 317). Integration then, combines subjects into broad fields, establishes problem-solving courses, and develops instructional units which center upon the logic of a task rather than the logic of a subject. Each of these practices, say the authors, is a shift from faithful elaborations of a discipline to one where subject-matter lines are broken down. The order of placement of contacts or experiences has in the past usually been by relative degree of difficulty of content. Lucio and McNeil suggest the principle of dependency as an alternative. For example, to understand life science depends on a prior understanding of the nature of chemistry. Therefore, schools should first offer physics, then chemistry, and finally, life science. There is a conflict over organization with a primary breakdown between functionalists and disciplinarians. Disciplinarians tend toward specialization because they value the differentiation found in a particular knowledge as important in itself whereas functionalists argue that that the schools organize for integration so that learners are able to solve moral and practical problems of a personal and social nature. The authors feel there are advantages to both positions and propose a stand in the middle ground. They state: (Lucio and McNeil, 1968, p. 320)

we recommend the teaching of disciplines drawn from the humanities, physical and life science, mathematics, and the social sciences... Newer curriculum plans in response to social problems will call for preselection by scholars of the resources (for example, principles, concepts, interpretations) from the disciplines which promise to be relevant to the problems at hand.

Holmes and Brameld provide considerable insight into the need for a true interdisciplinary approach to education. Holmes is oriented more toward helping the career choice of the high school or college student in this country whereas Brameld is concerned with the long range and world-wide aspects of education. Lucio and McNeil, on the other hand, provide in unbiased summary form, the opposing views of both sides in the issue, the disciplinarians and the functionalists.

LITERATURE RELATED TO ENVIRONMENTAL PROBLEMS

Pitkin (1968), a writer and lecturer, has a special interest in demography. His main theme is that the world population growth must be brought under control. He says, "it is amazing that so much has been left to chance. In no other area are planners and intellectuals more open to the criticism that they are mere dreamers" (Pitkin, 1969, p. 474). He feels that although we do project from past experience, our grave mistake is in settling for whatever happens. Pitkin said it really isn't so much a matter of whether we can provide for the increasing populations, "but at what social, moral, and esthetic costs?" (Pitkin, 1968, p. 476). It is here that our leaders, in and out of education, must stand. In the past, our approach to social problems usually has been to try to ignore them; then, too late, the remedial program is found to be either inadequate or outmoded. "The gap from appropriation to obsolescence needs to be widened; our pace is too fast for our institutions" (Pitkin, 1968, p. 478). In many cases, says Pitkin, our programs merely slow the pace, as in pollution control, rather than improving the situation. The biggest problem of all is how to motivate our

people to have small families in good times or bad. Pitkin does not profess to have the answer but it is his hope that leaders in education will assume a special role. "They are the great question-askers, perhaps ultimately the movers and shakers" (Pitkin, 1968, p. 479). Hopefully he says, the discussion once started, will move out of professional education circles and into the classrooms. Conceivably, we may find that in the asking, the question will be answered.

Lamson (1969) appears to feel that man has his future in his own hands. The main threats to his future come from man's own creations--his use of technology and the cultural institutions he has created. Because he no longer has the margin for error that his once fewer numbers provided, he should take care not to manipulate his environment in ways that cause irreversible changes or that produce paralysis of communication and transportation facilities such as occurred in the Northeast power failure of 1966. Man and his environment interact continuously and he should consider the genetic, physical, and psychological effects of his actions not only on the present generation but future generations as well. Through education he must prevent failure on social and political levels that would cause deterioration of his physical and biological surroundings. He urges science teachers to convey the attitudes and skills needed to protect and promote environmental quality. Pitkin and Lamson both stress the importance of population and environmental controls in order to preserve our planet for future generations and they both agree that the education profession must play a key role in effecting solutions.

RECENT RESEARCH IN SCIENCE TEACHING

A source independent of the curriculum project committees supplies affirmation for their efforts. Lucio and McNeil (1969, p. 131) state that

reaction against the 'grass roots' approach has increased of late...

The trend toward national projects which define content and method promises to replace 'one of the most pathetic sights on the current educational horizon--myriads of local school communities, whose members have had little or no scientific training, trying to produce a modern science curriculum'

However a note of caution has been voiced by Welch (1968). He felt that it may be necessary to evaluate the national curriculum projects. His report showed that the available information on acceptance of the Physical Science Study Committee (PSSC) was incomplete. Figures were contradictory and lacked a sound statistical basis. A similar situation appears to exist in other curricular areas. United States Office of Education and the National Science Foundation-Educational Services, Inc. figures varied by a factor of two for the 1964-65 PSSC enrollment. Welch recommended that some capable group accept responsibility and compile and evaluate the vital statistics for the various science projects.

Welch and Walberg (1969) state that most curriculum study groups have not made valid evaluations related to course improvement. Many committees seem to confuse the term evaluation with achievement testing. In other words, they are testing to see how well students did in the course, and not how much better their curriculum study course is compared to an older conventional course. Welch and Walberg have designed an alternative model of curriculum evaluation named Project Physics which they feel is more valid. They define evaluation as "those activities which provide information useful in course

improvement and which show how effective the course is under specified school conditions" (Welch and Walberg, 1969, p. 10). The authors' research objectives are threefold: to improve the course; to provide consumer information; and to provide educational research. To achieve these objectives they designed three instruments. The first measures the change in students, the second describes the kinds of students, and the third describes the kinds of teachers. They administered these tests before, during, and after courses in Project Physics. As a control tests were also administered to students and teachers in nonproject courses. They realize that their participants are all volunteers and do not represent random samples on which statistical inferences may be made. However, their trial model did permit a tentative contrast between the experimental and control schools and allowed for a number of correlational studies among teachers and students. They point out that their purpose is not to demonstrate the relative quality of their course but rather to specify differential changes that occur. Welch and Walberg plan further studies using random samples. Emphasis thus far has been on the physics curriculum but the authors say their research may be applied to other curricular areas.

Blosser and Howe (1969) analyzed recent research as it related to the education of secondary science teachers. They found that an interest in science appears to precede an interest in teaching and that there are identifiable personality traits associated with individuals entering science teaching from science backgrounds. They also found that science teachers possess no greater degree of knowledge and understanding of science methodology than do teachers of

other subjects. A group of philosophy majors were included in one investigation and it was found that they demonstrated a better understanding of the nature of science than did the population of science teachers (this would seem to lend support to the feasibility of a true interdisciplinary approach because the non-science teachers, at least, have an acquaintance with other disciplines). There is strong evidence that an understanding of the nature of science and scientific methodology can be taught. The data can be used to infer that this aspect of the preparation of science teachers deserves further study. The most important area of competency for a science teacher was found to be that of effective use of laboratory work to teach methods by which scientists have solved problems and have helped students to learn to identify problems and solve them empirically. It was found, as of 1964, that 123 institutions in the United States offered some type of preparation for earth science teachers. Recommendations by many competent persons indicated a concern for teacher function (see Definition of Terms) and teacher competencies rather than for credit hours of courses in the sciences or professional education. However, as Blosser and Howe pointed out, state certification requirements have not reflected the function and competency emphasis. The emphasis is still on course work and credit hours, and the trend is toward increasing them quantitatively.

Paull, Larson, and VandenAvond (1969) did research through which they hoped to predict the effect of an ESCP course on college level geology. They used the Test of Scientific Knowledge (TOSK) and a modified college physical geology examination. The latter was modified in the sense that the professors personal

bias (lecture related questions) was removed. Their approach seemed rather meticulous and the results should be of sufficient validity as to allay the fears expressed by Welch (1968). The authors feel that ESCP is superior to either general science or a non-ESCP course for strengthening the science backgrounds of students in the secondary schools. They say that TOSK predicts that ESCP students are better prepared for physical geology than students without ESCP. They also feel the results confirm that an experienced, well qualified ESCP teacher is more effective than those that are not ESCP trained. Paull, Larson, and VandenAvond, concluded that ESCP is an effective program for improving scientific understanding and abilities of students.

Champlin (1970) made a review of recent research related to ESCP. It had been five years since the first instructional material for ESCP appeared. During this period nine research studies and several surveys had been conducted. Six of the studies dealt with student achievement and their findings seem to indicate the ESCP is superior to non-ESCP courses. However, a clear-cut case could not be established due to the small number of studies and to the diversity among them. The Differential Aptitude Test (DAT) and the Test of Scientific Knowledge (TOSK) were used. The researchers, by their cautious statement of outcome, seemed to be well aware of the problems related to validity as brought out by Welch (1968). Champlin (1970, p. 7) placed considerable emphasis on the research finding "that the combination of the right curriculum with the appropriate teacher, was an important factor in influencing student outcomes". He closed by saying, "the ultimate value of ESCP can only

be decided through careful research" (Champlin, 1970 p. 38). The foregoing articles were cited because they give some insight into the recent evaluative research relative to science courses and science teaching.

A GEOLOGIST'S VIEW

Gilluly (1962) emphasized the importance of geology in the life of man; he discussed its historical aspects dating back to the time of the Industrial Revolution. He also stressed the point that mineral deposits are exhaustible, a fact carrying with it great social and political implications yet one often overlooked by economists and politicians. He stressed three main points: first, the extreme age of our earth; second, that environmental conditions have been relatively static for about the last billion years; third, that we are the surviving end products of a fantastically marvellous evolutionary sequence of which our species is but a tiny and fragile remnant. Gilluly reminds us that changes range from the vast, in terms of millions or billions of years to some tectonic activities that occur in seconds, e.g. the Disappointment Bay, Alaska earthquake, a dislocation of forty-two feet in ten seconds. This concept of change is something all too few engineers are aware of. We are in the middle of the earth's geologic history, and many cultural attempts to control natural processes are planned on too short a time scale. He says, "geology teaches us of the great antiquity of our globe and of the life upon it. It teaches of a persistence of conditions much like those of our day" (Gilluly, 1962, p. 9). However, it just as insistently teaches us that the landscape is not permanent, that erosion and uplift are everywhere about us, and that we cannot hope to permanently

preserve our surroundings as they are now. Gilluly's views seem to lend support to the argument that a broad overview of the field of knowledge is needed by secondary students and the general public. His approach was made all the more interesting because of its historical, political, and economic overtones, which makes it somewhat interdisciplinary in character.

CHAPTER III

ANALYSIS OF DATA

The data relating to earth science teaching in Montana is from four sources: the thirty-one question questionnaire sent to the Montana earth science teachers; a fifteen question instrument distributed to students in physical geology at Montana State University (MSU) during the 1968-1969 academic year; a short three question instrument devised for students in physical geology at MSU during the spring quarter 1970; and the science teacher lists for Montana from 1963 to 1970 (excluding those for 1964-65 and 1965-66 which were not available). Analysis is in narrative form except where tables or charts are more explicit. Copies of the questionnaires may be found in the Appendix. The order of discussion is generally as found in the questionnaires. Unless referenced specifically, correlations with the McMannis and Shenkle Report (1965) were found to be not significant.

THE SCIENCE TEACHER QUESTIONNAIRE

Two questions on districting and type of school were asked because the population of a district and the population of an individual school directly influence the answers received. A breakdown of the sixty-eight questionnaires by school districts showed 21 schools in class I districts, 31 schools in class II districts, and 16 schools in class III districts. The sixty-eight schools that reported back included 46 senior high schools, 15 junior high schools, and 6 combination junior-senior high schools. One teacher did not indicate his type of school.

Another group of questions (#3, #4, #5, #6, #7, #10) was deemed important because it gave an indication of teacher load, preparation time, potential problems relative to span of attention, and the general quality of each course. Class periods ranged from forty-five to seventy minutes in fourteen different time spans. The data showed that 56 teachers taught in the fifty to sixty minute range. Fortunately for the students, only 3 teachers said they had seventy minute periods. There were 8 whose class periods ranged from forty-five to forty-nine minutes, or who had modular scheduling (see Definition of Terms). Measurements with normal children have been made to test span of attention. They yielded values ranging from seconds to forty-five minutes (Moyer and Von Haller Gilmer, 1955). There have been many other studies made relative to this complex subject and they seem to support the conclusion that overly long class periods in secondary schools should be used with caution. As expected, teachers in the class II and class III districts tended to teach earth science fewer times a day but nearly all taught it four or five times a week. In the class I districts 16 teachers taught earth science three to five times a day. The student-to-teacher ratio reported ranged from a low of ten to one to a high of thirty-eight to one. Eleven teachers reported twenty-five students as average. Other average figures that occurred frequently were 30, 28, 27, 26, 20, 16, and 15 students. Answers related to the length of course indicated that 60 teachers were on a two semester basis and 5 on a one semester basis. One teacher covered the course in one and one-half semesters, another in four semesters, and one did not comment. Planned

laboratory periods ranged from none to three. There were, regrettably, 19 "no lab" responses. Thirteen said they held one lab per week; 17 had two labs per week. According to McMannis and Shenkle (1965), most schools reported about twenty per cent of their time is spent as lab time. Surmising correctly that not all earth science teachers teach in their major field, they were asked to state the total number of classes taught per day and the number of free periods they had per day. Only 10 reported having two free periods, 2 reported no free periods, and 51 reported one free period; 1 had guidance duties after teaching one class, 1 had four to nine free periods (modular scheduling), 1 had less than a full free period, and 2 did not comment. Not surprising, the teaching load is heavy. Data from question ten show that the majority of the teachers had only one free period for preparation. Class load seemed excessive: 11 indicated thirty or more students, 32 indicated from twenty-four to twenty-nine students. Only 25 or about thirty-seven per cent had less than twenty-three students per class. About 90 per cent of the teachers reported they were on a two semester basis. This is indeed encouraging since this course cannot be taught meaningfully in a shorter period of time. Personnel representatives Winston Weaver of the Billings school district and Russell Carlson of the Great Falls school district both report (1970, oral communication) that all of their schools will be on a two semester basis by the fall semester 1970.

Question eight about grade level was asked to get some idea of how well the study guide in science recommendations were being followed. The response to the grade level in which the course was taught showed that the schools sur-

veyed were, for the most part, following the study guide. Fifty-three teachers which is about seventy-eight per cent of the total, taught at least in the ninth grade, 10 in the eighth grade, and 5 above the ninth grade. Only one school each in the Billings and Great Falls school districts teach earth science in the ninth grade; the rest are eighth grade courses. The McMannis and Shenkle Report (1965) indicated that eighty-five per cent were teaching in the ninth grade. The trend seems to be a bit uncertain in this area.

Question nine on ability levels was asked to help ascertain classroom atmosphere. Ability grouping is not felt to be advisable except under extremely repetitive situations. Arbitrary grouping may create undesirable pressures that can lead to discipline problems. Grouping to achieve homogeneous academic ability has always been illusory since homogeneity in any one respect will inevitably introduce heterogeneties in others (Taba, 1962, p. 170). There were 46 teachers who reported that they did not divide their classes into ability levels; 20 who said they did; there were 2 who did not comment.

In an attempt to see if the earth science teaching effort was badly decentralized the teachers were asked in question eleven how many other teachers in their system taught earth science. There were 35 teachers in the class II and class III districts who reported that there were no other earth science teachers in their system; 11 reported one other teacher. Answers from class I districts were more difficult to classify since some teachers either misunderstood the question or were not sure how many others in their system taught earth science. However, by noting duplicate answers and comparing with the "Montana Science

Teachers List", it seems that the following number of teachers present earth science course work in class I schools.

Anaconda	2	Helena	3
Billings	5	Kalispell	1
Great Falls	3	Miles City	0
		Missoula	3

The low numbers quoted show that the tendency for school administrators to fill teaching voids in their faculty schedule with any available teacher is not a major problem in Montana--at least not in earth science teaching.

The next group of questions considered (#12, #13, #14) was posed to find out what types of teaching facilities were available. Earth science teachers need a room of their own in order to prepare a proper atmosphere; they need a lab of their own in order to prepare demonstrations ahead of time. Thirty-eight teachers reported that they had their own classroom facilities while 30 said they must share their facilities. In rating those facilities 9 said excellent, 17 good, 23 fair, and 19 poor. There were 49 who did not have separate laboratory facilities, 17 who did, and 2 who did not comment. Rating of the labs showed that 8 were excellent, 8 were good, 12 fair, and 1 poor. There were 39 who did not rate the labs (those respondents indicating no separate lab facilities). The McMannis and Shenkle Report (1965) indicated that out of 35 respondents, only 1 had an earth science room for a lab, 8 used a general purpose room, 4 used a general science room, and the other 22 used physics or chemistry facilities or had none at all. The number of teachers having their

own lab facilities increased by twenty-two per cent since 1964. Table I gives a comparative analysis of the foregoing data.

TABLE I
DISTRIBUTION OF TEACHING FACILITIES
AND RELATED TEACHER EVALUATIONS

	Teacher's own room	Teacher shares room	Teacher ratings			
			E	G	F	P
Classroom	38	30	9	17	23	19
Laboratory	17	49	8	8	12	1

Question fifteen asked about annual budgets for earth science because the amount of money available reflects directly on the quality of the course. Inflation and the somewhat more sophisticated requirements of the ESCP course require a firmer commitment of a more substantial sum of money by the school administration than heretofore has been customary. Annual budgets for earth science courses were not overly generous. Thirteen reported less than \$200 per academic year; 18 ranged between \$200 and \$500; one person said it varied between \$200 and \$900; one bold soul said "the sky's the limit"; there were 35 who either did not know their budget or said it was variable. More definite answers probably would have resulted had the question been more specific. The McMannis and Shenkle Report (1965) showed a few with fairly liberal budgets (to a maximum of \$500 per year) but most respondents received less than \$100 per year. Comparison of the two reports seems to show only slight improvement in the situation.

The next group of questions (#16, #17, #18) were asked to get some idea of the educational atmosphere in the classroom, in particular, how the teachers conducted their classes. When asked how they spent their classroom time, 37 checked lecture, 52 discussion, 20 review of text, and 16 commented under "other". The latter included miscellaneous labs, group studies, demonstrations, and student investigations. In a closer analysis, it was found that 36 teachers used either lecture alone or in combination with discussion or review of text. This was fifty-three per cent of the total. According to McMannis and Shenkle (1965) classroom time averaged eighty per cent lecture-discussion and twenty per cent lab time. This would seem to indicate a desirable drift away from lecture-type courses.

Asked whether homework was assigned, 66 said yes, 2 said no. Fifty-three said their assignments were light, 8 were heavy. Fifty-seven said they assigned from the text; 27 assigned outside reading; 25 assigned problems; there were 10 miscellaneous comments which referred to science notebooks and projects, reports, worksheets, lab results and observation.

Response to the query on field trips per semester was rather disappointing. Field trips are an important part of an earth science course. About the only way to really appreciate earth features is by an in context first-hand view. Admittedly there are logistical problems to be solved, especially when classes are large, but the active support of a principal or superintendent goes a long way toward their resolution (Goedkin, 1969). Twenty-five or nearly one-third of the group said they conducted no trips; 23 or nearly another third

said said they conducted one field trip; 10 said they conducted two field trips per year; another 9 respondents said they took anywhere from three to twelve field trips during the semester; and one did not comment. It is possible that those taking in excess of three or four field trips really meant per academic year. Figure 2 shows the percentage distribution of the field trips. The trips involved examination of local geomorphic features, local formations, local fossils, local mineralogy, glacial features, and visits to meteorology stations. Since there is only one meteorology department in Montana, at Bozeman, the respondents probably meant United States weather facilities at local airports. One mentioned a trip to Craters of the Moon, Idaho, several to Yellowstone National Park, three mentioned having access to aircraft, and several mentioned field trips that included ecological aspects. These last few and especially those that include ecology could be rather rewarding because the interrelationships of the biological and geological aspects of our environment are so much more evident. Geographical location, weather, climate, and intraschool coordination all have a profound effect on field trip activity and course sequence. The McManis and Shenkle Report (1965) indicated that about fifty per cent of the teachers take students on field trips, but only at the rate of one or two per year. A few conducted as many as five field trips per year. A comparison between two questionnaires would seem to indicate a slight degree of improvement. The reluctance to take field trips might be construed as a reflection of both inadequate background, which tends to lower self-confidence, overcrowded teaching schedules, and difficulty in securing school board approval to use a school bus.

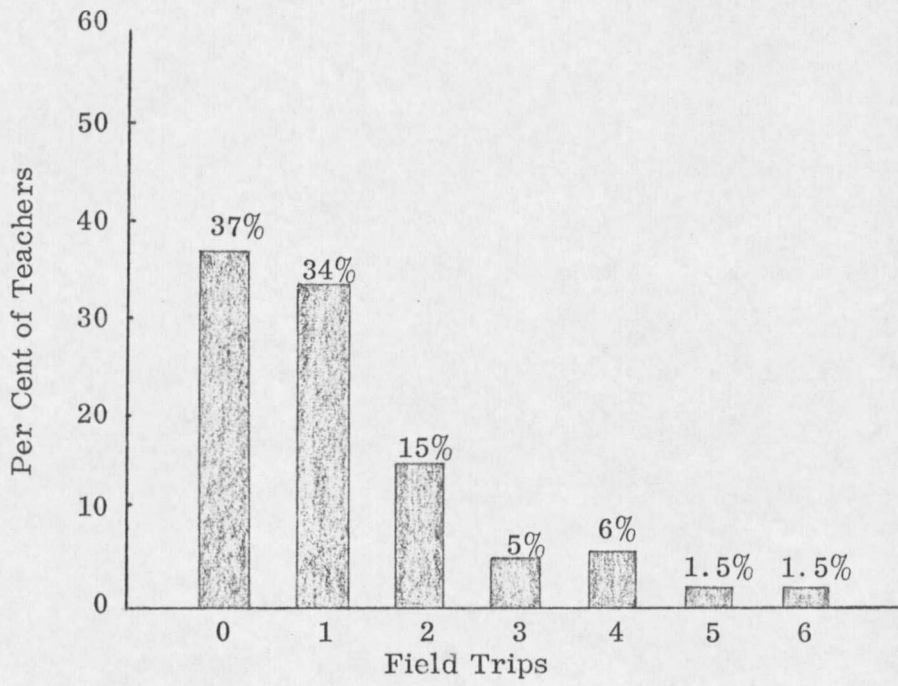


Figure 2. Per cent distribution from teachers who take field trips

Question nineteen was asked in order to determine the actual text book distribution and the degree of acceptance of the ESCP test. A variety of responses was received. "Modern Earth Science" by Ramsey and Burckley (MES) proved to be the most popular; it elicited 47 responses. "Investigating the Earth" the ESCP text published by Houghton Mifflin ran second with 14 users, 4 of which were in class II and III districts. There were 10 who used "The World We Live In" by Namowitz and Stone (WWLI) and 4 who used "Earth and Space Science" by Wolfe, et al. (ESS). Other texts mentioned were not used by more than one teacher and are listed in the Appendix. At least three either used no text or were in a state of transition. Three said they used two texts, and at least two said they hoped to go to ESCP in the 1969-1970 academic year. The fact that the ESCP text accounted for twenty per cent of the total is an encouraging trend.

The next group of questions (#20, #21, #22) were of a follow-up to question nineteen. The teachers were asked which chapters or units they omitted and why; did they follow the sequence recommended by the author, and if not, why not; and optionally what sequence did they follow. The variety of responses due to the many different texts used and local conditions made analysis of the data difficult and somewhat subjective. Subject matter areas had to be picked arbitrarily in order to obtain a close clustering of responses. The results were not surprising, considering Montana's landlocked geographical location and many inadequately prepared teachers. Omissions are as tabulated below.

Oceanography	17	Astronomy	9
Meteorology	16	Geomorphology	7
Climate	15	Tectonics	3
Historical aspects	11	Rocks	2
Earth motion		2	

Fifteen said they omitted nothing but judging from two comments about scanning, their depth of coverage may be subject to some speculation. Thirty remarked that lack of time was the main problem; this seems to correlate strongly with the data of question ten. Eight did not comment. There were 37 who do follow the recommended sequence, 25 who do not, and 6 who did not comment. Reasons given for not following the author's sequence are as follows:

Influenced by various course overlaps and local scheduling	16
Lack proper facilities	1
Weather conditions	8
Don't like suggested sequence	7
Affected by current events	1
Varies according to class ability	1
Varies according to teacher ability	1

The comment "don't like suggested sequence" would seem to indicate more confidence on the part of the teacher and less dependence on the text. The comment "varies according to class ability" is disturbing because evaluation of students from year to year might not be entirely consistent. Of those who

follow the sequence five liked the text as is, one admitted to very little background, and one said "in a rut". One teacher who uses "Modern Earth Science" said he inserted a month of physics and chemistry. This teacher has neither a major nor a minor in earth science but stated his background was in physics or chemistry. He may find the ESCP text more to his liking. When asked, as an optional question just what sequence actually is followed, 23 said they followed the text (these were part of the 37 who answered in question 21), 19 commented in some detail, and 26 did not comment at all. The data on sequence followed, when examined, did not present any useful or meaningful patterns and are not included in this report. The data compiled for this question group seems to reveal certain patterns. One was a correlation between teachers who followed the sequence and who had a limited course background; this could equate to lack of confidence. A check of the data did show some correlation. There were thirty teachers who said they followed the sequence and who had a minor or less for background. However seventeen others who had neither major nor minor said they did not follow the sequence. The evidence is not conclusive and could be a subject of further research by someone with a background in psychology. For those that did not follow the text, twenty-seven in all, it could mean the text used was less than ideal. The large number of units omitted by these teachers seems to reflect both a lack of preparation time and a proper background.

It would seem that "Investigating the Earth", the ESCP text, is as close to ideal as one can hope to get. It was devised by enlightened individuals

in a democratic group atmosphere which encouraged a maximum of creativity. It continued over an extended time period because there was a need for evaluation, feedback, and improvement. There were several preliminary copies issued, teachers actually used them, informed people supplied constructive comments, revisions were made, and finally a workable text was published. A consensus from many minds should be far superior to that which evolves from one or only a few minds; the fewer minds the more subjective. Therefore, some of the comments that pertain to the text, and to ESCP in particular, as well as analysis by indirect means might be rather revealing. Comments that ESCP is too difficult because of mathematical concepts or other reasons, should not deter its acceptance. Rather, a review of the prior education of the students in the school system might well be in order. Those that object because of the overlap of subject matter might be the very ones who need to be brought up to certification standards or who need their world broadened. The new ESCP text is revolutionary in many ways in its treatment and organization of subject matter, it does not follow traditional outlines which are neat and simple. It is rather one of overlapping concepts where, for example, water is not concentrated in its sphere or cycle but rather as it arises in concepts of atmospheric circulation ocean currents, ground water, erosional processes, etc. Many seem to feel most uncomfortable with this change. There are, of course, educators who feel that text book courses of any sort are no good and for them, the ESCP text is not the answer. However, for the level of training of earth science teachers in Montana colleges, a text that emphasizes laboratory exper-

imentation as this one does has much to recommend it.

As has just been shown "Modern Earth Science" seems to be popular where the teacher lacks a strong background in earth science. This text is quite well written, is all-inclusive, has good vocabulary and review question sections, and there are numerous excellent color plates. At the very least it has real value as a back-up or reference book. Unfortunately, the texts "Investigating the Earth" (ESCP), "Modern Earth Science", and "Earth and Space Science" (which is similar to MES) were the only ones available in the MSU library; the investigator was unable to analyze the other texts that are being used.

To check on teacher alertness to recent developments in earth science teaching question twenty-three asked about the new ESCP texts. Forty-five said they had seen them and 23 had not. Asked if they would like to use them, 31 said yes, 11 said no, 4 said maybe, and 14 did not comment. One teacher said he had used the ESCP text before. An optional part of this question asked them to give a reason for their answer. The response was good and comments were quite varied. Because some insight may be gained from them they are included in this report as follows:

Will use next academic year	4
Too difficult	3
Too elementary	1
Lack space or lack equipment	4
Like present text	3

Overlap of material is confusing	2
Too much lab and lacks vocabulary	1
Labs good for lower IQ's	1
Requires additional teacher training	1
Excessive work load; lack of time	1
Unrelated to student interest	2
Common concept of text unnecessary	1
We teach geology only	1
Lacks necessary teacher to student ratio or space (This teacher averages 33 students)	1
Teacher leaving or course dropped	2

Again, a pattern seemed to emerge from this data which was similar to the one discussed in the last group. To check it out a search of the original talley sheets was made for all those respondents whose answers contained the combination of: "MES" text used; did follow the sequence in the text; and had a limited earth science background (a minor or less). Out of the grand total of forty-seven people who used "MES", twenty-eight had a teaching minor or less. Of these twenty-eight, eighteen followed the sequence, and ten did not. The eighteen teachers seem to make a significant correlation. From it, one could infer that "MES" is a text preferred by those who must or wish to take the easy way out. For the ten not following the sequence one might speculate in several directions. Perhaps they did not because they lacked background; then again, perhaps they had enough self-confidence to strike out on their own.

Question twenty-four on cocurricular involvements was asked to get

some idea of teacher interests and how they might influence school preparation time during and outside of regular school hours. The response to the question was quite heavy. There were 46 separate organizations listed by the 68 teachers. Of these 13 were considered to be an intraschool type and 33 were considered to be external to the school. There were 146 memberships listed for all involvements. Of these, 42 teachers belonged to the internal type and 104 teachers belonged to the external type. Seven said they belonged to the National Association of Geology Teachers (NAGT). Details of this analysis appear in Table II.

The next group of questions (#25, #26, #27, and #28) give considerable insight into the academic preparedness of our Montana earth science teachers. Because this subject is so vitally important in its effect on our children it will be covered in more detail than some of the other areas. Asked to list their degrees, the response indicated:

B.A.	20	M.A.	4
B.S.	44	M.S.	13
B.Ed.	1	M.Ed.	3
	M.A.T.	1	

It was gratifying to see that out of the 68 respondents, there were 21 that have master's degrees. Three teachers have a degree in geology, 1 said he is a geological engineer, 1 is a mechanical engineer, and 1 has a degree in zoology. There were 16 who said they have a teaching major in earth science; 14 have a teaching minor in earth science; 38 or fifty-six per cent have neither major nor

TABLE II
TEACHER COCURRICULAR INVOLVEMENTS

Name of organization	Abbrv'n.	No. of teachers
EXTERNAL ORGANIZATIONS		
1. American Association for the Advancement of Science	AAAS	1
2. American Association of Petroleum Geologists	AAPG	1
3. American Cancer Society	ACS	1
4. American Institute of Professional Geologists	AIPG	1
5. Association of Catholic Teachers	ACT	1
6. Audubon Society		1
7. Boy Scouts of America (Troop Chairman)	BSA	1
8. Coaches Association		1
9. College Teaching		1
10. Church		1
11. Driver Education Association		1
12. Investment Club		1
13. Knights of Columbus	K of C	1
14. Lions Club		1
15. Local Education Association	LEA	9
16. Montana Education Association	MEA	29
17. Montana Geological Society	MGS	2
18. Montana Geology Teachers Association	MGTA	1
19. Montana Science Teachers Association	MSTA	1
20. National Association of Biology Teachers	NABT	1
21. National Association of Geology Teachers	NAGT	7
22. National Council of Teachers of Mathematics	NCTM	1
23. National Education Association	NEA	23
24. National Science Teachers Association	NSTA	7

TABLE II (continued)

Name of organization	Abbrev'n.	No. of teachers
25. National Wildlife Federation	NWF	1
26. Phi Delta Kappan	PDK	1
27. Society of Limnology		1
28. Society of Mammology		1
29. Society of Vertebrate Paleontology		1
30. State Professional Rights and Responsibilities Committee	PR & R	1
31. Teaching of Skiing		1
32. Toastmasters International		1
33. United States Naval Reserve (executive officer)	USNR	<u>1</u> 104
INTRASCHOOL & STUDENT ORGANIZATIONS		
1. Coaching		17
2. Class Sponsor or Advisor		9
3. Director of Student Activities		1
4. Field Trips		1
5. Intramural Club Sponsor		1
6. Junior Optimists Club Sponsor		1
7. Junior Prom Sponsor		1
8. Lettermen's Club Advisor		1
9. Parent-Teachers' Association	PTA	2
10. Pet Club		1
11. Photo Club		1
12. Play Director		1
13. Science Club or Fair		4
14. Social Committee Chairman		<u>1</u> 42
		146

minor. Counting workshops, institutes and interdisciplinary courses (of which there were at least 20 different courses involved), the 38 teachers averaged 2.3 courses each. Obviously some had meaningful sequences in at least a few more subject matter areas than this average shows. Six said they had no earth science courses at all. There were 4 who indicated being very close to a minor; they had at the least taken some mineralogy. Seventeen had had at least two earth science courses. The data would seem to indicate that any course beyond the introductory ones is a somewhat difficult hurdle to manage. An analysis of the courses in earth science taken by those without even a minor may be found in Table III. When queried as to whether they taught earth science by choice or were selected to volunteer, 36 indicated choice, 30 indicated selection, and two did not respond. Several commented that since being asked to teach out of their field they found earth science quite interesting and did not wish to return to their original field. The McMannis and Shenkle Report (1965) said earth science course work varied from none to one hundred and thirty-five quarter hour credits. There were about twenty-one people who had less than fifteen quarter hours credit, seven who had between fifteen and thirty, and seven who had more than thirty. Since a teaching minor in Montana requires a minimum of thirty quarter credits it can readily be seen that only six of the thirty-five respondents or about seventeen per cent were qualified to teach earth science. (Certification, 1968, p. 6). In 1969 there were thirty people or forty-four per cent of the respondents with at least a teaching minor in earth science. This amounts to a twenty-seven per cent increase which seems to

TABLE III

EARTH SCIENCE AND RELATED COURSES TAKEN BY THOSE WITH
LESS THAN A MINOR

Name of course	Number of teachers
EARTH SCIENCE	
Physical geology	30
Historical geology	10
Mineralogy	5
Geomorphology	1
Weather/climate/meteorology	8
Astronomy	6
Conservation	4
Foundations of earth science	1
Physical geography	5
Field geology	1
Montana geology & resources	1
Biology & geology of the Rocky Mountains	1
INTERDISCIPLINARY	
Anthropology	1
Ecology	1
World geography	1
Advanced biology	1
MISCELLANEOUS GROUPING	
Unknown 3 quarter sequence in earth science	2
Summer Institute (Drake University 12 credits)	1
Mineralogy workshop	1
Summer workshop; geology; astronomy; NSF; ESCP	5
Petroleum Institute	2
10 credits but did not specify which	1

reflect the increased offerings in earth science. In 1964 neither Eastern Montana College nor Rocky Mountain College offered an earth science teaching minor. Since 1968 both of these colleges began to offer a minor and both the University of Montana and Montana State University began to offer a major. A letter by the investigator was sent to the Certification Supervisor in the Office of the Superintendent of Public Instruction requesting data on the number of earth science and general science teachers certified since the study guide in science was issued in 1961. The reply was most cordial but the desired data could not be furnished. It would have required about forty man-hours of time and a clerk could not be spared to extract data from the records.

Questions #29 and #30 were asked to gain some insight as to teacher resourcefulness and hopefully to be able to determine where teachers might be helped to get more material and equipment. Response to the query on resource materials and equipment was quite varied; the grand tally for three types of school districts is shown below. Surprisingly only one person mentioned the state film library and one other the local museum.

Library (personal, school, university, public)	37
Audio-visual aids (films, filmstrips, personal slides, charts, maps, transparencies, overlays)	25
References (NSF & ESCP material, text examination copies, AGI source book, trade journals, Holt Library of Science Series)	10
Materials from local district "resource center"	2
State Film Library	1
Local Museum	1

University or college resources	3
Yellowstone National Park, Craters of the Moon	3
Resource People (U.S. Bureau of Reclamation, U.S. Forest Service, U.S. Meteorological Station, U.S. Seismological Station, mining engineers	8
Local area (for field trips and resources)	3
Display cases	1
Very much	7
Very little	6
No comment	10

The type of laboratory equipment available to the teachers is as shown below:

Globe	62
Planetarium	20
Celestial sphere	15
Topographic maps	56
Relief maps	42
Binocularscope	21
Structual models	32
Clay models of stratigraphic groups	15
Diorama	5
Stream table	23
Moh's scale of hardness	41
Rock and mineral collection--broad coverage	23
Rock and mineral collection--restricted	29

Rock and mineral collection--did not indicate which	13
Rock and mineral collection--no comment	3
Fossil collection--broad coverage	9
Fossil collection--restricted	24
Fossil collection--did not indicate which	8
Fossil collection--no comment	27

Three blank spaces were provided for each respondent in the event he had equipment not listed. There were 37 entries of which 7 listed ESCP equipment, 6 borrowed physics and chemistry equipment, 3 telescope, 2 stereoscopes for aerial photos, 2 earth science charts, 2 weather scopes, and 1 each for balances, graduates, projection globe, barometer, meteorological equipment, and contour set. The other 9 comments were more in the line of audio-visual aids or otherwise did not fit the question. The McMannis and Shenkle Report (1965) listed data that is remarkably similar to that developed in the 1969 questionnaire.

And finally, the last question (#31) was asked to determine whether there was a higher level course available to those students with the interest and motivation. Fifty-nine answered no, seven yes, and two did not comment. There was no noticeable change in trend since the McMannis and Shenkle Report (1965).

THE SCIENCE TEACHER LISTS

An analysis of the Montana Science Teacher lists from 1963 to 1970 was made in an attempt to determine trends with reference to earth science teaching in Montana and to help substantiate data from other sources. Although the

1964-65 and 1965-66 lists were not available, some information for 1964-65 on earth science appeared in the McMannis and Shenkle Report (1965).

The data show that from 1963 to 1967 a trend away from general science and toward earth science had been established. However, reference to Figures 4 and 5 will show that in 1967-68 the number of general science teachers rose again from 176 to 207 teachers while earth science teachers increased from 90 to 97. This can be partially explained by the increase in the total number of schools, up four from 211. At the same time the number of schools offering earth science increased from seventy-six to eighty-two while the number of schools offering general science increased from 100 to 105. In spite of the four new schools, general science seemed to have the edge over earth science. There has been practically no change in the data since then. However, according to Clark Fowler, Science Supervisor in the Office of the State Superintendent of Public Instruction (1970, oral communication) the data for the 1970-71 science teacher list may show a slight upturn. He believes interest in earth science and ESCP to be increasing in various districts throughout the state. The tapering off and slight downturn for earth science up to last fall could be explained by the lack of adequately prepared teachers. The records in the student certification office at Montana State University show eleven people have been certified as general science majors and twenty-three as general science minors. In this same time period, January 1, 1968 to July 6, 1970 only ten people have been awarded teaching certificates in earth science and of these only three were majors. Another explanation could be the small size of

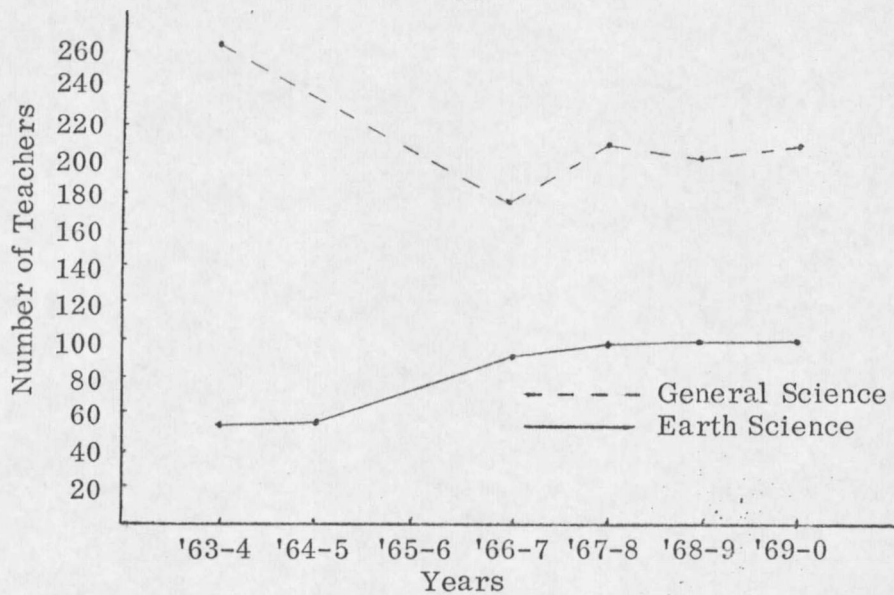


Figure 3. Changes in the number teaching earth science and general science, 1963 to 1970

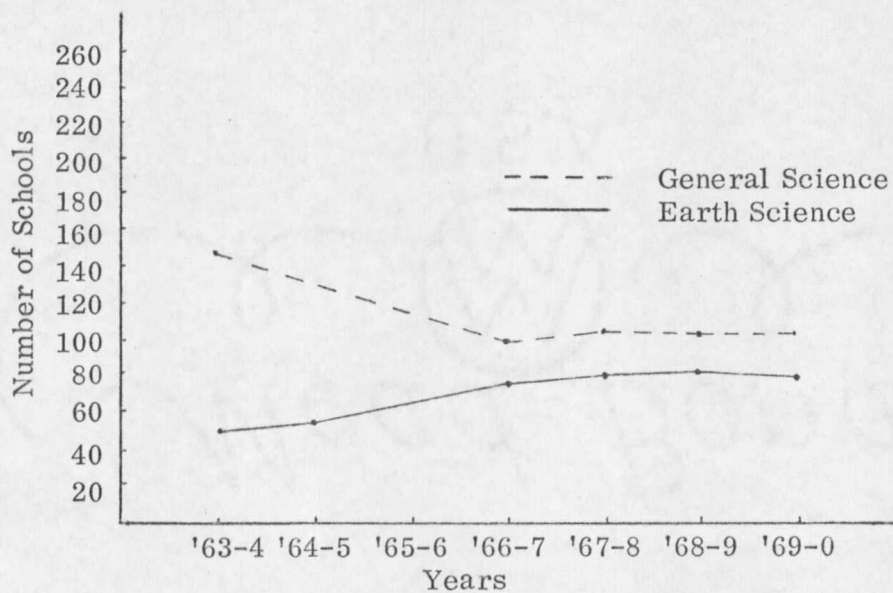


Figure 4. Changes in the number of schools teaching earth science and general science, 1963 to 1970

the school districts. Even had there been no shortage of earth science teachers it is doubtful whether the smaller districts would have been financially capable of hiring them. These districts need teachers who can teach in several fields. Many superintendents have notified the Placement Office at Montana State University that they need "a" person to teach biology, chemistry, physics, and general science or earth science (J. W. Breeden, 1970, oral communication). When one reviews the requirements for a teaching option, it can be readily seen that most prospective teachers cannot teach well in all of those fields. As this survey has brought out, over half of the responding teachers do not have even a teaching minor in earth science. Several superintendents have expressed a desire for prospective teachers with bachelor's degrees rather than for those with master's degrees (Montana Collegian, Spring 1970, p. 3). Obviously they can hire more people with bachelor's degrees than they can with master's degrees for the same money. Attitudes such as these are regrettable for it brings into question the quality of education received by some of our children. A professional teacher who is certified to teach biology can and does quite frequently teach earth science if he has a minimum of fifteen quarter credits in earth science (Endorsement requirements for accreditation as of April 1968, secondary schools, State Superintendent of Public Instruction, Montana). Conversely, a person certified to teach earth science can, but rarely does, teach biology if he has fifteen quarter credits of life science. The traditional fields of biology, physics, and chemistry are recognized as requiring certain basic minimal subject matter background.

However, many people, school administrators included, think they know something about "the earth" and fail to see that earth science teachers also need some minimal subject matter background. See Table IV for an analysis of teaching combinations in Montana. Traditionally, the earth science teachers have had a strong background in biology and/or chemistry (Weitz, 1969, p. 2). These people have no trouble teaching general science. However, a teacher trained in earth science may be very weak in the biological sciences. A deterrent to minoring in the biological sciences at Montana State University is massive size of that teaching minor--a minimum of forty-four credit hours. A teacher trained in earth science has his choice of job locales narrowed down considerably. If there are no vacancies in the first class districts he and many young Montana students are out of luck; the teacher has no challenging job and the students may be deprived of a quality education in earth science. The trend may very well be leading back to general science by default on the part of Montana educators. This change may be so gradual that it will not even be recognized by an official change in name. But, the problem is not so simple as to be confined to the smaller school districts. Some first class school systems, and Butte is a good example, list nothing but straight general science courses.

GEOLOGY STUDENT QUESTIONNAIRES

The earlier of these questionnaires (A) was designed to get the secondary school students' point of view; the most recent questionnaire (B) was designed, hopefully, to gather some data pertaining to the effect of ESCP on college level geology. As it turned out, the latter was much too optimistic an endeavor.

TABLE IV
TEACHING COMBINATIONS

Earth science	General science	Biology	Chemistry	Physics	Physical science	Number of teachers
X						32
X	X					4
X		X				11
X			X			10
X				X		4
X					X	1
X			X	X		5
X		X	X	X		2
X			X	X	X	1
X	X		X	X		1
X		X	X			4
X		X	X		X	1
X	X	X	X			2
X	X		X			1
X		X		X		7
<u>X</u>	X	X				<u>1</u>
16 combinations						Total is 87

Instrument A, see the Appendix, was designed to require answers for at least the first two questions from all respondents. However, a negative answer for question one, "have you ever had a course in earth science or geology before?", meant that the rest of the instrument after question two would be left blank. The second question asked whether they had ever had a course in chemistry before and if so was it a difficult course. Two of the students made rather incisive comments about chemistry that bear repeating. One said he had not had any chemistry and to the question "was it difficult for you?" he answered, "It probably would have been". The other student, in answer to whether chemistry was difficult for him said, "sort of but I think it was more difficult for the instructor".

A total of 234 questionnaires of type A were completed. Of these, 6 students entered data pertaining to college level courses; they were removed from consideration. Of the 228 remaining, 74 said they had had an earth science course in high school and 154 said they had not. It must be remembered that the information given by the students can be no more recent than three years ago, much of it is at least five or six years old, and some dates to the early sixties. Although the data offers no startling revelations, it does seem to be average enough to be of interest if for nothing else but verification of intuitive feelings.

The data, as based on the three answers to the first two questions can be found in Table V.

Since 154 of the questionnaires had a no answer for the first question,

and since questions #3 to #15 were unanswered, they were removed from further consideration. The 74 remaining questionnaires were then tallied. Answers to questions #3 to #6 which related to school, location, teacher name, and date were too diverse to get any meaningful results and are not a part of this report. Question #7 asked for grade level and number of semesters.

TABLE V
DISTRIBUTION OF ANSWERS TO QUESTIONS 1 AND 2
ON GEOLOGY STUDENT QUESTIONNAIRE A

Answer to question #1*	Answer to question #2+	Number of instruments	Subtotals	Total
yes	yes yes	22		
yes	yes no	34		
yes	no --	18	74	
no	yes yes	53		
no	yes no	67		
no	no --	34	154	
Answered with college course data		6	+	228 = 234

*Have you ever had a course in earth science or geology before ?

+Have you ever had a course in chemistry? If yes, was it difficult for you?

The totals made ideal random distribution curves. There were 33 who had earth science in grade nine, 8 in grade eight, 10 in grade ten, 4 in grade seven, 5 in grade eleven, 1 in grade six, and 2 in grade twelve. Those who had courses above grade nine tended to be mostly out-of-state students. There were 52 who said the course was two semesters long, 12 said one semester, and 1 said three semesters. Grades were skewed toward the high side; there

were 10 A's, 35 B's, and 21 C's. One would expect this since those students with the better grades are usually the ones who attend college. Absence of D's and F's was attributed either to a reluctance to report a low grade or to the "natural selection" of the more capable students into the university. The parts of the course found most interesting are tabulated below:

rocks and minerals	13
maps (topographic)	6
weather (meteorology)	6
oceans	2
astronomy and space	3
earth genesis	3
glacial features	4
geomorphology	6
volcanism	4
earthquakes	3
structure	2
mountain building	3
historical/fossils	5
natural forces	1
weathering	1
geology	2
field trips	1
lab exercises	1

projects	1
all parts	1
none (one student said the teacher couldn't come down to their level).	3
found tectonics, geomorphology, ocean currents boring	1
all except chemical composition of rocks (this student said he liked organic chemistry)	1

The wide and varied distribution would seem to indicate that an enthusiastic and knowledgeable teacher can make any aspect of earth science interesting. Those students who didn't like some or all parts of the course were negative in their answers pertaining to recommending the course to friends and to teacher enthusiasm. Fifty-five students said they would have recommended their earth science course to friends and 11 said no. To the question as to how well versed the teacher was, 56 said yes, 12 said no. There were 46 who thought their teacher was enthusiastic while 19 said no he was not. Asked about laboratory work, 22 said they did have some while 44 said they did not. Their answers for time spent in lab in hours per week are tabulated below:

less than one hour	3	two and one-half hours	1
one hour	6	three hours	2
two hours	5	three to four hours	1
five hours			1

The question "do you have much homework?" elicited 28 yes answers and 39 no answers. Asked, "did it help you to understand the material better?" 29 said

yes, 8 said no. The answers given by the students relative to homework seemed to indicate that those exposed to it felt it was beneficial. Talleys do not necessarily balance. Many respondents did not answer the questionnaire completely. In the case of the homework question those that answered no could have had some homework. In that event they could still give an affirmative answer to the question about whether it helped them. The very low number of no responses, eight to be exact, is attributable to the fact that those who answered no to the first part and interpreted it to mean no did not bother to answer the second part. The fact that the overwhelming majority of the teachers, sixty-six of them, assigned homework indicates the teachers felt it worthwhile. Eighty per cent of those who assigned homework said the load was light. Not many students reported taking field trips. The tabulation is as follows:

no field trips	57	two field trips	2
one field trip	5	three field trips	1
		four field trips	2

Very few could remember the name of their text books. Five hinted at "Earth Science" which might have been the text by Fletcher and Wolfe. Only one other was specific and he mentioned "Modern Earth Science". As stated before the data is not surprising but perhaps may supply some reinforcement for the intuitive feelings that secondary teachers have about how their students perform.

Instrument B, see the Appendix, was devised with the optimistic premise that there would be a correlation between those who had had an ESCP course in

TABLE VI

DISTRIBUTION OF ANSWERS TO GEOLOGY STUDENT QUESTIONNAIRE B

Answer to question #1	Answer to question #2	Location	Number of instruments	Grade distribution				
				A	B	C	D	F
Yes	Yes	Conn. & Mont.	2	0	0	0	0	0
Yes	No	Montana	27	2	10	10	5	0
Yes	No	out-of-state	5	0	1	3	1	0
No	No	Montana	68	5	24	32	3	4
No	No	out-of-state	22	3	6	10	3	0
No	No	did not say	15	0	5	7	3	0
No	NC	Anaconda	1	gave no name				
			140 total					

high school and better than average grades in the physical geology course at Montana State University. However, of the 140 questionnaires distributed to spring quarter 1970 students, only 2 said they had had an ESCP course; one being from out of state. When final grades were checked, these two crucial students came out with D's. The only conclusion that could be drawn from this data is that the standard bell curve fits ESCP courses too and we must have gotten students from the lower end. However, some value was derived from the data by sorting the questionnaires according to yes and no answers and correlating final grades with the grouping. The fact that the distribution is so completely normal is the interesting part of the analysis. The students were first asked if they had had an earth science course in high school and to answer yes or no. They were then asked if they used the ESCP text and to answer yes or no. The students were also requested to state where the course was taken and to sign their names. Distribution of the data is shown in Table VI.

CHAPTER IV

SUMMARY

The past decade has seen a resurgence of earth science over general science as the introductory high school science course. There has been dissatisfaction with general science because it tends to teach facts, because subject matter is now being covered in earlier courses, and because it suffers from a lack of continuity. Earth science, on the other hand, presents ideas in the context of experience of problems that relate to a unifying theme. This theme, a study of man's environment may be the key educational factor in man's first real effort to control environmental pollution.

A review of the literature shows support for one of the main contentions of this thesis, that education can and should take the initiative in the midst of this population-environmental pollution-technological crisis. A true interdisciplinary approach is recommended by some visionary authors as the only way to overcome apathy and to ultimately resolve global problems. The best way to accomplish this would be to educate future teachers and administrators by using the same methods on the college level; obtain the support of federal and private national organizations; use modifications of the team teaching method; establish and maintain extremely good lines of communication in a school district from the principal on down; make use of frequent seminars and in-service courses for teaching staffs. Research is beginning to show that the committee developed curriculum projects with their investigative laboratory type approach can be far superior to the traditional lecture and review-of-text courses.

Such research as has been performed by this investigator shows that trends for earth science teaching in Montana are not encouraging. Over fifty per cent of the professional teachers now teaching earth science are not adequately trained in this field. The extremely small size of some Montana school districts, the methods for raising funds, and lack of vision on the part of some school boards and administrators are just a few of the stagnating factors that hold the trend toward earth science to a snail's pace. There is no organizational structure in Montana that is actively trying to remedy these problems.

Still unresolved are the problems of how to finance this general educational effort adequately, how to promote earth science with its environmental aspects on a state and national scale, and how to properly develop awareness of vocational and professional careers at the elementary and secondary levels of schooling.

These problems must be resolved and resolved soon. It is important to remember that the students of today are the citizens of tomorrow. If they are to make intelligent political decisions concerning environmental problems they must be based on some understanding of the earth, its life, and the processes which affect it.

CONCLUSIONS

Introduction

Montana is ideally suited for a study of earth science because of its wealth of interesting natural phenomena, especially its geology. Exposure

to earth science would, we hope, endow many students with a feeling of pride in their state and perhaps motivate them to seek a career here in Montana. Perhaps this will come about, but it is hard to be optimistic in the face of a continuing shortage of qualified earth science teachers. Merrill and Shrum (1966, p. 24) and others have discussed the problem over the past five years but both initiative and facilities for in-service training for general science teachers seem to be lacking, particularly in the smaller school districts. Admittedly the vast territory of Montana is a problem shared by several of the western states. However, old established practices can also dilute the effect of newer innovations. It has always been customary in small districts to assign teachers in the classical sciences to general science teaching duties. Now that earth science has been recommended the same practice is carried over. It is entirely possible that the school administrators feel the same way about earth science as the general public does about education; that is, having been exposed to it in a general way makes everyone somewhat of an expert in the field. The fact that the numerical data show that earth science is losing ground to general science seems to support what was just said about the attitude of school superintendents. Responsible people in the State Office of Public Instruction express optimism that earth science is catching on but this may be true only of ESCP courses and only in the cities where earth science has been stronger. Specific conclusions stated hereafter will be categorized by the various educational levels.

National and Regional Levels

There is no national group to supply the initiative needed to move edu-

cation toward earth science. These were sentiments voiced by Reith (1969, p. 43). The National Association of Geology Teachers (NAGT) has been fighting an uphill battle for years but it is hard to reach those teachers drafted into earth science who have been trained in other major fields. Even when the few who are interested and want to remain in the field are added to the ranks of qualified teachers their numbers are too few to exert much pressure. Since individual school districts in the fifty states are autonomous units it would seem rather futile to attack the problem from local or even regional levels. Direction coming from a central group influential with all of the classical sciences may be the answer. Organizations such as the American Association for the Advancement of Science (AAAS), the National Science Teachers' Association (NSTA), or the National Science Foundation (NSF), if properly staffed, and working in concert with the American Geological Institute (AGI) and the American Institute of Biological Sciences (AIBS) might be effective in this area.

To aggravate an already inertia-bound system even further the upcoming Earth Science Curriculum Project requires even better trained teachers and more sophisticated and expensive laboratory equipment.

A true interdisciplinary approach to the world-shaking problems of our day is needed in the secondary schools. Such an approach which emphasizes kinship rather than differences between the disciplines is vital. Since it has been determined that non-science teachers can have as good or better understanding of the philosophy of science as do science teachers, then at least one avenue lies open for improved communication between the sciences and the

humanities.

Earth science because it presents ideas in the context of experience or problems that relate to a unifying theme, man's environment, is ideally suited (as is biological science) for the core of this new curricular approach. The students of today are the citizens of tomorrow. If they are to make intelligent political decisions concerning environmental problems they must be based on some understanding of the earth, its life, and the processes which affect it.

Teachers tend to stress that which is most familiar to them. They omit quite a bit from a course if their background is limited. This is what is happening to earth science as it did previously with general science. Teachers trained in the other classical sciences emphasize units most closely related to their major field and they tend to skim over or skip other units.

State Levels

Teacher certification policies between the states are not standardized. As an example, North Dakota schools are set up primarily on an 8-4 system with earth science mandatory in the eighth grade. A first grade professional certificate valid for three years is issued. It authorizes the person to whom it is issued to teach all grades and subjects in elementary and secondary schools (Stinnett, 1967, p. 144). In West Virginia, state law requires that teachers be certified in the subjects they teach. Even though earth science is taught in that state there is no earth science certification available; the teachers have to be certified under the general science classification. Consequently there are many people lacking an earth science background who are

legally able to teach earth science (Graham, 1968, p. 49). In Montana there are eighteen school districts set up on a 6-3-3 basis and 153 districts operating on an 8-4 basis. This means that in some instances grades seven and eight may be taught in the elementary schools. However, Montana has overlapping certification requirements. An elementary teacher is certified for grades kindergarten to nine (K-9) and secondary teachers are certified for grades seven to twelve (7-12). Since all known earth science is taught in either the junior or senior high school the teachers are legally required to be certified, at the least, as having an earth science minor with a minimum of thirty quarter credits of earth science course work.

The financial support systems appear to be obsolescent. School levies are the only taxes on which the voter is able to cast a direct ballot. Many a taxpayer vents his frustration by voting against the levy. In recent years an increasing number of school districts have had to set up one or more additional ballots before getting their levies through.

Montana

Teachers in Montana are overworked, underpaid, and in the case of earth science teachers, inadequately trained.

Earth science is fairly new in Montana as a teaching major. Most teacher preparation has been in general science or the biological sciences. When teachers enroll for additional course work they tend to concentrate in the life sciences. This tendency has been verified in West Virginia by Graham (1968, pp. 37-38). Table VI shows the heavy concentration of

teachers with life science backgrounds.

There are at least several qualified teachers with master's degrees in geology who presently are unable to obtain reasonably desirable positions as earth science teachers in Montana (W. J. McMannis and J. W. Breeden, 1970, oral communication). Paradoxically, it is the candidate with the advanced degree who finds it most difficult to secure a teaching position. Admittedly, the current economic recession does not help the situation, nor does the mill levy system which is used to raise additional school funds in Montana. Mill levys for 1970-71 have been in trouble in Lewistown, Glendive, and other Montana communities (News item in the Great Falls Tribune, April 8, 1970, p. 13). An austerity program was invoked by the Bozeman school district so as to avoid an increase in the mill levy rate (Editorial in the Bozeman Daily Chronicle, March 29, 1970, p. 4).

Local Levels

The smaller Montana school districts are unable to innovate readily because their extremely small size has a limiting effect on their budgets. Because many earth science teachers are reluctant and principals rarely seem to encourage, most secondary school students are being deprived of the excellent learning opportunities that can be secured from earth science field trips.

College Levels

There are only a limited number of earth science courses available to the working teacher in Montana. Teachers, even if they have the desire and initiative lack the opportunity to improve their background.

Those teachers who do have an earth science background must find it difficult to keep up with recent events. There is no currently active university level organization in Montana, associated with an earth science department, that can maintain open lines of communication with them.

RECOMMENDATIONS

Introduction

It would seem that control and preservation of man's environment is the overriding consideration of the day. It would also seem that this can only be accomplished by a concerted and concurrent effort of education and by control of population. Earth science, as a discipline is ideally suited to play a key interdisciplinary role in the study of environmental problems. It can provide an interesting, meaningful, relevant, and continuous type of curriculum in which each student may become actively involved.

National and Regional Levels

Earth science professionals should strive for appointments to the executive boards of the national science associations.

Earth science professionals should publish in the professional journals of other disciplines. The articles need to stress the importance of an interdisciplinary approach, especially when teaching about problems related to environment and overpopulation.

The national earth science organizations and the federal government should offer scholarships so as to attract more able students into the earth science teaching profession.

These same organizations should initiate a concerted program to influence those now trained as general science teachers to undertake a re-training program for earth science teaching.

A federal-state financing system with a minimum of federal control should be sought to replace education levys at the local level. Perhaps some sort of "participatory democracy" might work.

State Levels

Teacher certification policies between the states, particularly in earth science should be standardized.

Based on a review of related literature and from the research data that has been compiled, all science teachers should have some exposure to earth and life sciences. All have a common minimum background in either physics or chemistry and many have courses in both. Such an exposure would give secondary school students a somewhat better chance for a quality education. It should also help the science teachers to be more receptive to communication with the other science disciplines and hopefully lead to an eventual truly interdisciplinary education. A multiple nested curricula was described by Connally (1966) that allows for teacher education within the existing earth science curriculum. It could possibly be a starting point for such an endeavor.

State offices of public instruction should phase out certification of general science teaching majors; policies that pertain to earth science certification should be consistently enforced.

Montana

The state office of public instruction should enforce its certification laws especially as they pertain to the earth science discipline.

The general science teaching major should be dropped from the certification list. After all it is a gross inconsistency since recommendations of the study guide for science have been in existence since 1961. Perhaps one way to effect this change would be to declare a three to five year period after which general science would no longer be a legal teaching major or minor. This would give the unqualified teachers now teaching earth science ample time to pick up necessary courses or to switch to another field.

Funds for education are extremely limited in Montana. The population is only about 700,000 and there is very little industry. Most school money must come from the school land income, property taxes, and mill levies. A review of related literature and research data show that earth science budgets are inadequate. A consolidation of numerous small school districts throughout the state would make more of the existing school funds available per pupil than at present.

Local Levels

Only fully trained earth science teachers should be hired even though it means a reshuffling of teaching staff duties.

The responsibility for teaching earth science should be integrated under a single teacher or the necessary minimum few qualified teachers. School administrators should defer from the expediency of filling blocks in the

teaching schedule with bodies. Their prime responsibility is, after all, to secure the best possible education for the children placed in their schools.

Reith (1969, p. 49) suggested that where student demand is light a single fully trained and qualified earth science teacher might be hired for two or more contiguous districts. This could help alleviate the pressure for "jack-of-all-trades" teachers in third class districts; it might also be given consideration in the larger city districts.

All earth science teachers should be encouraged to attend in-service earth science programs.

Principals should provide classroom and laboratory facilities for exclusive earth science use and actively encourage a program whereby equipment may be shared with schools of nearby districts.

There is a real need for frequent field trips in a course of this type. Administrators should encourage teachers in this respect. Earth science and life science field trips are no less important than athletic events for which students are excused and for which transportation is provided. If time can be set aside for pep rallies and games, there seems no justifiable reason why time for science field trips cannot be worked into the schedule.

A modification of team teaching may enable the individual school system to effect an interdisciplinary approach to environmental problems within the existing curricular framework. It would require that teachers guest-lecture in classrooms of other disciplines when appropriate; it might require an assemblage of several classes in the various disciplines in order to gain

common knowledge or experience.

College Level

General science should be dropped as a certifiable teaching major or minor by the colleges and universities.

Certain summer education courses should be required of the "tenured" teachers who vision has been narrowed by the years. For example, courses such as History of Education, General School Curriculum, Comparative Education, and Systematic Philosophies of Education. A course such as trends in science teaching should be broadened to stress earth science rather than general science and a truly interdisciplinary emphasis assigned to the course.

Colleges and universities working with the regional accrediting association should exert sufficient pressure at the secondary education level so as to discourage continuation of general science teaching majors.

More earth science courses, summer quarter included, should be made available to the working teachers. Courses beyond the introductory level seem to be a particularly difficult hurdle for the working teacher to overcome since they are not available during the summer quarter in Montana. Mineralogy-lithology for example could perhaps be offered on a staggered basis to get three quarters of course work into two summers.

There seems to be a trend at least in larger school districts, towards placing teachers where they may teach in their major fields. This trend is desirable and should be encouraged. It would seem logical, therefore, that

institutions of higher learning reconsider their policy pertaining to teaching minors. It seems most illogical to select a minor on the basis of how few credit hours are involved or for other clearly subjective reasons. Rather, the criteria should be, does it help to develop an interdisciplinary point of view and does it supplement and strengthen the teacher in areas peripheral to his major field. In the case of earth and life science teachers there should be no question as to the answer. This idea would work well even in class III districts, if they were to consolidate.

A liaison between the Montana University System and the public schools of our state should be established. The State Board of Education should recommend that institutions within the system having the capability should set up continuing coordinative bodies that could supply advice, resource people, and equipment. In the case of earth science, mineral kits would be an example. The intent would be to maintain open lines of communication with the public schools for they are, after all, the prime source of our college students.

The emphasis in this paper has been on the role that earth science can play in an interdisciplinary approach to our environmental problems. However, as the paper evolved it became evident that the ideas were still too tradition bound. It seems now that the most effective way to implement this interdisciplinary approach is not just with earth science (or biology) as a core, but rather the two disciplines combined into a two year natural science (or environmental science) curriculum; all of this preceded by a year of physical science.

RESEARCH TOPICS BEYOND THE SCOPE OF THIS PAPER

Many students in the secondary schools of our nation lack interest and

motivation. Suspect is our continuing failure to provide an interesting, relevant, and continuous type of curriculum in which each student may become involved. A study should be made to determine just how extensive the problem may be.

A topic worthy of study is earth science as a terminal course; it could open the door to many students for hobby interests which might aid mental hygiene.

The subject of careers is not adequately explored at either the secondary or college level. As the student develops awareness he may switch major fields. Much valuable time can be lost to say nothing of the confusion in trying to eliminate course conflicts thereafter. Research in this area would need to be directed so as to determine what is being done now and what can be done to provide secondary school students with a better awareness of jobs and careers. An extension of this research to the college level will probably be necessary.

The lecture and review of text teaching methods are still being used by many Montana earth science teachers. The same is undoubtedly true for the other subject matter areas. Courses that use an investigative approach, independent student research, and class discussions are said to be superior. A study designed to measure just how extensively these poorer methods are being used and to suggest remedies might be useful.

There seems to be very little information available that is related to earth science teaching budgets. Many Montana teachers did not even know how much their annual budget was. Obviously, a beginning budget will be much

higher than the carry-over budget needed for succeeding years. A published guide on financial needs certainly would strengthen the teacher's persuasive power with his principal.

Institutions of higher learning should continue, without let-up, their emphasis on interdisciplinary attitudes. An area worthy of research might be the extent of overlap in courses being offered by the separate disciplines. The objective would be a better curriculum for students which would provide them with more education; no increase in the number of overall courses; no need for a five year program. The existing situation might be thought of as a "scheduling crisis".

SELECTED REFERENCES

Books

- Brameld, Theodore, 1965, Education as power. San Francisco: Holt, Rinehart, and Winston. 146pp.
- Ehrlich, Paul R., 1968, The population bomb. New York: Ballantine Books. 223pp.
- Elam, Stanley, and McLure, William P. (ed.), 1967, Educational requirements for the 1970's an interdisciplinary approach. New York: Praeger. 266pp.
- Hayakawa, Samuel I., 1964, Language in thought and action (2d ed.). New York: Harcourt, Brace, and World. 350pp.
- Hoover, Kenneth H., 1966, Learning and teaching in the secondary school. Boston: Allyn and Bacon. 543pp.
- Lucio, William H., and McNeil, John D., 1969, Supervision: a synthesis of thought and action (2d ed.). New York: McGraw-Hill. 329pp.
- Moustakas, Clark, 1956, The teacher and the child. New York: McGraw-Hill. 265pp.
- Taba, Hilda, 1962, Curriculum development theory and practice. New York: Harcourt, Brace, and World. 526pp.
- Udall, Stewart L., 1963, The quiet crisis. New York: Holt, Rinehart, and Winston. 209pp.

Publications of the Government and Other Organizations

- Designing education for the future; an eight state project, 1968, Reports; vol. 6, Planning for effective utilization of technology in education. Denver: ESEA of 1965. 372pp.
- Haight, Rex C., n. d., Nine hundred and ninety-nine square miles and seventy-nine pupils. Montana State Department of Public Instruction. 6pp.
- Montana. Laws, Statutes etc., 1947, Revised Codes of Montana, vol. 4, pt. 2, Indianapolis, Indiana; Allen Smith Company. 590pp.
- Montana State Superintendent of Public Instruction, 1969, Certification of teachers and school administrators in Montana (5th ed.). Helena: Superintendent of Public Instruction. 16pp.

- Montana. State Superintendent of Public Instruction, April 1968, Endorsement requirements for accreditation, secondary schools. Helena: State Superintendent of Public Instruction. 4pp.
- Montana. State Superintendent of Public Instruction, 1963, 1966-1970, List of Montana Science Teachers. Helena, Superintendent of Public Instruction. 26pp.
- Montana. Department of Public Instruction, 1969, Montana Education Directory 1969-1970. Helena: State Superintendent of Public Instruction. 133pp.
- Montana. State Superintendent of Public Instruction, 1961, The Study Guide in Science, Grades 7 to 9. Helena; Superintendent of Public Instruction. 57pp.
- Stinnett, Timothy M., 1967, A manual on certification requirements for school personnel in the United States. Washington, D. C.: National Education Association. 256pp.

Periodicals

- Bisque, Ramon E., 1966, Why teach earth science in our secondary schools? ESCP Newsletter, no. 12, pp.1-2.
- Blosser, Patricia E., and Howe, Robert W., 1969, An analysis of research related to the education of secondary school science teachers. Science Teacher, vol. 36, no. 1, pp.87-95.
- Carter, Jack L., 1967, Is there a method to our madness. ESCP Newsletter, no. 14, p.2.
- Champlin, Robert F., 1970, A review of the research related to ESCP. Journal of Geologic Education, vol. XVIII, no. 1, pp.31-39.
- Connally, G. Gordon, 1966, Multiple nested curricula and the N-6 major. Journal of Geologic Education, vol. XIV, no. 2, pp.54-56.
- Earth Science Curriculum Project, Steering Committee, 1963, The Earth Science Curriculum Project, Newsletter, no. 1, pp.1-7.
- Goedkin, Ronald E., 1969, A principal's experiences in implementing the earth science curriculum project. Journal of Geologic Education, vol. XVII, no. 4, pp.157-158.
- Helburn, Nicholas, 1967, Geography projects and ESCP are complimentary. ESCP Newsletter, no. 13, p.2.

- Henderson, Bonnie C., 1969, Student enrollment in earth science 1968-69. *Geotimes*, November, pp.18-20.
- Holmes, Chauncey D., 1969, Geology and liberal education. *Journal of Geologic Education*, vol. XVII, no. 4, pp.142-144.
- Katz, Joseph and Korn, Harold A., 1968, The graduates: did they find what they needed? *American Education*, vol. 4, no. 5, pp.5-8.
- Ladd, George T., 1968, ESCP...an investigative approach for teaching earth science to students of all levels of ability. *Journal of Geologic Education*, vol. XVI, no. 2, pp61-64.
- Lamson, Robert W., 1969, The future of man's environment. *Science Teacher*, vol. 36, no. 1. pp.25-30.
- Merrill, William M., and Shrum, John W., 1966, Planning for earth science teacher preparation. *Journal of Geologic Education*, vol. XIV, no. 1, pp.23-25.
- Moyer, K. E. and von Haller, Gilmer B., 1955, Attention spans of children for experimentally designed toys. *Journal of Genetic Psychology*, vol. 87, pp.187-201.
- Paull, R. A., Larson, A. C., and VandenAvond, R., 1969, Predicting the effect of ESCP on introductory college geology courses. *Journal of Geologic Education*, vol. XVII, no. 2, pp.47-53.
- Pitkin, Walter, Jr., 1968, Too many people: can educators find an answer? *Phi Delta Kappan*, vol. XLIX, no. 9, pp.473-479.
- Schreiber, Daniel, 1968, 700,000 dropouts. *American Education*, vol. 4, no. 6, pp.5-7.
- Shrum, John W., and Thompson, John R., 1966, Need foreseen for 12,000 new earth science teachers by 1970. *ESCP Newsletter*, no. 10, pp.1-4, 8.
- Staff Report, 1970, Few areas immune as job market tightens. *Montana Collegian*, vol. XLVI, no. 1, 32pp.
- Udall, Stewart L., 1967, Our perilous population implosion. *Saturday Review*, September 2, pp.10-13.
- Wilson, J. Tuzo, 1969, Some aspects of the current revolution in the earth sciences. *Journal of Geologic Education*, Vol. XVII, no. 4, pp.145-150.

Weitz, Joseph L., 1969, Earth science education 1969. ESCP Newsletter, no. 19, pp.1-3.

Welch, Wayne W., 1968, The need for evaluating national curriculum projects. Phi Delta Kappan, vol. XLIX, no. 9, pp.530-532.

Welch, Wayne W., and Walberg, Herbert J., 1968, A design for curriculum evaluation. Science Education, vol. 52, no. 1, pp.10-16.

Essays and Articles in Collections

Rogers, Carl R., 1968, Significant learning: in therapy and education. In Teaching, ed. Ronald T. Hyman. Philadelphia: J. B. Lippincott, pp.152-165.

Teilhard de Chardin, Pierre, 1956, The antiquity and world expansion of human culture. In Man's role in changing the face of the earth, ed. William L. Thomas Jr. Chicago: University of Chicago Press. pp.103-112.

Unpublished Materials

Graham, Mildred W., 1968, A study of the status of earth science teachers in West Virginia. Unpublished Master's thesis, The Ohio State University, Columbus. 67pp.

Gilluly, James, 1962, The place of geology in American life, in a lecture given at Vermillion, South Dakota, April 27.

McMannis, William J. and Shenkle, Robert E., 1964, Report of the committee on status of earth science teaching in Montana secondary schools. (Unpublished) To Roger J. Reede, committee chairman, North Central Section, National Association of Geology Teachers. 2pp.

Merriman, Marilyn H., 1966, A study of earth science courses and a request for suggestions from earth science teachers. Unpublished Master's thesis, The Ohio State University, Columbus. 83pp.

Reith, Howard K., 1969, A study of earth science teachers and practices in North Dakota for the academic year 1968-1969. Unpublished Doctoral dissertation, The University of North Dakota, Grand Forks. 59pp.

Newspapers

Bozeman Daily Chronicle, March 29, 1970.

-82-

Bozeman Daily Chronicle, July 17, 1970.

Great Falls Tribune, April 8, 1970.

- APPENDIX

[COPY]

May 7, 1969

Mr. Wilbert Howell
Lewis & Clark Junior High School
Billings, Montana 59102

Dear Mr. Howell:

Don't say it! Yes, this is indeed another questionnaire but - it is designed to help you, the earth science teacher. Up to and including the present time, relatively little was and is known about earth science curricula in our State of Montana. This simplified questionnaire is an attempt on my part to find out what is going on in Montana. However, put your mind at ease for it has nothing to do with a standardized curriculum and all replies will be kept strictly confidential. No signature is required.

I am presently on a leave of absence from the General Electric Company and am a graduate student at Montana State University, Department of Earth Sciences. I'm working toward a Master of Science degree in Applied Science (Earth Sciences) with a minor in Education. My ultimate goal is to get a job teaching earth science in a Montana high school.

These questionnaires, when completed and returned to me will provide the necessary data for my thesis, "Analysis of Earth Science Teaching in Montana Secondary Schools". If you will complete this form for me, I will in return send you a report on my findings. I will try to develop some suggestions as to how earth science teaching may be improved in the state. This report should prove of interest to you if the feedback on the questionnaires has been objective and accurate. It could also help to make your teaching effort more meaningful and perhaps more effective.

Sincerely,

Richard L. Mackin

Richard L. Mackin

RLM/llm
enclosure

-85-

[COPY]

May 7, 1969

To the Science Department Head:

We are trying to reach all schools that are offering Earth Science and/or Geology courses or units in these subjects. Would you please have someone reply to this questionnaire even though Earth Science is not offered at your school.

Thank you,

Richard Mackin

Richard Mackin

[COPY]

QUESTIONNAIRE

1. The school I teach in is in a class _____ district.
2. It is a (junior) or (senior) high school.
3. Class periods are _____ minutes long.
4. I have _____ earth science classes per day that are taught _____ times a week.
5. I average _____ students per earth science class (minimum number _____ maximum number _____).
6. I cover this course of study in _____ semester(s).
7. I have _____ lab periods a week per class.
8. The grade level of these earth science classes is _____.
9. They (are) (are not) divided into ability levels.
10. I teach a total of _____ classes per day with _____ free periods per day.
11. How many other teachers in your system teach earth science? _____
12. I (have my own classroom) (must share my facilities).
13. How do you rate your present classroom facilities?
POOR FAIR GOOD EXCELLENT
14. Do you have a separate lab _____? If so, how do you rate it?
POOR FAIR GOOD EXCELLENT
15. What is your annual budget for earth science? _____
16. My classroom time is spent mainly by (lecturing) (discussion) (review of text assignment) (other _____).
17. Do you assign homework? _____ Are assignments (light) (heavy)? Are they (in text) (outside reading) (problems) or (_____)?

18. How many field trips do you plan during the semester? _____
Would you explain briefly what you do? _____

19. The name of our text is _____
by _____ published by _____.
20. I omit the following chapters or units _____

because _____

21. I (do) (do not) follow the sequence as suggested by the author of the text.
My reasons for not doing so are: _____

22. This is optional; answer if you can. What is the topical sequence that you
do follow? _____

23. Have you seen the new ESCP texts and teacher guides? _____. Would
you like to use them? _____. If not (and this is optional) can you
give the reason. _____

24. Would you list your extracurricular or cocurricular involvements. Include
memberships in professional organizations. _____

25. I hold the following college degrees. _____

26. I (do) (do not) have a teaching (major) (minor) in earth science.

27. If the answer to 26 is negative, what courses in earth science have you taken? _____

28. Do you teach these earth science courses by choice or were you selected to volunteer? _____

29. What resource materials and references are available to you? _____

30. What type of laboratory and demonstration equipment is available to you?
For example:

- | | |
|---|--|
| <input type="checkbox"/> Globe | <input type="checkbox"/> Structural models |
| <input type="checkbox"/> Planetarium | <input type="checkbox"/> Clay models of stratigraphic groups |
| <input type="checkbox"/> Celestial sphere | <input type="checkbox"/> Diorama |
| <input type="checkbox"/> Topographic maps | <input type="checkbox"/> Stream table |
| <input type="checkbox"/> Relief maps | <input type="checkbox"/> Moh's scale of hardness |
| <input type="checkbox"/> Binocularscope | <input type="checkbox"/> _____ |
| <input type="checkbox"/> _____ | <input type="checkbox"/> _____ |

Rock & mineral collection (broad coverage) (restricted)

Fossil collection (broad coverage) (restricted)

31. Does your school system have an advanced course in earth science as a follow-up for 11th and/or 12th graders? _____

[COPY]

STUDENT QUESTIONNAIRE - EARTH SCIENCE COURSES IN MONTANA [A]

1. Have you ever had a course in earth science or geology before? _____
2. Have you ever had a course in chemistry? _____ If yes, was it difficult for you? _____

If the answer to the first question was yes, please answer the following questions. If no, stop here.

3. Where? (city of town) _____
4. When? (date) _____
5. Name of school _____
6. Teacher's Name _____
7. Grade level of course _____; number of semesters _____
8. Grade received (in earth science) _____
9. Which parts of the course did you find most interesting?
10. Would you have recommended the course to your friends? _____
11. Did your teacher seem well-versed in the field of earth science? _____
Was he enthusiastic? _____
12. Was laboratory work included in this course? _____ If so, can you give an approximation of the time spent per week in lab. _____
13. Did you have much homework? _____ If so, did it help you to understand the material better? _____
14. How many field trips did you have? _____
15. Can you remember the name of the text that you used?
Name of text was _____

[COPY]

EARTH SCIENCE SURVEY [B]

Spring Quarter 1970

 Yes No Have you had an earth science course in high school?
(If yes enter the grade on the line)

Yes No Did you use the ESCP text? ESCP means Earth Science
Curriculum Project.

Where did you take the earth science course?

Name of School

Town or City

State if not Montana

Your Name

TEXTS USED BY MONTANA EARTH SCIENCE TEACHERS

Title of Text	Teachers using
Brown, Howard, and others, 1958, Introduction to Geology, Boston: Ginn & Co. 644pp.	1
Earth Science Curriculum Project, 1967, Investigating the Earth, Boston: Houghton Mifflin. 594pp.	14
Fletcher, Gustave, and Wolfe, Caleb, 1959, Earth Science 4th ed. Boston: Heath. 556pp.	1
Namowitz, Samuel, and Stone, Donald, 1965, Earth Science; the World We Live In, 3rd ed. Princeton: Van Nostrand. 597pp.	10
Ramsey, William, and Burckley, Raymond, 1965, Modern Earth Science, New York: Holt, Rinehart, & Winston. 664pp.	47
Thurber, Walter, and Kilburn, Robert, 1965, Exploring Earth Science, Nineteen Sixty-Five, Boston: Allyn & Bacon. 446pp.	1
Wolfe, Caleb, and others, 1966, Earth and Space Science, Boston: Heath. 630pp.	4

