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Student Achievement in, and Attitudes toward Earth-Science Courses in Secondary Schools

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STUDENT ACHIEVEMENT IN, AND ATTITUDES TOWARD EARTH-SCIENCE COURSES IN SECONDARY SCHOOLS

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CHAPTER I

THE PROBLEM

Trends in Earth-Science Education

Since the early 1950's, the number of secondary schools offering courses in earth science has increased rapidly and there appears to be a national trend toward including a specific course in earth science in the junior-or senior-high school science program. Although rapid growth has been relatively recent, pre-college earth-science courses, or courses that contained units on earth science have been offered for many years. According to Stone (1962):

> "For more than a century, earth science had been widely taught under the title of physical geography or physiography, and in the latter part of the nineteenth century this subject was selected by more secondary school pupils than any of the other sciences offered at the time."

This trend soon changed and by the early 1920's general science had begun to replace physical geography (considered equivalent to earth science and hereafter referred to as earth science) in the science curriculum. Part of this decline Orgren (1969) attributes to the fact that:

> "General science was promoted as an ideal introduction to science; it promised to examine topics from biology, chemistry, physics--all the sciences. But even more importantly, it promised to pay particular heed to the method of science and to be much less concerned with lists of facts to be memorized. Also, it professed a strong interest in man as the focus of his natural environment."

Kendall (1968) explained the decline in earth-science enrollments in this manner:

> "In the 1890's and early 1900's the earth science course offered in the schools consisted of one-semester courses in astronomy and geology, or in some instances courses called physical geography. With the development of refined requirements in chemistry and biology, and the invention of a descriptive, technology-oriented course called general science, interest in earth science dwindled. Some of the subject matter of geology and astronomy was carried over to general science but the treatment was brief and superficial. By mid-twentieth century the study of geology and astronomy had virtually vanished and physical geography had turned into social studies, eliminating much of the study of the physical features of the land and atmosphere in favor of an emphasis on cultural and economic aspects."

Thus, by the late 1940's earth science had virtually disappeared from the curriculum in most states. An examination of the data in Table 1 indicates that the percentage of students enrolled in earth science in grades 9-12 declined from nearly 30 per cent in 1900 to .4 per cent by 1949. Furthermore, by 1949, nearly 21 per cent of all students were taking a general science course.

In the Biennial Survey of Education in the United States - 1948-50, (1951), it was reported that "seventy-two per cent of all pupils in grades 7 and 8, and 65 per cent of all pupils in grade 9 were registered in general science in 1949." Although the decline in earth science enrollments appeared to be part of a nationwide trend, some states, and in particular New York, continued to offer courses in earth science.

TABLE 1

ENROLLMENTS, BY PERCENTAGES, IN VARIOUS SCIENCE COURSES OFFERED IN GRADES 9-12 OF PUBLIC SCHOOLS OF THE UNITED STATES, 1890 TO 1949[A]

Year	Total Enroll-ment	Biology	General Science	Earth Science	Geography	Physics	Chemistry
1890	202,963					22.8	10.1
1900	519,251			29.8		19.0	7.7
1910	739,143	1.1		21.0		14.6	6.9
1915	1,165,495	6.9		15.3		14.2	7.4
1922	2,155,460	8.8	18.3	4.5		8.9	7.4
1928	2,896,630	13.6	17.5	2.8	.3	6.8	7.1
1934	4,496,514	14.6	17.8	1.7	2.1	6.3	7.6
1949	5,399,452	18.4	20.8	.4	5.6	5.4	7.6

[A] Data from Biennial Survey of Education in the United States - 1948-50 (1951).

In describing the background of the earth-science course in New York, Ming (1968), indicated that "instruction in earth science, under one name or another, has been going on in the state since as far back as 1836." Ming further states that:

> "The earth science offered in the State around the turn of the century was essentially a course in physical geology, often known as physiography; the course was particularly popular in the schools of the New York City-Long Island area. During the early years of the present century, instruction in earth science lost ground as greater emphasis was placed on other science courses."

Ming also reported that in 1939 the course was reorganized and was renamed Earth Science. The new course represented not only a change in name but also a change in content since it included more

work in the disciplines of astronomy and meteorology. In 1949, another change in emphasis took place which resulted in an increase in earth-science enrollments throughout the state.

Stone (1958) describes the change in this manner:

> "In that year an experiment designed to take care of individual differences as far as science interests and aptitudes are concerned was tried out by one school. The experiment consisted of having carefully selected science-minded ninth-year pupils take earth science rather than the ninth grade general science. The results that year were so satisfactory that the same school has continued the program without interruption and has been joined by 94 other schools with a total of 117 ninth year earth science classes throughout the state."

A comparison of enrollment figures indicates how rapidly the course in earth science has developed since 1949. During the 1951-52 school year, courses in earth science were offered to 9,993 students in New York State (Stone, 1962). By 1967, there were more than 54,000 students enrolled in earth-science courses (Matthews, 1968). Encouraged by the initial success of the New York program and other activities such as the International Geophysical Year, Project Mohole and the space program, other states began to expand their earth science programs.

In 1959, the Pennsylvania Department of Public Instruction reorganized its science curriculum and introduced the course in earth science as a ninth grade alternative to general science or as an extra high school science course (Moss, 1959). This decision led to a rapid increase in earth-science enrollments throughout the state. There were nine Pennsylvania schools offering courses in earth science to approximately 800 students during the 1957-58

school year (Kosoloski, 1962). By 1969, courses in earth science were being taught to over 118,000 students in more than 800 Pennsylvania schools (Geyer and Shirk, 1970).

In a survey of earth-science enrollments in New Jersey, Laux (1962), reported that "the incidence of earth-science courses in the New Jersey secondary school science sequence had increased tremendously (600 per cent) between 1956-57 and 1961-62." In a more recent report, Pollock (1968) indicated that by 1966 "earth science was being taught in 20 of the 21 New Jersey counties."

Kendall (1968), reported that in Connecticut, 27 schools offered a course in earth science during the 1959-60 school year. By 1967, approximately 80 per cent of Connecticut public secondary schools offered a course in earth science to about 20,000 students.

Although much of the early growth in earth-science enrollments took place in eastern schools, by 1964 this trend had become nationwide. A survey conducted by the Earth Science Curriculum Project indicated that schools in all 50 states and the District of Columbia planned to offer courses in earth science during 1963-64 (Matthews, 1964). In addition to the impetus supplied by the revised earth-science programs in Pennsylvania and New York, much of the recent growth of earth science can be attributed to the development of the Earth Science Curriculum Project and other earth-science programs.

The Earth Science Curriculum Project (hereafter referred to as ESCP) was developed as a direct result of the Duluth Conference, which was organized by the American Geological Institute (AGI) and was held on the campus of the University of Minnesota in the summer

of 1959. Kline (1966) described the conference as follows:

> "At this conference a source book for teachers was produced by a group of 32 writers. This source book was published by Holt, Rinehart and Winston, Inc., in 1962 as the Geology and Earth Sciences Sourcebook for Elementary and Secondary Schools. Encouraged by its initial effort, the AGI decided to initiate a major interdisciplinary course-content improvement program in the earth sciences. Funds to support the initial phase of the project, formally designated the Earth Science Curriculum Project (ESCP), were granted by the National Science Foundation early in 1963."

Since then the project has developed rapidly, and conservative estimates indicate that over three quarters of a million junior high school students have used the ESCP materials (Romey, 1970). In addition to the textbook and teachers guide, ESCP has also produced a series of reference pamphlets, four major films and the ESCP Newsletter that have served to keep teachers and interested persons informed of the activities and progress of ESCP. The Earth Science Curriculum Project terminated most of its activities in June, 1970, but the American Geological Institute continued its effort to improve earth-science education by developing the Earth Science Teacher Preparation Project (ESTPP), and the Environmental Studies for Urban Youth (ES).

Another program developed which was earth-science oriented was the Junior High School Science Project developed at Princeton University. The course developed is entitled Time, Space, and Matter: Investigating the Physical World and is intended for use in the junior high school.

Ferris (1963) describes the course in this way:

> "The course represents several changes from the traditional pre-high school science program. For example, there is no textbook for the student. The keynote of the course is action, and the student makes things happen. He conducts a series of open-ended investigations, and he records all his observations made in class, at home, and in the field. These observations are constantly refined and corrected as the student increases his understanding of the physical world. With the cumulative summary of his investigations, the student quite literally builds his own textbook."

Thus, the course is almost entirely laboratory oriented based upon the concepts of inquiry and "open-ended" laboratory investigations.

With the development of the ESCP and Time, Space, and Matter programs, other inquiry-oriented earth science programs soon appeared. Among these were the Science Research Associates (SRA), Inquiry Development Program in Earth Science. The SRA program was developed by J. Richard Suchman and L.W. McCombs and uses the inquiry method of learning in which students formulate and test their own theories to account for phenomena they have observed. Although the SRA program has not attained the popularity of the ESCP and Time, Space, and Matter programs it is unique in that it provides the student with a close approximation of the methods of inquiry used by professional geologists in the field.

As a result of the rapid development of the new courses in earth science there soon developed a critical need for teachers qualified to teach the course. Although many new teacher-preparation programs in earth science have been initiated in recent years, the shortage of teachers with strong academic preparation in the earth

sciences remains a serious problem. This fact was pointed out in a recent study by Passero (1970) in which he stated:

> 1. Secondary earth-science teachers are generally poorly prepared to teach the subject, and although the situation is improving slightly, much remains to be done.
>
> 2. Many earth-science teachers are former general science or biology teachers who already possess the bachelor's degree.
>
> 3. Graduate programs for earth-science teachers preparation are being developed at such a rapid rate that it is questionable whether adequate planning preceded their implementation.
>
> 4. There is a very definite need for qualified earth-science teachers.

Although courses in earth science have developed rapidly during the last decade, relatively little research has been conducted in an attempt to evaluate existing earth-science programs. In a recent article, Champlin (1970), stressed the need for additional research in earth-science education. Champlin stated that additional research was needed in such areas as "pupil characteristics and behavior" as well as "teacher characteristics and behavior."

It is apparent then, that as the role of earth-science education has become better defined, additional information is needed regarding the academic preparation of earth-science teachers, their effectiveness in the classroom, the achievement of their students, and the opinions of teachers and students concerning the earth-science course. Certainly such information is needed in order to improve the quality of earth-science education and to facilitate the evaluation of existing earth-science programs, and it is for these

reasons that this study was undertaken.

The Problem

The overall purpose of this study was to identify some of the factors related to student achievement and student ratings of teachers in typical earth-science classrooms. Factors selected for study included student achievement, student ratings of teacher performance, teacher perceptions of the class, the academic preparation of the teachers and student opinions concerning the earth-science course. Specifically, this study was undertaken in order to determine:

1. What relationships exist between student achievement and some of the distinguishing characteristics of the teachers?

2. What relationships exist between student achievement and the educational background of the teachers?

3. What relationships exist between the nature of the school environment and student achievement?

4. What relationships exist between student achievement and the characteristics of the students themselves?

5. What relationships exist between student opinions concerning the earth-science course and student achievement?

6. What relationships exist between ESCP and non-ESCP students and student achievement?

7. What relationships exist between student achievement and the students' perceptions of their teachers?

8. What relationships exist between ESCP and non-ESCP students and the manner in which they perceive their teacher?

9. What relationships exist between student opinions concerning the earth-science course, and the way

in which they perceive their teachers?

10. What relationships exist between student perception of their earth-science teacher, and the manner in which teachers perceive the classes?

CHAPTER II

REVIEW OF RELATED RESEARCH

A review of the literature that was identified as being related to earth-science education and teacher evaluation indicated that the research studies identified could reasonably be divided into the following categories, namely: (1) that related to the academic preparation of earth-science teachers, (2) that concerned with the evaluation of various earth science programs, and (3) that related to the measurement of teacher effectiveness.

Research Related to the Academic Preparation of Earth-Science Teachers

Since the early 1960's, the number of earth-science courses offered in secondary schools has increased at a rapid rate. As the number of schools offering courses in earth science has increased, there developed a critical need for qualified earth-science teachers. This need was recognized as early as 1959 when Brown (1959) reported in a survey he conducted that most general-science teachers were poorly prepared to teach earth science. In his study, Brown examined the credentials of 203 teachers of general science who were candidates for participation in the General Science Seminar that was held during the 1958 Summer Session at Colorado College in Colorado Springs. In classifying the candidates, Brown "considered that less than 10 semester hours of a particular science is unsatisfactory, 10 to 29 hours satisfactory, and 30 or over excellent preparation to teach

at the levels involved." His survey revealed that 88.7 per cent of the applicants had unsatisfactory backgrounds in earth science while only 10.3 per cent had a satisfactory background, and 1 per cent had an excellent background. In addition, he reported that 46.2 per cent of the candidates had no formal training in earth science. In conclusion, Brown stated, "The reason that there is so little interest in the Earth Sciences is that the teachers who introduce our children to the whole field of science are so poorly informed about our science."

Moss (1962) reported another study dealing with an analysis of the applications to an Earth Science Teachers Institute held at Franklin and Marshall College during the summer of 1961. Of the 279 applicants who were teachers of earth science, Moss reported that only 169 of the 279 teachers had taken one or more courses in geology, and only 15 had taken at least one course each in geology, meteorology, and astronomy. Although the average number of courses the group completed in the areas of mathematics, biology, chemistry, and physics was 13.4, the average in geology, meteorology, and astronomy was only 1.4. Moss reached a conclusion similar to Brown's (1952), when he stated that it was painfully obvious that schools are assigning poorly prepared teachers to the earth-science courses.

Laux (1962), in a survey of earth-science teachers in New Jersey, reported findings similar to those of Moss. Seventy-two schools and 109 teachers of earth science took part in the survey that was conducted during the 1961-62 school year. An analysis of the data revealed that "slightly more than half of the teachers had taken one

or more courses in geology, but only about one-third of the respondents had completed course work in astronomy or meteorology, and only 10 per cent had studied oceanography." In addition, Laux reported that ". . . twenty per cent had not earned a single credit in any of the earth sciences, and sixty-nine per cent had fewer than nine total credits in the earth sciences."

Sarner and Edmund (1963), in a study of the science backgrounds of applicants to an Earth Science Institute offered at Temple University, reported similar findings. "Almost 10 per cent of the sample had had no biology and almost 25 per cent had had no chemistry, while over 25 per cent had had no physics and over 50 per cent had done no work in earth science."

In a more comprehensive survey of applicants for several Earth Science Institutes in Oklahoma and Texas, Boyer and Snyder (1964), concluded that "the survey results confirm the urgent need for additional training of these secondary-school teachers." Their study revealed that "only 25 applicants (2 per cent) had geology degrees — 24 bachelor's and one master's degree — and all applicants averaged only 5.9 course hours total in all the earth sciences . . . ."

Somewhat different results were reported by Skinner and Davis (1965) in their survey concerned with the preparation of earth-science teachers in Ohio in which 53 teachers of secondary earth science participated. An analysis of their academic preparations revealed that almost one-fourth of the teachers reported undergraduate majors in one of the earth sciences. A further analysis indicated "that only 6 of the 53 teachers have taken <u>no</u> college credits in the earth

sciences and that nearly two-thirds have more than 10 credit hours in these fields. The mean number of semester hours of credit in earth science is 21." Skinner and Davis indicated that the relatively strong backgrounds of earth-science teachers in Ohio could be attributed to their participation in NSF Summer Institutes as well as the "cautious introduction of this course into the state's high schools."

Several studies concerning teacher preparation have been conducted by members of the Earth Science Curriculum Project staff. A survey conducted by Shrum and Thompson (1966) further confirmed the inadequate academic preparation of many earth-science teachers. The sample included 315 Earth Science Curriculum Project (ESCP) teachers, and 2,480 other earth-science teachers. The survey revealed that over 50 per cent of the teachers had not taken courses in astronomy, more than 60 per cent had no course work in meteorology, and almost 90 per cent had no formal training in oceanography. The average number of semester hours in the earth sciences completed by the ESCP teachers was 22.4 while the non-ESCP teachers averaged 18 semester hours.

Almost identical findings were obtained in another survey of earth-science teachers conducted by the ESCP staff (1967) during the 1966-67 school year. Over half the teachers responding reported little or no background in astronomy, meteorology and oceanography and the average number of semester hours in various earth-science courses was similar to that revealed in previous studies.

Results from the study conducted by Shrum and Thompson (1966)

were compared with more recent data collected by the ESCP staff (1968). A comparison of the data from the two studies revealed that there was a general improvement in the earth-science background of the 1968 group as compared with that of the 1965 sample. However, 10 per cent of the teachers in the 1968 survey had not taken a course in any earth-science area.

As part of a more extensive study of the eighth-grade earth-science program in Texas schools, Kline (1966) assessed the academic preparation of 491 teachers of earth science. He reported that ". . . 86 per cent of the teachers reporting had no courses in astronomy; in meteorology, 87 per cent reported no courses; in oceanography, 94 per cent reported no courses; in earth science, 58 per cent reported that they had taken no courses; and 70 per cent reported that they had taken two or less courses." Kline concluded that "the teachers reporting were not prepared to teach earth-science courses in the eighth-grades of Texas."

In a recent report, Geyer and Shirk (1970), analyzed the development of the course in earth science in Pennsylvania schools from 1958 through 1968. They reported that whereas "in 1958 few if any teachers teaching the earth-science course had an earth-science background, in 1968, approximately 10 per cent of the sample studied specialized in earth science at the undergraduate level." Eighty per cent of the teachers participating in the 1968 survey indicated that they had not elected even one course in the earth sciences.

Qutub (1970) studied the status of earth science in the state of Illinois in which a total of 652 teachers reported on their

academic preparation in the earth sciences. Of this number, 47 per cent had not taken a single course in geology, and ninety per cent had not elected a course in oceanography. He also reported that ". . . 69 per cent had never taken a course in astronomy . . . 71 per cent never studied meteorology . . . and about one-third of the teachers had not taken any course work in any of the earth-science disciplines . . . ."

The research cited in this section indicates that despite efforts to improve the quality of the education of teachers of earth science, a great number of earth-science teachers are poorly prepared to teach the subject. Although several studies, Shrum (1963), Mayer (1967), and Passero (1970), have examined the problem of educating earth-science teachers in depth and have suggested programs for re-training, much still needs to be done in terms of teacher preparation.

Research Related to the Evaluation of Existing Earth-Science Programs in Secondary Schools

Interest in the evaluation of earth-science programs has increased in recent years, probably because of the ESCP program. However, when the numbers of studies dealing with the evaluation of science programs in other areas, are compared with those for earth-science programs, it is evident that the latter are relatively scarce. In a recent article, Champlin (1970) acknowledged this phenomenon and stressed the need for additional research in earth-science education. The studies reviewed in this section include only

those concerned with the evaluation of existing earth-science courses.

Many of the early studies dealing with courses in earth science involved achievements of students in earth-science courses with students in a general science. Kosoloski (1962) reported on a study conducted by the Pennsylvania Department of Public Instruction in which scores of ninth-grade students receiving instruction in these two science programs were compared. "The two types of groups tested involved (1) students receiving instruction for one year in a course specifically labeled Earth and Space Science, and (2) students who for one year were enrolled in a regular General Science program." Both groups were administered a test developed by a teacher of earth science who checked the test items against the Pennsylvania Earth and Space Science program and submitted the items to a committee of teachers of Earth and Space Science for review. An analysis of the results revealed that "the results showed conclusively that the ninth grade Earth and Space Science students were superior to the ninth grade General Science in the area tested." The results from this study must be viewed with caution since the results showed only that general science was not teaching students earth science as well as it was general science.

In another study, Toohey (1963) compared the effects of laboratory versus lecture methods of instruction in earth science and general-science classes on student achievement. The comparisons made with the two groups dealt with achievement in subject matter, their retention of science subject matter and their ability to read and comprehend subject matter. One hundred and fifty students enrolled

in the ninth grade participated in the study and were divided into four experimental groups and one control group. The groups were then given a series of tests during the school year, including a science background test, a test of reading and of comprehension of science subject matter and other tests to measure intelligence and retention of science subject matter. From an analysis of the data, Toohey concluded the following:

> "1. The earth-science course of study is significantly superior to the general-science course of study for increasing ninth-grade student achievement of science subject matter.
>
> 2. The science achievement of students enrolled in earth-science and general-science courses of study is significantly superior to the science achievement of those students who take no formal course in ninth grade science.
>
> 3. The earth-science course of study is significantly superior to the course of study in general science with respect to developing the ability of students to read and comprehend science subject matter.
>
> 4. The laboratory method of teaching is significantly superior to the lecture method of teaching both earth-science and general-science courses of study, because students retain significantly more subject matter when taught by the laboratory method."

As a result of his findings, Toohey recommended that the course in earth science replace the general-science course and that it be taught by "laboratory methods".

In a more recent study Coleman (1970), compared the effects of ESCP and General Science on the development of interdisciplinary science concepts by ninth-grade students. The study was conducted over a period of eight months and involved one hundred fifty ESCP students from 9 classes, and one hundred fifty general-science

students from 7 classes. The criterion measure used was the Test of Scientific Knowledge (TOSK) that was administered at the beginning and end of the school year. An analysis of the data indicated that "when the initial differences between pre-test scores of the two groups were controlled, there was a significant difference in achievement between the two groups . . . and . . . the ESCP course was more effective in student development of interdisciplinary science concepts."

Somewhat similar studies were conducted by Sargent (1966) and Schirner (1967) in an attempt to identify the effect of teacher behavior in the classroom on student achievement. In his study, Sargent (1966) attempted to measure student achievement in authoritarian and in permissive classrooms. The authoritarian and permissive teachers were identified using McGee's F-Scale: Form 30. The findings indicated that student achievement in authoritarian and permissive classrooms differed significantly with teachers having different academic majors. The findings also revealed that student achievement in authoritarian and permissive classrooms did not differ significantly between teachers who held the bachelor's degree and those who held a master's degree. Sargent also reported that gains in achievement differed significantly when authoritarian teachers who had from thirteen to twenty-four semester hours of education were compared to those who had zero to twelve hours.

Schirner (1967) also investigated the effects of the teacher variable, using both ESCP and non-ESCP students. He examined the effects that the teachers' verbal behavior, philosophical orientation,

and type of course had upon various student outcomes, such as: the students understanding of science, their critical thinking ability and their basic knowledge of the principles, methods and procedures of science. Schirner used six pre-tests and post-tests to measure student outcomes. His major findings follow:

> "1. The ESCP students do significantly better on the ESCP final examination whereas the non-ESCP students do significantly better on the Earth-Science Final.
>
> 2. The ESCP students develop into significantly better critical thinkers as measured by scores on the Watson-Glaser Critical Thinking Appraisal than the non-ESCP students.
>
> 3. The compatibility of the factors represented by ID ratio (a measure of teacher directness or indirectness), TNT ratio (the teachers expressed philosophical orientation), and the type of course lead to significantly greater achievement in most student outcomes."

Several other studies have been undertaken in which the achievements of ESCP and non-ESCP students were compared. These include those reported by Champlin (1970) in his review of research related to earth-science programs.

One of the studies he reviewed was that of the Psychological Corporation that was conducted during the initial phase of the ESCP evaluation program. The study was national in scope and involved teachers and students from various parts of the country. The experimental group involved those students using ESCP materials and the control group, those studying conventional earth science. Several pre- and post-test measures were administered to both groups.

In reporting the results of the study, Champlin (1970) indicates that the experimental group scored higher than the control group on

both the Differential Aptitude Test (DAT) and the Test on Science Knowledge (TOSK). Similarly, it was found that the ESCP group scored significantly higher than the control group on the ESCP Comprehensive Final. Champlin (1970), however, states that the results of the study must be viewed with caution . . . "since the examination was written to test the achievement of ESCP students . . . and . . . that since the groups were not randomly selected, systematic bias such as better teachers and laboratory facilities for the ESCP groups may have influenced the results."

Champlin (1970) also reviewed a study by Champlin and Hassard in which different results than those stated above were revealed although similar criterion measures were used. An analysis of the results failed to indicate a statistically significant difference between the test scores of the ESCP and non-ESCP students on the ESCP Comprehensive Final or on the Test on Science Knowledge. "Thus, The Psychological Corporation Study reported a cautious difference in favor of the experimental ESCP groups when compared with the control group of non-ESCP students. Champlin and Hassard, on the other hand, reported no significant differences in a similar study with a smaller sample (Champlin, 1970)."

Champlin (1970), also cited a study by Mooney designed to determine if the ESCP course could replace a half-year earth science-half year physics course taught in the Richmond, Virginia public schools. The population consisted of 400 students divided equally into control and experimental groups. Both the control and experimental groups were administered several tests and gains in achievement

were compared. In reporting the results of the study, Champlin (1970) stated that "results from the testing . . . failed to demonstrate a significant difference . . . and . . . it was therefore determined that ESCP could replace the half-year earth science-half year physics course and produce the same achievement."

As compared with the ESCP program relatively little research has been conducted using the Time, Space, and Matter (TSM) program. In one study, however, Friend (1969) compared the relative effectiveness of two methods of teaching TSM with selected eighth-grade pupils. The primary purpose of the investigation was to determine whether the pupil-inquiry method was superior to a teacher-directed method of teaching TSM. Friend used the Watson-Glaser Critical Thinking Appraisal, the Test on Understanding Science and a teacher constructed test as the measuring instruments. Based on an analysis of various difference scores between pre- and post-test he made the following conclusions:

> "1. The pupil-inquiry method of teaching TSM is a more effective method of developing eighth grade pupils' understanding of the methods of science than the teacher-directed method.
>
> 2. The pupil-inquiry method of teaching TSM is a more effective method of developing bright eighth grade pupils' understanding of the methods of science than the teacher-directed method.
>
> 3. The pupil-inquiry method of teaching TSM is a more effective method of developing average eighth grade pupils' understanding of the methods of science than the teacher-directed method.
>
> 4. Neither method is superior to the other in developing the critical thinking ability of

eighth grade pupils, whether they are bright or average.

5. Neither method is superior to the other in the teaching of science facts and principles to eighth grade pupils whether they are 'bright' or 'average'."

Wynne (1969) attempted to determine the "effectiveness of the TSM program in developing students' ability to apply basic science processes, in developing their awareness of the probabilistic nature of knowledge, in increasing their knowledge of general science content, and in improving their attitude toward science as a school subject." He used the achievements of students in general science and earth science as a basis for comparison. Using various criterion measures, Wynne reported that the TSM approach is more effective than the general-science approach in helping students learn to apply science processes, understand the "probabilistic" nature of knowledge, and learn the facts of general science. He also reported that the earth-science approach was comparable in effectiveness in helping students learn to apply science processes and learn the facts of general science. As a final conclusion, Wynne reported that no one of the approaches had a greater effect than another on the attitudes of the children towards science and that the TSM program was not consistently more effective at either the eighth-grade or ninth-grade level.

Of the five studies reviewed comparing student outcomes in ESCP versus non-ESCP courses, the studies by the Psychological Corporation as cited by Champlin (1970), and those by Schirner (1967), and Coleman (1970) all favored the ESCP group. The studies by Champlin and

Hassard as cited by Champlin (1970), and Mooney, as cited by Champlin (1970), failed to elicit significant differences between student achievement in ESCP and non-ESCP programs. An evaluation of these studies does not lead to any definite conclusion concerning the superiority of the ESCP course over the more conventional earth-science program. Similarly, since only two studies were reviewed in which the Time, Space, and Matter program was evaluated, there is little conclusive evidence to suggest the superiority of the TSM course over the more conventional earth-science programs.

Research Related to the Measurement of Teacher Effectiveness

A search of the literature revealed no studies which were related specifically to the teaching effectiveness of the earth-science teachers. However, much literature has accumulated over the years regarding teacher effectiveness. The studies reviewed here include only those that influenced the experimental design of this study.

Much of the early research concerned with teacher effectiveness was concerned with the reliability of student ratings in revealing teacher behavior. One of the investigators who pioneered the use of student rating scales was Remmers. From a study he conducted in 1930 using the Purdue Rating Scale for Instructors, Remmers (1930) reported that as the number of students rating the teacher increased to thirty, the reliability of the instrument increased to .97. In a later study, Remmers (1934) concluded "that students could make reliable judgements about the classroom traits of teachers."

Starrack (1934) reported findings similar to those of Remmers'. He concluded that the use of student ratings of instructors tended to increase the teaching effectiveness of the faculty. Starrack also reported that the ratings received by teachers tended to increase with successive ratings, and that the academic ability of the student does not seem to be related to the rating given the teacher.

Young (1939) reported on a study in which he attempted to measure some of the factors affecting high-school teachers' effectiveness as measured by principals' ratings. An analysis of the ratings of the 1,521 teachers who were included in the study revealed that the teachers with higher academic degrees were rated higher than those with lower academic degrees. It was also reported that the teachers who had 24 or more semester hours in Education were rated higher than those who had less than 24 semester hours in Education. Young also reported that teachers with extensive training in their fields of specialization were rated higher than those who had less training.

In conclusion, Young stated that "the successful completion of more than 24 semester hours of college credit in subject matter in one's teaching field, and the completion of more than 24 semester hours of college credit in Education, combined with teaching experience, tend to make one a more efficient teacher."

Several studies have been completed by Bryan involving the use of pupil ratings of teachers. In a study involving both junior- and senior-high-school students, Bryan (1937) reported the average ratings received by junior- and senior-high-school teachers on

different items show great similarity. Additional data failed to reveal significant differences between the ratings by pupils of high intelligence and those of pupils of low intelligence.

Other studies by Wharton (1968), Hess (1970), Hauss (1970), and Torrence (1970), dealt with additional aspects of teacher effectiveness. Wharton (1968) investigated the relationship between selected student characteristics and student ratings of teacher effectiveness. These characteristics were sex, intelligence, overall high-school grade point average, grade received from the teacher being rated, ethnic group membership, preference for the subject, personal acquaintance with the teacher, and contact with the teacher in extracurricular activities. An analysis of the ratings of forty-six teachers revealed that course rating, course grade, personal acquaintance with the teacher, and contact with the teacher in extracurricular activities were all statistically significantly related to the ratings of the teacher.

Hauss (1970) and Hess (1970) conducted studies similar to those just mentioned involving an assessment of the relationship of selected variables to teacher effectiveness as determined by the building principal. Although one study involved elementary teachers and the other secondary teachers, similar findings were revealed in both studies. Both studies indicated that the age of the teacher, and years of teaching experience are related to teacher effectiveness, with the most effective teachers being 35 years or younger, and with two to ten years of experience.

In a study completed at Western Michigan University, Wilson

(1971) conducted a comprehensive study to identify factors related to student ratings of teachers. The investigation consisted of analyzing data obtained previously that were descriptive of teachers, the teaching situation, and the teachers' perceptions of the class, and determining how such data were related to student ratings of teachers. The subjects for the investigation consisted of secondary teachers served by the Educator Feedback Center at Western Michigan University during the years 1968-70. A total of 1,180 teachers were rated by 51,966 students providing a composite of 2,100 class reactions to characteristics of teacher performance.

Analysis of the data revealed that the teacher's perception of the class, the marital status of the teacher, experience of the teacher, age of the teacher, type of community and graduate major of the teacher were related to student ratings at a high level of confidence and were found to account for a significant portion of the variance in criterion measures. The factors that seemed relatively unrelated to student ratings of teachers included the interaction effect of type of community and socio-economic status of the community, class subject, teacher sex and the undergraduate major of the teacher.

A review of the literature cited in this section reveals that student ratings of teachers seem to represent a valid means of assessing teacher effectiveness, but should not be the only criteria upon which effectiveness is determined. The studies reviewed revealed that in many cases there is a relationship between teacher effectiveness and such variables as student achievement, teacher age,

size of community, size of class and other situational variables.

CHAPTER III

DESIGN AND METHODOLOGY

Purpose

The design of, and methods used in, this study are described under five major headings: (1) Definition of Terms, (2) Review of the Problem, (3) Population and Sample, (4) Procedures, and (5) Statistical Techniques Employed.

Definition of Terms

The following definitions were adopted to delineate terms used throughout the study.

1. ESCP earth-science students and teachers are the science students and teachers included in this study who use the textbook and program of the ESCP curriculum.

2. Non-ESCP students and teachers are the teachers and students included in this study who use materials other than the ESCP in the classroom.

3. Student achievement refers to the gains made by students between the two administrations of the *Dubins Earth Science Test: Form A* and *Form B*.

4. Student ratings of teachers refer to the students perceptions of their teachers overall performance as indicated by the mean of the ratings assigned by the class to each of the teacher characteristics measured by the Earth Science Teacher Image Questionnaire (TIQ).

A copy of this form is included in Appendix A.

5. The educational background of the earth-science teachers refers to the numbers of semester hours of courses in earth science, geology, chemistry, mathematics, and Education the earth-science teachers have earned at both the undergraduate and graduate levels.

6. The Earth Science Class ID Form is the form completed by all teachers in the study. The form elicited information concerning their ages, educational backgrounds, and other relevant characteristics. A copy of the form is included in Appendix A.

7. The opinions of earth-science teachers are measured by their responses to items 11, 12, and 15 on the Earth Science Class ID Form.

8. The opinions of earth-science students refers to the responses of students to items on the Earth Science Student Opinion Questionnaire. A copy of this questionnaire is included in Appendix A.

9. The teacher perception of the class refers to a mean of the ratings assigned by the teacher to the class characteristics of ability, behavior, attitude, and industry. This information was obtained from responses to question 27 of the Earth Science Class ID Form.

10. The school environment refers to factors such as the type of community in which the school is located, the size of the school, and the type of facilities the school has provided for learning.

11. Teacher characteristics refer to the factors such as age, sex, marital status, and teaching experience of the earth-science

teachers.

12. Student characteristics refer to factors such as the type of curriculum in which students are enrolled, sex, grade level, vocational plans, and their opinions of the earth-science course.

Review of the Problem

The purpose of this study was to investigate some of the factors that are related to student achievement and student ratings of teachers in typical earth-science classrooms.

Specifically, the research sought to elicit answers to the following questions:

1. What relationships exist between student achievement and some of the distinguishing characteristics of the teachers?

2. What relationships exist between student achievement and the educational background of the teachers?

3. What relationships exist between the nature of the school environment and student achievement?

4. What relationships exist between student achievement and the characteristics of the students themselves?

5. What relationships exist between student opinions concerning the earth-science course and student achievement?

6. What relationships exist between ESCP and non-ESCP students and student achievement?

7. What relationships exist between student achievement and the students' perceptions of their teachers?

8. What relationships exist between ESCP and non-ESCP students and the manner in which they perceive their teachers?

9. What relationships exist between student opinions concerning the earth-science course, and the way

in which they perceive their teachers?

10. What relationships exist between student perception of their earth-science teacher, and the manner in which teachers perceive the classes?

Population and Sample

Population and sampling procedure

Since several visits were to be made to those schools participating in the study, it was desirable to limit the size and geographic location of the sample. Consequently, it was decided to limit the population to public schools not farther than 150 miles from Kalamazoo and within the state of Michigan. The schools selected were obtained from a list of schools offering earth science prepared by Cranson (1969). Forty-four schools on his list met the geographic requirements stated above.

A letter explaining the purpose of the study and a cover letter written by Dr. George G. Mallinson, Dean, The Graduate College, Western Michigan University were sent to the principals of each of the 44 schools. Also included was a self-addressed, postage-paid envelope with a return form on which the principal could indicate whether personnel in his school system might be willing to discuss participation in the study. The principal was also asked to indicate the names of those teachers who taught at least one earth-science course and might be willing to participate in the study. Copies of the letter and questionnaire sent to the high-school principals and the cover letters appear in Appendix B.

A total of 29 affirmative replies were received. Of the

remaining 15 schools contacted five did not respond, eight did not offer earth science but were offering physical or general science, and two replies were negative. Upon receipts of an affirmative reply, person-to-person telephone calls were placed to the principals of each of the schools to schedule meetings with them and their earth-science teachers during May and June 1970. At these meetings a copy of the form entitled "Description of the Study" was given to each person present. A copy of this form is included in Appendix B. Also, copies of tests and other forms to be used were distributed, and any questions concerning the study were answered and the responsibilities of the school and the teacher were described. The selection procedure described was based on similar procedures used by Poel (1970) and by Van Koevering (1969). As a result of these selection procedures, 29 schools and 45 teachers agreed to participate.

The final sample included 43 teachers and 28 schools, since one teacher transferred schools, and another teacher taught earth science as a one-semester course. A description of the sample is included in Table II.

Procedures

Instruments and procedures used

Two questionnaires were administered to the earth-science students: (1) the Earth Science Teacher Image Questionnaire in which the students evaluated their earth-science teachers, and (2) the Earth Science Student Opinion Questionnaire in which students gave information concerning the earth-science course in which they were

TABLE II

Summary of Sample

School Name	Number and Sex of Participating Teachers		Earth-Science Textbook Used	Grade Level	Numbers of Students
	Male	Female			
Climax Scotts Jr. High	1	-	*Modern Earth Science*, Ramsey, *et al.*	7	34
Colon H. S.	1	-	*Modern Earth Science*, Ramsey, *et al.*	8	26
Comstock H. S.	1	-	*Modern Earth Science*, Ramsey, *et al.*	9-12	29
Delton Kellogg H. S.	1	1	*Modern Earth Science*, Ramsey, *et al.*	9-12	79
Gobles H. S.	1	-	*Modern Earth Science*, Ramsey, *et al.*	9-10	55
Godwin Heights H. S.	1	-	*Modern Earth Science*, Ramsey, *et al.*	9-12	48
Homer Comm. School	-	1	*Modern Earth Science*, Ramsey, *et al.*	8-9	27
Hopkins H. S.	1	-	*Modern Earth Science*, Ramsey, *et al.*	8	90

TABLE II (continued)

School Name	Number and Sex of Participating Teachers		Earth-Science Textbook Used	Grade Level	Numbers of Students
	Male	Female			
Schoolcraft H. S.	1	-	*Modern Earth Science*, Ramsey, *et al.*	9	61
Bloomingdale H. S.	1	-	*Investigating the Earth*, ESCP	9	103
Chelsea H. S.	-	2	*Investigating the Earth*, ESCP	9-12	88
Hastings H. S.	1	-	*Investigating the Earth*, ESCP	9-12	104
Jackson East Jr. High	1	1	*Investigating the Earth*, ESCP	9	100
Niles Ballard Jr. High	2	-	*Investigating the Earth*, ESCP	9	207
Jackson N. E. Jr. High	1	-	*Investigating the Earth*, ESCP	8-9	56
River Valley H. S. (Three Oaks)	2	-	*Investigating the Earth*, ESCP	9	78
Grand Haven Jr. High	1	-	*Earth Science: The World We Live In*, Namowitz, *et al.*	9	49

TABLE II (continued)

School Name	Number and Sex of Participating Teachers		Earth-Science Textbook Used	Grade Level	Numbers of Students
	Male	Female			
Lakeshore Jr. High (Stevensville)	2	1	Earth Science: The World We Live In, Namowitz, et al.	8	159
Portage Central H. S.	-	1	Earth Science: The World We Live In, Namowitz, et al.	10-12	47
Dowagiac Central Jr. High	3	1	Time, Space, and Matter, Secondary School Service Project	8	111
Belleview Jr. High	-	1	World of Matter and Energy, Brandewein et al.	8	63
Byron Center Jr. High	1	-	Matter: Its Form and Changes, Brandewein, et al.	7	56
Harper Creek Jr. High	1	1	Singer Science Series, MacCracken, et al.	7	57
Wattles Park Jr. High	1	1	Singer Science Series, MacCracken, et al.	7	100

TABLE II (continued)

School Name	Number and Sex of Participating Teachers		Earth-Science Textbook Used	Grade Level	Numbers of Students
	Male	Female			
New Buffalo Jr. High	1	-	*Exploring Earth Science*, Thurber, *et al.*	8	51
Burr Oak H. S.	-	1	*Earth Science*, Brown, *et al.*	8	46
Jackson Park Jr. High	3	1	Multiple Text	8	110
Eau Claire H. S.	1	-	*Pathways in Science*, Oxenhorn	8	22

enrolled, their vocational plans, and other information about their science backgrounds.

1. <u>The Earth Science Teacher Image Questionnaire</u> is a one-page version of the two-page Student Opinion Questionnaire developed by the Educator Feedback Center at Western Michigan University. This instrument was selected because it has been found reliable and valid for measuring students' opinions of their teachers. The form consists of sixteen items and covers most of the areas cited in the literature as being important aspects of teaching. A sample of the questionnaire is included in Appendix A.

The questionnaires were delivered to each school during the Spring 1971 and were administered to students in each classroom. The five possible responses to the items were: Poor, Fair, Average, Good, and Excellent. Upon completion of the questionnaires, a student collected those for the entire class and placed the completed forms in a pre-addressed envelope that was then sealed and mailed. Upon receipt of the completed questionnaires, the information was coded and transferred to IBM cards for analysis.

In return for this cooperation, each teacher received a computer printout that contained an analysis of his students' responses to the questionnaire. Included were mean scores for each item, an item analysis, and the standard deviation for responses to each item. A sample computer printout is included in Appendix C.

The Educator Feedback Center in a recent report stated that the reliability coefficients for the different scaled questionnaire items, using 50 teachers (one class per teacher) range from .83 to

.94. Other research by Bryan (1967), using a twelve question version of the questionnaire report reliability coefficients ranging from .77 to .95.

2. The Earth Science Student Opinion Questionnaire was administered to students during the Spring of 1971. In it the students were asked to indicate (1) if they planned to attend college, (2) the other science courses they had taken, (3) whether they thought the earth-science course was interesting, (4) if they would take another course in earth science, and (5) other information including that about laboratory work, their opinions of the course, and the materials presented in the course. The information from these forms was then coded and transferred to IBM cards for analysis. A copy of the form is included in Appendix A.

Student achievement in earth science was measured using the Dubins Earth Science Test: Form A and B (Dubins, 1969). The test is one of a series of science tests published by Harcourt, Brace and Jovanovich. According to the author of the test, the Dubins Earth Science Test measures the extent to which important educational objectives of a typical earth-science course have been attained by students in grades 8 through 12 (Dubins, 1969).

During the Spring 1968, experimental forms of the test were administered to 8,491 students in 57 public schools. An analysis of the responses indicated that the mean values in achievement were 27.2 for Form A, and 27.1 for Form B. Using the split-half method and the Spearman-Brown Prophecy Formula the coefficient of reliability was found to be .88.

The test was published in 1969 and is intended for use in either ESCP or non-ESCP earth-science programs. The percentage distribution of the items with respect to the major areas of earth science for forms A and B respectively are: geology (36.7%, 36.8%); astronomy (25.0%, 26.6%); meteorology (23.3%, 25.0%); and oceanography (15.0%, 11.7%).

The items on the Dubins Earth Science Test were analyzed by the investigator in an attempt to determine if the test was suitable for measuring student achievement in both ESCP and non-ESCP classrooms. Using guidelines which describe the basic principles covered in ESCP as described on pages 3-4 of the Teacher's Guide: Investigating the Earth, each item of the test was examined to determine if it was dealt with in ESCP and in the non-ESCP materials. If an item was one of factual recall it was judged to be of the non-ESCP type, whereas if it conformed with the guidelines set forth in the Teacher's Guide: Investigating the Earth, it was judged to be of the ESCP type. As a result of this analysis it was concluded that the distribution of questions made the test suitable for measuring achievement in both types of programs.

In this study the Dubins Earth Science Test was administered as a pretest by the teachers during the Fall 1970. All test forms and answer sheets were delivered personally to all schools so that all teachers were familiar with the directions of the test. Upon completion of the testing program the tests were collected by the investigator and were scored by the Testing Service of Western Michigan University. Scores for all students were then transferred

to IBM cards for further analysis. Each teacher was then sent a letter describing the pre-test analysis and a computer printout containing the pre-test scores for all participating students. A sample letter and computer printout are contained in Appendix D.

The post-test was administered during the Spring 1971. If a school used Form A for the pre-test, then Form B was used for the post-test. All tests and answer sheets were delivered and collected by the investigator. In turn for their cooperation, all teachers received computer printouts containing gain scores for each of their students and average gain scores for each class. A sample computer printout is contained in Appendix E.

One questionnaire, entitled the Earth Science Class ID Form, was administered to the earth science teachers. On the form, the teachers were asked to respond to items concerning their educational backgrounds, ages, teaching experience, and other teacher-related characteristics. Included with this questionnaire was a one-page form on which teachers rated each of their earth-science classes. If a teacher had more than one class, additional rating forms were provided. The teachers rated each of their classes on its (1) ability, (2) behavior, (3) industry, (4) enthusiasm, and (5) laboratory work. The possibilities for rating were Poor, Fair, Average, Good, and Excellent. These forms were delivered to the teachers by the investigator during May 1971, and were returned upon completion to the investigator in a self-addressed stamped envelope. Upon receipt of a completed form the information was coded and transferred onto IBM cards for further analysis. A sample of the Earth Science Class

ID Form along with a sample class rating form are found in Appendix A.

Statistical Techniques Employed

A variety of statistical techniques were used for determining the nature of the relationships among the dependent and independent variables. The one-way analysis of variance was the most commonly used statistical technique in this investigation. This design was chosen since many of the comparisons involved two or more categories of an independent variable and one dependent variable. The analysis of the differences between means were reported in the form of F ratios. Other analyses involved the computation of ratios for the differences in means between the various combination of cells. The probability of observing these levels by chance was reported at the .05 level of significance.

Since the statistical significance of the association between two variables is related to the size of the sample, several researchers including Hays (1963) suggest that the strength of association should be reported in the data analysis. Determining the strength of association allows the researcher to make inferences with respect to predicting one variable from another. The statistical techniques used to derive the strength of association were r^2 and E^2.

Other analyses included the computation of product-moment coefficients of correlation for analyzing the relationships that might exist between student ratings of the teacher, and teacher ratings of the students. The statistical significance of the coefficients of

correlation, r, was evaluated at the .05 level of significance.

CHAPTER IV

ANALYSIS OF THE DATA

Purpose

The data collected as described in Chapter III were analyzed by analysis of variance models, "t" tests and product-moment coefficients of correlation. The purpose of this chapter is to report the findings and results of the analysis insofar as they are relevant to the questions posed in Chapter III. Included in this chapter are (1) descriptions of the final populations used in the analysis, and (2) the results of the analyses.

Populations Included in the Analysis

Student population

The subjects in this study consisted of all the students who took both the pre- and post-test forms of the Dubins Earth Science Test. These were 1,672 students from 81 earth-science classes. Students were also asked to respond to items on the Earth Science Teacher Image Questionnaire, and the Earth Science Student Opinion Questionnaire. Since all students taking the pre- and post-tests did not complete responses on the other two forms there are differences among sample sizes. Of the 1,672 students who were administered the pre- and post-tests a total of 1,623 responded to items on the Earth Science Teacher Image Questionnaire whereas 1,615 students responded to items on the Earth Science Student Opinion

Questionnaire. Other differences among the sample sizes occurred when students didn't respond to certain items on the Earth Science Student Opinion Questionnaire. Additional data concerning characteristics of the student population are contained in Table III.

TABLE III

Enrollment Characteristics of the Student Population

Curriculum and Sex of Students	Grade Level of Students						
	7	8	9	10	11	12	Totals
ESCP Male	0	14	250	18	8	5	295
ESCP Female	0	10	224	6	7	4	251
Non-ESCP Male	106	265	185	30	13	10	609
Non-ESCP Female	113	215	135	24	16	14	517
Totals	219	504	794	78	44	33	1672

Teacher population

As stated earlier, forty-three teachers from 28 schools agreed to participate in the study. Since some teachers taught more than one class, a total of eighty-one classes were involved. Scheduling problems prevented two classes from completing the Earth Science Teacher Image Questionnaire and the Earth Science Student Opinion Questionnaire, so in some cases, the data reported are for 79 classes. Additional data concerning the teacher population appear in Table IV.

TABLE IV

Characteristics of the Teacher Population

Teacher Code	Sex	Age Bracket	Degree Status	Teaching Experience In Earth Science	Teaching Experience Total
01	M	>39	B.A.	4	14
02	M	25-39	B.S.	1	4
03	M	>39	M.A.	9	11
04	M	25-39	B.S.	2	5
05	F	30-39	B.A.	1	1
06	M	>39	M.A.	4	7
07	M	30-39	M.S.	4	8
08	F	>39	B.S.	4	28
09	M	20-24	B.S.	2	2
10	M	20-24	B.S.	2	2
11	M	30-39	B.S.	3	6
12	F	25-29	B.S.	1	4
13	F	>39	M.A.	1	4
14	M	30-39	M.A.	1	9
15	M	30-39	B.A.	8	8
16	F	20-24	B.S.	1	2
17	M	>39	M.A.	4	12
18	M	30-39	M.A.	5	12
19	M	30-39	M.A.	5	8
20	M	>39	B.S.	3	14
21	M	25-29	B.S.	3	4
22	M	30-39	B.A.	2	9
23	M	30-39	M.A.	3	6
24	F	25-29	B.S.	4	3
25	M	25-29	M.A.	2	4
26	F	30-39	B.A.	7	9
27	M	No response		1	11
28	M	30-39	B.S.	1	4
29	M	20-24	B.A.	1	1
30	F	25-29	B.A.	1	6
31	F	20-24	M.A.	3	4
32	M	30-39	B.S.	4	9
33	F	20-24	B.A.	1	1
34	M	25-29	M.A.	2	4
35	M	>39	M.A.	No response	
36	M	25-29	B.S.	1	5
37	M	>39	B.S.	5	13
38	F	>39	B.S.	6	17
39	F	>39	B.S.	4	8

TABLE IV (continued)

Teacher Code	Sex	Age Bracket	Degree Status	Teaching Experience In Earth Science	Teaching Experience Total
40	M	>39	M.A.	4	9
41	M	25-29	B.S.	1	3
42	M	>39	M.A.	6	13
43	M	30-39	B.A.	1	5

Major Findings

Various characteristics of the earth-science teachers and their students were examined in order to answer the questions posed in Chapter III. These questions, together with the data related to the answers, appear below:

Question 1: *What relationships exist between student achievement and some of the distinguishing characteristics of the teachers?*

Tables V through XI summarize the data and the analyses used to determine the relationship between distinguishing characteristics of the teachers and student achievement. Student achievement in all analyses represents the gains made by students between the two administrations of the *Dubins Earth Science Test*: *Forms A* and *B*. The distinguishing characteristics that were used for comparison purposes included (1) sex of the teachers, (2) age of the teachers, (3) total teaching experience, and (4) earth-science teaching experience.

TABLE V

Analyses of Variance
for the Relationship Between Sex of the Teacher
and Student Achievement

SEX	MEAN	SD	N
Males	6.53	7.50	1251
Females	6.06	7.13	421
Totals	6.41	7.41	1672

Source of variation	SS	df	Ms	F	P	E^2
Between Group	70.00	1	70.00	1.274	$>.05$	.001
Within Group	91789.77	1670	54.96			
Total	91859.77	1671				

The analysis in Table V indicates that a significant (.05) relationship was not found between the average gain score of students having male teachers and those having female teachers. The strength of association, E^2, as determined by the data reveals that less than one per cent of the variance in student achievement can be accounted for by the sex of the teacher.

TABLE VI

Analysis of Variance for the Relationship Between Age of the Teacher and Student Achievement

AGE	MEAN	SD	N
20-24	3.53	7.02	264
25-29	6.03	7.08	310
30-39	8.07	7.51	589
> 39	6.66	6.98	487
Totals	6.54	7.36	1,650

Source of Variation	SS	df	Ms	F	P	E^2
Between Group	3,852.54	3	1,284.18	24.72	≤.05	.04
Within Group	85,516.73	1646	51.95			
Total	89,369.27	1649				

TABLE VII

"t" Test Data for the Relationship Between Age of the Teacher and Student Achievement

AGE	20-24	25-29	30-39
25-29	t=4.21 df=572 p=≤ 05		
30-39	t=8.31 df=851 p=≤.05	t=3.95 df=897 p=≤.05	
> 39	t=5.84 df=749 p=≤.05	t=1.24 df=795 p=>.05	t=3.16 df=1074 p=≤ 05

The results from Table VI and Table VII suggest that a significant (.05) relationship exists between the ages of the teachers and student achievement. Students who had teachers in the 20-24 year old age bracket achieved at a significantly (.05) lower level than students who had teachers in any of the other age categories. Students who had teachers in the 25-29 age bracket achieved at a significantly higher level than students who had teachers in the 20-24 age bracket, and at a significantly (.05) lower level than students who had teachers in the 30-39 age bracket. Students who had teachers in the 30-39 age bracket achieved at a significantly (.05) higher level than students who had teachers in the other age brackets. Students who had teachers in the over 39 age bracket achieved at a lower level than students who had teachers in the 30-39 age bracket, but higher than students who had teachers in the other age brackets. The strength of association indicates that four per cent of the variance in achievement could be accounted for by the age of the teacher.

TABLE VIII

Analysis of Variance for the Relationship Between Teaching Experience and Student Achievement

Years of Teaching Exp.	MEAN	SD	N			
1-3	4.74	4.18	298			
4-6	6.63	7.92	468			
7-10	7.71	7.15	437			
> 10	6.24	7.14	426			
Totals	6.47	7.44	1629			
Source of variation	SS	df	Ms	F	P	E^2
Between Group	1598.01	3	532.67	9.75	$\leq .05$	.02
Within Group	88771.91	1625	54.63			
Total	90369.92	1628				

TABLE IX

"t" Test Data for the Relationship Between Teaching Experience and Student Achievement

Teaching Experience	1-3	4-6	7-10
4-6	t=3.32 df=764 $p=\leq .05$		
7-10	t=5.50 df=733 $p=\leq .05$	t=2.16 df=903 $p=\leq .05$	
> 10	t=2.77 df=722 $p=\leq .05$	t=0.76 df=892 $p=> .05$	t=3.02 df=861 $p=\leq .05$

Mean scores from Table VIII and Table IX indicate that students who had teachers with from 7-10 years teaching experience achieved at a significantly (.05) higher level than students who had teachers with from 1-3 years, 4-6, or greater than 10 years experience. In addition, students who had teachers with from 1-3 years experience achieved at a significantly (.05) lower level than students of teachers in any of the other experience categories. The only relationship that was not significant at the .05 level was the achievement of students who had teachers with 4-6 years of experience when compared with students of teachers who had more than 10 years of teaching experience. Two per cent of the variance in student achievement could be attributed to the total teaching experience of the teacher.

TABLE X

Analysis of Variance for the Relationship Between Teaching Experience in Earth Science and Student Achievement

Teaching Experience In Earth Science	MEAN	SD	N			
1 year	4.60	6.98				
2-4 years	6.95	7.76				
$>$ 4 years	7.50	6.83				
Totals	6.47	7.45				
Source of variation	SS	df	MS	F	P	E^2
Between Group	2,043.41	2	1,021.70	18.81	$\leq .05$	.02
Within Group	88,326.51	1626	54.32			
Total	90,369.92	1628				

TABLE XI

"t" Test Data for the Relationship Between Teaching Experience in Earth Science and Student Achievement

Teaching Experience In Earth Science	1	2-4
2-4	t=5.22 df=1260 p=<.05	
>4	t=5.86 df=781 p=<.05	t=1.18 df=1211 p=>.05

An examination of the data in Table X and Table XI suggests that a significant (.05) relationship exists between the numbers of years of teaching experience in earth science, and student achievement. Students who had teachers with more than four years of experience in teaching earth science achieved at a higher level than students of teachers who had 2-4, or 1 year of teaching experience in earth science. It was also noted that students who had teachers with only one year of experience in teaching earth science achieved at a significantly (.05) lower level than students in the other two groups. Two per cent of the variance in student achievement could be attributed to the teaching experience in earth science of the teacher.

From the analyses, it is apparent that little relationship existed between the sex of the teacher and student achievement. However, relationships did exist between achievement and the total

teaching experience, and between the teaching experience in earth science of the teacher. None of the teacher characteristics mentioned seemed to account for a substantial amount of the variance in student achievement. The greatest amount of variance accounted for in student achievement was four per cent, and this was attributed to the age of the teacher.

Question 2. What relationships exist between student achievement and the educational background of the teachers?

Tables XII through XIX present the analyses used to determine the relationships between the educational background of the teachers, and student achievement. Factors that were used for comparison purposes include the (1) type of degree earned by the teacher, (2) numbers of hours in earth science completed, (3) numbers of hours of graduate work in earth science completed, (4) numbers of hours in related sciences completed, and (5) numbers of hours in Education completed.

TABLE XII

Analysis of Variance and "t" Test
Data for the Relationship Between Type of Degree Earned
and Student Achievement

Degree Earned	MEAN	SD	N
Bachelors	5.75	7.02	935
Masters	7.58	7.65	715
Totals	6.54	7.36	1650

Source of variation	SS	df	MS	F	t	P	E^2
Between Group	1358.37	1	1358.37	25.43	5.04	$\leq .05$	.02
Within Group	88010.90	1648	53.40				
Total	89369.27	1649					

An examination of the data in Table XII suggests that students who had teachers with a Master's Degree achieved at a significantly (.05) higher level than students of teachers who have a Bachelor's Degree but less than a Master's Degree. The strength of association, E^2, reveals that two per cent of the variance in student achievement could be attributed to the type of degree of the teacher.

TABLE XIII

Analysis of Variance for the Relationship Between Numbers of Hours in Earth Science and Student Achievement

Number of Hours	MEAN	SD	N
0-6	4.74	7.44	335
7-12	4.37	6.61	198
13-18	7.83	7.29	127
19-24	7.26	8.48	243
> 24	7.16	7.01	769
Totals	6.41	7.41	1672

Source of variation	SS	df	MS	F	P	E^2
Between Group	2629.85	4	657.46	12.28	$\leq .05$	.03
Within Group	89229.92	1667	53.53			
Total	91859.77	1671				

Analyses of the data in Tables XIII and XIV suggest that a significant (.05) relationship exists between the numbers of semester hours in earth science teachers have completed and the achievement of their students. The results indicate that students of teachers who had more than 12 hours of credit in the earth sciences had significantly higher scores than students of teachers who had less than 12 hours of credit in the earth sciences. Approximately three per cent of the variance in achievement could be attributed to the numbers of hours in the earth sciences the teachers completed.

TABLE XIV

"t" Test Data for the Relationship Between Numbers of Hours in Earth Science and Student Achievement

Number of Hours	0-6	7-12	13-18	19-24
7-12	t=0.57 df=531 p=>.05			
13-18	t=4.00 df=460 p=≤.05	t=4.41 df=323 p=≤.05		
19-24	t=3.79 df=576 p=≤.05	t=3.92 df=439 p=≤.05	t=0.64 df=368 p=>.05	
>24	t=5.18 df=1102 p=≤.05	t=5.05 df=965 p=≤.05	t=0.99 df=894 p=>.05	t=0.19 df=1010 p=>.05

TABLE XV

Analysis of Variance and "t" Test Data for the Relationship Between Graduate Work in Earth Science and Student Achievement

Graduate Work In Earth Science	MEAN	SD	N				
No Graduate Work	4.70	7.02	577				
Graduate Work	7.31	7.45	1095				
Totals	6.41	7.41	1672				
Source of variation	**SS**	**df**	**MS**	**F**	**t**	**P**	**E^2**
Between Group	2594.47	1	2594.48	48.54	6.97	$\leq .05$	.03
Within Group	89265.30	1670	53.45				
Total	91859.77	1671					

The analysis in Table XV indicates that students of teachers who have completed some graduate work in the earth sciences achieved at a significantly (.05) higher level than students of teachers who have not completed any graduate work in the earth sciences. The value of E^2, suggests that approximately three per cent of the variance in achievement could be attributed to the numbers of hours of graduate work that a teacher completed in earth science.

TABLE XVI

Analysis of Variance for the
Relationship Between Numbers of Hours in
Related Sciences and Student Achievement

Hours in Related Sciences	MEAN	SD	N			
0-12	8.39	8.22	272			
13-24	5.80	7.09	272			
>24	6.08	7.20	1128			
Totals	6.41	7.41	1672			
Source of variation	**SS**	**df**	**MS**	**F**	**P**	**E^2**
Between Group	1289.75	2	644.88	11.88	$\leq .05$	.01
Within Group	09570.02	1669	54.27			
Total	91859.77	1671				

TABLE XVII

"t" Test Data for the Relationship Between Numbers
of Hours in Related Sciences and Student Achievement

Numbers of Hours	13-24	> 24
0-12	t=3.93 df=542 p=$\leq$.05	t=4.61 df=1398 p=$\leq$.05
13-24		t=.58 df=1398 p=>.05

An examination of the data in Tables XVI and XVII indicates that a significant (.05) relationship exists between student achievement and the numbers of hours in related sciences that teachers have completed. Also, a significant relationship appears to exist in achievement between students of teachers who had completed 0-12 hours in the related sciences and students of teachers in the other two categories. A significant difference (.05) was not found in achievement, however, between those students who had teachers who completed from 13-24 hours in the related sciences, and those who completed more than 24 hours in the related sciences. Only one per cent of the variance in achievement could be attributed to the related science backgrounds of the teachers.

TABLE XVIII

Analysis of Variance for the Relationship Between Numbers of Hours in Education and Student Achievement

Numbers of Hours	MEAN	SD	N
0-12	7.06	8.30	330
13-24	6.76	7.08	713
> 24	5.68	7.23	629
Totals	6.41	7.41	1672

Source of variation	SS	df	MS	F	P	E^2
Between Group	561.11	2	280.55	5.13	$\leq .05$	.006
Within Group	91298.66	1669	54.70			
Total	91859.77	1671				

TABLE XIX

"t" Test Data for the Relationship Between Numbers of Hours in Education and Student Achievement

Numbers of Hours	13-24	> 24
0-12	t=0.60 df=1041 p=> .05	t=2.66 df=957 p=≤.05
13-24		t=2.76 df=957 p=≤.05

The analyses in Tables XVIII and XIX indicate that students of teachers who had from 0-12, or 13-24 hours completed in Education, achieved significantly (.05) higher than students of teachers who had completed more than 24 hours in Education. A significant (.05) difference was not evident between the achievement of students of teachers who completed 0-12 hours in Education, and teachers who completed between 13-24 hours in Education. The strength of association derived from the data indicates that less than 1 per cent of the variation in student achievement could be attributed to the numbers of hours completed in Education by the teachers.

From the analyses presented, it is apparent that a relationship did exist between the type of degree earned by the teacher, the numbers of hours teachers completed in the earth sciences, the graduate work completed in earth science and student achievement. Other positive relationships were found between the numbers of hours teachers com-

pleted in related sciences, the numbers of hours completed in Education and student achievement.

The variance in student achievement could not be attributed substantially to any of the teacher characteristics under consideration although differences were significant. The greatest amount of variance attributable to any characteristic was three per cent, and that was attributed to the numbers of hours in earth science the teacher had completed.

Question 3. <u>What relationships exist between the nature of the school environment and student achievement?</u>

Tables XX through XXIII contain analyses of data that were used to determine the relationships between student achievement and the nature of the school environment. Factors that were used for comparison purposes included (1) teacher rating of laboratory facilities, and (2) the type of community in which the school is located.

TABLE XX

Analysis of Variance for the Relationship Between Rating of Laboratory Facilities and Student Achievement

Rating of Facilities	MEAN	SD	N			
Well Equipped	6.93	6.89	352			
Adequately Equipped	7.75	7.50	723			
Poorly Equipped	4.49	7.20	597			
Totals	6.41	7.41	1672			
Source of variation	**SS**	**df**	**MS**	**F**	**P**	**E^2**
Between Group	3590.14	2	1795.07	33.94	$\leq .05$	.04
Within Group	88269.63	1669	52.89			
Total	91859.77	1671				

TABLE XXI

"t" Test Data for the Relationships
Between Rating of Laboratory Facilities
and Student Achievement

Rating	Adequately Equipped	Poorly Equipped
Well Equipped	t=1.73 df=1073 p=> .05	t=5.11 df=947 p=≤.05
Poorly Equipped	t=8.00 df=1318 p=≤.05	

An examination of the data in Tables XX and XXI indicates that students who had teachers who rated their laboratory facilities as being well-equipped or adequately equipped had significantly (.05) higher levels of achievement than students whose teachers rated their laboratory facilities as being poorly equipped. A significance (.05) was not found however between the achievement of students whose teachers rated the laboratory facilities as well equipped and students whose teachers rated the laboratory facilities as adequately equipped. The value of E^2, as determined from the data suggests that four per cent of the variance in achievement may be attributed to the adequacy of laboratory facilities as judged by the teachers.

TABLE XXII

Analysis of Variance for the Relationship Between Type of Community and Student Achievement

Community Type	MEAN	SD	N			
Urban	7.53	6.80	557			
Suburban	8.21	7.92	412			
Rural	4.16	6.98	665			
Total	6.33	6.33	1634			
Source of variation	**SS**	**df**	**MS**	**F**	**P**	**E^2**
Between Group	5389.07	2	2694.53	52.29	$\leq .05$	.06
Within Group	84050.07	1631	51.53			
Total	89439.14	1633				

TABLE XXIII

"t" Test Data for the Relationship Between Type of Community and Student Achievement

Community Type	Urban	Rural
Suburban	t=1.43 df=967 p= $> .05$	t=8.77 df=1075 p= $\leq .05$
Rural	t=8.49 df=1220 p= $\leq .05$	

An examination of the data in Tables XXII and XXIII indicates that significant (.05) differences were not evident between the achievements of suburban and urban students. Significant (.05) differences in achievement were evident between rural students and students in the other two categories. The strength of association reveals that six per cent of the variance in achievement may be attributed to the type of community in which the school is located.

From these analyses it is apparent that significant (.05) relationships existed between student achievement and the quality of facilities the teacher believes the school has provided for learning as well as the type of community in which the school is located. Students who had use of well equipped laboratory facilities as judged by the teacher, achieved at significantly (.05) higher levels than students who were in schools with poorly equipped laboratories. Further, students from urban or suburban communities achieved at a significantly (.05) higher levels than students from rural communities. Nearly four per cent of the variance in achievement may be attributed to the laboratory facilities provided for learning, whereas six per cent of the variance in achievement may be attributed to the type of community in which the school was located.

Question 4. _What relationships exist between student achievement and the characteristics of the students themselves?_

Tables XXIV through XXVII contain analyses of the data used to determine the relationships between characteristics of the students and student achievement. The characteristics of the students examined included (1) the grades in which the students were enrolled,

and (2) the vocational plans of the students. Additional data concerning the characteristics of the students are found in the analyses of the data concerning question 6.

TABLE XXIV

Analysis of Variance for the Relationship Between Student Grade Level and Student Achievement

Grade Level	MEAN	SD	N
Seventh	5.14	6.71	219
Eighth	6.07	8.37	504
Ninth	6.53	6.92	794
Tenth	8.46	7.35	78
Eleventh	8.84	6.69	44
Twelfth	9.21	6.08	33
Totals	6.41	7.41	1672

Source of variation	SS	df	MS	F	P	E^2
Between Group	1272.02	5	254.40	4.68	$\leq .05$	.01
Within Group	90587.75	1666	54.37			
Total	91859.77	1671				

TABLE XXV

"t" Test Data for the Relationship Between
Student Grade Level and Student Achievement

Grade Level	Eighth	Ninth	Tenth	Eleventh	Twelfth
Seventh	t=1.46 df=721 p= > .05	t=2.66 df=1011 p= ≤ .05	t=3.65 df=295 p= ≤ .05	t=3.33 df=261 p= ≤ .05	t=3.28 df=250 p= ≤ .05
Eighth		t=1.07 df=1296 p= > .05	t=2.38 df=580 p= < .05	t=2.13 df=546 p= ≤ .05	t=2.11 df=535 p= ≤ .05
Ninth			t=2.33 df=870 p= ≤ .05	t=2.16 df=836 p= ≤ .05	t=2.19 df=825 p= ≤ .05
Tenth				t=.28 df=120 p= > .05	t=.51 df=109 p= > .05

An examination of the data in Tables XXIV and XXV reveals that achievement of students increased as their grade levels increased. Tenth, eleventh and twelfth grade students achieved at a significantly (.05) higher level as compared with students in the seventh, eighth and ninth grades. Ninth-grade students achieved at a significantly (.05) higher level than seventh graders, but significant (.05) differences in achievement were not evident between eigth- and ninth-grade students. Only one per cent of the variance in achievement may be attributed to the grade level of the students.

TABLE XXVI

Analysis of Variance for the Relationship Between Student Vocational Plans and Student Achievement

Vocational Plans	MEAN	SD	N			
Will Attend College	7.22	7.64	953			
Probably Will Not	5.27	6.92	289			
Undecided	4.58	6.55	213			
Totals	6.44	7.43	1455			
Source of variation	**SS**	**df**	**MS**	**F**	**P**	**E^2**
Between Group	1708.85	2	854.43	15.77	$\leq .05$	.02
Within Group	78652.33	1452	54.17			
Total	80361.18	1454				

TABLE XXVII

"t" Test Data for the Relationship Between Student Vocational Plans and Student Achievement

Vocational Plans	Probably Will Not	Undecided
Will Attend College	t=3.88 df=1240 p= $\leq .05$	t=4.66 df=1164 p= $\leq .05$
Probably Will Not		t=1.12 df=500 p= $> .05$

The analysis in Table XXVII indicates that students who indicated that they would probably attend college achieved at significantly (.05) higher levels than students who indicated they probably would not attend, or those students who were undecided about their vocational plans. A significant (.05) difference in achievement was not evident between students who were undecided about their vocational plans and students who indicated that they probably would not attend college. The strength of association indicates that two per cent of the variance in achievement may be attributed to the vocational plans of the students.

Analyses of the results in this section indicate that both the grade levels of the students and their vocational plans are significantly (.05) related to student achievement. None of the student characteristics, however, contributed substantially to the variance in student achievement. The greatest amount of variance in achievement that may be attributed to student characteristics was two per cent, and that to the vocational plans of the students.

Question 5. What relationships exist between student opinions concerning the earth-science course and student achievement?

Tablex XXVIII and XXIX contain analyses of the data used to determine the relationships between student opinions concerning the earth-science course and student achievement. The analyses were based upon student responses to question 11 of the Earth Science Student Opinion Questionnaire. For purposes of analysis, responses were grouped into three categories and included responses that indicated that the course in earth science was (1) more interesting than most

other courses, (2) of average interest level, and (3) less interesting than other courses.

TABLE XXVIII

Analysis of Variance for the Relationship Between Student Opinions and Student Achievement

Student Opinions	MEAN	SD	N			
More Interesting	6.82	6.54	417			
Average	6.73	7.78	821			
Less Interesting	4.75	7.39	228			
Totals	6.45	7.42	1466			
Source of variation	SS	df	MS	F	P	E^2
Between Group	783.81	2	391.90	7.16	$\leq .05$	.01
Within Group	80018.54	1463	54.70			
Total	80802.35	1465				

TABLE XXIX

"t" Test Data for the Relationship Between Student Opinions and Student Achievement

Student Opinions	Average	Less Interesting
More Interesting	t=.21 df=1236 p= >.05	t=3.67 df=643 p= $\leq$ .05
Average		t=3.44 df=1047 p= $\leq$ .05

An examination of the data reveals that a significant (.05) relationship exists between student opinions concerning the earth-science course and student achievement. Students who found the course to be average or above average in interest level achieved at a significantly (.05) higher level than students who found the course to be below average in terms of interest. Only one per cent of the variance in student achievement could be attributed to the student opinions of the earth-science students.

Question 6. What relationships exist between ESCP and non-ESCP students and student achievement?

Tables XXX and XXXI contain analyses of the data for determining the relationship between ESCP and non-ESCP students and student achievement. The relationships investigated include (1) relative achievements of ESCP and non-ESCP students and, (2) the relative achievements of ESCP and non-ESCP students on the basis of sex.

TABLE XXX

Analysis of Variance for the Relationship Between ESCP and non-ESCP Students and Student Achievement

Curriculum	MEAN	SD	N			
ESCP	6.80	6.87	546			
Non-ESCP	6.23	7.65	1126			
Totals	6.41	7.41	1672			
Source of variation	SS	df	MS	F	P	E^2
Between Group	118.45	1	118.45	2.16	>.05	.001
Within Group	91741.32	1670	54.94			
Total	91859.77	1671				

An examination of Table XXX fails to reveal significant (.05) differences between the achievements of ESCP and non-ESCP students. The strength of association suggests that less than one per cent of the variance in achievement may be attributed to the type of earth science program in which the students were enrolled.

TABLE XXXI

Analysis of Variance for the Relationships Among Student Sex, Type of Earth-Science Program in Which the Student is Enrolled and Student Achievement

		SEX OF STUDENTS	
		MALE	FEMALE
Type of Curriculum	ESCP	Mean=6.38 SD=6.87 N=295	Mean=7.23 SD=6.85 N=251
	Non-ESCP	Mean=6.27 SD=7.84 N=608	Mean=6.16 SD=7.42 N=517

Source of variation	SS	df	MS	F	P	E^2
Rows	137.93	1	137.92	2.51	>.05	.001
Columns	58.22	1	58.22	1.06	>.05	.001
Interaction	94.21	1	94.21	1.71	>.05	.001
Within Cell	91580.53	1667	54.94			
Total	91870.88	1670				

An examination of Table XXXI fails to reveal that significant (.05) differences exist between the sex of the students and their achievement, or between the type of earth-science program in which they are enrolled and their achievement. ESCP females did score higher than students in any other group. However, values for E^2

indicate that less than one per cent of the variance in student achievement may be attributed to the interaction relationships of students sex and type of curriculum.

The analyses of the data fail to suggest that significant differences in achievement are found between ESCP and non-ESCP students. Less than one per cent of the variance in achievement may be attributed to the type of curriculum in which students are enrolled, or the sex of the students.

Question 7. What relationships exist between student achievement and the students perceptions of their teachers?

Tables XXXII and XXXIII contain analyses of the data used to determine the relationships between student perception and student achievement. For more meaningful analyses, mean class ratings were divided into three categories that included those teachers with these ranges of ratings: (1) High (4.99-4.00), (2) Medium (3.99-3.00), and (3) Low (2.99-1.00).

TABLE XXXII

Analysis of Variance for the Relationship Between Student Perception of Their Teacher and Student Achievement

Student Perception	MEAN	SD	N			
High	6.96	7.31	481			
Medium	5.54	7.05	853			
Low	7.94	8.25	289			
Totals	6.39	7.41	1623			
Source of variation	**SS**	**df**	**MS**	**F**	**P**	**E^2**
Between Group	1463.90	2	731.95	13.51	$\leq .05$	.02
Within Group	87752.88	1620	54.17			
Total	89216.77	1622				

TABLE XXXIII

"t" Test Data for the Relationships Between Student Perceptions of Their Teachers and Students Achievement

Student Perception	Medium	Low
High	t=3.47 df=1332 p= $\leq .05$	t=1.72 df=768 p= $> .05$
Medium		t=4.78 df=1140 p= $\leq .05$

An examination of Tables XXXII and XXXIII reveals that teachers who received high or low class ratings had students who achieved at significantly (.05) higher levels than teachers who received medium class ratings. Furthermore, teachers who received low class ratings had students who achieved at a significantly (.05) higher level than students of teachers in the other two ranges. Two per cent of the variance in achievement may be attributed to the mean class ratings given the teacher.

Question 8. <u>What relationships exist between ESCP and non-ESCP students and the manner in which they perceive their teachers</u>?

The analyses used to identify differences between ESCP and non-ESCP students and the manners in which they perceive their teachers appear in Table XXXIV. Since perceptions were based on class means, "N" in this case represents the number of classes.

TABLE XXXIV

Analysis of Variance for the Relationship Between ESCP and non-ESCP Students and Teacher Perception

Type of Student	MEAN	SD	N			
ESCP	3.61	.48	28			
Non-ESCP	3.61	.61	51			
Totals	3.61	.57	79			
Source of variation	SS	df	MS	F	P	E^2
Between Group	.00024	1	0.000	.001	>.05	.00
Within Group	25.63303	77	0.333			
Total	25.63327	78				

The data in Table XXXIV fail to suggest that a significant (.05) difference exists between the way ESCP teachers are perceived by their students and the way non-ESCP are perceived by theirs. Less than one per cent of the variance in student perception of the teacher may be attributed to the type of earth-science curriculum in which they were enrolled.

Question 9. <u>What relationships exist between student opinions concerning the earth-science course, and the way in which they perceive their teachers</u>?

Tables XXXV and XXXVI contain analyses of data relevant to the relationships among student opinions concerning the earth-science course, and the way in which they perceive their teachers. The student responses were grouped in the following categories, (1) above average in interest level, (2) average in interest level and (3) below average in interest level.

TABLE XXXV

Analysis of Variance for the Relationship
Between Student Opinions Concerning the
Earth-Science Course, and Student Perceptions
of Their Teacher

Student Opinions	MEAN	SD	N			
Above Average	3.75	.51	460			
Average	3.58	.56	896			
Below Average	3.31	.62	259			
Totals	3.59	.33	1615			
Source of variation	SS	df	MS	F	P	E^2
Between Group	31.31	2	15.66	50.5	$\leq .05$	.06
Within Group	499.69	1612	0.31			
Total	531.00	1614				

TABLE XXXVI

"t" Test Data for the Relationship
Between Student Opinions Concerning the Earth-Science
Course and Teacher Perception

Student Opinions	Average	Below Average
Above Average	t=5.44 df=1354 p= $\leq$ .05	t=10.09 df=717 p= $\leq$ .05
Average		t=6.54 df=1153 p= $\leq$ .05

The analyses in Tables XXXV and XXXVI indicate that a significant (.05) relationship exists between student opinions concerning the earth-science course, and the manner in which they perceive their teacher. Students who had above average opinions of the earth-science course had teachers whose mean class rating was significantly (.05) higher than students of teachers in the other two categories. Also, students whose opinions of the earth-science course was rated as "average" in interest had teachers whose mean class rating was significantly (.05) higher than students who thought that the earth-science course was below average in interest. Six per cent of the variance in teacher perception could be attributed to the students opinions of the earth-science course.

Question 10. *What relationships exist between student perception of their earth-science teacher, and the manner in which teachers perceive the classes?*

TABLE XXXVII

Extent of Agreement Between Teacher Perception of the Class and Student Perception of Their Teacher

Matched Pair	N	r	P	r^2
Teacher Perception x Student Perception	79	0.34	$\leq .05$	.11

The data in Table XXXVII suggest that a significant (.05) relationship exists between the way in which teachers perceive their classes, and the manner in which students in those classes perceive

their teachers. The strength of determination figure, r^2, indicates that eleven per cent of the variance in student perception may be attributed to the teacher's perception of the class.

CHAPTER V

THE PROBLEM AND METHODOLOGY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

The Problem and Methodology

Although there has been a tremendous growth in the number of schools offering earth-science courses at the secondary level, relatively little research has been conducted in an attempt to evaluate the effectiveness of these programs. Therefore, the purpose of this study was to determine the extent to which certain factors were related to student achievement and teacher effectiveness in earth-science classes in a selected group of Michigan schools.

Specifically, this study was aimed at eliciting answers to these questions:

1. What relationships exist between student achievement and some of the distinguishing characteristics of the teachers?

2. What relationships exist between student achievement and the educational background of the teachers?

3. What relationships exist between the nature of the school environment and student achievement?

4. What relationships exist between student achievement and the characteristics of the students themselves?

5. What relationships exist between student opinions concerning the earth-science course and student achievement?

6. What relationships exist between ESCP and non-ESCP students and student achievement?

7. What relationships exist between student achievement and the students' perceptions of their teachers?

8. What relationships exist between ESCP and non-ESCP students and the manner in which they perceive their teachers?

9. What relationships exist between student opinions concerning the earth-science course, and the way in which they perceive their teachers?

10. What relationships exist between student perception of their earth-science teacher, and the manner in which teachers perceive the classes?

Forty-three teachers from twenty-eight schools in southwestern Michigan, and 1,672 students from 81 earth-science classes in these schools were the subjects in the investigation. Student achievement was measured by gain made on the Dubins Earth Science Test (Forms A and B) from the beginning to the end of the study. Students perceptions of their teachers were measured by an analysis of student responses to items on the Earth Science Teacher Image Questionnaire. Other information concerning various teacher and student characteristics were obtained from an analysis of teacher responses to the Earth Science Class ID Form, and student responses to the Earth Science Student Opinion Questionnaire. All data from responses to these test instruments were transferred to IBM cards for further analysis.

Several "t"-tests and one-way analysis of variance models were used to determine the extent and direction of the relationships that might exist between student achievement and various student and teacher characteristics. A two-way analysis of variance model was used to determine the types of relationships that might exist among the factors of student achievement, sex, and type of earth-science program in which the students were enrolled.

Data related to the students perceptions of their teachers were analyzed by using one-way analysis of variance models and product-moment coefficients of correlation. Analyses were judged as significant only if they met the minimal criterion of the .05 level of significance. Strengths of association (E^2), and of determination (r^2) were reported with the analyses to aid the interpretation.

Conclusions

Interpretations of the analyses presented in Chapter IV are categorized into the three following groups together with discussions of some of their implications: (I) The relationships between student achievement, and various teacher characteristics, (II) The relationships between student achievement and various student characteristics, and (III) The relationships between student perception of the teacher, and various student and teacher characteristics.

I. The relationships between student achievement, and various teacher characteristics

A. Significant differences were not found between the sex of the teacher and student achievement. Students of male teachers scored higher than students of female teachers, but the lack of a significant difference would seem to indicate that the sex of the teacher is not a consequential determining factor of student achievement.

B. Significant relationships were found to exist between student achievement and other teacher characteristics including:

1. Age
2. Total teaching experience
3. Teaching experience in earth science
4. Degree status

All the analyses indicate that experience and age are significant factors in determining student achievement. The students of younger teachers and of those with minimal teaching experience achieved at significantly lower levels than students of older, or more experienced teachers. The students of teachers with a Master's Degree, the latter some indication of age, and or, experience, achieved at higher levels than students of teachers with the Bachelor's Degree but had not completed the Master's Degree.

C. A consequential relationship existed between the numbers of hours in earth science a teacher has taken, and student achievement. Students who had teachers who completed from zero to six, or seven to twelve hours in earth science, achieved at significantly lower levels than those who had teachers who had completed more than thirteen hours of credit in the earth sciences. Thus the results indicate that the number of hours teachers have completed in the earth sciences are related to a high degree to student achievement.

D. A consequential relationship also existed between student achievement and the graduate work in the earth sciences a teacher had completed. Students of teachers who had completed some graduate work in the earth sciences achieved at a significantly higher level than students of teachers who had not completed any graduate work in the earth sciences. This seems to substantiate the conclusions stated previously that the background of the teacher in the earth sciences is significantly related to student achievement. It is apparent from these findings that the completion of some graduate course work in the earth sciences is also significantly related to student achievement.

E. Significant relationships also existed between student achievement and the numbers of course hours teachers completed in (1) the related sciences, and (2) Education. Students of teachers who had completed from zero

to twelve hours in related sciences, achieved at a significantly higher level than students of teachers who had from thirteen to twenty four, or greater than twenty four hours credit in the related sciences. It was also found that teachers with from zero to twelve or thirteen to twenty four hours of credit in Education courses, achieved at higher levels than students of teachers who had completed more than twenty four hours. From these findings it seems that, unlike the conclusions concerning teacher background in the earth sciences, completion of more than twelve hours of credit in either the related sciences or Education on the part of the teacher is not significantly related to student achievement in the earth sciences. This finding may be attributed to the fact that teachers who completed less than twelve hours in related science or Education courses were those teachers who had completed more course work in the earth sciences.

F. Highly significant relationships were found between the type of facilities the school has provided for learning and student achievement. Students of teachers who judged their laboratory facilities as being either well equipped or adequately equipped achieved at significantly higher levels than students whose teachers believed they had facilities poorly equipped for teaching earth science. The results seem to indicate that students tend to perform at higher levels when the facilities are judged by the teachers to be adequate.

G. A highly significant relationship was found to exist between the type of community in which the school was located and student achievement. Students in rural communities achieved at significantly lower levels than students from suburban or urban communities. This seems to indicate that students tend to perform at higher levels in suburban or urban communities, and that this may be related to the nature of the school environment and is significantly related to student achievement.

II. The relationships between student achievement and various student characteristics

A. A significant relationship was found between

student grade level and student achievement. The achievements of students increased with an increase in grade level. Since the Dubins Earth Science Test was written primarily for ninth-grade students, the results are not surprising, but do perhaps indicate a significant relationship between student maturity and achievement.

B. A significant relationship existed between the vocational plans of students and their achievements. Students who indicated they would probably attend college achieved at a higher level than students who were undecided, and than those who indicated that they would probably not attend college. These results seem to indicate that students who plan to attend college have greater ability levels and therefore achieved at a higher level than other students. The difference in the size of the groups may have influenced this finding, and therefore it should be interpreted with some caution.

C. A significant relationship was found to exist between student opinions of the earth-science course and their achievement. Students who perceived the course to be above average or average in interest level achieved at a significantly higher level than students who perceived the course to be below average in interest level. This seems to indicate that the more students "like" a particular course, the higher will be their achievement or visa versa. This conclusion must be viewed with some caution since there was great differences in the numbers of students in the interest categories.

D. Significant differences were not evident between the achievements of ESCP and non-ESCP students when compared only on the basis of sex or on the type of earth-science program in which they participated. It is interesting to note that ESCP students did have a higher average mean score than non-ESCP students and that ESCP females achieved at a higher level than any other group. These

findings seem to indicate that the Dubins Earth Science Test is not weighted in favor of either ESCP or non-ESCP, if differences in achievement between the groups are used to evaluate the "neutrality" of the test.

E. A significant difference was found between the manner in which students perceived their teachers and student achievement. Students who rated their teachers low, achieved at a significantly higher level than those who rated their teachers as medium or high. This seems to indicate that students who achieved at higher levels were more "critical" of their teachers effectiveness, and thus tended to rate them lower.

III. The relationship between student perception of the teacher and various student and teacher characteristics

A. Significant relationships were not found between the type of earth-science program in which students were enrolled and their perceptions of their teachers. Both ESCP and non-ESCP teachers had the same mean class ratings. This substantiates the findings reported earlier that in general few differences were found between ESCP and non-ESCP students who participated in this study.

B. A highly significant relationship existed between student opinions concerning the earth-science program in which they enrolled and the way in which they perceived their teacher. Students who found the course in earth science to be above average in interest level, rated their teachers at a significantly higher level than students who found the course to be either average or below average in interest level. This finding seems to indicate that as interest in the course increased, student perceptions of their teacher did also.

C. A significant relationship was found between student perception of the teacher, and the manner in which

> teachers perceived the class. This finding indicates that ratings of teachers by students and the teachers perception of the class were highly positively related.

Implications

The results of this study seem to indicate several areas of importance for evaluating earth-science programs. It is evident that the educational background of the teacher, particularly in the earth sciences, may be an important factor in determining student achievement. This also holds true for the relationships between achievement and the nature of the school environment. If the results of this study are valid, then schools that cannot provide adequate facilities or properly prepared teachers for earth-science programs probably should not expect students to perform at maximal levels of achievement.

It is apparent from the results of this investigation that little difference in achievement, as measured by gain scores on the _Dubins Earth Science Test_ existed between ESCP and non-ESCP students. An examination of the contents of the _Dubins Earth Science Test_ by the investigator, indicates that the test does not "favor" either ESCP or non-ESCP students, and therefore probably can be used in other research studies in which differences in achievement between the two groups are investigated.

The conclusions indicate strongly that success in the earth-science course, as measured by achievement, is closely related to student opinions concerning the course in earth science. Perhaps teachers of earth science should strive to provide their students

with a "feeling of success" such that students would develop more positive attitudes concerning the course in earth science and their teachers as well.

Recommendations

There are many recommendations that could be made to further substantiate the results of this study. Some of the more cogent follow:

1. A replication of this study is indicated but with a random sample of students and teachers from schools located in a more diverse geographical area.

2. A further analysis should be made concerning the relationships among such factors as the types of facilities provided for learning, the types of communities in which the school are located, and student achievement. These studies should be conducted in a restricted geographical area so that more explicit relationships between the school environment and various student and teacher outcomes may be examined.

3. Research should be undertaken to determine the extent and types of relationships between student attitude and success in the earth-science course. Such research might indicate whether success determines student attitudes or visa versa.

4. The investigator recommends that additional research be conducted in an attempt to determine whether existing earth-science teacher training programs are producing teachers who are properly prepared to provide students with the motivation to learn earth

science and have feelings of success with their efforts. It is apparent that student success is related in some way to the educational backgrounds of their teachers and in this sense better programs for the preparation and certification of earth-science teachers are needed. However, it is strongly recommended that the practice of placing unqualified earth-science teachers in the classroom be discontinued as soon as possible in all schools.

APPENDIX A

Instruments Used

EARTH SCIENCE TEACHER IMAGE QUESTIONNAIRE

Do not begin until you are told to do so by the person in charge.
Check (X) your answers to questions 1-16.

WHAT IS YOUR OPINION CONCERNING THIS TEACHER'S:	Poor	Fair	Average	Good	Excellent
1. KNOWLEDGE OF SUBJECT: (Does he have a thorough knowledge and understanding of his teaching field?)	___	___	___	___	___
2. CLARITY OF PRESENTATION: (Are ideas at a level which you can understand?)	___	___	___	___	___
3. FAIRNESS: (Is he fair and impartial in his treatment of all students in the class?)	___	___	___	___	___
4. CONTROL: (Is the classroom orderly but also relaxed and friendly?)	___	___	___	___	___
5. ATTITUDE TOWARD STUDENTS: (Do you feel that this teacher likes you?)	___	___	___	___	___
6. SUCCESS IN STIMULATING INTEREST? (Is this class interesting and challenging?)	___	___	___	___	___
7. ENTHUSIASM: (Does he show interest and enthusiasm for the subject? Does he appear to enjoy teaching this subject?)	___	___	___	___	___
8. ATTITUDE TOWARD STUDENT IDEAS: (Does this teacher have respect for the things you have to say in class?)	___	___	___	___	___
9. ENCOURAGEMENT OF STUDENT PARTICIPATION: (Does this teacher encourage you to raise questions and express ideas in class?)	___	___	___	___	___
10. SENSE OF HUMOR: (Does he share amusing experiences and laugh at his own mistakes?)	___	___	___	___	___
11. ASSIGNMENTS: (Are assignments sufficiently challenging without being unreasonably long?)	___	___	___	___	___
12. APPEARANCE: (Are his grooming and dress in good taste?)	___	___	___	___	___

	Poor	Fair	Average	Good	Excellent
13. OPENNESS: (Is this teacher able to see things from your point of view?)	___	___	___	___	___
14. SELF-CONTROL: (Does this teacher become angry when little problems arise in the classroom?)	___	___	___	___	___
15. CONSIDERATION OF OTHERS: (Is he patient, understanding, considerate, and courteous?)	___	___	___	___	___
16. EFFECTIVENESS: (What is your overall evaluation of your teacher's effectiveness?)	___	___	___	___	___

EARTH SCIENCE CLASS ID FORM

Date ____________

Teacher Background Information:

1. Name ____________

2. Highest degree held ____________

3. Major subject area (undergraduate) ____________

   Minor subject area (undergraduate) ____________

4. Major subject area (graduate) ____________

   Minor subject area (graduate) ____________

5. How many hours of credit have you taken in the following areas:

   Physical Geography ______
   Physical Geology ______
   Historical Geology ______
   Paleontology ______
   Oceanography ______
   Rocks and Minerals (or a similar course) ______
   Methods Course in Teaching Earth Science ______
   Astronomy ______
   Meteorology ______
   Field Geology ______
   Space Science ______
   Other (specify) ______

6. Approximately how many hours of credit have you completed in the following fields:

   Biology ______
   Chemistry ______
   Physics ______
   Mathematics ______
   Education Courses ______

7. Approximately how many hours of graduate work have you completed in geology or earth science? ______

8. If you have attended in-service or summer institutes in earth science, please fill out the information below:

Institution	Type of experience (i. e., graduate work, methods course or undergraduate work)	Subject Area

9. Teaching experience:

Total ___ In this school ___ In earth science ___

10. Age Bracket: (check one) 20-24 _____ 25-29 _____ 30-34 _____ 35-39 _____ 40-44 _____ 45-49 _____ 50-54 _____ 54- + _____

11. Do you enjoy teaching the course in earth science?

Yes _____ No _____

12. If you have taught courses other than earth science, how do your feelings about teaching earth science compare with the other science courses?

_____ Enjoy teaching earth science more
_____ Would prefer to teach another science
_____ No preference one way or the other

13. What subjects other than earth science are you teaching this year?

________________, ________________, ________________

14. What subjects other than earth science have you taught?

________________, ________________, ________________

15. Please indicate by checking the appropriate space what place you feel earth science should occupy in the school science curriculum:

___ Should be a required course and share equal status with physics, chemistry and biology.
___ Should be an elective course.
___ Should be taught to slow learners only.
___ Should be taught as an advanced course to fast learners.
___ Other (please specify) ________________.

16. At what grade level(s) do you feel the course in earth science should be offered?

7th ___, 8th ___, 9th ___, 10th ___, 11th ___,
12th ___, 9-12 ___, Other (specify) ______

17. Approximately how many classroom hours per week are involved in laboratory work?

Zero ___, 1-3 hours ___, 3-5 hours ___, 5-7 hours ___,
more than 7 hours ____

18. Do you feel there should be more or less emphasis placed upon laboratory work?

More _____ Less _____

19. Approximately how many hours per week do you spend in setting up laboratory experiments?

Zero ___, 1-3 hours ___, 3-5 hours ___, 5-7 hours ___,
7-9 hours ___, more than 9 hours ___

20. How would you rate the facilities your school has provided for teaching earth science? (This includes lab equipment, library books and the classroom itself.)

_____ Labs and classrooms are poorly equipped

_____ Labs and classrooms are adequately equipped

_____ Labs and classrooms are well equipped

21. Do you take any field trips as part of the course work?

Yes (how many) _____ No _____

Classroom Information:

22. How many earth science sections are being taught in your school this year? _____

23. What is the total number of students enrolled in earth science this year? _____

24. Total number of females enrolled in earth science this year. _____

25. Type of community in which school is located:

    Large Urban (greater than 10,000) _____

    Small Urban (less than 10,000) _____

    Suburban (bedroom community) _____

    Rural _____

26. Socio-economic status of the community in which your school is located:

    Low _____ Low Middle _____

    Middle _____ High Middle _____

    High _____

27. How do you perceive this earth science class ____(HR.)____ along the following dimensions. (Place an X in the appropriate region.)

    a. Ability (How would you rate this class in terms of overall ability?)

    Excellent Good Average Fair Poor

    ____

    b. Behavior (How would you rate this class in terms of behavior in the classroom situation?)

    Excellent Good Average Fair Poor

    ____

c. Industry (How would you rate the "effort" put forth by this class in order to complete the required assignments?)

Excellent Good Average Fair Poor

---

d. Enthusiasm (How would you rate the enthusiasm this class exhibits towards the earth science course?)

Excellent Good Average Fair Poor

---

e. Laboratory Work (How would you rate the quality of the lab work completed by this class?)

Excellent Good Average Fair Poor

EARTH SCIENCE STUDENT OPINION QUESTIONNAIRE

NAME ____________________ GRADE LEVEL __________

HOUR EARTH SCIENCE

SCHOOL ____________________ CLASS MEETS __________

TEACHER ____________________

Instructions:

Please answer the following questions by placing a check in the blank beside the answer you feel best answers the question.

1. Do you plan to attend college?

   1) _____ Definitely will
   2) _____ Probably will
   3) _____ Probably not
   4) _____ Definitely not
   5) _____ Completely undecided

2. Place a check beside the science courses you have taken.

   1) _____ General Science
   2) _____ Physical Science
   3) _____ Physical Geography
   4) _____ Physics
   5) _____ First-Year Biology
   6) _____ Second-Year Biology
   7) _____ First-Year Chemistry
   8) _____ Second-Year Chemistry
   9) _____ Other (please specify) ____________________

3. Would you tell your friends to take the earth science course you are now enrolled in?

   1) _____ Yes
   2) _____ No
   3) _____ Undecided

4. Do you think the earth science course is:

   1) _____ More interesting than other science courses I have taken
   2) _____ Less interesting than other science courses I have taken
   3) _____ More interesting than some, less interesting than other science courses
   4) _____ I have not taken another science course.

5. If you had the chance, would you take another course in earth science?

    1) _____ Yes
    2) _____ No
    3) _____ Undecided

6. If you went on to college, would you like to take another course in earth science?

    1) _____ Yes
    2) _____ No
    3) _____ Undecided

7. Do you think earth science should be a course taken by all students, or should it be an elective?

    1) _____ Should be required of all students
    2) _____ Should be an elective
    3) _____ Undecided
    4) _____ Other (please specify) ____________________

8. Do you find the material covered in your earth science course easy to understand?

    1) _____ Almost all of the material is easy to understand
    2) _____ Most of the material is easy to understand
    3) _____ Most of the material is hard to understand
    4) _____ Almost all of the material is hard to understand

9. What part of the course did you enjoy the most? (You may check more than one answer.)

    1) _____ Laboratory work
    2) _____ Reading the book
    3) _____ Lectures by the teacher
    4) _____ Field trips
    5) _____ Other (please specify) ____________________

10. What part of the course did you enjoy the least? (You may check more than one answer.)

    1) _____ Laboratory work
    2) _____ Reading the book
    3) _____ Lectures by the teacher
    4) _____ Field trips
    5) _____ Other (please specify) ____________________

11. What is your overall opinion of the earth science course?

1) _____ The most interesting course I've ever had
2) _____ One of the most interesting courses I've ever had
3) _____ More interesting than some, less interesting than other courses I have taken
4) _____ The least interesting course I've ever had

12. If you had a chance to improve the earth science course, which of the following would you do? (You may check more than one choice.)

1) _____ I wouldn't change the course
2) _____ I would add more laboratory work
3) _____ I would take more field trips
4) _____ I would use a different book
5) _____ Other (please specify) ____________________

APPENDIX B

Letters Sent to Cooperating Schools

May 12, 1970

Ordinarily, Dr. Paul E. Holkeboer, Coordinator of Graduate Science Education, would have written this letter to have endorsed the study being undertaken by Mr. Sam Yoveff. However, Dr. Holkeboer is recovering from a mild heart attack, and I have agreed to write this letter in his stead.

The course in earth science, as indicated by Mr. Yoveff, is developing rapidly. Unfortunately, it has no long tradition, and consequently, there are many problems yet to be solved concerning its place in the science curriculum. A few of these are being investigated by Mr. Yoveff.

We hope sincerely that it will be possible for you and your teachers of earth science to participate in carrying out this study. It is only with the help of persons such as you and your staff that the problems can be resolved.

Sincerely,

George G. Mallinson, Dean

GGM/bjs

May 12, 1970

The Division of Science Education at Western Michigan University is currently concerned with identifying some of the characteristics that distinguish earth-science teachers and students in Michigan. An effort is now being made to survey schools in Michigan with the hope of identifying some of these characteristics. This, of course, will require the assistance of earth-science teachers and students in a representative sampling of schools. We are writing this letter to inquire about the possibility of your school's participating in this study during the 1970-71 school year.

There is a national trend toward making earth science an integral part of the science curriculum. Figures projected for Michigan for the 1970-71 school year indicate that approximately 375 schools will be offering a regular earth-science course, and that student enrollment will exceed 40,000. As the demand for earth-science teachers grows, school planners, administrators and earth-science teachers will be faced with the problem of improving the quality of earth-science education in Michigan and in evaluating the existing earth-science programs at the levels at which they are taught.

We are hoping for your participation for the reasons that are implied in the previous statement. A maximum of three periods during the school year of student time and approximately one hour of teacher time will be needed in order to gather the data. No teacher or school will be rated or judged in any way by the researcher, and all the data will be kept completely confidential and complete anonymity is assured.

Before we proceed, we would like to ask your permission to write your earth-science teacher or teachers a letter similar to this one describing the study. In addition, we would like to arrange a conference with you on a date that is mutually satisfactory to describe the study further and discuss your cooperation. We hope to arrange the conference before the end of the school year, although some may need to be held in the early summer. Where possible, it is also hoped that the earth-science teacher or teachers may be present at this meeting so that any questions they may have concerning the study can be answered. At the conference your decision concerning participation can be made.

If such an arrangement is satisfactory with you, please fill out the enclosed form and return it in the self-addressed envelope. Upon receipt of the form, we will be contacting your office to set up a conference.

Your cooperation will be appreciated.

Sincerely,

Sam Yoveff
Science Education
Chemistry Department
Western Michigan University
Kalamazoo, Michigan 49001

SY/lkn

Enclosure

PLEASE RETURN TO:

Mr. Sam Yoveff
School of Graduate Studies
Western Michigan University
Kalamazoo, Michigan 49001

PARTICIPATION IN THE EARTH-SCIENCE STUDY

1. We would be interested in discussing the opportunity to participate in the Earth-Science Study.

   Yes _____ No _____

2. The names of the teachers in our school who teach at least one earth-science class follow:

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

Signature ____________

Address ____________

____

Telephone No. ____________

DESCRIPTION OF THE STUDY

A. General Design

This study is focused on the various earth science courses taught in Michigan Public Schools. A major objective is to examine some of the distinguishing characteristics of Michigan earth science teachers and their students. In addition, students will be asked to evaluate their teacher according to a form developed by the Educator Feedback Center at Western Michigan University. Some testing of students will be necessary to measure achievement gains during the school year. No teacher or school will be rated or judged by the researcher in any way, and all of the above data will be considered completely confidential and complete anonymity can be assured.

B. Procedure

1. Population and Sample: A sample of forty earth science classes and their teachers in forty schools from the lower peninsula of Michigan will be involved in the study. The sample will be a select group of classrooms designed to represent earth science classes and teachers in general.
   a) Only one class or section of each participating teacher will be involved in the project. Each teacher will be visited at least twice by Mr. Sam Yoveff, a former junior college physical science instructor, so that some personal contact can be maintained between the

researcher and the subjects involved in the study.

b) Each teacher will be told of the approximate time of each visit; however, no rigid schedule will be observed in order to maintain maximum flexibility and to allow the researcher to plan around the teacher's schedule rather than vice versa.

2. Testing: All test materials will be provided by the Science Education Division of Western Michigan University. All materials will be mailed to the teachers with return postage. Teachers will be asked to administer the following test:

   The Dubins Earth Science Test Form A, Harcourt, Brace and World, 1969. This test requires one class period to administer and must be administered in September and May of the 1970-71 school year. Thus, two class periods of fifty minutes are required for testing.

3. Questionnaires: All questionnaire forms will be provided by the Science Education Division of Western Michigan University. Questionnaires will be completed by both the earth science teachers and their students. A description of the questionnaires to be used in given below:

   a) Teacher Questionnaire: One questionnaire will be completed by the earth science teachers:

      1) A modified version of the Class I D Form developed by the Education Feedback Center at Western Michigan University. This form enables the teacher to rate the earth science class in various categories such

as ability, behavior, industry and class attitude. In addition, the teacher will be asked to provide information concerning his training, background and his attitudes about the earth science course he is presently teaching.

b) Student Questionnaires: Two questionnaires will be com- by the earth science students:

1) The Student Opinion Questionnaire, developed by the Education Feedback Center at Western Michigan University. This questionnaire enables the students to evaluate their teacher and will require from 15 to 20 minutes of the students' time.

2) The Student Attitude Questionnaire which will enable the students to give their opinions concerning the earth science course. This questionnaire will also require from 15 to 20 minutes of the students' time.

C. In return for the teacher's and school's cooperation and assistance as outlined above, the Science Education Division will render the following services:

1. Summary reports of the study will be produced and delivered as soon as data has been analyzed (two copies per school--more if requested).

2. Teachers will receive pre-, post- and gain scores for all of their students taking the Dubins Earth Science Test mentioned earlier. Pre-test scores will be available

by November 1970, and post-test scores and gain scores by June 1971. A letter of interpretation will accompany all data (two copies per school--more if requested).

3. Each teacher will receive results concerning his Teacher Image Profile as determined by student response to the Teacher Image Questionnaire. A letter of interpretation will accompany all data (two copies per school--more if requested).

4. Other requests which do not conflict with the experimental design will be considered and granted if possible.

D. Science Education Division and Personal Vita

1. Head of Science Education Division -- Dr. Paul E. Holkeboer
Science Education
Chemistry Department
Western Michigan University
Kalamazoo, Michigan 49001

2. Project Advisor -- Dr. Lloyd Schmaltz, Head
Geology Department
Western Michigan University
Kalamazoo, Michigan 49001

3. Principal Investigator -- Mr. Sam Yoveff
Science Education
Chemistry Department
Western Michigan University
Kalamazoo, Michigan 49001

Home Address: 1229 Little Drive
301 C
Kalamazoo, Michigan 49001

Telephone--Home:
381-8582
(collect calls
accepted)
School: 383-4994

Age: 27 years old

Marital Status: Single

Education: B.A. Western Michigan University, 1965
Currently working on a Ph.D. in Science Education at Western Michigan University.

Experience: Two years of teaching physical science at Highland Park Community College, Highland Park, Michigan.
Two years of laboratory teaching at Western Michigan University in connection with a university fellowship.

APPENDIX C

Sample Computer Printout for Teacher Image Questionnaire

TEACHER NAME HR CLASS MEETS

TEACHER ID

ITEM	NUMBER	MEAN	FREQUENCY 1S	2S	3S	4S	5S	STANDARD DEVIATIONS
1	21	3.76	1	3	2	9	6	1.1508
2	21	2.62	3	7	7	3	1	1.0455
3	21	2.29	6	7	4	4	0	1.0754
4	21	2.76	6	3	6	2	4	1.4444
5	21	2.29	8	5	3	4	1	1.2778
6	21	2.52	8	2	5	4	2	1.4013
7	21	3.62	2	4	2	5	8	1.3965
8	21	3.24	1	6	5	5	4	1.1914
9	20	3.95	0	2	6	3	9	1.0712
10	21	2.71	5	4	5	6	1	1.2399
11	21	2.71	3	7	6	3	2	1.1606
12	21	3.19	3	2	6	8	2	1.1800
13	21	2.71	4	5	7	3	2	1.2009
14	21	2.76	3	9	2	4	3	1.3058
15	21	2.57	1	10	8	1	1	0.8492
16	21	2.62	4	7	4	5	1	1.1742
TOTAL	335	2.89	58	83	78	69	47	1.3023

APPENDIX D

Pre-Test Analysis Information

November 6, 1970

Enclosed you will find the results of the Dubin's pre-test analysis for your school and for the overall sample. I apologize for the long delay in returning the results to you, but several problems arose in scoring the blue answer sheets some classes used. The problems have been solved and I can assure you that the post-test scores will be returned to you without delay.

The data enclosed includes the student's name, their pre-test score (out of 60), the class average and the standard deviation for that class. Also included is the average score for all students involved in the study, the overall standard deviation, and the total number of students involved in the study. By comparing the results you should be able to interpret how your class compares to the entire sample.

The scores on the test ranged from a high score of 49 to a low score of 1. There were three students in the high and one student in the low group. Many of the low scores can be attributed to the fact that most of these students did not complete the whole test.

On some data sheets, you will notice question marks in place of a name. If these are present, I either could not read the student's name, or he or she left it out. In some cases the student's first name has been cut short. This is due to the fact that I allowed for only 16 spaces on the data cards for a student's name. If there are any mistakes you wish changed, please inform me of them when I next visit your school.

You will be receiving additional data in a few weeks. I once again apologize for the delay, and I am looking forward to meeting with you next spring when I again will visit your school.

Sincerely,

Sam Yoveff
Science Education
Chemistry Department
Western Michigan University

SY:pw

Enclosure

SAMPLE PRE-TEST ANALYSIS

NAME OF SCHOOL　　TEACHER'S NAME　　HOUR CLASS MEETS

NUMBER OF STUDENTS

NAME OF STUDENT	PRE TEST SCORE
	14
	9
	11
	17
	18
	7
	14
	20
	12
	13
	20
	11
	7
	4
	10
	13
	8
	7
	13
	14
	12
	12

CLASS AVG = 12.091　　STANDARD DEVIATION = 4.122

AVERAGE SCORE OF ALL STUDENTS = 19.240
STANDARD DEVIATION FOR ALL STUDENT SCORES = 7.562
TOTAL NUMBER OF STUDENTS = 2151

APPENDIX E

Post-Test Analysis Information

May 25, 1971

Dear

Enclosed you will find the post test scores for your students who took the post test. Since all schools have not yet completed the post test, an overall summary is not enclosed.

Also enclosed you will find a postcard addressed to me. If you wish additional data sent to you during the summer, then please fill in the information and return it to me.

I would like to thank you for the cooperation you have shown me, and I do hope the results of the study have proved interesting. Once again, thanks for making it all possible.

Sincerely,

Sam Yoveff, Science Education
Department of Geology
Western Michigan University

SY:gb

SAMPLE POST-TEST ANALYSIS

SCHOOL NAME TEACHER'S NAME HOUR CLASS MEETS

NUMBER OF STUDENTS

STUDENT NAME	PRE TEST	POST TEST	GAIN SCORE
	13	13	0
	44	49	5
	22	38	16
	17	30	13
	26	23	-3
	35	40	5
	21	24	3
	19	34	15
	14	21	7
	25	37	12
	15	23	8
	15	33	18
	17	42	25
	16	26	10
	22	18	-4
	9	22	13
	17	NO POST TEST SCORE	
	32	29	-3
	29	31	2
	19	NO POST TEST SCORE	
	21	34	13
	14	NO POST TEST SCORE	
	32	41	9
	17	38	21
	14	NO POST TEST SCORE	
	16	NO POST TEST SCORE	
	1	36	35
	NO PRE TEST SCORE	27	

CLASS AVG PRE TEST = 20.074
STANDARD DEVIATION PRE TEST = 8.606
CLASS AVG POST TEST = 30.826
STANDARD DEVIATION POST TEST = 8.606
AVG GAIN SCORE =10.00
NUMBER OF STUDENTS TAKING BOTH TESTS = 22.00

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