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A study of earth science teachers and practices in North Dakota for the academic year 1968-1969

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A STUDY OF EARTH SCIENCE TEACHERS AND PRACTICES IN NORTH DAKOTA FOR THE ACADEMIC YEAR 1968-1969

by

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This Dissertation submitted by Howard C. Reith in partial fulfillment of the requirements for the Degree of Doctor of Education from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

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Date June 18, 1969

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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF ILLUSTRATIONS

Figures

ABSTRACT

In the period between 1961-1964 the North Dakota department of Public Instruction initiated long overdue changes in the science curriculum for the seventh, eighth, and ninth grades of the public schools. These involved changes from general science to the life, earth, and physical sciences. During this same period there was a revitalization of interest in earth science at the national level, with the public school enrollment rising from several thousand to well over one million.

Because of the rapid national growth in earth science enrollment, and the status of earth science in North Dakota, a study to determine the strengths and weaknesses of the existing procedures at both levels was urgently needed. No recommendations may legitimately be made nor new policies delineated until the problems have been determined. The purpose of this paper, therefore, is to define the weaknesses of the national and state curricula and to make recommendations on the basis of the findings.

Nationwide data were collected by letters sent to each state department of education requesting information regarding certification policies, grade level of earth science presentation, and any other state requirements. Additional national data were gathered from the available literature.

Information on earth science in North Dakota was gathered from the results of a questionnaire sent to each earth science teacher, and from a study of the teacher's data card on file in Bismarck. The data were translated into Fortran and processed by the computer at the University of North Dakota.

The results indicate that on the national and state level earth science procedures are weak. Over one-third of the states have no teacher certification policies in earth science. The subject is being taught, for the primary part, by unqualified teachers.

In North Dakota, the situation is somewhat less than adequate. The teachers generally have little or no formal earth science education. The facilities, laboratory space, and equipment are insufficient. And, the programs do not even begin to approach the objectives outlined by the state.

The recommendations for improvement of the North Dakota earth science program include: strengthening of teacher certification requirements; enforcement of existing requirements by the state board; integration of earth science courses under the responsibility of a single teacher; promotion of realistic majors at the college level; and the recommendation that all science teaching majors must minor in earth science.

INTRODUCTION

Why is earth science a better course for secondary schools than general science? Earth science is the only science that can integrate all the other sciences into a sequential, logical order or presentation. Earth science is vitally concerned with the environment and the relationship between nature and man. Soils, conservation, weather, hills and valleys, rivers and oceans, stars, space and time all form the basis of earth science. The scope of earth science includes mathematics; it includes the manipulation of concepts; it embraces problem solving, and other developmental procedures; and it is flexible enough to allow many levels of instruction within the same heterogeneous class. Concepts of the vastness of space and time are developed in astronomy and historical geology; appreciation of the forces of nature is gained in the study of geomorphology, meteorology, and oceanography; the understanding of man's effect on his planet is attained through a knowledge of geology.

THE PROBLEM

The sudden expansion in demand for earth science education has left not only North Dakota, but also the major portion of the country unprepared. The growth is due to the need for understanding the relationships between man and his environment. Never before in man's history has so much time and money been expended toward the comprehension of the earth and its surroundings as is being invested today.

Because of these developments, a detailed study of the earth science teachers and practices in North Dakota is vital not only to the educational institutions of the state, but also to the earth science students, for no recommendations may be made, nor policies changed until the facts are known. This paper intends to determine the strengths and weaknesses of the teachers, facilities, and curricula of the earth science course in North Dakota. Conclusions and recommendations will be established on the basis of the findings.

The areas to be studied include:

1. The teacher
    - A. Academic preparation
    - B. Academic improvement subsequent to teaching
    - C. Subject assignments
    - D. Teaching methods
    - E. Pupil loads
    - F. Attitudes
    - G. Trends
2. The earth science facilities
    - A. Type of rooms available for earth science
    - B. Type and amount of teacher demonstration equipment
    - C. Type and amount of equipment available for student manipulation
    - D. Trends
3. The earth science curriculum
    - A. Textbooks and laboratory manuals used in earth science

B. Amount of laboratory experience

C. Amount of field trip activity

D. Type of earth science material discussed and omitted

E. Trends

4. Financial trends and implications

5. Demand for earth science

A. Nationally

B. Locally

6. Conclusions and recommendations

A. College and university level

B. School district level

SCHOOL ORGANIZATION

The state of North Dakota has one of the lowest population densities in the conterminous United States. Approximately 650,000 persons reside on 70,665 square miles, or a population density of a little better than nine persons per square mile. The agrarian economy has few industries to help support the education community. As a result of this lack of money and low population density the educational system is varied in structure and efficiency.

The schools are organized on a county basis under the control of a county superintendent who has jurisdiction over those schools in the county which do not employ a city superintendent (North Dakota Department of Public Instruction, 1967a, p. 14). The towns within a county may be in separate districts, each district having a school board or committee responsible to the state legislature. North Dakota has fifty-three counties containing 498 school districts. The districts are classified: (1) high school districts with grade k-12, (2) graded elementary districts with grades 1-8, (3) one-room rural districts. At the close of the 1967-1968 academic year, there were 270 high school districts, 66 graded elementary school districts, 102 one-room rural districts, and 60 districts not operating schools.

The 1967 population of the public elementary schools totaled 102,389 students, with 94 percent of this population enrolled in the high school districts, 4 percent in the graded elementary districts, and 2 percent in the one-room rural districts. The size of the elementary enrollment varied from 11,278 students in Grand Forks district to 3 students in Wilbur and Henry districts. Specifically, in the eighth grade there were 10,963 pupils in the high school districts, 484 pupils in the graded elementary districts, and 122 in the one-room rural districts. These 11,569 eighth grade pupils represent approximately 11 percent of the total elementary population (North Dakota Department of Public Instruction, 1967a, p. 14; 1967b, p. 10-85).

SCIENCE IN THE ELEMENTARY SCHOOL

The majority of the North Dakota public schools are organized on an 8-4 plan. In recent years, other plans have been introduced such as the junior high school and the middle school. The junior high school is limited to high school districts and contains grades 7-9. The middle school is a recent innovation in education. It consists of grades 5-8.

North Dakota requires that earth science be taught at the eighth grade level. This means that in the graded elementary and middle schools earth science may be treated as an elementary subject taught by an elementary teacher. In the junior high schools earth science is considered a secondary school subject which must be taught by a secondary school teacher.

The state recommends that an elementary school curriculum devote between 225-275 minutes a week to the teacing of science in the seventh and eighth grades. But, the state recommends that at least 280 minutes a week be devoted to science in the seventh and eighth grades in a junior high school. This means that the student in a 6-3-3 system will have more exposure to the earth and life sciences than a student of one of the other two organizations (8-4 or 4-4-4).

In August, 1963, the Department of Public Instruction published a study guide for earth science in the eighth grade. Included in the publication were recommendations for the various units of earth science to be taught, the amount of time to spend on each unit, the methodology of instruction, and sources for materials. Unfortunately, there was no recommendation for the minimum educational background that should be required of the earth science teacher. This factor is important in terms of the organization of the school system. If the school is organized on an 8-4 or a 4-4-4 plan, the earth sciences may be taught by a teacher with no science background. But, if the school system has a junior high school, (by definition) this is a secondary school and the teacher must have at least 16 hours of semester credit in earth science fields (North Dakota Department of Public Instruction, 1967d, p. 2). Therefore, the organization of the school, coupled with the certification requirements of the state, may cause a great variability in the type and amount of earth science that is available to the student.

SCHOOL ACCREDITATION AND TEACHER CERTIFICATION

Accreditation is a method of school classification used by all of the states to improve the curriculum and thus the education of the students. The rating is assigned on the basis of the total school program in relation to the requirements of the state. In North Dakota, the classification of schools is separated; there is one set of requirements for the elementary schools, and a second set for the secondary schools.

The elementary schools are merely classified as either accredited or non-accredited. The secondary schools have a range of classification. The range goes from first class, 1-A, which "approaches a comprehensive high school" through third class, 3-A, which "meet minimum requirements only," to non-accredited, N/A (North Dakota Department of Public Instruction, 1967a, p. 31).

For science teacher accreditation, the elementary school teacher must hold either a First or Second Grade Professional Certificate which requires a major in elementary education. The secondary school teacher, on the other hand, must hold a First Grade Professional Certificate and may teach only the subjects in which he majored or minored (North Dakota Department of Public Instruction, 1967a, p. 47; 1966d, p. 2-4).

SCOPE AND LIMITATION

This study will concentrate on the practices and facilities of earth science in those 498 public school districts with an eighth grade. The data will be limited to the material that was gathered from the teacher forms on file at the Department of Public Instruction in Bismarck, as well as that material gathered from a questionnaire sent to each of the earth science teachers of North Dakota.

The study is not designed to criticize existing practices, rather it is designed to find the weaknesses in the existing procedures and to recommend corrective measures. Therefore, the tables and figures found in the text are not to be used for onerous comparisons, but are meant to be used as tools by the educators and administrators to bring the methods and facilities of earth science to some degree of equality throughout the state. Nor, is this study designed as a causitive research. The reason for particular practices rest with the administration of each school district, and for that reason is beyond the scope of this paper.

NEED AND PURPOSE

A study of this type has never been done in North Dakota. Dr. Wilson M. Laird, Chairman of the Geology Department at the University of North Dakota and State Geologist, has shown interest in this study by his efforts in preparing a curriculum for the preparation of earth science teachers.

The value of this study will depend upon the Education Department at the University of North Dakota using it as a foundation in planning the future course material for potential elementary and secondary school teachers.

The study will be of use to the Department of Public Instruction as a basis for equalizing and updating certification and accreditation requirements in the upper grades of the elementary schools.

Finally, the study will provide a foundation for future studies of procedures and facilities not only of earth science, but also of the other sciences recommended for the upper elementary grades.

EARTH SCIENCE NATIONWIDE

In recent years there have been many investigations of the various aspects of earth science and secondary education. These studies can be divided into three generalized categories: (1) nationwide studies of the educational background, teaching assignments, salaries, and other selected data concerning earth science teachers (Coash, 1963; Schrum and Thompson, 1966; Mathews, 1964; Earth Science Curriculum Project staff, 1966, 1968; Fry, 1968; Henderson, 1964, 1965, 1967a, 1967b, 1969; Schrum, 1963), (2) state studies of earth science teachers and facilities (Haley, 1968; Stoever, 1968; Kendall, 1968; Pollack, 1968; Laux, 1962; Skinner, 1967; and various state departments of education), and (3) college level studies of teacher training (Stephenson, 1964; Schrum, 1963, 1966; National Science Foundation, 1968).

The results from these investigations indicate that there has been a dramatic increase in the number of students studying earth science, and a sharp increase in the demand for earth science teachers. New York, for example, had 1,850 Regent papers written for earth science in 1945, whereas in 1968 there were 37,278 papers written (written communication, 1969, New York State Department of Education). In 1954, Pennsylvania had eight hundred students at nine selected schools enrolled in an earth science program; in 1963 there were 68,431 students in 550 schools (Mathews, 1964, p. 1).

Nationwide, Schrum (1963) determined that there were 190,518 students of earth science taught by 4,195 earth science teachers in 3,052 secondary schools in forty-four states. He estimated that there would be one million students enrolled in earth science by 1970. A revised estimate by the ESCP staff (1966) projected an enrollment of 1.7 million students by 1970. And by 1968, there were better than 1.2 million students being taught by more than 7,700 teachers (ESCP Newsletter, 1968, p. 7).

This rapid increase in demand for the study of earth science has taxed the teaching profession to the limit. Table 1 shows the results of two questionnaires circulated by the ESCP staff in 1966 and 1968. Even though there was an overall increase in the earth science education background of the teachers, over 80 percent still had less than six semester hours of formal study in the fields of astronomy, meteorology, or oceanography, and the majority of earth science teachers had less than twelve hours in geology.

Henderson (1969) compiled the results of surveys concerning the vocational activities of earth science graduates between the years 1960-1968. She found that there were 5,890 earth science graduates employed as teachers at both the secondary and collegiate level in 1968 as compared to 2,605 in 1960. Since the demand for earth science teachers in the secondary schools was between twelve and thirteen thousand in 1968, the implication is that more than one-half of the earth science teachers have been acquired from other teaching areas. This inference is substantiated by the results of the 1968 ESCP questionnaire which shows that even though the great majority

TABLE 1.--Semester Hours of Background in the Earth Sciences of Earth Science Teachers During 1966 and 1968 (Adapted from ESCP Staff, 1968, Teacher Questionnaire: ESCP Newsletter, no. 7, p. 6)

Subject	Year	Semester Hours				
		0	1- 6	7-12	13-18	19-30
Astronomy	1966	58%	32%	8%	2%	0
	1968	44%	43%	11%	2%	1%
Geography	1966	50%	32%	8%	3%	7%
	1968	53%	35%	6%	3%	2%
Geology	1966	15%	27%	21%	13%	24%
	1968	10%	22%	20%	16%	26%
Meteorology	1966	64%	33%	2%	1%	0
	1968	50%	41%	8%	1%	1%
Oceanography	1966	83%	15%	2%	0	0
	1968	72%	22%	3%	2%	2%

of the earth science teachers had been teaching for over five years, they had been teaching earth science for less than three years.

It was necessary to draft these teachers from other fields for at least two reasons: (1) the sudden increase in demand for earth science teachers coincided with a decrease in the number of college students majoring in the earth sciences, and (2) the states require only a minimum of earth science education of the earth science teacher. The enrollment of students majoring in all phases of earth science steadily declined from more than 8,000 students, in 1960, to less than 6,000 students in 1965 (Downes and Henderson, 1968, p. 21). A survey by Henderson (1967a) delineated the decline in greater detail. In 1959, there were 3,566 geology majors registered as seniors, while in 1965, there were only 1,561. During this same period, 1959-1965, the total student enrollment had increased from 30,000 to 500,000 and the teacher demand had risen from less than 1,000 to almost 8,000 (ESCP, 1966, p. 2). It was not until 1967 that there were 8,000 college students enrolled in some phase of an earth science curriculum, and by that time the demand for earth science teachers had increased again by almost one-half (Henderson, 1967a).

The state and regional accrediting policies in earth science are ineffective as they are now written. Regionally, only one of the six accrediting associations specifies standards in science areas; these sciences are biology, physics, chemistry, physical science, and consumer science. Earth science is not even mentioned (College Blue Book, 1968).

On the state level, there is little agreement among the state departments of education regarding policies of earth science. Tables 2-4 summarize replies to letters sent to the fifty state departments of education, requesting policy statements of earth science and earth science teachers. One-half of the respondents indicated that the grade level for earth science instruction was left to the discretion of the local school authorities (table 2). The result is that the grade level of earth science instruction, if it is taught at all, varies in these states from the sixth grade to the twelfth grade.

TABLE 2.--Policies of Fifty State Departments of Education Regarding the Grade Level of Earth Science Instruction

Earth Science Grade Level	Required	Recommended	Sanctioned	Total
Seventh Grade	0	0	0	0
Eighth Grade	2	2	0	4
Ninth Grade	2	3	0	5
Junior High School; Grades 7-9	1	5	2	8
Grade Level authorized by the local School Board	0	0	25	25
Grade Level recommended by the Regional Accreditation Association	0	1	0	1
No Information	---	---	---	7

Only five of the state departments of education require earth science instruction at the seventh, eighth, or ninth grade level, and ten states recommend earth science during one of the three years of junior high school. One state recommends earth science at the grade level stated by the regional accrediting association. But, since the regional associations do not specify earth science, the limitation is ineffective.

Teaching certificates are available for earth science teachers in twenty-seven of the responding states (table 3). Eighteen states have no provisions for the granting of earth science certificates, although earth science is presently taught in all fifty states. A more revealing fact is that one state reported that even though it certifies earth science teachers, there have been no applications for this certificate.

TABLE 3.--Earth Science Certification Policies of Fifty State Departments of Education

Specific Earth Science Certificate	7
General or Professional Certificate Available with an Endorsement in the Major or Minor Field of Earth Science	20
Certificate Automatically Granted by the State upon Graduation from an Accredited School	5*
No Earth Science Certification	18

*This category does not necessarily imply earth science endorsement.

It is possible to ascertain the relationships between the state requirements and the actual teacher preparation in earth science. Almost one-half of the states allow the subject to be taught by a teacher having less than thirteen semester hours of earth science education (table 4). The 1968 ESCP questionnaire results indicate that 52 percent of the teachers have acquired up to

TABLE 4.--Semester Hours of Earth Science Necessary for Teaching Earth Science as Required by Fifty State Departments of Education

Semester Hours	Number of States
0	10
1- 6	4
7-12	8
13-18	16
19-24	10
25-30	2

twelve hours in geology (see table 1). Ten states (20 percent) require no formal preparation in the earth sciences. The ESCP results also show that 20 percent of the earth science teachers have three hours or less in geology, and eight of the states, almost 20 percent, require 7-12 hours of earth science; 20 percent of the teachers have this minimum in geology.

Consequently, the present status of earth science education in the United States is a result not only of a sudden demand for earth science teachers, coupled with low education requirements of the states, but also of an unpreparedness of the teacher training institutions in meeting the demand.

NATIONAL TRENDS IN EARTH SCIENCE

It is apparent that the trend is changing. The universities and colleges are beginning to recognize and alleviate the situation.

The Geoscience Directory (Henderson, 1968) shows that the number of geoscience departments in degree granting schools has increased from two hundred eighty-six in 1964, to three hundred eighty in 1968. And, of these three hundred eighty schools, one hundred sixty-two offer a degree in earth science teaching. This directory also indicates that there are three hundred sixty-four more schools offering courses in earth science during 1968 than in 1964.

The student picture is also improving. During the period 1960-1964 the number of students majoring in geology steadily decreased, but the period from 1964-1968 showed an improvement, such that by 1968, there were about 16,000 students majoring in geology and earth science teaching. The number of students in college earth science courses has climbed steadily through this period. In 1960, there were slightly more than 52,000 students taking courses in geology, whereas, the 1968 total showed more than 114,000 (Downes and Henderson, 1968, p. 20).

Therefore, it is probable that the earth science programs will be improved as a result of the expansion of teacher training institutions into earth science curricula and the continued growth of college student enrollment in earth science courses. In order to maintain the refinement of the earth science curriculum, the state and regional certification and accreditation policies must be revised to place a greater emphasis on the quality of the earth science teacher.

RESEARCH PROCEDURE

THE QUESTIONNAIRE

The questionnaire sent to all the eighth grade earth science teachers of North Dakota is a four-page booklet containing twenty-five questions on the first three pages. The fourth page is for comments by the teachers.

The questions are written such that a minimum of time is required to complete the form. All but five of the questions may be answered by a check mark in the appropriate box. Of the five exceptions, three request an answer requiring a number, one requests the title and publisher of the text and laboratory manual, and one requests the listing of the teacher's weekly schedule, grade level of the subject(s) taught, and the number of years he has taught that subject (Appendix I).

There were two reasons for this type of format. First, the questionnaire is quite long, and it was believed that a minimum of writing would increase the probability of the form being completed by the earth science teacher. Second, the check type of answer is preferable for accuracy in translating the returns into the Fortran that is used in the computer analysis.

The questionnaire is divided into two categories. The first eighteen questions relate to the classroom situation, including class size, number of sections taught, laboratory equipment, classroom use, texts, money available, field trip activity, and other pertinent subjects. Questions 19-24 determine the science courses taken by earth science teachers subsequent to their teaching. Also, these questions determine the source of funds for the courses, the field of study, the number of semester hours, as well as the locations of the colleges. Question 25 requests a listing of the weekly schedule to determine the type and variation of responsibilities handled by earth science teachers.

There are two questions that have led to some ambiguity on the part of the teachers and require an inference in the subsequent translation of the teacher's answer. These are questions 5 and 22. Question 5 was included as a straight-forward request for the percentage of class time spent in laboratory activity. The ambiguity occurs because the range of the first choice is too large, 0-20 percent. This range should have been subdivided into three finer ranges: (1) 0, (2) 1-10, and (3) 11-20. Fortunately, it is possible to estimate the amount and kind of laboratory activities of those teachers who checked the 0-20 percent box on the basis of their answers to the other questions, especially questions 8, 9, 11, 12, and 17.

Question number 22 is even less specific and thus is much more difficult to answer and translate. The term "preparation" is not defined clearly. The replies indicate that the respondants had some difficulty in completing this question. But, the directions for this question state that if the teacher has had no preparation in the discipline the space is to be marked with a zero. The interpretation of the responses is based upon the number and location of the zeroes which indicate the areas of greatest weaknesses in the backgrounds of the earth science teachers.

For some reason, the questionnaire is less appropriate for the elementary school teachers; there was only a slightly better than 10 percent return from the graded elementary and one-room rural school districts. The twenty questionnaires that were returned from these school districts showed that the teachers had no major difficulties in completing the form. But, the remaining one hundred seventy-eight teachers were either not sufficiently motivated to complete the form, or found enough of the questions sufficiently difficult to answer that they rejected the entire questionnaire.

RESEARCH METHOD

One of the more difficult tasks in the gathering of data for this study was the initial problem of acquiring the names and addresses of the eighth grade science teachers. The North Dakota State Department of Public Instruction made available a list of all the eighth grade teachers in the state, along with their school addresses, plus a separate set of address labels. But, because of the state's existing policy of not listing the subject responsibility of North Dakota elementary school teachers, it was not possible for the Department of Public Instruction to subdivide the more than 2,000 names into categories.

The task of determining the names of the earth science teachers was eased by making the assumption that in the one-room rural schools and the graded elementary schools the eighth grade teacher will also be the earth science teacher, since this is the required science in the eighth grade. One hundred ninety-eight of these teachers were sent questionnaires.

Gathering the names of the earth science teachers in the high school districts was a more difficult problem, for in many cases the eighth grade teacher is also on the faculty of the high school. Also, since most of these districts have departmentalized schools, a simple assumption or a random sample of the teacher population would probably not yield significant results.

Two methods were employed to determine the names of these earth science teachers. The first was a reference to a list made available by Dr. C. A. Wardner, director of the Academic Year Science Institute at the University of North Dakota. This list is a compilation of all the science and mathematics teachers, plus the listing of the science and mathematics courses that they were teaching in North Dakota during the academic year 1967-1968. This list was compared to the list of names supplied by the Department of Public Instruction. It was found that more than 20 percent of the eighth grade teachers on the institute list were not on the state list.

Because of the great number of deleted names, a second method of procuring the information was devised. A listing was made of all the high school districts in which the identity of the earth science teacher was unknown. A phone call was made to each of the schools in the district and the name of the earth science teacher was obtained. Two hundred sixty-eight earth science teachers were identified by these procedures.

By the end of February, 1969, a total of four hundred sixty-six questionnaires had been prepared for mailing. The envelopes contained a cover letter signed by Dr. Wilson M. Laird, head of the Geology Department at the University of North Dakota (Appendix II), the questionnaire (see Appendix I), and a stamped, addressed return envelope for the completed form.

Approximately, two weeks after this mailing, telephone calls were made to those teachers in the high school districts who had not returned the questionnaire. By early April, about 68 percent of the forms had been returned from the high school districts and about 10 percent from the graded elementary and one-room rural school districts.

The data were gathered from the questionnaire, translated into Fortran, and the mean, frequency, standard deviation, correlations, and other statistical data were calculated for each item. Because of the difficulties inherent in coding question 25, this item was not programmed for computer analysis, but was tallied and analyzed manually.

More information concerning each teacher was collected from IBM data cards on file at the computer center in Bismarck. These cards are compiled every year by the Department of Public Instruction from information supplied by each school in the state. The information includes such items as social security number, age, sex, certification type, name of school where teaching, salary, teaching experience, subjects presently teaching (for secondary teachers), number of pupils, and other pertinent data. The information deemed relevant for this study was limited to salary, sex, certification type, college degree, and teaching experience.

EARTH SCIENCE IN NORTH DAKOTA

INTRODUCTION

Life science, earth science, and physical science are now required subjects in the seventh, eighth, and ninth grades in North Dakota schools. The development of this science curriculum has been a cooperative effort of the North Dakota Department of Public Instruction, public school administrators and teachers, and state college personnel. But, there are still many problems confronting these groups in attaining a satisfactory earth science program. The teachers have little if any formal preparation in earth science. Facilities and space are inadequate or non-existent. Public school administrators are still unsure of the essence and relevance of the subject. The Department of Public Instruction has not yet developed adequate certification requirements for earth science teachers, and the state colleges are still developing programs and curricula for training earth science teachers.

HISTORY OF THE EARTH SCIENCE PROGRAM IN NORTH DAKOTA

Earth science as a separate discipline is a relatively recent expansion of the North Dakota elementary education curriculum. Prior to 1963, earth science units were included in the existing general science courses. In 1961, and again in 1963, the North Dakota Department of Public Instruction published an elementary science handbook for distribution to those teachers who desire to do experiments beyond those usually found in a textbook. The handbook is divided into topics: fire, air, water, life, conservation, geology, astronomy, meteorology, chemistry, and gravity. The preface to the handbook reports, "three GENERAL SCIENCE BOOKS (sic) are compiled in this volume" (North Dakota Department of Public Instruction, 1961, p. 3). General science courses, however, traditionally repeat the material presented to the student as he progresses through the grades.

In order to eliminate this repetition of science details and to devise a curriculum allowing more student participation in the science learning situation, a steering committee was appointed in 1961 by Mr. M. F. Peterson, Superintendent of Public Instruction. The committee was composed of North Dakota public school and college science teachers, public school administrators, and staff members of the North Dakota Department of Public Instruction. Mr. Harald Bliss, then science consultant for the Department of Public Instruction, was appointed editior responsible for the publication of study guides in the fields of physical science, life science, and earth science.

The primary duty of the committee was to rearrange the topical material of science in the seventh, eighth, and ninth grades. They deleted biological and earth science topics from the ninth grade in order to allow more time for physical science subject-matter such as measurement, elementary chemistry, and elementary physics. They reorganized the eighth grade course by excluding physical science to permit an expansion of the earth science subjects, astronomy, space science, meteorology, geology, and oceanography. The seventh grade science course was remodeled with emphasis on the life sciences, encompassing such topics as biology, agriculture, conservation, and human beings (North Dakota Department of Public Instruction, 1963, p. XI).

The public school administrators of North Dakota were informed of these changes in the curriculum by the Department of Public Instruction and at present more than 95 percent of the schools have accepted and implemented this revised program (oral communication, Mr. R. Klein, North Dakota Department of Public Instruction).

STATISTICS AND TRENDS IN NORTH DAKOTA PUBLIC SCHOOLS

The public school student and teacher populations have remained extremely stable for the thirty-year period from 1938-1968. Statistics calculated from the total eighth grade student population for this thirty-year period disclose that the average enrollment in the state has been 11,000 eighth graders. The standard deviation of this group is only thirty-nine. Meanwhile, the percentage of eighth grade graduates has increased from 51 percent in 1939 to a little better than 90 percent in 1968. In 1939, only one-half of the eighth grade graduates continued to finish a four-year term of high school education; by 1966 this figure had reached 90 percent (North Dakota Department of Public Instruction, 1966b, p. 125-128).

The teacher population, reflecting the stability of the student population, has also remained relatively constant. The average number of teaching positions within the state for the thirty-year period has been 7,150 positions, with a standard deviation of less than 50 positions.

Within this relatively stable framework, there has been a radical change in the overall quality of the teaching staff. The shift from a predominately rural school organization to a more departmentalized graded grouping, together with the imposition of additional certification requirements, has resulted in teachers who are better equipped in both subject matter and educational philosophy.

The change from the rural organization to the more efficient graded groupings was achieved by the merger of many smaller districts. The number of one, two, and three-teacher schools has decreased from 3,900 in 1939, to less than 175 in 1967. The total number of schools in operation has declined from 4,550 in 1939 to fewer than 800 in 1968 (North Dakota Department of Public Instruction, 1966b, p. 125; 1968, p. 72).

The decreasing number of schools is also a direct reflection of the increasing cost of education. Since 1939, the pupil teacher ratio has averaged 19:1, with a standard deviation of two. But, the average cost per pupil has risen from 73 dollars in 1939 to over 600 dollars in 1968. A comparison of the cost of education in Billings County and Grand Forks County illustrates the economic futility of attempting to maintain many one- or two-room schools. Billings County, located in the west-central part of the state, contains one school district with fourteen operating school buildings. The pupil-teacher ratio is much less than average, 13:1, and the cost per pupil in 1966 was 615 dollars. Grand Forks County, located in the northeast section of the state, contains fifteen operating school districts with twenty-three schools. The pupil-teacher ratio is above the average at 24:1, but the cost per pupil for a more comprehensive program, was only 423 dollars. This is almost 200 dollars less than in Billings County.

The future indications are that the school districts must continue to merge, and at an increasing rate, as the price of education maintains a steady increase. The price rise is due to higher salary increments, more expensive construction and maintenance costs, and the initiation of educational programs requiring acquisition of equipment. Examples of these programs are language laboratories, data processing, PSSC, Chem Study, BSCS, and ESCP. All these programs are predicated on student manipulation of experimental devices.

THE FACILITIES FOR EARTH SCIENCE EDUCATION IN NORTH DAKOTA

In recent years, there has been an increased emphasis placed on the earth science discipline by the various communication media. The undersea adventures of Jacques Cousteau are seen almost monthly on television. Television programs concerning vulcanism, mountain climbing, and archeology have been sponsored by the National Geographic Society and are aired almost as often. Recent tragedies in mines, as well as by landslides and earthquakes are major items for discussion on news programs. Radio, television, and newspapers have daily articles on space exploration and moon geology. Weather programs provide an introduction to cloud formations and weather fronts. Even the battle zones in Vietnam are often explained through use of geologic terminology. This great exposure to earth science aspects creates a curiosity in the minds of the school-age children. It is especially true of the young teenager in the eighth or ninth grade, because he is now able to comprehend the significance, implication, and the relationship of the many aspects of his environment.

The schools of North Dakota are not equipped to utilize or even begin to satisfy these sophisticated demands of the student, especially in earth science. The earth science classroom and laboratory space in the state is inadequate or non-existent, the equipment is in disgracefully short supply; furthermore, the teachers are not trained in, nor are they committed to earth science teaching. Most public school administrators do not appreciate the nature of earth science; and, money is either not made available by the district or not used by the teacher for purchasing necessary earth science supplies.

CLASSROOM AND LABORATORY FACILITIES

Despite the many school district consolidations, the earth science classroom and laboratory facilities remain entirely insuffienct for conducting a comprehensive earth science program. Three of every ten group number 1 (the one hundred-eighty responding teachers who teach primarily in graded elementary schools, middle schools, or junior high schools) and three-fourths of group number 2 (the twenty responding teachers who teach primarily in the one- or two-room rural schools) report that they do not have water or benches available for teacher demonstration and experimentation in their science rooms. Many of the responding teachers supplemented their report with the additional information that neither electricity nor gas is available to their demonstration areas.

A compilation of the two hundred returned questionnaires indicates that almost a majority of the earth science students are deprived of laboratory experience simply because the laboratory facilities are non-existent (table 5).

TABLE 5.--Location of Laboratory Facilities as Reported by Two Hundred Group #1 and Group #2 Respondents

Location	Group #1 (N=180)	Group #2 (N-20)
In the same room used for Earth Science	53.3%	18.0%
In a room regularly scheduled for laboratory use	6.1%	0
In a room available when needed	11.7%	23.0%
In a room obtained only with some difficulty	8.9%	6.0%
Facilities unavailable in the school	20.0%	53.0%

The lack of laboratory space is not the only inconvenience confronting the earth science teacher. The majority, 61 percent of group number 1, must share their earth science room with teachers of non-science oriented disciplines. This is a serious problem for it means that the earth science teacher is frequently unable to prepare classroom demonstrations ahead of class time, and he is limited in in the number and type of long-term projects that he or his students may construct and maintain. In many cases, therefore, the teacher is unable to utilize to full extent and effectiveness the bulletin board and shelf space. In all probability, there are distracting displays or projects of the other class occupying space that could be effectively used for earth science.

One-tenth of group number 1 teachers instruct earth science in more than one room. It is reasonable to assume that this procedure is even less successful than sharing an earth science room with another discipline. The two-room teacher usually has to transfer any and all demonstration equipment between the rooms; frequently in the rush between classes, the material is misplaced or destroyed. Consequently, the roving teacher tends to forego short-term experiments and demonstrations in his teaching methods. The students of these teachers frequently are subjected to a second-rate science education.

LABORATORY AND DEMONSTRATION EQUIPMENT

The disciplines usually discussed in any primary earth science course include astronomy, geology, meteorology, and oceanography. Some teachers may tend to emphasize different aspects of this grouping, such as the expansion of meteorology to include climatology, or the amplification of astronomy to include space exploration. In any case, certain equipment is required to present adequately the four basic areas of earth science.

Question 17 of the questionnaire (Appendix I) lists twenty-three items deemed of primary importance to a basic earth science course. The stream table may be considered an inexpensive luxury item. But, it is believed that understanding geomorphic development, especially near-shore and fluvial environments, will be greatly augmented by the manipulation and observation of stream table processes. Other items might have been included on the list, such as telescopes, microscopes, wave tanks, aerial photographs, and star charts. But, these were considered as equipment useful primarily for expanded programs and to be purchased when money became available.

The geology section of an earth science course is divided into mineralogy, petrology, geomorphology, physical geology, historical geology, and possibly structural geology and tectonics. Streak plates, hydrochloric acid, specific weight balances, hand lenses, magnets, bunsen burners, sediments, minerals, and rock samples are all necessary items in mineralogy and petrology. Streak plates, for example, are used to identify softer minerals on the basis of powder colors. The majority of both groups of teachers lack this inexpensive item (table 6). Hydrochloric acid, essential in the identification of carbonate rocks and minerals, is unavailable to 8 percent of group number 1 and 35 percent of group number 2 teachers. The specific weight balance, required to differentiate minerals of similar external characteristics is needed by 16 percent of group number 1 and 71 percent of group 2. Hand lenses and magnets are tools used to establish crystal structure and mineral composition, but one-fourth of group number 1 and four-tenths of group number 2 teachers do not have access to them. Sediments, minerals, and rock samples, the basic constituents of the earth are absent from the

TABLE 6.--Equipment Reported as Unavailable to Group #1 and Group #2 Teachers in North Dakota

Equipment List	Group #1 (N=180)	Group #2 (N=20)
Earth Science Filmstrips and Transparencies	24%	16%
Movie Projector	2%	42%
Slide Projector	9%	24%
Celestial Globe	61%	88%
Terrestrial Globe	40%	65%
Prisms	12%	29%
Barometer	17%	65%
Hydrometer	28%	77%
Bunsen Burner	9%	47%
Sediment Samples	32%	47%
Hydrochloric Acid	8%	35%
Specific Weight Balance	16%	71%
Topographic Maps	51%	41%
Raised Relief Maps	75%	83%
Hand Lenses	15%	35%
Magnets	9%	6%
Fossils of Fossil Models	45%	53%
Streak Plates	57%	77%
Rock Samples	13%	12%
Mineral Samples	19%	53%
Stream Table	86%	94%
Geologic Models	82%	88%
Weather Maps	57%	59%

supplies of the schools of the majority of the reporting teachers, even though these teachers could easily gather many samples from local stream beds, gravel pits, and rock piles.

The other disciplines of geology, physical and historical, geomorphology, and structural geology, require maps, photographs, slides, and models to assist the student in projecting the concepts of landform development and stratigraphic succession. Yet, over 80 percent of the responding teachers do not possess geologic models. The majority of the teachers may not use topographic or raised relief maps; 40 percent of group number 1 and 65 percent of group number 2 do not even have terrestrial globes! Slide projectors are not available to almost one-tenth of the group number 1 and one-fourth of the group number 2 teachers. Finally, neither filmstrips nor overhead transparencies are among the earth science supplies of approximately one-fifth of the responding teachers.

The interpretation of these statistics is that the majority of earth science students in North Dakota cannot obtain an adequate background in geologic procedures with the equipment that is available in the elementary schools.

The remaining entries in table 6 are basic items for use in the presentation of topics in astronomy and meteorology. The celestial globe is a requisite for the explanation of the ecliptic, navigation, the celestial sphere, and other celestial phenomena. Only 40 percent of group number 1 and 12 percent of group number 2 have this tool. The barometer, hydrometer, and weather maps should be available to a teacher as part of a comprehensive presentation of weather. Nevertheless, 18 percent of group number 1 and 65 percent of group number 2 do not have a barometer; 28 percent and 17 percent, respectively, lack hydrometers, and only four of every ten responding teachers have weather maps. The equipment and supplies are, therefore, very limited.

THE ELEMENTS OF AN INFERIOR EARTH SCIENCE EDUCATION

The deficiency of equipment and space for earth science is the result, not the cause, of an inferior elementary science program. The source of the deficient program may be localized in the elementary earth science teaching staff. The average earth science teacher is neither adequately prepared in earth science, nor fully committed to earth science teaching. The consequences of the poor preparation are: (1) a program that depends heavily on and is organized around a text; (2) a program that will omit material not readily available for teacher review; (3) a program that allows little deviation from a particular day's prepared material.

The results of a course offered by non-enthusiastic teachers are: (1) a static program in both subject matter and class presentation; (2) presentation of subject material by lecture rather than discovery methods; and (3) rapid migration of earth science teachers into their major subject fields.

North Dakota teachers are, in general, inadequately prepared to teach earth science. In the fields of astronomy and meteorology, over one-half of group number 1 and almost three-fourths of group number 2 lack formal preparation (table 7). Only one-fourth of all the responding teachers have formal background in oceanography. Two-thirds or more of the respondents lack training in historical

TABLE 7.--Percentage of North Dakota Earth Science Teachers with No Preparation in Various Fields of Earth Science

Subject	Group #1 (N=180)	Group #2 (N=20)
Astronomy	57%	71%
Field Methods	75%	59%
Geomorphology	59%	65%
Historical Geology	61%	64%
Meteorology	55%	76%
Methods of Earth Science Teaching	29%	41%
Oceanography	75%	76%
Paleontology	68%	77%
Physical Geology	46%	59%
Rocks and Minerals	44%	53%

geology and paleontology. Almost one-half of group number 1 and more than one-half of group number 2 need training in mineralogy, petrology, and geomorphology. And, more than 60 percent of the respondents have no experience in field methods.

The majority of earth science teachers in North Dakota are not fully committed to earth science teaching. Apparently, the earth science teachers were not hired to teach earth science, nor are they expecting to stay in earth science teaching. Ninety percent of group number 1 are responsible for disciplines other than earth science (fig. 1). In fact, only 16 percent of the respondents teach more than two sections of earth science in a day (fig. 2). The

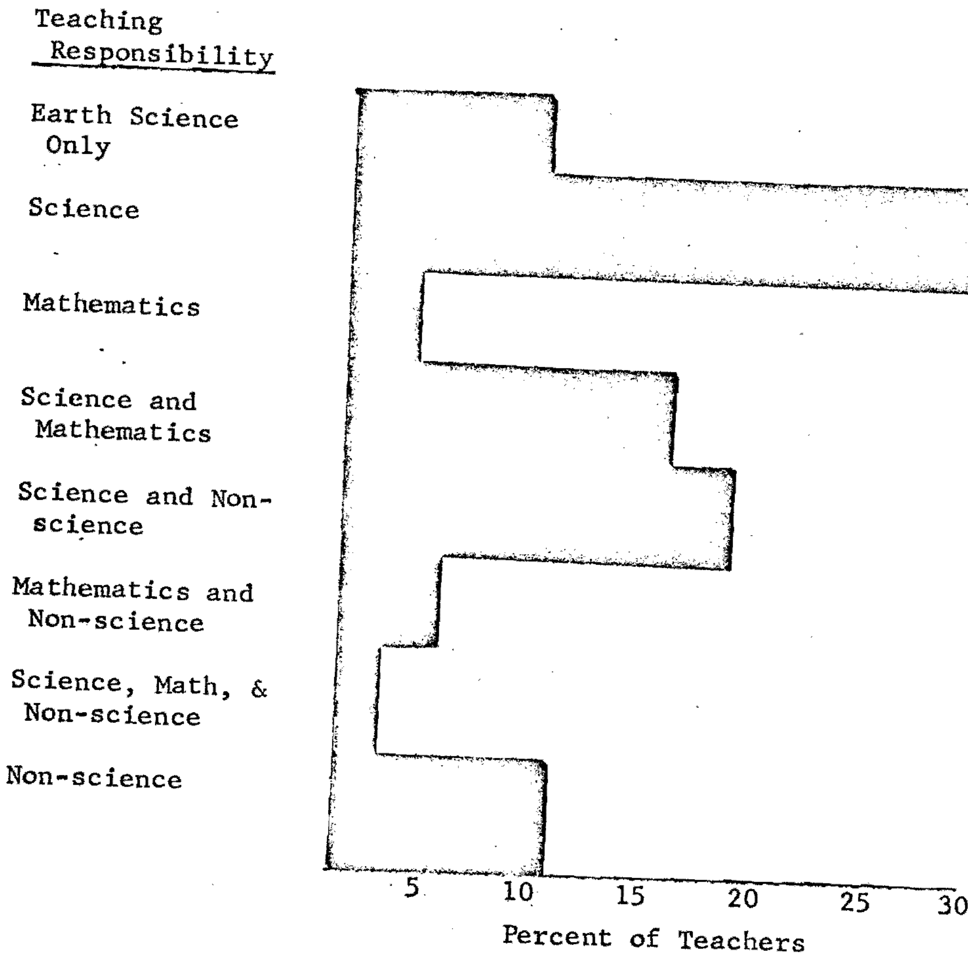

Figure 1.--Teaching Responsibilities of One Hundred Eighty Group #1 Teachers.

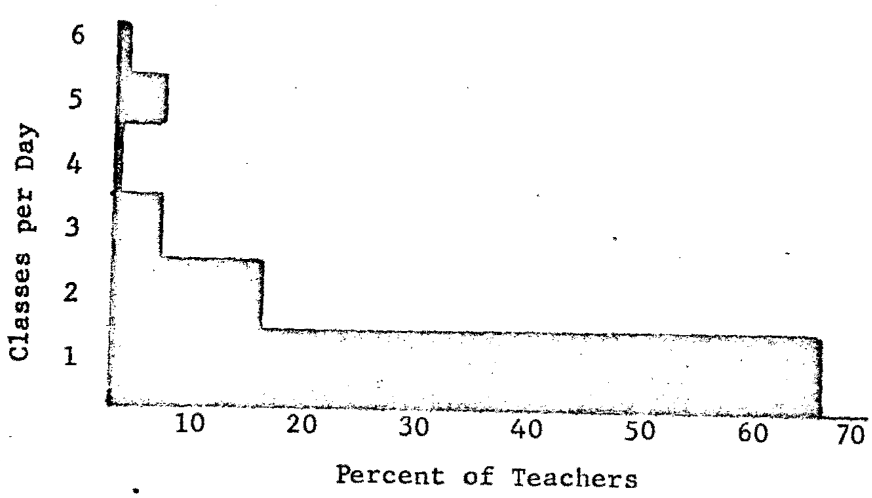

Figure 2.--Number of Daily Earth Science Classes for One Hundred Eighty Group #1 Teachers.

implication of these facts is almost 90 percent of the earth science teachers have had earth science assigned to them at the time of or subsequent to hiring, even though the teachers were unprepared to teach earth science. Two-thirds of group number 1 have been teaching earth science three years or less (fig. 3). This highly skewed relationship suggests that as soon as the teachers achieve some seniority, they move fully into their major discipline (fig. 4).

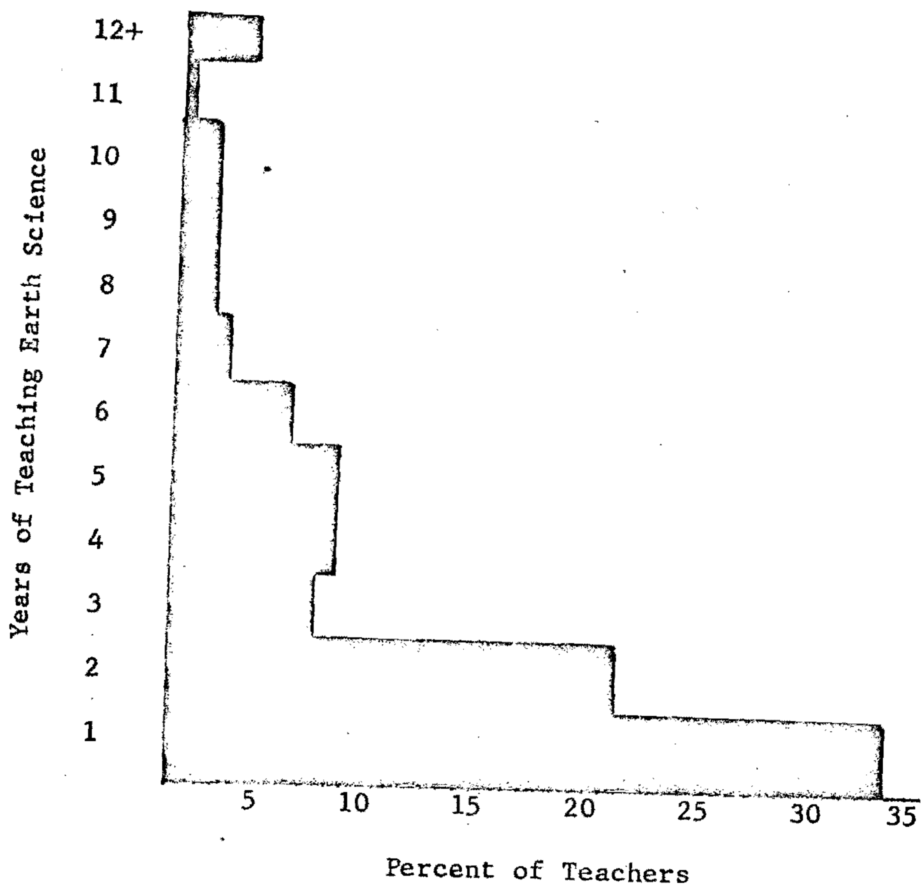

Figure 3.--Distribution of Teaching Experience in Earth Science of One Hundred Eighty Group #1 Teachers.

Teachers who are fully committed to a subject presumably will advance academically in that subject. Less than one-third of the respondents have taken a course in geology subsequent to their

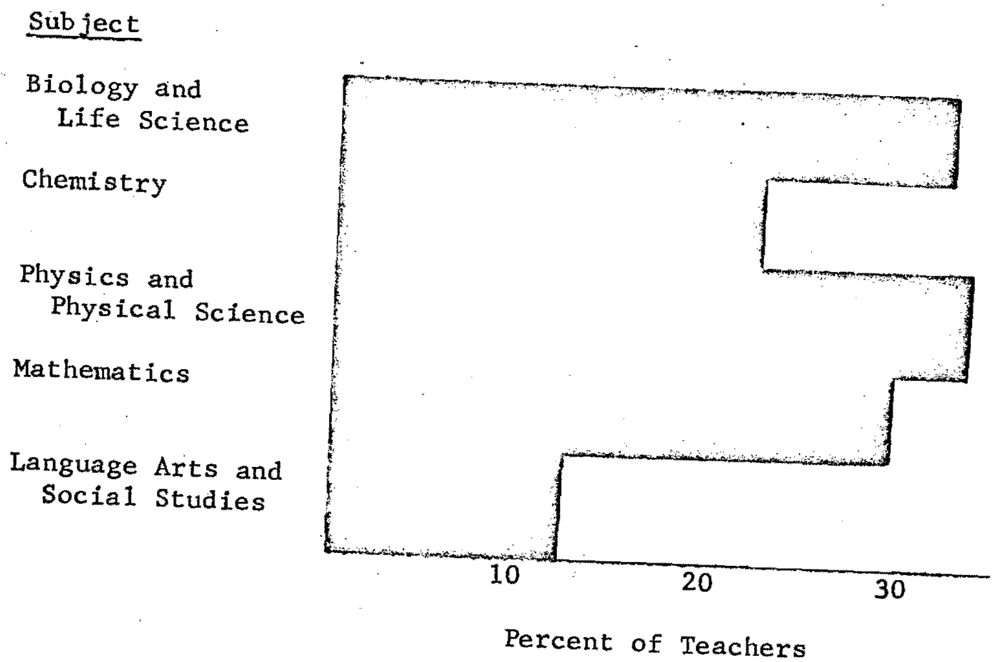

Figure 4.--Major Teaching Areas of One Hundred Eighty Group #1 Teachers.

teaching, even though 100 percent are teaching earth science. Approximately 30 percent of group number 1 teach biology, and 93 percent of these have taken graduate work in biology. About 22 percent of group number 1 instruct chemistry courses, and all of these have received graduate credit in chemistry. Approximately one-third of group number 1 include mathematics as part of their teaching load, while 94 percent of this group have received graduate credit in this subject. The correlation between teaching responsibility in physics and geography also approaches a correlation of 1. The significance of these data is that the majority of the earth science teachers responding to the questionnaire are not expecting nor preparing to stay in earth science teaching.

THE EARTH SCIENCE PROGRAM

> It should be noted that the seventh and eighth grade science programs are designed to provide an understanding and appreciation of the living and physical environments. . . . it is hoped that the teachers will not require rote memorization of facts, but will make every effort to stimulate the interest and imagination of the students. In the suggestions for teachers much emphasis is placed on student activities, both in the classroom and out of doors (sic) (North Dakota Department of Public Instruction, 1963, p. XI).

This quotation from the introduction of the earth science handbook delineates with some specificity the type of program to be offered to the young earth science student. But, the consequence of teacher inadequacy and the lack of committment precludes the presentation of the discovery approach requested by the Department of Public Instruction. More than one-fifth of group number 1 exclude oceanography, 11 percent omit meteorology, and a total of 6 percent do not discuss geology and astronomy. Almost two-thirds of both groups expect to take only one field trip or less this academic year (1968-69) (fig. 5). Three-fourths of the responding teachers spend less than 20 percent of their earth science instruction in laboratory activities (fig. 6). In fact, only 14 percent of group number 1 teachers use a laboratory manual as a teaching aid.

Far from gaining an understanding and appreciation of their physical environment, it appears from the data that the earth science student is being confronted with a course that might tend to stifle his imagination, extinguish his curiosity, and confound his understanding of his surroundings.

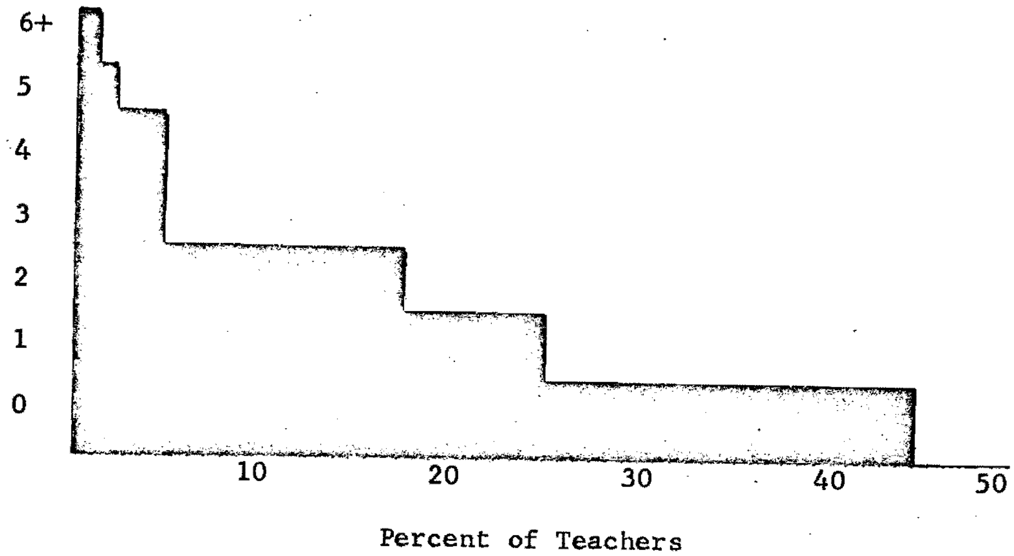

Figure 5.--Number of Field Trips Planned by One Hundred Eighty Group #1 Teachers for 1968-1969.

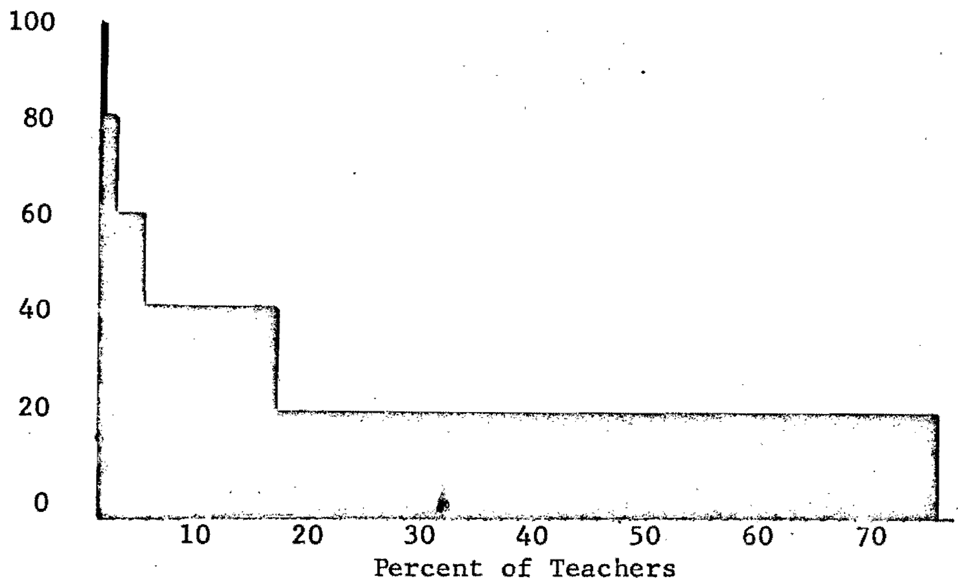

Figure 6.--Percent of Earth Science Laboratory Activity as Reported by Two Hundred North Dakota Earth Science Teachers.

CONCLUSIONS

Introduction

The scope and essence of the problems in earth science are such that specific conclusions and recommendations must be made at each level of the educational structure rather than as a series of generalizations.

The classical sciences of biology, chemistry, and physics, have had a long history and tradition within the framework of the public school curriculum. This tradition has given these sciences a stable base for growth in the directions indicated by advances in subject knowledge, teaching techniques, and educational philosophies. Earth science, as a specific discipline, is new and is in the process of replacing an inadequate conglomeration of science units that have usually been included in the curriculum as "general science."

This replacement process has caused serious problems for earth science. General science, traditionally, was taught by members of the classical sciences as a supplementary assigned subject. This procedure usually resulted in a course that was presented as a diluted version of the teacher's major discipline (AAAS Cooperative Committee, 1960, p. 1024-1029; ESCP, 1967, p. 6-7). The introduction of earth science has not really changed this procedure. Earth science is being delegated to teachers who have been hired for other responsibilities, making earth science a subordinate subject.

The National and Regional Level

The discipline of earth science is moving in an almost irreversible direction back toward general science.

An enrollment in earth science of over two million students is estimated for 1971. By 1972 there will be a demand for over 20,000 earth science teachers; to fill this demand, over 12,000 earth science-deficient teachers will be used. Because of this, the termination will be a revitalization of a general science curriculum. This conclusion seems inescapable. The average teacher, unprepared in earth science and not fully committed to the discipline, according to the questionnaire used in this study, tends to teach earth science in terms of the subject most familiar to him. He will discuss those units he understands and reject the remaining areas (see p. 40). This process of rejection is occurring now. Thirteen percent of the earth science teachers responding to the ESCP questionnaire of 1968 indicated that they were not including ground water, climatology, igneous rocks, and geomorphology in their courses (ESCP Newsletter, 1968, p. 6).

There is little pressure at the national and regional level to correct this reversion to general science; there is no national group that <u>effectively</u> promotes earth science methods in the public schools. The National Association of Geology Teachers has reached only a small percentage of the earth science teachers. The Council on Education in the Geological Sciences has published valuable material, but its major emphasis is on college preparation. The major publishing houses have relased very few earth science source books and earth science methods materials. But, at the same time, ESCP is developing materials and methods which require a trained teacher for successful presentation. The regional accrediting associations have no guidelines for earth science procedures or equipment requirements.

State Level

While the fifty states have specific guides for the classical science courses, the earth science curriculum has few, if any, enforced guidelines or requirements. The majority of state departments of education leave the course content and teaching faculty to the discretion of the local school committee (see table 2). Approximately one-third of the states do not even have certification policies for earth science teachers, and many of the remaining states apparently do not enforce those policies they have established. Therefore, the state guidelines in earth science are ineffective in stopping the backward trend of earth science toward general science.

North Dakota

The issues at the state level in North Dakota are similar to those at the national level with two exceptions: (1) North Dakota requires earth science at the eighth grade level; only four states require earth science at any level. This forces the schools to implement a program for which they are not prepared. (2) The eighth grade is the division separating elementary and secondary teacher certification. The consequence of this, is the probable utilization of unprepared and unenthusiastic teachers in earth science programs. The sum of these two effects is an inefficient, detrimental earth science program that apparently is in existence only because of the state requirement.

Some of the stated objectives of the North Dakota earth science curriculum are:

(1) to develop initiative, resourcefulness, and creativity.

(2) to learn the methodology of scientific investigation and develop the ability to interpret observation and/or data.

(3) to provide exploratory experience on which to build further science learning and cultivate a curiosity on the part of the student.

(4) to begin the development of attitudes necessary for further critical thinking.

(5) to help students, through observations, become aware of their environments, and help the students explain and/or understand occurrences in their environment.

(6) to develop skills in areas such as:
A. use of laboratory equipment
B. problem solving
C. making home-made equipment

(North Dakota Department of Public Instruction, 1963, p. VI).

In general, the North Dakota schools are not meeting these objectives. There is little opportunity to develop creativity; there is insignificant laboratory activity which is needed to discover the methods of science; there are few field trips for exploratory or observational methods necessary for establishing a true awarness of the environment; and, the use of lectures alone, will not develop the initiative, resourcefulness, or attitudes of critical thinking. Achievement test data reinforce this assumption.

The Science Research Associates (SRA) Achievement Series is given to sixth and eighth grade students every year. The results of the 1968 battery indicates a percentile loss of as much as eighteen percentile units between the sixth and eighth grades. In the blue version, the sixth grade results place the state mean at the fifty-first percentile, and the eighth grade mean at the forty-fourth percentile, or a loss of seven percentile units. In the green version, which represents a measuring device for the intermediate level of achievement, the sixth grade mean for the state is at the sixty-seventh percentile, and the eighth grade mean is the forty-ninth percentile, or a loss of eighteen percentile units (written communication, North Dakota Department of Education).

There are at least three interpretations of these particular results. One is that the science programs in the seventh and eighth grades do not increase the knowledge or achievement of the student. Another interpretation is that the state achievement is staying the same but that the national achievement level is rising. A third interpretation is that the North Dakota level is indeed rising, but that the national level is rising at a faster rate than North Dakota. Regardless of the interpretation, the eighth grade science achievement has fallen below the national average, and the science program in North Dakota, therefore, must be considered inadequate.

The blame for this inadequate program should not be placed solely on the state board of public instruction; the colleges, as well as the local school committees, must share fully in the guilt. Because the schools are not demanding qualified earth science teachers, the colleges are under no pressure to prepare such teachers. This means that even if the schools now demand these teachers, it will take at least four years to begin to supply them. Thus, the existing practice of hiring members of other disciplines and assigning them to earth science will continue until there is no need for earth science teachers, or until someone feels an inadequate job is being done by these untrained teachers.

RECOMMENDATIONS

Introduction

There is difficulty in suggesting methods for alleviating the problems besetting earth science because the problems lie at many levels or organization, and many individuals are still not convinced of the need for earth science.

However, earth science is vital to the curriculum of the public school because of its intrinsic value in developing a comprehensive understanding of man and nature.

National and Regional

The national earth science associations must attempt to influence more teachers. The majority of earth science teachers are responsible for disciplines other than earth science; therefore, the earth science associations should advertise their existence and philosophies in the publications of the other sciences as well as in the journals of the national state education associations.

The regional accreditation associations must be prevailed upon to establish standards for earth science as part of their accreditation requirements.

State Levels

Teacher certification standards for earth science teachers must be raised equal to those required of the teachers in the classical sciences.

Minimum equipment criterion should be established for all the schools that teach earth science.

The grade level of earth science presentation should be made uniform in each state.

Earth science must be designed and taught as a laboratory-oriented discipline scheduled over an entire academic year.

State departments of education must enforce their existing policies.

North Dakota

State Level

The State Department of Public Instruction must require earth science teachers to possess a First Grade Professional Certificate with a major or minor in earth science.

The State Department of Public Instruction must enforce its existing policies regarding:

(1) time allotted to earth science in the school

(2) minimum equipment required for a science course

The state department must urge the earth science teachers to achieve the objectives outlined in the earth science study guide.

Local Level

The local school committee must require that the teacher responsible for teaching earth science have some formal earth science background.

Fully trained earth science teachers should be hired whenever possible, even if this means shifting responsibilities of other teachers.

During the period in which there is an insufficient supply of qualified earth science teachers, two or more contiguous districts should be encouraged to hire a trained earth science teacher to supplement the existing programs. This teacher could make periodic school visits to reinforce the presentation of earth science. He will also be available to conduct workshops involving the local earth science teachers.

The local school committees should encourage earth science teachers to attend in-service earth science courses.

The principals must assign rooms specifically for earth science instruction. Under no conditions should an earth science teacher be required to teach earth science in more than one room. This means that laboratory space, demonstration areas, and classroom activity will be contained in one location.

The principal must encourage laboratory and field trip activity.

In the cases where several teachers from varying science or math disciplines are all teaching some earth science, the principal should assign the several earth science classes to one teacher.

The principal should encourage an equipment-sharing program with the schools of the nearby districts.

College Level

The colleges must develop a workable minor in earth science. A suggested minor is:

(1) oceanography, meteorology, astronomy
(6 semester credits)

(2) physical geology, with emphasis on mineralogy, petrology, and geomorphology
(4 semester credits)

(3) historical geology, with emphasis on stratigraphy, paleontology, and structural geology
(4 semester credits)

(4) research problems in earth science
(2-4 semester credits)

Students enrolled for a teaching certification in one of the classical sciences should be required to take a minor in earth science.

The earth science teachers in North Dakota have indicated the desire for in-service courses in both specific subject material and earth science methodology. These courses should be developed and offered.

There should be an expansion of the Cooperative College-School Science Program into the districts near the state colleges offering earth science teaching programs.

APPENDIX I

1. Please check the appropriate box after each question.
2. Those few questions requiring a written answer may usually be completed in only a few words.
3. Comments may be made on the reverse side of the questionnaire.

1. Earth science is taught as:
   - ☐ a full year course
   - ☐ a half year course
   - ☐ less than a half year course
   - ☐ other (please explain)

2. The number of days that an earth science class meets with you each week (including laboratory time) is:
   ☐ 1, ☐ 2, ☐ 3, ☐ 4, ☐ 5, ☐ other (please explain any irregular scheduling)

3. The number of minutes each week that an earth science class receives instruction in earth science is:
   - ☐ less than 50
   - ☐ 51-100
   - ☐ 101-150
   - ☐ 151-200
   - ☐ 201-250
   - ☐ 251-300
   - ☐ greater than 300
   - ☐ please explain any irregularities pertinent to the question.

4. In your system, is earth science:
   ☐ an elective, ☐ required, ☐ other, (please explain)

5. What per cent of your earth science class time is spent in laboratory activity during an average week?
   - ☐ 0-20
   - ☐ 21-40
   - ☐ 41-60
   - ☐ 61-80
   - ☐ 81-100
   - ☐ other (please explain)

6. The maximum number of earth science sections that you teach in a day is:
   ☐ 1, ☐ 2, ☐ 3, ☐ 4, ☐ 5, ☐ 5, ☐ 6, ☐ 7, ☐ other.

7. The enrollment in all the earth science classes that you teach is between:
   - ☐ 1-10
   - ☐ 11-20
   - ☐ 21-40
   - ☐ 41-60
   - ☐ 61-80
   - ☐ 81-100
   - ☐ 101-120
   - ☐ greater than 121

8. Do you have teacher demonstration facilities (water and tables) available in your regularly scheduled earth science room(s)?
   ☐ yes, ☐ no, ☐ comments

9. Do you have tables and running water for student laboratory use:
   - ☐ in the same room that you usually teach earth science
   - ☐ in another room that is scheduled for your use during the week
   - ☐ in another room that is available when needed
   - ☐ in another room that may be obtained only with some difficulty
   - ☐ facilities not available
   - ☐ other (please comment)

10. Do you teach earth science regularly in more than one room?
   ☐ yes, ☐ no, ☐ please explain any irregularities that you think may be pertinent to the question.

11. Is your regularly scheduled earth science room(s) also used to teach non-science and/or non-math subjects.
   ☐ yes, ☐ no, ☐ comments

12. What is the title of the text or texts used in your earth science course? Published by?

____

If you use a lab manual: title ______________________________

13. Please check those topics included in your earth science course:
☐ geology, ☐ astronomy, ☐ meteorology, ☐ oceanography
☐ other (please list)

14. On how many field trips do you plan to take your earth science classes this year? ____________

15. Do you teach ESCP (Earth Science Curriculum Project)? ☐ yes ☐ no
15a. If not fully, estimate %____________

16. Do your students use ESCP equipment? ☐ yes ☐ no

17. Equipment checklist: Please check in the column "yes" if the equipment is available for your use either in your room, building, or school system. Check the column "no" if the equipment is not available.

	YES	NO
earth science filmstrips and transparencies	☐	☐
movie projector	☐	☐
slide projector	☐	☐
celestial globe	☐	☐
terrestrial globe	☐	☐
prisms	☐	☐
barometer	☐	☐
hydrometer	☐	☐
bunsen burner	☐	☐
sediment samples (clay, silt, gravel, etc.)	☐	☐
hydrochloric acid	☐	☐

	YES	NO
specific weight balance (beam balance or other)	☐	☐
topographic maps	☐	☐
rasied relief maps	☐	☐
hand lenses	☐	☐
magnets	☐	☐
fossils or fossil models	☐	☐
streak plates	☐	☐
rock samples	☐	☐
mineral samples	☐	☐
stream table	☐	☐
geologic models	☐	☐
weather maps	☐	☐

18. The money available for your earth science material this year is between:
☐ $ 0-25
☐ $26-50
☐ $51-75
☐ $ 76-100
☐ $101-200
☐ greater than 200 (please state amount)

19. Have you ever been a participant in a government-sponsored program for the earth sciences?
☐ no
☐ NSF-AYI (Academic Year Institute)
☐ NSF-ISI (In Service Institute)
☐ NSF Summer Institute
☐ other (please list)

20. Were these government programs in North Dakota institutions?
☐ yes, ☐ no (please list the state(s) where attended)
☐ does not apply

21. Have you attended government-sponsored programs for courses other than earth science?
☐ no, ☐ yes (please list the sponsoring agency and the state where the course was taken)

22. On the basis of your preparation, rank the following subdivisions of earth science. Use "1" as most preparation, "2" as next most, etc. If no preparation place an "O."

____ astronomy
____ meteorology
____ oceanography
____ historical geology
____ rocks and minerals
____ geomorphology (land forms)
____ physical geology
____ paleontology (fossils)
____ field methods
____ methods of teaching earth science

23. Since you have started teaching, have you attended courses in:
(Place the number of semester hours of credit for course(s) in the appropriate square. Convert quarter hours to semester hours by multiplying by 2/3)

	regular semester hours	summer session hours	extension course hours	institute courses	location of school (by state)
geology					
astronomy					
meteorology					
biology					
chemistry					
mathematics					
physics					
geography					

24. If you were to enroll in an in-service earth science class, rank your preference of content; 1—best, 2—next best, etc.

____ a general view of the various earth science disciplines
____ specific earth science courses that cover the material in depth
____ methods of teaching earth science, with some discussion of subject matter
____ other (please be specific)

25. Please list teaching schedule below.

Course or other assign. (inc. Admin.)	Grade Level	Times per week	Years experienced in that course or assignment

APPENDIX II

The University of North Dakota

GRAND FORKS 58201

DEPARTMENT OF GEOLOGY

Dear Earth Science Teacher:

Enclosed is a questionnaire concerning your earth science program. The questionnaire was designed not only to evaluate the present facilities and instruction of earth science, but also to provide information by which we may revitalize this aspect of the teacher education program at the University of North Dakota.

The Department of Geology is eager to assist you, but we need your cooperation in order to be effective. Therefore, it is hoped that you will complete and return this questionnaire without delay.

If you have any questions, write me or call me collect at 777-2811.

Sincerely yours,

Wilson M. Laird

Wilson M. Laird, Chairman
Department of Geology

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Enclosure

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