A Study of the Attitudes of the Non-Science Major toward Science and Its Importance in Curriculum Design

Larry J. Fairbanks
Western Michigan University

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A STUDY OF THE ATTITUDES
OF THE NON-SCIENCE MAJOR TOWARD
SCIENCE AND ITS IMPORTANCE
IN CURRICULUM DESIGN

by

Larry J. Fairbanks

A Dissertation
Submitted to the
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of the
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A STUDY OF THE ATTITUDES OF THE NON-SCIENCE MAJOR TOWARD SCIENCE AND ITS IMPORTANCE IN CURRICULUM DESIGN

Larry J. Fairbanks, Ed.D.
Western Michigan University, 1977

The purposes of this study were to: (1) Identify and explore the non-science majors' attitudes toward science; (2) Use the results of the investigation to design a course to be used by instructors of Earth and Space Science.

Two major instruments were developed to collect data for the study. The first was an Attitude Inventory and the second was a Course Content Inventory. A major goal of the Attitude Inventory was to collect data with which to develop an Attitude Index which could be used to predict those non-science majors who have some "negative" attitudes toward science. The course design would then be focused on the modification of these "negative" attitudes to positive attitudes toward science.

The results of the study permitted the following conclusions: (1) The Attitude Index which was developed showed no significant difference between those students classified as having "negative" attitudes and the total sample on the variables age, sex, race, and previous
science background; (2) There was a significant difference between these groups indicating that students with "negative" attitudes do delay taking their science requirement; (3) The non-science majors' "negative" attitudes appear to be a reluctance to take science courses because of the students' concerns about the difficulty of these courses.

A course was designed in the area of Earth and Space Science which had as its major objective the reduction of the concerns of these students toward the difficulty of science.
ACKNOWLEDGEMENTS

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I would also like to share the results of this endeavor with my wife, Peggy. Without her love, help, and understanding throughout the last two years, this study would never have been completed. To my children, Steve, Ron, Laura, and Mike, who learned to walk softly when Dad was working, a special thanks.

Larry J. Fairbanks
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Statement of the Problem</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Importance of the Study</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Definition of Terms</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Delimitation of the Study</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Hypotheses for the Study</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>7</td>
</tr>
<tr>
<td>II</td>
<td>REVIEW OF RELATED LITERATURE</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Science for the Non-science Major</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>How Science Courses Can be Structured for the Non-science Major</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Attitudes and the Non-science Major</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>The Learning Environment and the Non-science Major</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>32</td>
</tr>
<tr>
<td>III</td>
<td>DESIGN AND METHODOLOGY</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Review of the Problem</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>The Population</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Instrument Design</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Data Collection Procedures</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>39</td>
</tr>
<tr>
<td>IV</td>
<td>RESULTS</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Background Information on Respondents</td>
<td>40</td>
</tr>
</tbody>
</table>
## Purpose, Findings, Limitations, Conclusions and Recommendations

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose of the Study</td>
<td>80</td>
</tr>
<tr>
<td>Findings</td>
<td>80</td>
</tr>
<tr>
<td>Limitations of the Study</td>
<td>95</td>
</tr>
<tr>
<td>Conclusions and Recommendations</td>
<td>97</td>
</tr>
<tr>
<td>Summary</td>
<td>100</td>
</tr>
</tbody>
</table>

## REFERENCES

- REFERENCES ........................................................................... 101

## APPENDIX A: Questionnaire on the Attitude Inventory

- APPENDIX A: Questionnaire on the Attitude Inventory .................. 106

## APPENDIX B: Attitude Inventory

- APPENDIX B: Attitude Inventory ........................................ 111

## APPENDIX C: Course Content Inventory

- APPENDIX C: Course Content Inventory ................................ 121

## APPENDIX D: Letter for Course Content Inventory

- APPENDIX D: Letter for Course Content Inventory .................... 125

## APPENDIX E: What do you believe to have been the most valuable about the lectures?

- APPENDIX E: What do you believe to have been the most valuable about the lectures? ...... 127

## APPENDIX F: What do you believe to have been the least valuable about the lectures?

- APPENDIX F: What do you believe to have been the least valuable about the lectures? ...... 133

## APPENDIX G: What changes would you recommend in the lecture portion of the course?

- APPENDIX G: What changes would you recommend in the lecture portion of the course? ...... 139

## APPENDIX H: What do you believe to have been the most valuable about the laboratory experiences?

- APPENDIX H: What do you believe to have been the most valuable about the laboratory experiences? ........................................ 145

## APPENDIX I: What do you believe to have been the least valuable about the laboratory experiences?

- APPENDIX I: What do you believe to have been the least valuable about the laboratory experiences? ........................................ 151

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# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Sex Distribution Within the Physical Science Class</td>
<td>42</td>
</tr>
<tr>
<td>II Racial Distribution Within the Physical Science Classes</td>
<td>43</td>
</tr>
<tr>
<td>III Number of Previous Science Courses</td>
<td>44</td>
</tr>
<tr>
<td>IV Students with Previous High School Chemistry</td>
<td>45</td>
</tr>
<tr>
<td>V Students with a Previous Earth Science Course</td>
<td>45</td>
</tr>
<tr>
<td>VI &quot;Why Did You Enroll in this Science Course?&quot;</td>
<td>47</td>
</tr>
<tr>
<td>VII &quot;Should Science Be A Required Course for the Non-science Major?&quot;</td>
<td>48</td>
</tr>
<tr>
<td>VIII &quot;Should There Be Any Required Courses Outside of the Students' Major Field?&quot;</td>
<td>49</td>
</tr>
<tr>
<td>IX Comparison of Science Class With Other Classes in Social Science and the Humanities</td>
<td>50</td>
</tr>
<tr>
<td>X Respondents Attitude Levels</td>
<td>52</td>
</tr>
<tr>
<td>XI Combined Grouping of Attitude</td>
<td>52</td>
</tr>
<tr>
<td>XII Total Semester Hours of Credit Completed Before Enrolling in Physical Science</td>
<td>53</td>
</tr>
<tr>
<td>XIII Students in Science With Biology Before Entrance</td>
<td>54</td>
</tr>
<tr>
<td>XIV Number of Absences in the Physical Science Course</td>
<td>55</td>
</tr>
<tr>
<td>XV Grade in Physical Science</td>
<td>56</td>
</tr>
<tr>
<td>XVI Age Comparisons in Years Between the Total Respondents and Students With &quot;Negative&quot; Attitudes</td>
<td>57</td>
</tr>
</tbody>
</table>
TABLE

XVII Sex Distribution for the Students With "Negative" Attitudes ................. 59

XVIII Racial Distribution for the Students With "Negative" Attitudes ............... 59

XIX Distribution of Students in the Physical Science Classes ...................... 60

XX Previous High School Chemistry for Students With "Negative" Attitudes ........... 61

XXI Reasons Students With "Negative" Attitudes Enroll in a Course in Physical Science ... 62

XXII Student Responses, for the Students With "Negative" Attitudes, to the Question, "Should Science Be a Required Course for the Non-science Major?" ............... 63

XXIII Student Responses for the Students With "Negative" Attitudes to the Question, "Should There Be Any Required Courses Outside of the Students' Major Field?" .... 64

XXIV A Comparison of Total Semester Hours of Credit Completed Before Enrolling in the Course Physical Science .................... 65

XXV A Comparison of Previous Exposure to College Biology .......................... 67

XXVI "What Do You Believe To Be The Most or Least Productive Methods of Presenting Material?" 68

XXVII "What Method of Presentation Would You Prefer?" ............................. 69

XXVIII Evaluation of the Quantity of Material Covered in Lecture for Sample 1 .... 70

XXIX Evaluation of the Quantity of Material Covered in the Laboratory for Sample 1 ... 71

XXX Sample 1 Responses to the Question: "Do You Believe There Should Be Greater Student Participation in the Lecture Portion of the Course?" .......................... 73
| TABLE |
|------------------|------------------|
| XXXI Evaluation of the Student's Last Science Class and the Present Course as to Interest, Difficulty, and Relevancy | 75 |
| XXXII Sperman's Rank-correlation Coefficients | 76 |
| XXXIII Evaluation of the Present Course as to Interest, Difficulty, and Relevancy | 77 |
| XXXIV A Comparison of Attitudinal Change Toward the Course in Physical Science from Entrance to Completion | 78 |
| XXXV Hypothesis I: Students Who Elected the Physical Science Course | 82 |
| XXXVI Test of Hypothesis II | 85 |
| XXXVII Hypothesis III: Student Preference | 90 |

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CHAPTER I

INTRODUCTION

Statement of the Problem

A review of college catalogs indicates that there is a requirement that the non-science major take minimal course work in the sciences as a degree requirement at most community colleges, as well as in most four year institutions. In the case of the community-college student, the degree attained is the Associate Degree and for the four-year college student, the degree is the Baccalaureate Degree.

Minimal course work has traditionally been defined in community-college catalogs as a four-semester hour course in a Biological Science and a four-semester hour course in the area of Physical Science. These courses commonly have associated laboratory experiences.

Nordland (1974) indicated that science courses then offered for the non-science major in community colleges, in some cases, were not appropriate. The inappropriateness of those courses had its genesis in two basic areas.

1. The Instructor's Background

Some instructors of those courses tended to be strict disciplinary instructors. A strict disciplinary
instructor may be defined as one who has taken the majority of his own academic course work in a single science area with little academic preparation in the other areas of science. These instructors often spend the greatest amount of teaching time in their areas of speciality and little or no time in other science areas. For example, if the instructor is a Chemistry instructor, he stresses Chemistry to the exclusion of Physics, Geology, and Astronomy.

In addition to the science background being narrowly oriented, some instructors at the community college level have little formal background in the methodology of teaching in, or the philosophy of, the community college. Some of the science instructors are teaching courses for the science major as well as for the non-science major. Consequently, these instructors are introduced into two different teaching environments. The first environment involves the science majors. These students are characterized as being science motivated with a strong academic preparation in the sciences and mathematics. The second teaching environment involves the non-science majors. In this environment, the instructor works with students who have limited backgrounds in the areas of science and mathematics and who may exhibit low levels of interest in science. The situation often leads to

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frustration both for the instructor and for the students because the non-science major is often expected to have the same motivation and insight as the science major (Nordland, 1974). It is believed that too often, the same teaching approach and the same course content is covered for both groups.

2. Lack of Understanding of the Student

According to Grandits (1975), the non-science majors in community colleges tended to exhibit a wide range of attitudes toward science. Those attitudes varied from the students with positive attitudes who may have had a relatively strong academic preparation in science to the students with negative attitudes who may have had limited preparation in science.

A recent study of changing practices in undergraduate education conducted by the University of Michigan's Center for the Study of Higher Education for the Carnegie Council on Policy Studies in Higher Education involved a detailed examination of college catalogs and student transcripts. The results of the study indicated that students who had elective options tended to avoid the natural sciences in favor of the social sciences. A major reason given for natural sciences' low popularity was that the natural sciences are difficult (Plant, 1976).

The current non-science major is frequently committed to the attainment of a degree, either an Associate or
Baccalaureate in a minimum amount of time. The present requirement that the student must take the more difficult science courses for graduation can interfere with this goal in that it may lengthen his degree program with courses some consider to be irrelevant or overly difficult. It may be that the perceived difficulty of science courses has resulted in a broadly based negative attitude toward science.

Student attitudes regarding current science courses are a topic in which additional knowledge would be beneficial for the science instructor. The purposes of this study are to:

1. Identify and explore the non-science majors' attitudes toward science by the use of survey research.

2. Use the results of the above to develop a one-semester course in Earth and Space Science that has as one of its primary objectives the development of positive attitudes for the students toward science.

Importance of the Study

The study is expected to provide knowledge regarding the attitudes of the community-college student relevant to courses in science. It is anticipated that the study will provide data pertaining to the student's science background and attitudes toward science. This should lead to a better understanding of the non-science major. In
addition, student attitudes will be explored regarding course difficulty, course relevancy, course content, and preferred teaching methodology. This knowledge should be useful to science instructors in the structuring of their own courses for the non-science major.

It is anticipated that a one-semester course in Earth and Space Science will be developed which might be useful to instructors contemplating a course in the areas and particularly by the beginning science instructors at the community college level.

Definition of Terms

The term "non-science major" has taken on a number of meanings (Miles, 1975, Swenson, 1962), and therefore needs to be defined in the context of this study. When used in this study, the term "non-science major" will refer to the student not majoring in science, yet pursuing an Associate in Arts Degree. The non-science major includes the areas of:

1. Social Science, which includes such disciplinary groups as Economics, Geography, History, Political Science, Psychology, and Sociology.

2. Humanities, which includes the disciplinary groups of Art, English, Foreign Language, Journalism, Music, Philosophy and Speech.

3. Business, which includes Accounting, Business Administration, and Business Education.

4. Pre-professional curricula such as Law.
The concept of "fear" as used in the context of this study implies negative attitudes toward science. The student lacks confidence in his ability to comprehend the course material to such an extent that anxiety arises. The non-science major with negative attitudes has been noted by classroom and laboratory behavior and in personal discussions with these students.

**Delimitation of the Study**

This study focuses on the non-science major at two Michigan community colleges.

The Physical Science requirement at one of the institutions could be met by enrolling in either the course Physical Science (Chemistry and Physics) or the course Physical Science (Geology and Astronomy). Both of these courses with their concurrent laboratory experience are one-semester four credit-hour courses. The Physical Science course in the areas of Geology and Astronomy was developed to serve as a student option for those students who had previously taken Chemistry and/or Physics in high school.

The Science requirement at the second institution could be met by enrolling in a Physical Science course, a Biological Science course, or a Mathematics course to total eight credit-hours. The course work must include at least one laboratory course.
Hypotheses for the Study

The following four hypotheses were investigated in the study.

\( H_1 \): The majority of non-science majors elect the course Physical Science because it is a curricular requirement for the Associate in Arts Degree.

\( H_2 \): The majority of students believe that science courses require more study time, are more difficult, and that their grades will be lower than in their other courses in the humanities and social sciences.

\( H_3 \): The majority of students prefer instruction involving a combination of methods of presenting material rather than the lecture method alone.

\( H_4 \): There is a relationship between attitudes toward science and the variables age, sex, and race.

Summary

The purpose of Chapter I has been to state the problem, the importance of the study, definition of terms, delimitation of the study, and the hypotheses for the study. In Chapter II, there will be a review of the literature related to the study.
CHAPTER II

REVIEW OF RELATED LITERATURE

The literature dealing with the interaction between science and the non-science major is extensive, but the application of this body of research toward practical course curricular development is minimal (Agin, 1974).

There are four basic questions that need to be discussed to place the study in the proper context. These are:

1. Why are science courses required for the non-science major?
2. How can science courses be structured for the non-science major?
3. What is known about the attitudes of the non-science major toward science?
4. What is the relationship between the learning environment and the non-science major?

Science for the Non-science Major

The requirement of the Associate Degree at most community colleges and the Liberal-Arts Degree at most colleges and universities include basic courses that are considered necessary to enable the student to achieve a well-rounded education. A well-rounded education implies
one that gives students broad exposure to the areas of mathematics, social science, natural science and the humanities. Swenson (1962) indicated that these required courses are frequent targets of the criticism of students who are required to take them. Among the science students, the criticism is usually directed at the social sciences and the humanities, whereas those in the language arts or social sciences object to taking courses in science and mathematics. Many students believe that the best educational plan is to take as many courses as possible in their chosen fields and as few as possible in the areas they consider irrelevant. This viewpoint, which is adopted frequently in technical and occupational studies, may have merit, but as Swenson (1962) stated, "The specialist whose entire stock of knowledge lies within narrow limits is notoriously short sighted and unsympathetic with points of view other than his own or outside his profession" (p.5).

The advocates of a liberal education believe that, in two years of college, the student can not only achieve a degree of specialization, but also can gain insight into many diverse areas. These advocates of a liberal education believe there is a real danger in too much specialization early in the career of a student. As Ward (1972) reported, there is a vast difference between the individual who is merely trained and one who is educated because edu-
cation involves a broad base of understanding and knowledge.

Everyone in our society has a need for science education. The extent of these needs depends upon the goals and interests of each individual. Some individuals want to have a better understanding of natural phenomena whereas others have a desire to make science more useful to man. At the same time, all individuals of our society have a need for a better understanding of basic scientific concepts and methods, not to make them better scientists, but to help them become more knowledgeable citizens (Agin, 1974).

From these needs many goals of science education have been postulated. The primary ones are:

1. To prepare scholars in the several disciplines of science.

2. To provide individuals with a background for technological occupations or professions.

3. To provide individuals with a background in science as a part of their general education for effective citizenship (Pella, 1966).

This third goal of science education for individuals is not new. Benjamin Franklin argued for science education for effective citizenship when he set down the tenets for the Academy. Since the time of Franklin, others have
emphasized the same goal. Hurd (1970) believed that science education programs must prepare future adults to expect change and to meet change without shock, fear, or anxieties.

During the late 1950's and throughout the 1960's, numerous phrases have been proposed to express this goal of effective citizenship via science education. "Scientific literacy" is the term most frequently used. In 1964, the Curriculum Committee of the National Science Teachers Association (NSTA) stated, "science teaching must result in scientifically literate citizens" (p.4). This was expanded by NSTA's Committee on Curriculum Studies (1971) as follows: "The major goal of science is to develop scientifically literate and personally concerned individuals with a high competence for rational thought and action" (p.48).

Gatewood (1968) stated, in this context, "in a society that is scientifically and technologically oriented as ours is today, all students should be broadly educated in science, in its processes, its products, its philosophy, and its impact on society. The single most important goal of school science must be to prepare scientifically literate citizens for the future" (p.20).

As in most fields in education, cognitive knowledge in science is increasing at a tremendous rate. Knowledge
in the sciences doubles every eight and one-half to twelve years, according to Doll (1970). With this rapid increase in scientific knowledge, a general understanding of scientific concepts is necessary for the individual to function in modern society. Krauskopf (1971) stated that "The impact of science on modern culture has been so strong and so persuasive that some degree of scientific literacy is required of a well informed citizen in any of today's worlds, whether intellectual, political, economic or social" (p.11). Handler (1972) went further and indicated that unless man gains the scientific ability to understand his environment, he may destroy the only suitable habitat he has - the Earth.

The area of science crosses many boundaries or fields. As Saunders (1966) stressed, the variable methods of scientific inquiry offer the most adequate approach to the solution of educational problems. Scientific inquiry tends to be flexible and adaptable to a number of problems in various areas. Dobbs (1972) suggested that scientific inquiry can be used by a mechanic analyzing the problems with an automobile as well as by the family cook wondering why the cake didn't rise. He further indicated that the types of reasoning used by scientists are not unique to scientists; everybody uses reasoning. Labianca (1975) agreed with Dobbs and went on to say that "a command of
the ability to think logically and to communicate information on the basis of understanding is also an integral part of the study of other disciplines" (p.187). In effect, then, one of the science teacher's major goals is that of convincing the non-science major of the significance of Weaver's (1967) comments in "Science and Imagination" which stated "Science is not an arrogant dictator in the whole arena of life but rather a democratic companion of philosophy, of art, of religion, and of other valid alternative approaches to reality" (p.9).

The minimal level of course work in science is especially relevant to the elementary school teacher who can often by statements or expressions discourage students interest in science as they progress to junior and senior high school. Ward (1972) suggested that the misconceptions of "science is hard" and "I can't possibly understand it" have their roots very often in elementary school with improperly trained teachers (p.3).

There is no question that science exposure is desirable. The question remains, "Should it be required of a non-science major?" Conant (1959) advocated that two courses in science, specifically Physical Science and Biology, be required in high school for graduation because some degree of scientific literacy is important for all students. If science should be required in high school, does it follow then that science should be required in the...
community college? Payne (1974) related that colleges have recognized this sequence and therefore have included courses in science as part of the general education requirement for all degree candidates. All community colleges in the state of Michigan require science courses for an Associate in Arts Degree.

How Science Courses Can be Structured for the Non-science Major

The second question to be discussed is, "How can science courses be structured for the non-science major?"

The first step in discussing this important question is to understand the science background of the typical college student. Miles (1974) reported that among the non-science majors in most colleges and universities, less than 20% have had high school Physics, about 50% to 66% have had high school Chemistry, and few have studied Astronomy, Meteorology or Geology.

What area or areas of science are covered is probably not so important as how they are covered. Swenson (1962) stated that "to put non-science majors into courses designed for science majors is usually a mistake and frequently a fatal one" (p.5). The emphasis in courses for the science major must of necessity be on the factual content and technical skills needed as a preparation for future courses. Because the majority of non-science ma-
jors are terminal science students, the course need not build to another course but rather it can be designed as an entity.

Two major criticisms of science courses for non-science majors are (1) the specific vocabulary makes understanding more difficult and (2) it is too factual with too many facts to remember. Most science authors agree that every subject has its specialized vocabulary, but Bates (1973) explained that the existence of such a vocabulary does not make comprehension of a subject more difficult but easier. Science relies on sequential definitions in the understanding of complex concepts. The vocabulary, when defined and understood, aids in the understanding of these concepts.

Facts are important, because one cannot generalize meaningfully except from a basis of particulars (Ward, 1972). The extent of learning facts seems to be the important question. Miles (1974) stated "Facts are important, but they are of less permanent use and value to the student than the generalizations and theories developed from the facts" (p.7). These generalizations and theories tend to be more suited to a survey course rather than to a strict subject course. The survey course tends to add breadth to the student's background while the strict subject course tends to add depth. Therefore, the non-science student needs a broad background in science rather than a narrow
in-depth treatment of a single area (Wiggins, 1974). It is difficult to know what the future will bring to the non-science major and the student may find some of the knowledge helpful because of the added flexibility it affords in modern society.

To achieve this broadening of the science curriculum, Krauskopf (1971) recommended the interdisciplinary approach because "the synthesis of several major scientific disciplines has much in its favor as it provides a broad perspective of the knowledge and insights that science has afforded" (p.11). Bourne (1966) indicated that more efficient learning occurs when the student is given the opportunity to encounter the concept in a variety of situations. This might be extended to include a variety of disciplines.

If the interdisciplinary approach is used, then it becomes necessary to answer some of the charges which have been leveled against the standard curriculum, namely that it is sterile, lifeless, and indifferent (Van Till, 1971). Some of these charges can be eliminated by the design of the course and the relevance of the material covered to the student.

Labianca (1975) stated that "the college science teacher is faced with the challenge of proving to non-science majors that science is a part of their daily lives which does not have to be tuned out. The utility of science
must be demonstrated so that students can discard the notion that science is isolated and understandable only by a select few. The instructor must also show that although the study of science often involves memorization of information, this memorization is meaningless unless accompanied by a mastering of the reasoning essential for a complete understanding of the memorized information” (p.187).

The design of an interdisciplinary course can help to eliminate a sterile and lifeless course. The sequence of material covered, content of the material, and teaching methodology can, when unified, form an interesting course for the non-science major. Labianca (1975) noted that the interdisciplinary approach serves to reduce, if not eliminate, the feelings of alienation which non-science majors often have for science courses. He writes "The experience of this teacher has been that non-science majors perform more enthusiastically and more effectively when the interdisciplinary approach is used" (p.190).

The design of the course can also select some unifying theme upon which the course can be built. One unifying concept of all the sciences is that all the diverse phenomena of nature are tied together by surprisingly few relationships (Hewitt, 1974).

Reilly (1970) suggested, for example, one major theme or concept which might be used is energy which is common
to the areas of Biology, Chemistry, Physics, Astronomy and Geology. Agin (1974) pointed out that another major interdisciplinary theme is equilibrium: "It includes special cases from (a) Biology-homeostasis, (b) Chemistry-LeChatelier's principle, (c) Physics-the balanced lever, (d) Geology-isostasy, etc. All of these concepts are governed by the same basic underlying principle: parts of a system must be balanced" (p.411). It should be these underlying relationships or themes upon which the course curricula are based.

The course for non-science majors should, therefore, be a special course designed specifically for these students. The depth of the material covered and the laboratory experiences provided should be appropriate for the non-science major. This entails content which is at the level of the non-science major and experiences which are relevant to the understanding of the subject matter. Wiggins (1974) observed that these students prefer to see connections between topics and how the individual topics relate to some overall goal. This author, therefore, favors an interdisciplinary approach to science which is in sufficient depth for the student to gain an appreciation of science in addition to cognitive knowledge relevant to the topic.

In the area of Physical Science, a student should have the opportunity to broaden his background. As was
reported previously, between 50% and 66% of students in college have had a course in high school Chemistry. If a student is now required to elect another science course, it should be in an area other than Chemistry to achieve the goal of a broadened background. If one is to accept the recommendations of science authors as to an interdisciplinary course, (Labianca, 1975 and Krauskopf, 1971) the areas of Geology and Astronomy would meet the above objective.

Attitudes and the Non-science Major

Today's college science instructor is often confronted with students who are non-science majors and who approach courses in science with apprehension (Labianca, 1975). These students are characterized by what Bronowski (1966) called "the personal fear of what is unfamiliar" (p.12). These students have elected past courses outside the area of science and are now required to elect a science course. There is a feeling among some of these non-science majors that the science course can only be boring and that it involves memorization of excessive, irrelevant information which will be of no use after completion of the course. These students are characterized as having negative attitudes toward science. Other non-science majors may have a feeling of apathy
toward the course as well as courses in other disciplines and would be characterized as having a neutral attitude. Still others have pleasant memories of their past interaction with science and have no apprehension in electing a science course. In contrast, they look forward to the course as being exciting. This last group would be characterized as having positive attitudes toward science.

The science instructor should be concerned with changing the non-science majors' negative attitudes toward science particularly now in the period of declining enrollments in the sciences. It is this decline that, to a degree, initiates curriculum revision in an attempt to attract non-science majors into science courses. Part of the problem in attracting non-science majors, as was reported earlier, is that some will approach the study of science with fear and intense dislike or an almost complete lack of understanding as to its place in the total curriculum (Gratz, 1966). To combat this fear or negative attitude, science instructors have conducted studies on what course titles are more likely to attract non-science majors (Grandits and Young, 1975). In the above study, one of the conclusions was that "there is a definite trend among collegiate non-science majors to choose hypothetical science course titles containing specific adjectives which suggest relevancy as well as simplicity" (p. 197). The utilization of adjectives such as intro-
ductory, fundamental, modern, and contemporary in course titles was recommended by the above authors to attract students by promoting an interest in science.

One of the barriers to effective science teaching, as revealed by Blackwood (1964) in his nationwide survey of elementary teachers, was a lack of teacher interest in science. Of 17 percepts developed by Stollberg (1969) on the subject of professionalizing science education for the elementary teachers, he rated the teacher's attitude toward science as the most important. Stollberg suggested that teachers, who have a negative attitude toward science, can pass on this attitude to their pupils. Hone and Carswell (1969) supported Stollberg with the statement, "Children's built-in radar is fine-tuned to their teacher's feelings about science" (p.24). Washton's (1971) study indicated that pupils imitate the attitude of their elementary teachers toward science. In a report of his study of 100 New York teachers, Washton concluded: "They felt that their elementary school teachers disliked science and so it was contagious to dislike science. As a result, they were afraid to teach science to their pupils" (p.378).

One method of reducing fear is to promote success within the discipline. Washton's (1971) study confirmed the assumption that science knowledge has a positive effect on the teacher's affective domain of learning. He
said "Getting higher scores on standardized science tests will help reduce fear. Self-achievement is an effective weapon against negative attitudes or fears of teaching science" (p.378).

A large proportion of the course work in the sciences is taken by the future elementary-school teacher during the two years at the community college or the first two years at a four-year institution. It therefore becomes the responsibility of the science instructor in these courses to provide positive attitudes toward science for the prospective teacher. If the negative attitudes these teachers have toward science can be reduced, then possibly the negative attitudes of their future elementary students toward science can also be reduced.

The attitudes of students in an educational setting can have both positive and negative effects depending upon the direction of as well as the strength of the attitude within the student. DiVesta (1970) noted that a mild fear of failure can promote achievement while Cattell (1966) and Spillberger (1966) suggested that a high level of fear toward failure results in behavior that is directed toward reducing the fear as well as the avoidance of the associated task. The level of fear in the non-science major may stimulate the individual to greater achievement or if the fear becomes too high may lead to an escape from the
situation. The latter possibility may account for the higher withdrawal rates in the sciences than in the humanities and social sciences at Lake Michigan College. Research conducted by Ebel (1965) and Shrigley (1976) on fear of tests pointed out that mild degrees of fear facilitate and enhance test performance while more extreme degrees are likely to interfere with and depress test performance. Waite (1958) reported a study in which students having a mild fear of tests performed better than students having a high level of fear toward the taking of tests.

The role of the instructor, with the student who has a fear toward science, is to reduce the level of fear within the student. The level must be one which is constructive toward increased achievement rather than destructive leading toward under-achievement.

Community college instructors in all disciplines must deal with the student who is afraid of failure. As Cross (1971) states, "Fear of academic failure will be a major impediment for the 'new' students, those who rank in the lowest third on tests of academic aptitude, and it is that group which constitutes the greatest reservoir of future attenders" (p.3). As more and more students with lower academic achievement in secondary school attend the community college, this fear of failure will become a major problem to be faced by the instructor.
The present open door policy of community colleges allows entrance to all students regardless of their grade point average.

The requirement that students must take science courses for graduation means that the science instructor will have increasingly more reluctant students in the classroom. A major obstacle to the science instructor's control over the negative attitudes of students, is that these students do not become visible until late into the course. By the time the instructor becomes aware of this, it is difficult to reduce these negative attitudes.

A major thrust of this study is to identify these indices of negative attitudes for the non-science major. The purpose of this study is to use the indices to design a course in which the level of fear will not inhibit achievement.

The Learning Environment and the Non-science Major

Some studies have implied that students with negative attitudes toward course work may benefit from: (1) structured situations where short term objectives are clearly defined, (2) highly supportive classroom environments, and (3) interactions with instructors and peers where the students' accomplishments are indicated by guidance and feedback at relatively frequent intervals (Grimes, 1961).
Flanders (1951) in an earlier study suggested that students with negative attitudes benefit much more from the learner-centered and supportive instructor whose criticism is directed toward corrective and constructive measures rather than toward pointing out the personal inadequacy of the student.

Each student reacts to the learning environment in a different way, for every learner brings with him individualized conditioners of learning. Doll (1970) noted that these conditioners of learning include "his personality, his personal experiences, his mental ability, and the effects of the social order. The nature of the learner himself and of his background has a marked effect on what he learns and on his style of learning" (p.46). Therefore, the instructor must be aware of individual differences within the students and provide learning experiences by variable methods.

Doll also observed that there is a definite relationship between the learner's self-concept and the effectiveness with which he learns. Findings from research studies reveal that the individual performs according to his self-concept. The student who, therefore, has a low self-concept of himself in his interaction with science will tend to perform according to this self-concept. As Cross (1971) related, "Positive conditions for learning must assume
increasingly more importance if we expect these students to learn" (p.3).

There are some generally agreed upon concepts in the literature dealing with learning environments. These are:

1. A motivated student acquires what he learns more readily than one who is not motivated. Doll (1970) stated that "Motivation that is too great (especially pain, fear, and anxiety) may be accompanied by distracting emotional states, so that excessive motivation may be less effective than moderate motivation for learning some kinds of tasks, particularly those involving difficult discriminations" (p.50).

2. Learning motivated by reward is usually more effective than learning motivated by punishment. In this context Ahmann (1971) suggested that admonishing or ridiculing are not effective ways to initiate a positive change in behavior.

3. Learning that takes place because of self motivation is preferable to learning which is externally motivated.

4. Active participation in the learning process by the student is preferable to passive reception of the content to be learned.

5. Meaningful information is learned more efficiently than that which has no meaning to the student.
6. Learners progress in any area of learning only as far as they need to in order to achieve their purposes. Often they do well enough only to get by; with increased motivation they improve (Watson, 1960).

7. The more efficient effort is put forth by students when they attempt tasks which fall within their range of challenge - not too easy and not too difficult - where success is possible, but not certain.

8. Learners engage in an activity most willingly if they have helped select and plan the activity.

9. Learning is aided by formulating and asking questions that stimulate thinking and imagination (Watson, 1960).

10. In the learning of concepts, students need to have the concepts presented in a variety of situations.

Motivation of the learner is fundamental to the learning environment. In this context, Doll (1970) said that "Motivation proceeds from within the learner. Thus, only he can motivate himself; others merely set the stage or provide suitable conditions for this motivation. Further, motivation results from establishing and possessing goals. The goals most helpful in inspiring learning are
intrinsic ones, implicit in the learning itself; immediate goals, as opposed to deferred ones; and major goals rather than minor ones. Goals may be set so high as to be frustrating, or so low as to be unchallenging" (p.52). If one is to accept this premise, then it becomes the major responsibility of the instructor to help the student set realistic goals in order to inspire motivation.

Instructional methodology which can enhance the learning environment for students includes:

1. A well planned and structured course. In this regard, Korn (1972) stated that "Planning has been neglected as a component of instruction, even though planning is more important than execution or performance in the classroom" (p.127). Planning for effective learning involves the analysis of the total instructional strategy which, according to Lewis (1975) involved:
   (a) the establishment of specific learning and behavioral objectives; (b) the design of step-by-step learning sequences along with the appropriate selection of media and equipment best suited to each task; (c) the inclusion of progressive testing, reinforcement, recycling, and alternative instructional tech-
niques to serve the needs of the range of students in the specific course. Carroll (1965) referred to this planning as the quality of instruction and defined it as the degree to which the instruction is organized so that it is easily acquired by the student. Quality often depends on the clarity of the instructor's language and on his adaptation to the needs and characteristics of the student.

2. Flexibility in the presentation of material. The utilization of various aids to learning including programmed instruction, computer assisted instruction, and audio-visual aids (any device involving the use of sound or pictures or both) (Bugelski, 1964). The use of various learning aids helps to relieve boredom which may arise from a monotonous environment or the performance of repetitive tasks (De Cecco, 1968, p.138).

3. An understanding of what constitutes learning and contributing factors toward effective learning. Some psychologists (Thorndike, Hull, Skinner, Guthrie) recognized that learning occurs only when some action is performed by the learner, that learning involves some new or creative action.
on the part of the student. Mednick (1968) stated that "Learning results in a change in behavior and is a relatively permanent change" (p.18). Kimble (1963) suggested that learning is the "result of reinforced practice" (p.133).

4. Providing the opportunity for learning. John Carroll (1962, 1963, 1965), in his proposed teaching model, included as an instructional procedure to facilitate learning, the opportunity to learn, which is the amount of time actually allowed for learning in a particular teaching situation. In Carroll's opinion, inattention to this variable usually resulted in too little time being allotted to learning various tasks and in too much material being presented too fast.

5. A self-evaluation of the instructor's background. The instructor of today must keep up to date both in learning theory as well as his subject matter specialization. Martin (1971) reported that "90% of American faculties are engaged primarily in traditional teaching" (p.4). This traditional methodology is easy to understand.
for as Hefferlin (1969) stated, "Faculty members have observed their vocation for years, as students, before joining it. When someone observes the instructor's role for twenty years before assuming the role himself, he already knows what his role is" (p.7). The instructor, therefore, needs to perform a self-analysis of his teaching methodology relating to the desired learning environment. That, which is in opposition, needs to be changed. That which is in agreement needs to be reinforced. There are no simple remedies for effective teaching. Siegel (1968) said "Prescriptions for how to teach effectively are about as outdated as leeching" (p.144). The major impetus must be in the individual instructor's attempts in achieving better student learning. It is only through trial and error that this can be accomplished. When something "works" for the individual instructor, then there also is a responsibility to pass this along to his colleagues. Milton (1973) stated that "It is research that can guide us out of the overgrown thicket of dogma which surrounds current ideas about instruction and learning" (p.9).
Summary

Chapter II reviewed the literature relevant to this study. Included within this review was a discussion of (1) why science courses are required for the non-science major, (2) how science courses can be structured for the non-science major, (3) present knowledge about the attitudes of the non-science major toward science, and (4) the learning environment and the non-science major.

Chapter III contains the "Design and Methodology" of the study. This chapter will cover (1) a review of the problem, (2) the population, (3) instrument design, and (4) data collection procedures.
CHAPTER III

DESIGN AND METHODOLOGY

The design of and the methods used in conducting this study are described under the following four headings: (1) Review of the Problem, (2) The Population, (3) Instrument Design, and (4) Data Collection Procedures.

Review of the Problem

The purposes of this study were two-fold: (1) to identify and examine selected variables affecting student attitudes toward science and (2) to use these data as well as student attitudes toward the present Physical Science course in the design of a course in Earth and Space Science.

The proposed course will include methods for improving attitudes as well as methods for improving the learning environment.

The Population

The population consisted of those students enrolled in the day course of Physical Science at Lake Michigan College during the Fall semester 1975, and the Spring semester 1976. There were eight sections of Physical
Science offered during this period in which 131 students were enrolled, all of whom were non-science majors. The course content in four of these sections was in the areas of Chemistry and Physics. In the remaining four sections, the content was in the areas of Geology and Astronomy.

A second survey was conducted at Kellogg Community College during the Spring semester, 1977. This survey was conducted in two sections of the course Basic Science 102. This course had content in the areas of Astronomy, Physics, and Chemistry and was classified as a Physical Science course.

Instrument Design

Two major instruments were used in the collection of data for this study. The first was an Attitude Inventory and the second was a Course Content Inventory.

The Attitude Inventory was used to gather data relative to the non-science majors' attitudes toward science. The Course Content Inventory was used to gather data from a selected sample of instructors of Earth Science in the state of Michigan relative to the desired course content in an Earth Science course for non-science majors. Basic content for the Attitude Inventory was derived from hypotheses that were to be tested during the study.

For the purpose of this study, the concept of "negative" attitudes toward science referred to students'
reluctance to take science courses. The student with "negative" attitudes was categorized as one who had all or many of the following characteristics:

a) A student who believed that science should not be a required course for the non-science major. (Variable 7)

b) A student who was concerned with his ability to pass the course. (Variable 32)

c) A student who believed the course would be difficult before entrance into the course. (Variable 33)

d) A student who had a dislike for the course before entrance into the course. (Variable 34)

e) A student who delayed taking the course until late in his college career. (Variable 40)

The non-science majors' attitudes toward science were placed on a continuum index of 5 thru 15. The student with negative attitudes was one at the lower end of the continuum index while the student with positive attitudes was one at the upper end.

Student Attitude = Var.7 + Var.32 + Var.33 + Var.34 + Var.40

Negative = 1 + 1 + 1 + 1 + 1 = 5

Positive = 2 + 3 + 3 + 3 + 4 = 15

The evolution of the inventory to its final form took the following sequence:

1. A working draft of the inventory, originally called an "Informational Survey", was presented to members of the Doctoral Committee during the second week of November, 1975.
2. The survey was revised, based upon the committee's recommendations, until a fourth version was accepted in December, 1975.

3. This instrument was then utilized to gather data during the Fall semester, 1975 and the Spring semester, 1976.

4. Preliminary data received from the original survey was presented at the Michigan Science Teacher's Convention in February, 1977. The presentation was made to a section of Earth Science Instructors of Community Colleges. These results were favorably received with comments which were utilized in redesigning the Informational Survey.

5. In addition to comments received during the presentation, original comments received during the initial conducting of the survey during the Fall semester, 1975 and the Spring semester, 1976 were utilized in revising the Informational Survey to what was then called an Attitude Inventory.

6. The Attitude Inventory was submitted to a Jury of six instructors of non-science majors at Kellogg Community College for comments on the inventory. A copy of this inventory is included in Appendix A.

7. From the comments and suggestions made by the Jury at Kellogg Community College, the Attitude Inventory was revised to its final form. A copy of this Attitude Inventory is included in Appendix B.

There were 44 areas for which data were collected under the Informational Survey, 37 of which were on the survey and 7 of which came from the examination of records and transcripts. In addition, 9 open ended responses were requested from the subjects. In the revised Attitude Inventory, data on 42 areas were collected directly from the Inventory.
In an attempt to provide data on the desired course content for the course "Earth and Space Science", a Course Content Inventory was developed and sent during April, 1977, to 28 individuals known to be instructors in the area of Earth Science at 13 community colleges within the state of Michigan. The inventory was based upon the present course in Physical Science (Geology and Astronomy) at Lake Michigan College as well as other topics included in Earth Science, Geology, and Astronomy textbooks. A copy of the inventory is included in Appendix C and the letter in Appendix D.

Data Collection Procedures

The population consisted of the students who appeared on the IBM printout of class lists for the eight sections of Physical Science and the two sections of Basic Science. These original lists were modified for students who either added or withdrew from the course prior to the time the inventory was given.

There were 62 students in the sample for the Fall semester, 1975. Responses were received from 57 for a return rate of 91.94%. For the Spring semester, 1976, there were 69 students in the sample from whom 65 inventories were collected for a return rate of 94.20%. This represented a total of 122 respondents from the over-
all list of 131 students for a return rate of 93.13%.

There were a total of 42 students within the two sections of Basic Science at Kellogg Community College during the Spring semester, 1977. Responses were received from 34 students for a return rate of 80.95%.

The Attitude Inventory was administered the last week of classes during the Fall semester, 1975 and the Spring semester, 1976 to all students in the Physical Science classes who were in attendance on that day. A one-hour class session was allotted for the students to complete the instrument. The average amount of time required to complete the inventory was 35 minutes. Those students not in attendance were provided time during a later laboratory period to complete the instrument. Those students who were absent from the laboratory were given a copy of the inventory during the next class period to be completed outside of class. Of the nine students who did not complete the inventory, seven did not return to take the final examination. Two others transferred to Western Michigan University for the Winter semester prior to the end of the Fall semester at Lake Michigan College.

The completed Attitude Inventories were stored without being examined until after the final grades were submitted to the Registrar's Office. Because of the need for accurate information from student folders and transcripts,
the name of each respondent was obtained on the inventory with assurances that none would be examined until the final grades for the course were submitted.

For the revised inventory which was administered at Kellogg Community College, the inventory was given to students during their last laboratory period. Those students not in attendance were not given another opportunity to complete the instrument. The name was removed from the revised inventory and additional questions asked within the inventory to gather data previously collected by content analysis of student transcripts.

Data were also collected from instructors of Earth Science in community colleges throughout the state of Michigan pertaining to the desired course content for a course in Earth and Space Science. The Course Content Inventory was sent to 28 individuals known to be instructors of Earth Science. An original letter was sent addressed to the individual. A total of 24 responses were received for a return rate of 85.71%.

Summary

Chapter III presented the "Design and Methodology" of the study. Four major areas were covered. These were: (1) a review of the problem, (2) the population, (3) instrument design, and (4) data collection procedures. The "Results" of the study will be found in Chapter IV.
CHAPTER IV
RESULTS

The data received from (1) responses to the Attitude Inventory and (2) content analysis of student transcripts, were divided into four major areas for analysis:

I. Background information on respondents.
II. Student attitudes toward science.
III. The student with "negative" attitudes toward science.
IV. Attitudes toward science as it relates to curriculum development.

Tables were constructed to present data. Frequency distributions, measures of central tendency, and measures of variability were presented for quantitative interpretations.

For the following presentations, Sample 1 referred to the 122 respondents from whom data were collected during the Fall semester, 1975, and the Spring semester, 1976, at Lake Michigan College. Sample 2 referred to the 34 respondents from whom data were collected during the Spring semester, 1977, at Kellogg Community College.

Background Information on Respondents

The following is a description of the characteristics of the student samples.
Age distribution

<table>
<thead>
<tr>
<th>Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age</td>
<td>22.5 years</td>
</tr>
<tr>
<td>Median age</td>
<td>20.0 years</td>
</tr>
<tr>
<td>Modal age</td>
<td>19.0 years</td>
</tr>
<tr>
<td>Range of age</td>
<td>17 to 46 years</td>
</tr>
</tbody>
</table>

During the 1975-76 academic year, in which the data for Sample 1 were collected, Lake Michigan College had 1,103 full-time students (33%) and 2,236 part-time students (67%). The approximate mean age of the entire student population was 26 years. The mean age of the respondents in the study was 22.5 years. The age distribution within Sample 2 compared closely with that of Sample 1 except that the mean age of the respondents for Sample 2 was 20.4 years.

Sex distribution.

The statistical data on the sex distribution of the student population are included in Table I. From these results, it was noted that for Sample 1, the percentages of male students (46.7%) and female students (53.3%) were about equal. The overall sex distribution for Lake Michigan College for the 1975-76 academic year was male students (51.5%) and female students (48.5%). There were 3% more male students than female students college-wide. This was in contrast to the percentages of respondents in Sample 1 where there were 6.6% more females than males. The sex distribution within Sample 2 indicated that 61.8% of the sample were male as
compared to 35.3% who were female. There were 26.5% more males than females within Sample 2.

Table I
Sex Distribution Within the Physical Science Class

<table>
<thead>
<tr>
<th>Sex</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Sample 1 Combined Students</th>
<th>Sample 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>26 (40.6%)</td>
<td>31 (53.4%)</td>
<td>57 (46.7%)</td>
<td>21 (61.8%)</td>
</tr>
<tr>
<td>Female</td>
<td>38 (59.4%)</td>
<td>27 (46.6%)</td>
<td>65 (53.3%)</td>
<td>12 (35.3%)</td>
</tr>
<tr>
<td>No Response</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>1 (2.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

Racial distribution.

The racial distribution of the respondents appears in Table II. Results of content analysis of Sample I revealed that black and other minority students comprised 13.9% of the respondents while they comprised 17.8% of the entire student body. These minority students made up 20.7% of the Geology/Astronomy portion of Physical Science and 7.8% of the enrollment in the Chemistry/Physics portion of the course. The results of an analysis of the Attitude Inventory for Sample 2 revealed that 8.8% of the respondents were minority students. It was also found that 14.7% of the respondents failed
to indicate their race on the Attitude Inventory.

Table II
Racial Distribution Within the Physical Science Classes

<table>
<thead>
<tr>
<th>Race</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Sample 1 Combined Students</th>
<th>Sample 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>59 (92.2%)</td>
<td>46 (79.3%)</td>
<td>105 (86.1%)</td>
<td>26 (76.5%)</td>
</tr>
<tr>
<td>Other (Black or Minority)</td>
<td>5 (7.8%)</td>
<td>12 (20.7%)</td>
<td>17 (13.9%)</td>
<td>3 (8.8%)</td>
</tr>
<tr>
<td>No Response</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>5 (14.7%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

Science background.

The science background of the respondents appears in Tables III, IV, and V. Table III reports the number of science courses taken by the respondents before entrance into their physical science course. The mean number of previous science courses was 2.5 for Sample 1 and 3.3 for Sample 2. Both samples had a range of from zero to six. These results showed that Sample 2 respondents had nearly a full course in science more than the respondents in Sample 1.
Table III

Number of Previous Science Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astro.</th>
<th>Combined Students</th>
<th>Sample 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0 (0%)</td>
<td>2 (3.4%)</td>
<td>2 (1.6%)</td>
<td>1 (2.9%)</td>
</tr>
<tr>
<td>1</td>
<td>16 (25.0%)</td>
<td>5 (8.6%)</td>
<td>21 (17.2%)</td>
<td>4 (11.8%)</td>
</tr>
<tr>
<td>2</td>
<td>23 (35.9%)</td>
<td>23 (39.7%)</td>
<td>46 (37.7%)</td>
<td>6 (17.7%)</td>
</tr>
<tr>
<td>3</td>
<td>15 (23.4%)</td>
<td>18 (31.0%)</td>
<td>33 (27.0%)</td>
<td>8 (23.5%)</td>
</tr>
<tr>
<td>4</td>
<td>7 (10.9%)</td>
<td>7 (12.1%)</td>
<td>14 (11.5%)</td>
<td>6 (17.7%)</td>
</tr>
<tr>
<td>5</td>
<td>2 (3.1%)</td>
<td>2 (3.4%)</td>
<td>4 (3.3%)</td>
<td>6 (17.7%)</td>
</tr>
<tr>
<td>6</td>
<td>1 (1.6%)</td>
<td>1 (1.7%)</td>
<td>2 (1.6%)</td>
<td>3 (8.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

Data relating to the previous exposure of the respondents to a Chemistry course appear in Table IV. Data collected from the respondents in Sample 1 showed that 32.8% have had a previous course in Chemistry. An analysis of the data collected for Sample 2 indicated that 52.9% of the respondents have had a previous course in Chemistry while 47.1% have not.

Data relating to the students previous exposure to Earth Science, Geology or Astronomy appear in Table V. An analysis of Sample 1 revealed that few of the present non-science majors (5.7%) have had formal course work in the above areas. Three and four-tenths per cent of the present students in the Geology/Astronomy portion have had previous exposure in this area. The results of
Sample 2 revealed that 44.1% of the respondents have had a course in Earth Science.

Table IV
Students With Previous High School Chemistry

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Sample 1 Combined Students</th>
<th>Sample 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>45 (70.3%)</td>
<td>37 (63.8%)</td>
<td>82 (67.2%)</td>
<td>16 (47.1%)</td>
</tr>
<tr>
<td>Yes</td>
<td>19 (29.7%)</td>
<td>21 (36.2%)</td>
<td>40 (32.8%)</td>
<td>18 (52.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

Table V
Students With a Previous Earth Science Course

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Sample 1 Combined Students</th>
<th>Sample 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>59 (92.2%)</td>
<td>56 (96.6%)</td>
<td>115 (94.3%)</td>
<td>19 (55.9%)</td>
</tr>
<tr>
<td>Yes</td>
<td>5 (7.8%)</td>
<td>2 (3.4%)</td>
<td>7 (5.7%)</td>
<td>15 (44.1%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

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Reasons students elect the physical science course.

Data concerning student reasons for electing the course in the area of physical science are presented in Table VI. Of the 122 respondents in Sample 1, 105 or 86.1% elected these two courses because it was a requirement for an Associate in Arts degree. Four students (3.3%) elected the course as background for other science courses and 13 students (10.7%) elected the course for other reasons. Seven of the twelve responses (58.3%) listed under "other reasons" indicated that interest was the reason for electing the course. An analysis of Sample 2 revealed that 79.4% of the respondents elected the Basic Science course because it was a requirement for a degree. Of the remaining respondents, 5.9% elected the course as background and 14.7% for other reasons. Three of the five responses (60.0%) listed under "other reasons" indicated that interest was the reason for electing the course. (Table VI on page 47).

Science as a curricular requirement.

The data reported in Table VI disclosed that the majority of students elected the course because it was a requirement for graduation. Responses were collected to the question "Should science courses be required for
Table VI
"Why Did You Enroll In This Science Course?"

<table>
<thead>
<tr>
<th>Response</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Sample 1 Combined Students</th>
<th>Sample 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Course</td>
<td>53 (92.8%)</td>
<td>52 (89.7%)</td>
<td>105 (86.1%)</td>
<td>27 (79.4%)</td>
</tr>
<tr>
<td>Background for other Science Courses</td>
<td>3 (4.7%)</td>
<td>1 (1.7%)</td>
<td>4 (3.3%)</td>
<td>2 (5.9%)</td>
</tr>
<tr>
<td>Other</td>
<td>8 (12.5%)</td>
<td>5 (8.6%)</td>
<td>13 (10.7%)</td>
<td>5 (14.7%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

the non-science major?" These data appear in Table VII and results for Sample 1 showed that 73 respondents or 59.8% responded in the affirmative. The data also revealed that the students in the Geology/Astronomy portion supporting the question (65.5%) exceeded their counterparts in the Chemistry/Physics portion (54.7%) by 10.8%. The results for Sample 2 revealed that 58.8% of the respondents believed science should be a required course while 41.2% believed it should not be required. (Table VII on page 48).

Required courses as a curricular requirement.

To compare students' attitudes about science with their attitudes about other curricular areas, a third
### Table VII

"Should Science Be a Required Course for the Non-Science Major?"

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Combined Students</th>
<th>Sample 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>35 (54.7%)</td>
<td>38 (65.5%)</td>
<td>73 (59.8%)</td>
<td>20 (58.8%)</td>
</tr>
<tr>
<td>No</td>
<td>29 (45.3%)</td>
<td>20 (34.5%)</td>
<td>49 (40.2%)</td>
<td>14 (41.2%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

question was asked in the inventory. This question was "Should there be any required courses outside of the students' major field?" Data on this question appear in Table VIII. The data from Sample 1 indicated that 100 of the 122 respondents believed there should be required courses outside of the students' major field. This was 82.0% of the respondents. The data from Sample 2 revealed that 85.3% of the respondents believed there should be required courses outside of the students' major field.

**Students' attitudes toward science courses as compared with those toward non-science courses.**

In order to investigate student attitudes about science, it was determined that additional data were needed relevant to the students' opinions about course difficulty, time required for out-of-class study and
Table VIII

"Should There Be Any Required Courses Outside of the Students' Major Field?"

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Sample 1 Combined Students</th>
<th>Sample 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>53 (82.8%)</td>
<td>47 (81.0%)</td>
<td>100 (82.0%)</td>
<td>29 (85.3%)</td>
</tr>
<tr>
<td>No</td>
<td>11 (17.2%)</td>
<td>11 (19.0%)</td>
<td>22 (18.0%)</td>
<td>5 (14.7%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

Grades for science and non-science courses. These data are presented in Table IX.

Sample 1 responses, as listed in Table IX, showed that the majority of students in the Physical Science course perceived that they were studying more difficult material (61.5%), were required to spend a greater amount of time for out-of-class study (70.5%) for about the same grade (52.5%) as they did in their social science and humanities classes. The data from Sample 2 indicated basically the same results as in Sample 1, that the majority of students in the course Basic Science perceived that they were studying more difficult material (67.7%), were required to spend a greater amount of time for out-of-class study (61.8%) for about the same grade (52.9%) as they did in their social science and humanities classes.
Table IX
"Compared With My College Classes in the Areas of Social Science and the Humanities"

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No Response</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Difficulty</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of material in Phy. Sci.</td>
<td>2  (1.6%)</td>
<td>0  (0.0%)</td>
</tr>
<tr>
<td></td>
<td>75  (61.5%)</td>
<td>23  (67.7%)</td>
</tr>
<tr>
<td></td>
<td>37  (30.3%)</td>
<td>11  (32.3%)</td>
</tr>
<tr>
<td></td>
<td>8  (6.6%)</td>
<td>0  (0.0%)</td>
</tr>
<tr>
<td></td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td><strong>About the Same</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Less</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Time required for out-of-class study</strong></th>
<th>Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>in Phy. Sci.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>2  (1.6%)</td>
<td>0  (0.0%)</td>
</tr>
<tr>
<td></td>
<td>86  (70.5%)</td>
<td>21  (61.8%)</td>
</tr>
<tr>
<td></td>
<td>30  (24.6%)</td>
<td>13  (38.2%)</td>
</tr>
<tr>
<td></td>
<td>4  (3.3%)</td>
<td>0  (0.0%)</td>
</tr>
<tr>
<td></td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td><strong>My current grade in Phy. Sci.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>2  (1.6%)</td>
<td>0  (0.0%)</td>
</tr>
<tr>
<td></td>
<td>10  (8.2%)</td>
<td>5  (14.7%)</td>
</tr>
<tr>
<td></td>
<td>64  (52.5%)</td>
<td>18  (52.9%)</td>
</tr>
<tr>
<td></td>
<td>46  (37.7%)</td>
<td>11  (32.4%)</td>
</tr>
<tr>
<td></td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

Sample data relating to attitudes.

In an attempt to examine the attitudes of the non-science major toward science, additional attitude data were collected. Sample statistics based upon the index of attitudes as developed in Chapter III are included below.

**Attitude index toward science.**

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>9.07</td>
<td>9.20</td>
</tr>
<tr>
<td><strong>Std. Dev.</strong></td>
<td>2.21</td>
<td>2.65</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>5 thru 14</td>
<td>5 thru 13</td>
</tr>
</tbody>
</table>
The frequency and percentage of the respondents in each attitude level appear in Table X. The combined groupings of negative, average, and positive attitudes appear in Table XI.

For the purposes of this study, a "negative" attitude toward science was defined as a composite index score below 8 and a positive attitude as a composite index score above 10.

An analysis of the data in Table XI revealed that 19.7% of the respondents in Sample 1 and 14.7% of the respondents in Sample 2 fell into the classification of "negative" attitudes by having a composite index score of 5, 6, or 7.

Data were collected based upon how many semester hours of credit were completed before students enrolled in the physical science course. These data were needed to determine if there was any correlation between the attitudes and the students' level when physical science was elected. Table XII lists the total semester hours of credit completed before enrolling in the physical science course.

The results of data analysis revealed that 54.9% of the respondents in Sample 1 and 29.4% of the respondents in Sample 2 elected their science course before completing a full year at their respective college (30 semester hours). In addition, it was found that 22.1%
of the respondents in Sample 1 and 44.2% of the respondents in Sample 2 had more than 45 semester hours completed before taking their required course for graduation.

Table X
Respondents' Attitude Levels

<table>
<thead>
<tr>
<th>Value</th>
<th>Frequency</th>
<th></th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample 1</td>
<td>Sample 2</td>
<td>Sample 1</td>
</tr>
<tr>
<td>Negative</td>
<td>No response</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>25</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Table XI
Combined Grouping of Attitude

<table>
<thead>
<tr>
<th>Attitude</th>
<th>Composite Index Scores</th>
<th>Frequency</th>
<th></th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample 1</td>
<td>Sample 2</td>
<td>Sample 1</td>
<td>Sample 2</td>
</tr>
<tr>
<td>Negative</td>
<td>5 thru 7</td>
<td>24</td>
<td>5</td>
<td>19.7%</td>
</tr>
<tr>
<td>Average</td>
<td>8 thru 10</td>
<td>65</td>
<td>17</td>
<td>53.3%</td>
</tr>
<tr>
<td>Positive</td>
<td>11 thru 14</td>
<td>33</td>
<td>11</td>
<td>27.0%</td>
</tr>
</tbody>
</table>

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Table XII

Total Semester Hours of Credit
Completed Before Enrolling in Physical Science

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Sample 1 Combined Students</th>
<th>Sample 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>No response</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>1 (2.9%)</td>
</tr>
<tr>
<td>Less than 15</td>
<td>19 (29.7%)</td>
<td>17 (29.3%)</td>
<td>36 (29.5%)</td>
<td>1 (2.9%)</td>
</tr>
<tr>
<td>15 to 30</td>
<td>16 (25.0%)</td>
<td>15 (25.9%)</td>
<td>31 (25.4%)</td>
<td>9 (26.5%)</td>
</tr>
<tr>
<td>30 to 45</td>
<td>13 (20.3%)</td>
<td>15 (25.9%)</td>
<td>28 (23.0%)</td>
<td>8 (23.5%)</td>
</tr>
<tr>
<td>More than 45</td>
<td>16 (25.0%)</td>
<td>11 (19.0%)</td>
<td>27 (22.1%)</td>
<td>15 (44.2%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

Table XIII lists the students in both samples with a previous college Biology course before entrance into either the Physical Science or Basic Science course. These results indicated that 52.5% of the respondents in Sample 1 and 58.8% of the respondents in Sample 2 did not have a college Biology course before taking the Physical Science or Basic Science course.

To further investigate the levels of attitudes of the non-science major, data were collected on the number of absences and the course grade of all the students in Sample 1 within the appropriate portion of Physical Science. These results appear in Tables XIV and XV. Because the revised Attitude Inventory used to
gather data from the respondents in Sample 2 remained anonymous, the number of absences and grades within the course were not available for direct comparison with attitudes. (Table XIV on page 55).

Table XIII

Students in Science With Biology Before Entrance

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Sample 1 Combined Students</th>
<th>Sample 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>31 (48.4%)</td>
<td>33 (56.9%)</td>
<td>64 (52.5%)</td>
<td>20 (58.8%)</td>
</tr>
<tr>
<td>Yes</td>
<td>33 (51.6%)</td>
<td>25 (43.1%)</td>
<td>58 (47.5%)</td>
<td>14 (41.2%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

These data from Table XIV revealed that absences ranged from 0 to 24 with the mean number of absences being 5.2. There were 22.0% of the students in Sample 1 with more than seven absences. A Pearson product-moment correlation was run between the grade in Physical Science and number of absences. This value was \( r = -.40 \). (Table XV on page 56).
### Table XIV

Number of Absences in the Physical Science Course

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Sample 1 Combined Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5 (7.8%)</td>
<td>5 (8.6%)</td>
<td>10 (8.2%)</td>
</tr>
<tr>
<td>1</td>
<td>6 (9.4%)</td>
<td>5 (8.6%)</td>
<td>11 (9.0%)</td>
</tr>
<tr>
<td>2</td>
<td>11 (17.2%)</td>
<td>9 (15.5%)</td>
<td>20 (16.4%)</td>
</tr>
<tr>
<td>3</td>
<td>9 (14.1%)</td>
<td>9 (15.5%)</td>
<td>18 (14.8%)</td>
</tr>
<tr>
<td>4</td>
<td>6 (9.4%)</td>
<td>2 (3.4%)</td>
<td>8 (6.6%)</td>
</tr>
<tr>
<td>5</td>
<td>7 (10.9%)</td>
<td>7 (12.1%)</td>
<td>14 (11.5%)</td>
</tr>
<tr>
<td>6</td>
<td>4 (6.3%)</td>
<td>3 (5.2%)</td>
<td>7 (5.7%)</td>
</tr>
<tr>
<td>7</td>
<td>3 (4.7%)</td>
<td>4 (6.9%)</td>
<td>7 (5.7%)</td>
</tr>
<tr>
<td>8</td>
<td>2 (3.1%)</td>
<td>0 (0.0%)</td>
<td>2 (1.6%)</td>
</tr>
<tr>
<td>9</td>
<td>5 (7.8%)</td>
<td>3 (5.2%)</td>
<td>8 (6.6%)</td>
</tr>
<tr>
<td>10</td>
<td>3 (4.7%)</td>
<td>2 (3.4%)</td>
<td>5 (4.1%)</td>
</tr>
<tr>
<td>11</td>
<td>1 (1.6%)</td>
<td>1 (1.7%)</td>
<td>2 (1.6%)</td>
</tr>
<tr>
<td>12</td>
<td>0 (0.0%)</td>
<td>1 (1.7%)</td>
<td>1 (0.8%)</td>
</tr>
<tr>
<td>13</td>
<td>1 (1.6%)</td>
<td>1 (1.7%)</td>
<td>2 (1.6%)</td>
</tr>
<tr>
<td>More than 13</td>
<td>1 (1.6%)</td>
<td>6 (10.3%)</td>
<td>7 (5.7%)</td>
</tr>
</tbody>
</table>

Mean number of absences 5.2
Std. Dev. 4.7
Var. 22.2
Median 4.0
Mode 2.0
Range 0-24

The Student With "Negative" Attitudes Toward Science

Data analysis was performed on those students with "negative" attitudes. The student with "negative" attitudes was defined as a student having a composite index score below 8. The results of this data analysis are displayed along with a comparison to the total...
Table XV

Grade in Physical Science

<table>
<thead>
<tr>
<th>GPA</th>
<th>Sample 1 Students in Chem./Phy.</th>
<th>Sample 1 Students in Geol./Astron.</th>
<th>Sample 1 Combined Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1 (1.6%)</td>
<td>1 (1.7%)</td>
<td>2 (1.6%)</td>
</tr>
<tr>
<td>.5</td>
<td>2 (3.1%)</td>
<td>3 (5.2%)</td>
<td>5 (41.0%)</td>
</tr>
<tr>
<td>1.0</td>
<td>2 (3.1%)</td>
<td>5 (8.6%)</td>
<td>7 (5.7%)</td>
</tr>
<tr>
<td>1.5</td>
<td>15 (23.4%)</td>
<td>11 (19.0%)</td>
<td>26 (21.3%)</td>
</tr>
<tr>
<td>2.0</td>
<td>8 (12.5%)</td>
<td>6 (10.3%)</td>
<td>14 (11.5%)</td>
</tr>
<tr>
<td>2.5</td>
<td>18 (28.1%)</td>
<td>14 (24.1%)</td>
<td>32 (26.2%)</td>
</tr>
<tr>
<td>3.0</td>
<td>5 (7.8%)</td>
<td>6 (10.3%)</td>
<td>11 (9.0%)</td>
</tr>
<tr>
<td>3.5</td>
<td>12 (18.8%)</td>
<td>10 (17.2%)</td>
<td>22 (18.0%)</td>
</tr>
<tr>
<td>4.0</td>
<td>1 (1.6%)</td>
<td>2 (3.4%)</td>
<td>3 (2.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
</tr>
</tbody>
</table>

group of respondents. There were 24 students (19.7%) who fell into this composite index grouping for Sample 1 and 5 students (14.7%) classified as having "negative" attitudes in Sample 2.

Statistical data comparisons.

A comparison of the age distribution of the students with "negative" attitudes to the age distribution of the total respondents appears in Table XVI. These results showed that for Sample 1, the mean age of the student with "negative" attitudes was 24.9 years compared to a mean age of 22.5 years for the total respondents.
Table XVI

Age Comparisons in Years Between the Total Respondents and Students with "Negative" Attitudes

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Total Respondents Sample 1</th>
<th>Sample 2</th>
<th>Students with &quot;Negative&quot; Attitudes Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age</td>
<td>22.5</td>
<td>20.4</td>
<td>24.9</td>
<td>21.6</td>
</tr>
<tr>
<td>Median age</td>
<td>20.0</td>
<td>20.0</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>Modal age</td>
<td>19.0</td>
<td>19.0</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Range of age</td>
<td>17-46</td>
<td>18-40</td>
<td>19-38</td>
<td>19-30</td>
</tr>
</tbody>
</table>

Sample 1: t = 1.43 (.975^23 = 2.07)

The mean age of the student with "negative" attitudes for Sample 2 was 21.6 years compared to a mean age of 20.4 years for the total respondents. In both samples, the mean age of the students with "negative" attitudes was greater, but not significantly greater at the .05 level.

The distribution by sex between the students with "negative" attitudes and the total respondents is presented in Table XVII. The results for Sample 1 indicated that 66.7% of the students with "negative" attitudes were female compared with a female percentage of 53.3% for the 122 respondents as listed in Table 1. There were twice as many females (66.7%) with "negative" attitudes toward science than males (33.3%) in Sample 1. This difference, however, was not significant at the .05 level.
The results for Sample 2 revealed that 40.0% of the students with "negative" attitudes were female compared with a female percentage of 35.3% for the total respondents.

The racial distribution for students with "negative" attitudes appears in Table XVIII. A comparison of the students with "negative" attitudes with the racial distribution of the total respondents as listed in Table II revealed that for Sample 1, 33.3% of the students with "negative" attitudes were black or minority while the corresponding ratio for the total respondents was 13.9%. This percentage increase of black or minority students was 2.4 times higher than for the total respondents in Sample 1. This percentage increase, however, was not significant at the .05 level. An analysis of the data from Sample 2 showed that 20.0% of the students with "negative" attitudes were black or minority while the corresponding ratio for the total sample was 8.8%. This percentage increase of black or minority students was 2.3 times higher than for the total respondents of Sample 2.
Table XVII

Sex Distribution for the Students With "Negative" Attitudes

<table>
<thead>
<tr>
<th>Sex</th>
<th>Expected Frequency Sample 1</th>
<th>Observed Frequency Sample 1</th>
<th>Observed Frequency Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>11.2</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Female</td>
<td>12.8</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>24</td>
<td>5</td>
</tr>
</tbody>
</table>

Sample 1: $X^2 = .89$ $p > .05$

Table XVIII

Racial Distribution for the Students With "Negative" Attitudes

<table>
<thead>
<tr>
<th>Race</th>
<th>Expected Frequency Sample 1</th>
<th>Observed Frequency Sample 1</th>
<th>Observed Frequency Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>20.7</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Other (Black or Minority)</td>
<td>3.3</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>24</td>
<td>5</td>
</tr>
</tbody>
</table>

Sample 1: $X^2 = 2.56$ $p > .05$

Table XIX presents a breakdown of Sample 1 showing the distribution of the students with "negative" attitudes within the two portions of Physical Science.

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Table XIX
Distribution of Students in the Physical Science Classes

<table>
<thead>
<tr>
<th>Phy. Sci. Course</th>
<th>Expected Frequency Sample 1</th>
<th>Students with &quot;Negative&quot; Attitudes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem./Phy.</td>
<td>12.6 (52.5%)</td>
<td>17 (70.8%)</td>
</tr>
<tr>
<td>Geol./Astron.</td>
<td>11.4 (47.5%)</td>
<td>7 (29.2%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24 (100%)</strong></td>
<td><strong>24 (100%)</strong></td>
</tr>
</tbody>
</table>

Sample 1: $x^2 = 1.71$  $p > .05$

These results revealed that a much higher, but not significantly higher, percentage of students with "negative" attitudes (70.8%) elected the Chemistry/Physics portion of Physical Science than the total respondents (52.5%).

The number of students with previous exposure to a Chemistry course is presented in Table XX. A comparison of Table XX with Table IV, which listed the Chemistry background of the total respondents, revealed that in Sample 1, 79.2% of the students with "negative" attitudes did not have a course in Chemistry compared to 67.2% of the total student population. The results for Sample 2 revealed that 80.0% of the students with "negative" attitudes toward science did not have a course in Chemistry compared to 47.1% of the total respondents.
Table XX

Previous High School Chemistry
For Students With "Negative" Attitudes

<table>
<thead>
<tr>
<th>Response Category</th>
<th>Expected Frequency and Percentages Sample 1</th>
<th>Observed Frequency and Percentages Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>16.1 (67.2%)</td>
<td>19 (79.2%)</td>
<td>4 (80.0%)</td>
</tr>
<tr>
<td>Yes</td>
<td>7.9 (32.8%)</td>
<td>5 (20.8%)</td>
<td>1 (20.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>24 (100%)</td>
<td>24 (100%)</td>
<td>5 (100%)</td>
</tr>
</tbody>
</table>

Sample 1: \(X^2 = .89 \ p > .05\)

Attitudinal comparisons.

Data collected on the reasons why students elected a course in the area of physical science are presented in Table XXI. These results disclosed that for Sample 1, 95.8% of the students with "negative" attitudes elected the course because it was a curricular requirement compared to 86.1% for the total respondents exhibited in Table VI. The results for Sample 2 showed that 60.0% of the students with "negative" attitudes elected the Basic Science course because it was a required course compared to 79.4% of the total sample.
Table XXI
Reasons Students With "Negative" Attitudes Enroll in a Course in Physical Science

<table>
<thead>
<tr>
<th>Response Category</th>
<th>Expected Frequency and Percentages Sample 1</th>
<th>Observed Frequency and Percentages Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Course</td>
<td>20.6 (86.1%)</td>
<td>23 (95.8%)</td>
<td>3 (60.0%)</td>
</tr>
<tr>
<td>Background for Other Courses</td>
<td>3.4 (13.9%)</td>
<td>1 (4.2%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Other</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>2 (40.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>24 (100%)</td>
<td>24 (100%)</td>
<td>5 (100%)</td>
</tr>
</tbody>
</table>

Sample 1: $X^2 = 1.44$  $p > .05$

A tabulation of the responses, for students with "negative" attitudes, to the question "Should science be a required course for the non-science major?" are presented in Table XXII. A comparison of these student responses to those of the total respondents which appeared in Table VII indicated that for Sample 1, 50% of the students with "negative" attitudes believed it should be a requirement compared to 59.8% of the total respondents. The corresponding percentages for Sample 2 were 40.0% of the students with "negative" attitudes believed science should be a required course compared to 58.8% of the total sample.
Table XXII

Student Responses, For Students With "Negative" Attitudes, to the Question "Should Science Be a Required Course For the Non-Science Major?"

<table>
<thead>
<tr>
<th>Response Category</th>
<th>Expected Frequency and Percentages Sample 1</th>
<th>Observed Frequency and Percentages Sample 1 Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>14.4 (59.8%)</td>
<td>12 (50.0%) 2 (40.0%)</td>
</tr>
<tr>
<td>No</td>
<td>9.6 (40.2%)</td>
<td>12 (50.0%) 3 (60.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>24 (100%)</td>
<td>24 (100%) 5 (100%)</td>
</tr>
</tbody>
</table>

Sample 1: $X^2 = .48 \ p > .05$

Data gathered on the follow-up question, "Should there be any required courses outside of the students' major field?" are presented in Table XXIII. These results, compared with the results of Table VIII, disclosed that for Sample 1, 91.7% of the students with "negative" attitudes believed there should be required courses in comparison to 81.1% of the total respondents. Table XXIII revealed that, for Sample 2, 80.0% of the students with "negative" attitudes toward science believed there should be required courses outside of the students' major field compared to 85.3% of the total sample.
Table XXIII

Student Responses For the Students With "Negative" Attitudes to the Question "Should There Be Any Required Courses Outside of the Students' Major Field?"

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Expected Frequency and Percentages</th>
<th>Observed Frequency and Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample 1</td>
<td>Sample 1</td>
</tr>
<tr>
<td>Yes</td>
<td>19.7 (82.0%)</td>
<td>22 (91.7%)</td>
</tr>
<tr>
<td>No</td>
<td>4.3 (18.0%)</td>
<td>2 (8.3%)</td>
</tr>
<tr>
<td>Total</td>
<td>24 (100%)</td>
<td>24 (100%)</td>
</tr>
</tbody>
</table>

Sample 1: $X^2 = .97$  $p > .05$

Background comparisons.

Table XXIV exhibits the data comparing the total semester hours completed before enrolling in the Physical Science course both for the total respondents as well as the students with "negative" attitudes. An analysis of Table XXIV revealed that, for the total respondents of Sample 1, 22.1% completed more than 45 semester hours before they enrolled in the required science course. The corresponding percentage for the students with "negative" attitudes was 66.7%. Based on these percentages, over three times as many students with "negative" attitudes delayed this science requirement until the final semester before graduation. This difference was significant at the .05 level. It was
also found that 95.9% of the Sample 1 students with "negative" attitudes waited at least two full semesters before taking the course. The results of an analysis of Sample 2 showed that for the total respondents, 44.1% completed more than 45 semester hours before they enrolled in the science required course. The corresponding percentage for the students with "negative" attitudes was 60.0%, an increase of 15.9%. One hundred percent of the Sample 2 students with "negative" attitudes delayed their Physical Science requirement for at least two semesters.

Table XXIV

A Comparison of Total Semester Hours of Credit Completed Before Enrolling in the Course Physical Science

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Total Respondents</th>
<th>&quot;Negative&quot; Attitudes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample 1</td>
<td>Sample 2</td>
</tr>
<tr>
<td>Less than 15</td>
<td>36 (29.5%)</td>
<td>1 (2.9%)</td>
</tr>
<tr>
<td>15 to 30</td>
<td>31 (25.4%)</td>
<td>9 (26.5%)</td>
</tr>
<tr>
<td>30 to 45</td>
<td>28 (23.0%)</td>
<td>8 (23.5%)</td>
</tr>
<tr>
<td>More than 45</td>
<td>27 (22.1%)</td>
<td>15 (44.1%)</td>
</tr>
<tr>
<td>No response</td>
<td>0 (0.0%)</td>
<td>1 (2.9%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

Sample 1: $X^2 = 9.66$ (more than 45 semester hours)

$p < .05$
Data analysis was performed, comparing the total respondents with the students having "negative" attitudes, for previous experience in a college Biology course. These data are presented in Table XXV and include data previously listed in Table XIII.

The data appearing in Table XXV showed that, for the total respondents of Sample 1, 47.5% of the students took the Biological Science requirement before taking Physical Science. For the students with "negative" attitudes, 75.0% took Biology before taking the Physical Science requirement. For Sample 2, 41.2% of the total sample elected a college Biology course before electing the Basic Science course. For the students with "negative" attitudes, 80.0% elected a Biology course before electing their Physical Science course. (Table XXV on page 67).

Attitudes Toward Science as it Relates to Curriculum Development

These data were collected from the respondents relative to the design of the course Earth and Space Science as an integral part of this study.

Desired methodology.

A survey of present instructional methodology resulted in the selection of seven major types for inclusion in the Attitude Inventory. Students were
Table XXV
A Comparison of Previous Exposure to College Biology

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Expected Frequency and Percentages Sample 1</th>
<th>Observed Frequency and Percentages for Students with &quot;Negative&quot; Attitudes Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>12.6 (52.5%)</td>
<td>6 (25.0%)</td>
<td>1 (20.0%)</td>
</tr>
<tr>
<td>Yes</td>
<td>11.4 (47.5%)</td>
<td>18 (75.0%)</td>
<td>4 (80.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>24 (100%)</td>
<td>24 (100%)</td>
<td>5 (100%)</td>
</tr>
</tbody>
</table>

Sample 1: $X^2 = 3.82$  $p > .05$

asked to evaluate each instructional method of presentation as to its productivity. The results of this evaluation appear in Table XXVI and revealed that 115 respondents (94.3%) from Sample 1 considered the lecture method to be the most productive method for presenting material. The corresponding percentage from Sample 2 was 88.2%. Table XXVI also showed that for both samples, three out of the four most productive methods were the same. These methods were lecture, demonstrations, and 16mm films.

Table XXVII exhibits the students' preference for an instructional method. The results for Sample 1 in both the Chemistry/Physics portion and Geology/Astronomy portion of Physical Science were approximately equal.
An analysis of the responses revealed that 92.6% of the respondents in Sample 1 and 100% of the respondents in Sample 2 desired a combination of instructional methods.

Table XXVI

"What Do You Believe To Be The Most or Least Productive Methods of Presenting Material?"

<table>
<thead>
<tr>
<th>Method of Presentation</th>
<th>Most Productive</th>
<th>Least Productive</th>
<th>No Response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>115 (94.3%)</td>
<td>5 (4.1%)</td>
<td>2 (1.6%)</td>
<td>122 (100%)</td>
</tr>
<tr>
<td>Sample 2</td>
<td>30 (88.2%)</td>
<td>2 (5.9%)</td>
<td>2 (5.9%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td>35mm Slides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>64 (52.5%)</td>
<td>47 (38.5%)</td>
<td>11 (9.0%)</td>
<td>122 (100%)</td>
</tr>
<tr>
<td>Sample 2</td>
<td>14 (41.2%)</td>
<td>19 (55.9%)</td>
<td>1 (2.9%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td>16mm Films</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>69 (56.6%)</td>
<td>44 (36.1%)</td>
<td>9 (7.4%)</td>
<td>122 (100%)</td>
</tr>
<tr>
<td>Sample 2</td>
<td>21 (61.8%)</td>
<td>11 (32.4%)</td>
<td>2 (5.9%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td>Use of Overhead</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projectors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>80 (65.6%)</td>
<td>30 (24.6%)</td>
<td>12 (9.8%)</td>
<td>122 (100%)</td>
</tr>
<tr>
<td>Sample 2</td>
<td>13 (38.2%)</td>
<td>18 (52.9%)</td>
<td>3 (8.8%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td>Demonstrations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>105 (86.1%)</td>
<td>8 (6.6%)</td>
<td>9 (7.4%)</td>
<td>122 (100%)</td>
</tr>
<tr>
<td>Sample 2</td>
<td>31 (91.2%)</td>
<td>2 (5.9%)</td>
<td>1 (2.9%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td>Panel Discussions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>28 (23.0%)</td>
<td>84 (69.8%)</td>
<td>10 (8.2%)</td>
<td>122 (100%)</td>
</tr>
<tr>
<td>Sample 2</td>
<td>16 (47.1%)</td>
<td>16 (47.1%)</td>
<td>2 (5.9%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td>Field Trips</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>62 (50.8%)</td>
<td>49 (40.2%)</td>
<td>11 (9.0%)</td>
<td>122 (100%)</td>
</tr>
<tr>
<td>Sample 2</td>
<td>25 (73.5%)</td>
<td>7 (20.6%)</td>
<td>2 (5.9%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

These results revealed that a rank ordering of student attitudes as to the most productive methods of presenting material were:
Sample 1                  Sample 2
1. . . .lecture method...........demonstrations
2. . . .demonstrations...............lecture
3. . . .use of overhead projector....field trips
4. . . .16mm films..................16mm films
5. . . .35mm slides..................panel discussions
6. . . .field trips..................35mm slides
7. . . .panel discussions...........use of overhead projector

Table XXVII
"What Method of Presentation Would You Prefer?"

<table>
<thead>
<tr>
<th>Type of Presentation</th>
<th>Students in Chem./Phy. Sample 1</th>
<th>Students in Geol./Ast. Sample 1</th>
<th>Combined Students Sample 1</th>
<th>Students in Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture alone</td>
<td>5 (7.8%)</td>
<td>4 (6.9%)</td>
<td>9 (7.4%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Combination of Methods</td>
<td>59 (92.2%)</td>
<td>54 (93.1%)</td>
<td>113 (92.6%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

The amount of material presented in lecture and laboratory.

In order to judge the quantity of material which might be covered in the proposed course in Earth and Space Science, data were collected listing student attitudes about the present course. The results of these student attitudes appear in Tables XXVIII and XXIX.
Table XXVIII revealed that 73.8% of the respondents in Sample 1 believed the amount of material covered in the lecture portion was about right. The breakdown was 72.4% for the Geology/Astronomy portion and 75.0% for the Chemistry/Physics portion of Physical Science.

Table XXVIII

Evaluation of the Quantity of Material Covered in Lecture for Sample 1

<table>
<thead>
<tr>
<th>Amount of Material</th>
<th>Students in Chem./Phy.</th>
<th>Students in Geol./Ast.</th>
<th>Combined Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too much</td>
<td>15(23.4%)</td>
<td>15(25.9%)</td>
<td>30(24.6%)</td>
</tr>
<tr>
<td>About right</td>
<td>48(75.0%)</td>
<td>42(72.4%)</td>
<td>90(73.8%)</td>
</tr>
<tr>
<td>Too little</td>
<td>1(1.6%)</td>
<td>1(1.7%)</td>
<td>2(1.6%)</td>
</tr>
<tr>
<td>Total</td>
<td>64(100%)</td>
<td>58(100%)</td>
<td>122(100%)</td>
</tr>
</tbody>
</table>

Three open-ended response items were also requested from the respondents of Sample 1 in the inventory relative to the lecture portion of the course. These were: (1) What do you believe to have been the most valuable about the lectures? (see appendix E), (2) What do you believe to have been the least valuable about the lectures? (see appendix F), and (3) What changes would you recommend in the lecture portion of the course? (see appendix G).
A similar evaluation was performed for the laboratory portion of the course. These data are included in Table XXIX and appendix H, I, and J. Student responses on the amount of material covered indicated that 82.0% of the respondents believed the amount of material presented in the laboratory was about right. A breakdown of the entire sample by subject revealed that 86.2% of the students in the Geology/Astronomy portion and 78.1% of the students in the Chemistry/Physics portion also selected the category "about right." Within the Geology/Astronomy portion of Physical Science, 6.9% of the students believed there was too much material presented and an equal number believed too little material was presented.

Table XXIX

Evaluation of the Quantity of Material Covered in the Laboratory for Sample 1

<table>
<thead>
<tr>
<th>Amount of Material</th>
<th>Students in Chem./Phy.</th>
<th>Students in Geol./Ast.</th>
<th>Combined Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too much</td>
<td>4 (6.3%)</td>
<td>4 (6.9%)</td>
<td>8 (6.6%)</td>
</tr>
<tr>
<td>About right</td>
<td>50 (78.1%)</td>
<td>50 (86.2%)</td>
<td>100 (82.0%)</td>
</tr>
<tr>
<td>Too little</td>
<td>9 (14.1%)</td>
<td>4 (6.9%)</td>
<td>13 (10.7%)</td>
</tr>
<tr>
<td>No response</td>
<td>1 (1.6%)</td>
<td>0 (0%)</td>
<td>1 (0.8%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>59 (100%)</td>
<td>122 (100%)</td>
</tr>
</tbody>
</table>
Three open-ended response items were also requested from the respondents in Sample 1, relative to the laboratory portion of the course. These were: (1) What do you believe to have been the most valuable about the laboratory experiences? (see appendix H); (2) What do you believe to have been the least valuable about the laboratory experiences? (see appendix I); and (3) What changes in the laboratory experiences would you recommend? (see appendix J).

Student participation.

In an attempt to gain information about student attitudes regarding participation within the lecture portion of the course, the following question was asked: "Do you believe there should be greater student participation in the lecture portion of the course?" These results for Sample 1 are included in Table XXX. The data indicated that, of the 122 respondents, 54.9% did not believe there should be greater student participation while 43.4% were in favor. These were approximately the same percentages as in the separate portions of the course.

A comparison of the last science class and the present course.

Data reflecting the students' evaluation of both their last science class and the present science course appear in Table XXXI. These results revealed that the
Table XXX

Sample 1 Responses to the Question: "Do You Believe There Should be Greater Student Participation in the Lecture Portion of the Course?"

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>Students in Chem./Phy.</th>
<th>Students in Geol./Ast.</th>
<th>Combined Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>28 (43.8%)</td>
<td>25 (43.1%)</td>
<td>53 (43.4%)</td>
</tr>
<tr>
<td>No</td>
<td>35 (54.7%)</td>
<td>32 (55.2%)</td>
<td>67 (54.9%)</td>
</tr>
<tr>
<td>No response</td>
<td>1 (1.6%)</td>
<td>1 (1.7%)</td>
<td>2 (1.6%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>122 (100%)</td>
</tr>
</tbody>
</table>

The majority of students in Sample 1 found their last science class to be interesting (52.8%), of medium difficulty (63.1%), and somewhat relevant (63.1%). These students also found the present Physical Science course to be interesting (70.5%), of medium difficulty (70.5%), and somewhat relevant (59.8%). Similar results were received from the respondents of Sample 2. These results showed that the majority of students found their last science class to be interesting (41.2%), of medium difficulty (82.3%), and somewhat relevant (50.0%). These students also found the present Basic Science course to be interesting (67.7%), of medium difficulty (70.6%), and somewhat relevant (61.8%).
A Spearman's rank-correlation coefficient was calculated for the ordinal data collected between the last science course and the present science course to determine if there was any correlation between interest, difficulty, and relevancy. These data appear in Table XXXII. The correlations ranged from -.140 to .589 and were higher in most cases for Sample 2 than Sample 1. Only 5 of the 18 coefficients were significant at the .05 level. (Table XXXII on page 76).

A breakdown of students' attitudes toward the present science course appears in Table XXXIII. These results for Sample 1 showed that 79.3% of the enrolled students in the Geology/Astronomy portion of the course found it interesting, 75.9% found the course of medium difficulty and 63.8% found the course to be somewhat relevant. The corresponding percentages for the Chemistry/Physics portion of Physical Science were interesting (62.5%), of medium difficulty (65.6%) and somewhat relevant (56.3%). The percentages for the Basic Science course for Sample 2 were interesting (67.7%), of medium difficulty (70.6%), and somewhat relevant (61.8%). (Table XXXIII on page 77).
Table XXXI
Evaluation of the Student's Last Science Class
And the Present Course as to Interest,
Difficulty, and Relevancy

<table>
<thead>
<tr>
<th>Interest</th>
<th>Last Science Class</th>
<th>Present Science Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample 1</td>
<td>Sample 2</td>
</tr>
<tr>
<td><strong>Interesting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ave. interest</td>
<td>62 (52.8%)</td>
<td>14 (41.2%)</td>
</tr>
<tr>
<td>Not interesting</td>
<td>40 (32.8%)</td>
<td>10 (29.4%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td><strong>Difficulty</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very difficult</td>
<td>19 (15.6%)</td>
<td>6 (17.7%)</td>
</tr>
<tr>
<td>Med. difficulty</td>
<td>77 (63.1%)</td>
<td>28 (82.3%)</td>
</tr>
<tr>
<td>Easy</td>
<td>24 (19.7%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>No response</td>
<td>2 (1.6%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td><strong>Relevancy to student</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very relevant</td>
<td>24 (19.7%)</td>
<td>7 (20.6%)</td>
</tr>
<tr>
<td>Somewhat relevant</td>
<td>77 (63.1%)</td>
<td>17 (50.0%)</td>
</tr>
<tr>
<td>Not relevant</td>
<td>21 (17.2%)</td>
<td>10 (29.4%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>122 (100%)</td>
<td>34 (100%)</td>
</tr>
<tr>
<td>Present Science Course</td>
<td>Interest</td>
<td>Last Science Course</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Interest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>.1672</td>
<td>.0358</td>
</tr>
<tr>
<td>Sample 2</td>
<td>.093</td>
<td>.305</td>
</tr>
<tr>
<td>Difficulty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>.0347</td>
<td>.3735</td>
</tr>
<tr>
<td>Sample 2</td>
<td>-.140</td>
<td>.093</td>
</tr>
<tr>
<td>Relevancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>.1114</td>
<td>-.0964</td>
</tr>
<tr>
<td>Sample 2</td>
<td>.495</td>
<td>.400</td>
</tr>
</tbody>
</table>

\( r = 0.19 \) for Sample 1 and \( r = 0.34 \) for Sample 2 at the .05 level.

A comparison of attitudes toward the present science course from entrance to completion.

The respondents of both Sample 1 and 2 were asked to indicate their attitudes about the course in science from the time of entrance to the near completion of the course. Three areas were investigated: (1) student attitudes toward passing the course, (2) attitudes toward the difficulty of the course, and (3) attitudes toward liking or disliking the course. These results are presented in Table XXXIV. (Table on page 78).
Table XXXIII
Evaluation of the Present Course as to Interest, Difficulty, and Relevancy

<table>
<thead>
<tr>
<th>Interest</th>
<th>Students in Chem./Phy. Sample 1</th>
<th>Students in Geol./Ast. Sample 1</th>
<th>Students in Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interesting</td>
<td>40 (62.5%)</td>
<td>46 (79.3%)</td>
<td>23 (67.7%)</td>
</tr>
<tr>
<td>Ave. interest</td>
<td>22 (34.4%)</td>
<td>11 (19.0%)</td>
<td>10 (29.4%)</td>
</tr>
<tr>
<td>Not interesting</td>
<td>2 (3.1%)</td>
<td>1 (1.7%)</td>
<td>1 (2.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Difficulty</th>
<th>Students in Chem./Phy. Sample 1</th>
<th>Students in Geol./Ast. Sample 1</th>
<th>Students in Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very difficult</td>
<td>18 (28.1%)</td>
<td>11 (19.0%)</td>
<td>9 (26.5%)</td>
</tr>
<tr>
<td>Med. difficulty</td>
<td>42 (65.6%)</td>
<td>44 (75.9%)</td>
<td>24 (70.6%)</td>
</tr>
<tr>
<td>Easy</td>
<td>4 (6.3%)</td>
<td>3 (5.2%)</td>
<td>1 (2.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relevancy to student</th>
<th>Students in Chem./Phy. Sample 1</th>
<th>Students in Geol./Ast. Sample 1</th>
<th>Students in Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very relevant</td>
<td>18 (28.1%)</td>
<td>12 (20.7%)</td>
<td>9 (26.5%)</td>
</tr>
<tr>
<td>Somewhat relevant</td>
<td>36 (56.3%)</td>
<td>37 (63.8%)</td>
<td>21 (61.8%)</td>
</tr>
<tr>
<td>Not relevant</td>
<td>10 (15.6%)</td>
<td>9 (15.5%)</td>
<td>4 (11.8%)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>58 (100%)</td>
<td>34 (100%)</td>
</tr>
</tbody>
</table>
Table XXXIV

A Comparison of Attitudinal Change
Toward the Course in Physical Science
From Entrance to Completion

| Attitude Toward | Entrance | | | Completion | | | |
|-----------------|----------|----------|----------|----------|----------|----------|
|                  | Sample 1 | Sample 2 | Sample 1 | Sample 2 | Sample 1 | Sample 2 |
| Passing the course | | | | | | |
| Concerned | 77 (63.1%) | 20 (58.8%) | 66 (54.1%) | 10 (29.4%) | | |
| Somewhat concerned | 31 (25.4%) | 5 (14.7%) | 37 (30.3%) | 16 (47.1%) | | |
| Not concerned | 14 (11.5%) | 9 (26.5%) | 19 (15.6%) | 7 (20.6%) | | |
| No response | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (2.9%) | | |
| Total | 122 (100%) | 34 (100%) | 122 (100%) | 34 (100%) | | |
| Difficulty of course | | | | | | |
| Difficult | 85 (69.7%) | 9 (26.5%) | 39 (32.0%) | 10 (29.4%) | | |
| Of medium difficulty | 30 (24.6%) | 18 (52.9%) | 75 (61.5%) | 23 (67.7%) | | |
| Easy | 7 (5.7%) | 7 (20.6%) | 7 (5.7%) | 0 (0.0%) | | |
| No response | 0 (0.0%) | 0 (0.0%) | 1 (0.8%) | 1 (2.9%) | | |
| Total | 122 (100%) | 34 (100%) | 122 (100%) | 34 (100%) | | |
| Liking the course | | | | | | |
| Dislike it | 27 (22.1%) | 6 (17.7%) | 6 (6.6%) | 1 (2.9%) | | |
| Tolerate it | 58 (47.5%) | 7 (20.6%) | 41 (33.6%) | 12 (35.3%) | | |
| Enjoy it | 36 (29.5%) | 21 (61.8%) | 73 (59.8%) | 20 (58.8%) | | |
| No response | 1 (0.8%) | 0 (0.0%) | 0 (0.0%) | 1 (2.9%) | | |
| Total | 122 (100%) | 34 (100%) | 122 (100%) | 34 (100%) | | |

Summary

Chapter IV presented the "Results" of data analysis. The data were divided into four major areas for analysis. These were: (1) background information on the respondents, (2) student attitudes toward science,
(3) the student with "negative" attitudes toward science, and (4) student attitudes as they relate to curriculum development.

The purpose of the study, findings, limitations, and the conclusions and recommendations will be found in Chapter V.
CHAPTER V
PURPOSE, FINDINGS, LIMITATIONS,
CONCLUSIONS AND RECOMMENDATIONS

Purpose of the Study

There were two major purposes of the study. These were to:

1. Identify and explore the non-science majors' attitudes toward science.
2. Use the results of the investigation to design a course to be used by instructors of Earth and Space Science.

Two major instruments were used to collect data for this study. The first was an Attitude Inventory used to gather data relative to the non-science majors' attitudes toward science. The second was a Course Content Inventory used to gather data relative to the desired course content for a science course for the non-science major.

Findings

The findings were divided into two major areas for presentation: (1) findings from this study and (2) these findings and their relation to other studies.

Findings from this study.

In the investigation of the non-science majors' attitudes toward science, four hypotheses were tested at the .05 level of significance. These were:
1. The majority of non-science majors elect the course Physical Science because science is a requirement for the Associate in Arts Degree.

2. The majority of students believe that science courses require more study time, are more difficult, and that their grade will be lower than in their other courses in the humanities and social sciences.

3. The majority of students prefer instruction involving a combination of methods of presenting material rather than the lecture method alone.

4. There is a relationship between attitudes toward science and the variables age, sex, and race.

**Student attitudes of the total respondents toward science.**

1. Attitudes may effect enrollment. An analysis of the results of Table VI revealed that 86.1% of the Sample 1 respondents and 79.4% of the Sample 2 respondents elected the science course because it was required for a degree.

   The first hypothesis was that the majority of non-science majors elect the course Physical Science because science is a curricular requirement for the Associate in Arts Degree. The null hypothesis to be tested was $H_0$: there is no difference between the proportion of non-science majors electing the course because it is a curricular requirement and for other reasons.
Table XXXV

Hypothesis I
Students Who Elected the Physical Science Course

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Expected</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curricular requirement</td>
<td>105</td>
<td>61</td>
<td>166</td>
</tr>
<tr>
<td>For other reasons</td>
<td>17</td>
<td>61</td>
<td>78</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>122</td>
<td>122</td>
<td>244</td>
</tr>
<tr>
<td>Chi Square</td>
<td>36.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of freedom</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability</td>
<td>&lt; .001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sample 2**

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Expected</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curricular requirement</td>
<td>27</td>
<td>17</td>
<td>44</td>
</tr>
<tr>
<td>For other reasons</td>
<td>7</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>34</td>
<td>34</td>
<td>68</td>
</tr>
<tr>
<td>Chi Square</td>
<td>6.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of freedom</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability</td>
<td>&lt; .02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The \( H_0 \) will be rejected if the observed value of \( X^2 \) is such that the probability associated with its occurrence under \( H_0 \) for df = 1 is \( \geq 3.84 \) (Glass, 1970, p. 520).

The observed value of the Chi square with one degree of freedom was 36.5 for Sample 1 and 6.4 for Sample 2. This was significant at the .05 level. The null hypothesis was therefore rejected.
In general, these data suggest that if only those students who believe science should be a requirement would actually enroll in the course, there would be far fewer students enrolling in the course Physical Science at Lake Michigan College and the course Basic Science at Kellogg Community College.

2. An interpretation of the racial distribution within the two portions of Physical Science as presented in Table II revealed that the minority students made up 20.7% of the Geology/Astronomy portion of Physical Science and 7.8% of the enrollment in the Chemistry/Physics portion of the course. This difference was not significant at the .05 level. However, although not significant, the absolute difference between the two portions indicates that some of the minority students chose to take Geology/Astronomy rather than Chemistry/Physics.

3. The students' backgrounds showed that the number of previous science courses were related to current course work in the sciences, \( r = .35 \). There was, for all the respondents in Sample 1, a positive correlation between the number of previous science courses and grade in the Physical Science course. There was also a positive correlation showing that the greater the number of science courses in a student's background, the less difficult the student perceived the present science course. (Pearson product-moment coef. of \( r = .31 \)). This was significant
at the .05 level.

4. Table IV described the students' previous backgrounds in Chemistry. It revealed that 29.7% of the students in Sample 1 with a prior Chemistry course elected the Chemistry/Physics portion of Physical Science. This might be interpreted to mean that some students are opting for familiar coursework rather than unfamiliar coursework to broaden their backgrounds.

5. Table IX contained data comparing the respondents' attitudes toward their science courses with their other classes in the areas of social science and the humanities. This was used to test the second hypothesis, "The majority of students believe that science courses require more study time, are more difficult, and that their grade will be lower than in their other courses in the humanities and social sciences." The test of the hypothesis was that there is no difference between students' perceptions of the course in physical science and the students' perceptions of other classes in the humanities and social sciences. These perceptions included the students' evaluation of time for out-of-class study, course difficulty, and current grade. This hypothesis was evaluated using a significant test of proportions. The proportions necessary for significance at the .05 level were 57.5% for Sample 1 and 64.1% for Sample 2. Table XXXVI displays these data.
Table XXXVI
Test of Hypothesis II

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Confidence Interval</th>
<th>Data Value</th>
<th>Hypothesis Rejection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample 1</td>
<td>Sample 2</td>
<td>Sample 1</td>
</tr>
<tr>
<td>IIA</td>
<td>Time</td>
<td>57.5%</td>
<td>64.1%</td>
</tr>
<tr>
<td>IIB</td>
<td>Difficulty</td>
<td>57.5%</td>
<td>64.1%</td>
</tr>
<tr>
<td>IIC</td>
<td>Grade</td>
<td>57.5%</td>
<td>64.1%</td>
</tr>
</tbody>
</table>

The results of the test of proportions showed:

For Sample 1, the null hypothesis for Hypothesis IIA and IIB was rejected, i.e., the students believed that the Physical Science class did require more time for out-of-class study and was more difficult than their other classes in the areas of humanities and social science.

For Sample 2, the null hypothesis for Hypothesis IIB was rejected, i.e., the students believed that the Basic Science Class was more difficult than their corresponding classes in the humanities and social science areas.

6. Table XIV listed data on the number of absences within the Physical Science course. A Pearson product-
moment correlation coefficient run between the number of absences and grade in the course gave a value of \( r = -0.40 \). This showed a significant negative relationship at the .05 level between number of absences and grade in the course, i.e., the greater the number of absences, the lower the grade the student can expect.

The student with "negative" attitudes toward science.

Results of an analysis of students classified as having "negative" attitudes are listed in Tables XVI through XXV. Because there were only 5 students within Sample 2 classified as having "negative" attitudes, tests of significance were completed only for the Sample 1 respondents. These tests of significance showed:

1. There was no significant difference at the .05 level between the mean age of the students classified as having "negative" attitudes and the mean age of the total respondents. (t-test of means) \( t = 1.43; 0.975t_{23} = 2.07 \).

2. There was no significant difference at the .05 level between the following variables for the students classified as having "negative" attitudes and the total respondents.

   (a) Sex distribution \( \chi^2 = 0.89 \quad p > .05 \)

   (b) Racial distribution \( \chi^2 = 2.56 \quad p > .05 \)

   (c) Distribution of the students in the Chemistry/Physics or Geology/Astronomy portion of Physical Science. \( \chi^2 = 1.71 \quad p > .05 \)
d) Previous high school Chemistry  
\[ X^2 = 0.89 \quad p > 0.05 \]

e) Reasons students elect Physical Science  
\[ X^2 = 1.44 \quad p > 0.05 \]

f) Should science be a requirement?  
\[ X^2 = 0.48 \quad p > 0.05 \]

g) Should there be any required courses outside the student's major field?  
\[ X^2 = 0.97 \quad p > 0.05 \]

h) Previous exposure to College Biology  
\[ X^2 = 3.82 \quad p > 0.05 \]

3. There was a significant difference, for the students with more than 45 semester hours completed before enrolling in Physical Science, between the students classified as having "negative" attitudes and the total respondents at the 0.05 level of significance.  
\[ X^2 = 9.66 \quad p < 0.05 \]

A further interpretation of the data in Table XXIII showed that for the total respondents of Sample 1, 22.1% completed more than 45 semester hours before enrolling in the required science course. The corresponding percentage for the students with "negative" attitudes was 66.7%. Based on these percentages, over three times as many students with "negative" attitudes delayed this science requirement until the final semester before graduation. Table XXIII also revealed that 95.9% of the Sample 1 students with "negative" attitudes waited at least two full semesters before enrolling in the course. The results of an analysis of Sample 2 revealed that for the total
respondents, 44.1% completed more than 45 semester hours before enrolling in the science required course. The corresponding percentage for the students with "negative" attitudes was 60.0%, an increase of 15.9%. One hundred per cent of the Sample 2 students with "negative" attitudes delayed their physical science requirements for at least two semesters.

**Attitudes toward science as it relates to curriculum development.**

Student attitudes relative to curriculum development are listed in Tables XXVI through XXXIV. The findings showed:

1. Students perceived the lecture method of presentation and demonstrations as the most productive methods of presenting material. These two methods were ranked the top two in both Sample 1 and Sample 2. The respondents in both samples also ranked 16mm films as fourth.

2. Students selected "a combination of methods of presenting material" as their preference rather than the lecture method alone. The data from Table XXVII were used in testing the third hypothesis.

The third hypothesis was that the majority of students prefer instruction involving a combination of methods of presenting material rather than the lecture method alone. The null hypothesis to be tested was
there is no difference between the number of students selecting a combination of methods and the lecture method of presenting material.

The $X^2$ one sample test was selected because the hypothesis under test concerned a comparison of observed and expected frequencies in discrete categories. The significance level selected was .05. The observed value of the Chi square with one degree of freedom for Sample 1 was 54.3 and for Sample 2 was 22.7. These values were both significant at the .05 level; the null hypothesis was rejected. (Table XXXVII on page 90).

3. Students believed that the quantity of material presently being covered in lecture was about right or appropriate. It is of interest to note that although 1.7% of the respondents believed too little material was covered, 25.9% believed too much material was presented. This indicates that some students might wish a reduction in the course content covered in the lecture portion of the proposed course in Earth and Space Science.

4. Students within the Geology/Astronomy portion of Sample 1 believed that the quantity of material covered in the laboratory was appropriate for the proposed course in Earth and Space Science.
### Table XXXVII

**Hypothesis III**  
**Student Preference**

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Expected</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture alone</td>
<td>9</td>
<td>61</td>
<td>70</td>
</tr>
<tr>
<td>Combination of methods</td>
<td>113</td>
<td>61</td>
<td>174</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>122</td>
<td>122</td>
<td>244</td>
</tr>
</tbody>
</table>

Chi Square = 54.3  
Degrees of Freedom = 1  
Probability = < .001

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
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<tr>
<td><strong>Sample 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture alone</td>
<td>0</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Combination of methods</td>
<td>34</td>
<td>17</td>
<td>51</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>34</td>
<td>34</td>
<td>68</td>
</tr>
</tbody>
</table>

Chi Square = 22.7  
Degrees of Freedom = 1  
Probability = < .001

5. Data were collected on the student responses relative to the laboratory portion of the course. An interpretation of student responses revealed that the laboratory experiences complemented the lecture material and made understanding more meaningful. There was also a degree of uniformity in student responses recommending field trips. It is important to note that the students...
in Sample 1 ranked field trips as number 6 as to the most productive methods of presenting material, yet many desired field trips within the course.

6. The majority of students within the Geology/Astronomy portion of Sample 1 (55.2%) do not believe there should be greater student participation within the lecture portion of the course. These results tend to be confirmed by student responses appearing in Table XXVI, in which the Sample 1 students ranked field trips and panel discussions 6 and 7 as to the most productive methods of presenting material. These two methods were the only two which require some active participation by the students. This might be interpreted to mean that the majority of students tend to desire a passive role in the instructional process within the lecture portion of a science course.

Findings from the Course Content Inventory.

Data received from instructor responses to the Course Content Inventory are included in the appendices. Data on the Geological area of emphasis, the inclusion of laboratory experiences, the inclusion of field trips, and the inclusion of night observations are included in Appendix K. Data on the recommended course topics in Earth Science are included in Appendix L and data on the recommended course topics in Space Science are included in Appendix M.
An analysis of the responses of the community college instructors in Earth Science from the Course Content Inventory revealed the following:

1. The majority of the instructors (62.5%) believed that the Earth Science portion of the course should include content material from both Physical and Historical Geology although comments received indicated that the emphasis should be on Physical Geology.

2. Laboratory experiences should be included within the proposed course. The responses appearing in Appendix K showed that 90.9% of the instructors believed first that laboratory experiences should be included, and secondly that field trips (experiences) should be part of these laboratory experiences.

3. Night observations should be included within the Space Science portion of the proposed course. An analysis of the instructors' responses appearing in Appendix K revealed that 86.7% of the instructors believed night observations should be included within the proposed course.

Findings in relation to other studies.

An extensive review of the literature and research related to the attitudes of the non-science major toward science courses in curriculum development revealed no comparable study. As a result, very little data existed for comparison with the findings of the present
The findings relating to those research studies found included:

1. Previous background of the non-science major. Contrary to results published by Miles (1974) and reported in Chapter II stating "50% to 60% of non-science majors have had a high school Chemistry course," data collected from the respondents in Sample 1 showed only 32.8% have had such a course. An analysis of the data collected for Sample 2 revealed that 52.9% of the respondents have had a previous course in Chemistry while 47.1% have not. These results from Sample 2 do confirm the results published by Miles (1974).

2. Research studies conducted by Ebel (1965), Shrigley (1976), Spielberger and Katzenmeyer (1959) indicated that "negative" attitudes were detrimental to achievement. The results of this study for Sample 1 tended to agree with these studies. A Pearson product-moment correlation coefficient computed between "negative" attitudes and grade point average in the course was $r = .52$. This was significant at the .05 level and indicated that those students at the upper end of the negative attitude index (value 7) did get better grades than those at the lower end (value of 5).

3. A study conducted by the University of Michigan's Center for the Study of Higher Education as
discussed in Chapter I, revealed that students who had elective options tended to avoid the natural sciences in favor of the social sciences. This study supports this general conclusion in that a comparison of Table VII with Table VIII showed that for Sample 1, 82.0% of the respondents believed there should be required courses outside of the students' major field, yet only 59.8% believed science should be included in this requirement. The corresponding percentages for Sample 2 were 85.3% for required courses, 58.8% for science as a required course.

4. A research study reported by Grandits (1975) indicated that there was a relationship between attitudes and academic preparation in the sciences. A Pearson product-moment correlation between the attitude index and number of science courses gave a value of $r = .18$ which was not significant at the .05 level. The results of this study do not confirm the study by Grandits.

5. One of the conclusions of Washton's (1971) study, as discussed under the Review of the Literature, Chapter II, was that one method of reducing "negative" attitudes was to promote success within the discipline. Responses listed in Table XXXIV tended to confirm this for as the students' concerns for passing the course decreased, their dislike for the course also decreased.

6. Doll (1970) suggested that teachers should
provide learning experiences by variable methods. The results of the test of Hypothesis III showed that the majority of students did prefer instruction involving variable (a combination of) methods.

7. Grimes (1961) study implied that students with "negative" attitudes toward coursework benefited from structured situations where short term objectives were clearly defined. Although no direct evidence was gathered in the inventory, the open-ended responses listed in Appendix E and H tended to confirm the above in that a number of students' responses did recommend a structured course.

8. De Cecco (1968) reported that various learning aids helped to relieve boredom which arose from a monotonous environment. The open-ended responses listed in Appendices E thru J also tended to confirm this statement.

Limitations of the Study

The limitations or shortcomings of the study included:

1. The Attitude Inventory.
   a. It might have been more productive to use a Likert scale in certain areas of the inventory to enhance data analysis, particularly correlations between the variables.
b. Data might have been collected on the mathematics background of the respondents as well as the science background since mathematics is an integral part of most science courses.

c. Data might have been collected on the marital status, number of children, ages of children, and spouse's attitude to the student's educational pursuit. These data could provide additional variables from which student attitudes could more effectively be explored.

2. The Sample.

a. Although frequencies and percentages of certain variables gave indications of significance, actual testing at the .05 level showed non-significance in many cases. Increasing the sample size would provide greater reliability in the results.

b. Sample 2 was too small to give accurate results particularly when only 5 students fell into the classification of having "negative" attitudes.

3. The composite index of attitudes. There was evidence to suggest that the composite index of attitudes needed refinement. There is a question about the validity of the index, as it now stands, to indicate negative attitudes. Each of the variables within the index needs to be examined separately and correlated.
with students who exhibit various attitudinal levels. Additional variables might be added, either in combination with some or all of the original variables in the index.

4. The Course Content Inventory. This inventory could also have been given to those respondents within the Geology/Astronomy portion of the Physical Science course for comparison with the responses of the community college instructors. Although some of the same data were received through the open-ended responses in Appendices E through J, accurate comparisons were not available.

Conclusions and Recommendations

Insofar as the techniques used in this investigation may be valid, the following conclusions appear to be justified:

1. Science classes offered for the non-science major will have students with varying attitudes toward science. There is no significant data to suggest that the students within the two samples have "negative" attitudes. The data do suggest that the non-science major does believe the science courses to be more difficult than classes in other areas.

2. The majority of non-science majors elect a science course primarily because it is a required
course for an Associate in Arts degree. It is important for instructors of such courses to be aware of the attitudes of their students in the structuring and presentation of material in such a course.

3. Absences in a science course are related to achievement in the course. The instructor should be aware of this relationship and therefore stress class attendance.

4. The more science coursework students have in their backgrounds, the less difficult they perceive the present course. It is recommended that instructors gather data on their students at the beginning of classes. Included in these data should be the science background of the student. This information would be helpful to the instructor in identifying those students who might need additional help in the course.

5. Because a general goal of some science educators is a broad background in science, an inventory at the start of class would also reveal those students with prior Chemistry or Earth Science. These students might better be counseled into an area where there will not be duplication of content material. This could also be relayed to the faculty advisors so that the students are advised into the appropriate course before the start of classes.
6. Students perceive that they must spend a greater amount of time, study more difficult material, for about the same grade as they do in their other classes in the humanities and social sciences. It is recommended that students as well as their advisors be made aware of this. Students could then plan to elect their science courses along with other courses which are less demanding in time and difficulty.

7. Students with a concern about the level of difficulty of science do delay taking their science courses. If the instructor collects data from the incoming student on the number of semester hours the student has completed, the instructor would be more aware of those students who might have some concern about the difficulty of science. The instructor could then institute methods to reduce these concerns.

8. Two methods of presentation judged to be the most productive by students in both samples were the lecture method and demonstrations. Instructors' awareness of the above might help in the presentation of material.

9. The testing of Hypothesis III revealed that students desire a combination of methods of presenting material even though students perceive some of the methods as inferior as to productivity.

10. Based upon (1) student responses to the Attitude Inventory and (2) instructor responses to the
Course Content Inventory, the following recommendations are made relative to the design of a course in Earth and Space Science for the non-science major. One of the purposes of this course should be to modify the non-science majors' attitudes about the level of difficulty of a course in science.

The course design is divided into the following six areas and is included in Appendix N.

(a) Course Description
(b) Goals and Objectives
(c) Course Syllabus
(d) List of Laboratory Experiences
(e) List of Audio-Visual Materials
(f) Recommended Methodology for the Course.

Summary

Chapter V presented a review of the purpose of the study as well as the two major instruments used to collect data. The findings were divided into: (1) findings from this study and (2) findings related to other studies. The limitations of the study were also covered as well as the conclusions and recommendations.
REFERENCES


Bugelski, A. The psychology of learning applied to teaching. Indianapolis, N. Y.: Bobbs-Merrill, 1964.


Cross, K. P. New students of the "70's". The Research Reporter, 1971, 6(4), 1-5.


101

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Cross, K. P. New students of the "70's". The Research Reporter, 1971, 6(4), 1-5.


101

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Martin, W. B. The relevance of present educational systems. The Research Reporter, 1971, 4(2), 4-5.


Watson, G. What psychology can we feel sure about? *Teachers College Record, 1960, 61*, 5-7.


APPENDIX A

Questionnaire on the Attitude Inventory
Dear Science Instructor:

I am instructing the course Physical Science at Lake Michigan College, Benton Harbor, Michigan. This course was designed for the non-science major who must take four semester hours of credit in the area of Physical Science to meet requirements for the Associate in Arts Degree. As a science instructor for non-science majors, I am sure you are aware of student attitudes toward the course you instruct. These attitudes vary from the positive to the very negative. How often do we hear the following questions or statements?

"Why do I have to take this course?"
"Why do I have to study this material? I'll never use it."
"I would much rather take a course in Art, Sociology, or Psychology."
"This is too hard."
"Too much homework."
"I hate science."
"Too much math."

This attitude inventory was designed to gather data about the attitudes of students to determine if course design or methodology could be used to reduce the negative attitudes. In addition, the inventory was designed to gather data which might answer or provide insight to the following questions:

1. Is there a correlation between the negative attitudes of students and the variables sex, race, age, or previous course work in science?

2. Is there a correlation between student attitudes toward his or her last science course and the present course as to interest, difficulty, and relevancy?

3. Is there a relationship between students with negative attitudes and their class attendance and course grade?

4. Why are the science enrollments low in relation to the social science and the humanities?

5. What are student attitudes about the level of difficulty of the material, time required for out of class study, and grades, compared to their other classes in the social sciences and humanities?
6. Is there any correlation between grades received and class attendance?

7. Is there a change in attitudes of students from entrance to completion of the course?

8. What types of teaching methodology do the students prefer?

9. What types of laboratory experiences provide the most interest for students?

10. What course material needs to be strengthened, revised, or eliminated?

11. What can I do, as an instructor, to provide better learning experiences for the student?

Would you please complete the following questionnaire dealing with the attitude inventory and send to:

Mr. Larry J. Fairbanks
Lake Michigan College
1755 East Napier Avenue
Benton Harbor, Michigan 49022
Dear Science Instructor:

Please answer the following questions relating to this instrument by (1) checking the appropriate space or (2) by writing in the answers to those items where indicated on the lines provided.

1. Is this instrument an attitude inventory?
   Yes ( )  No ( )

2. Does the instrument provide data which is useful to the instructor in understanding student attitudes?
   Yes ( )  No ( )

3. Does the instrument provide data which is useful to the instructor in course revision?
   Yes ( )  No ( )

4. What information could be added or deleted under each part?
   I. Background Information
      a) Information which could be added:
         __________________________________________________________________________
         __________________________________________________________________________
      b) Information which could be deleted:
         __________________________________________________________________________
         __________________________________________________________________________
   II. General Reactions to the Present Course
      a) Additional information which could be added.
         __________________________________________________________________________
         __________________________________________________________________________
      b) Information which could be deleted.
         __________________________________________________________________________
         __________________________________________________________________________
   III. Course Evaluation
      a) Additional information which could be added.
         __________________________________________________________________________
b) Information which could be deleted.

____________________________________________________________________

____________________________________________________________________

IV. Attitudes toward the course.
a) Additional information which could be added.

____________________________________________________________________

____________________________________________________________________

b) Information which could be deleted.

____________________________________________________________________

____________________________________________________________________

5. Other comments about the instrument.

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

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APPENDIX B

Attitude Inventory
The following Attitude Inventory is being undertaken to find ways of making this course in science as relevant and as interesting as possible for you, the student. Your accurate responses to all items are extremely important, as the revision of the course will be based upon your responses.
ATTITUDE INVENTORY

Please respond to the following items listed below by (1) placing an x within the parenthesis for those items that have multiple choices or (2) by writing in the answers to those items where indicated on the lines provided.

I. Background Information

A. Why did you enroll in this science course?
   It is a required course..................( )
   Background for other science courses ...( )
   Other reasons ( ) Please state: ___________

B. Should science be a required course for the non-science major?
   Yes ( ) No ( )

C. Should there be any required courses outside of the student's major field?
   Yes ( ) No ( )

D. How would you evaluate the last science course in which you were enrolled, either in high school or elsewhere?
   Interest
   Interesting.............. ( )
   Average Interest....... ( )
   Not interesting .......( )
Difficulty

Very difficult ...............( )
Medium difficulty ...........( )
Easy ...........................( )

Relevancy to you

Very relevant ...............( )
Somewhat relevant ..........( )
Not relevant ...............( )

E. How many science courses have you taken previous to this course (include all courses taken since the 9th grade in high school and those taken in college).

Number _______________

F. Have you had a high-school chemistry course?

Yes ( ) No ( )

G. Have you had a high-school Earth Science course?

Yes ( ) No ( )

H. Did you take a college Biology course before entrance into this course?

Yes ( ) No ( )

II. General Reactions to Present Course

A. Compared with my college classes in the areas of Social Science and the Humanities.

1. The difficulty of the material in this science course is:

greater .....................( )

about the same .............( )

less ...........................( )
2. The time required for out of class study in this science course is:
   more ................. ( )
   about the same ...... ( )
   less.................. ( )

3. My average grade currently in this science course is:
   higher .................. ( )
   about the same ...... ( )
   lower.................... ( )

B. What do you believe to be the most or least productive methods of presenting material? (Please check each method as to the most or least productive. These methods do not refer to this class specifically but your entire educational experience.)

<table>
<thead>
<tr>
<th>Method of Presentation</th>
<th>Most Productive</th>
<th>Least Productive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>35mm slides</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>16mm films</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>Use of overhead projector</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>Demonstrations</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>Panel Discussions</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>Field Trips</td>
<td>( )</td>
<td>( )</td>
</tr>
</tbody>
</table>

C. What method of presentation would you prefer?
   Lecture alone ............... ( )
   Combination of methods ...... ( )
D. How would you evaluate this science course?

Interest

Interesting ..........( )

Average interest ......( )

Not interesting ........( )

Difficulty

Very difficult ........( )

Medium difficulty .....( )

Easy ...................( )

Relevancy to you

Very relevant ............( )

Somewhat relevant ......( )

Not relevant ............( )

III. Course Evaluation

This course in science included two facets, the "lectures" and the "laboratory experiences". Please respond to all the items about each of these facets:

Lectures:

A. What about the amount of material presented in the lectures?

Too much ............( )

About right ......( )

Too little ............( )

B. What do you believe to have been the most valuable about the lectures? (Please state)

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
C. What do you believe to have been the least valuable about the lectures?  (Please state.)

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

D. What changes would you recommend in the lecture portion of the course?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

E. Do you believe there should be greater student participation in the lecture portion of the course?

Yes ( ) No ( )

Laboratory Experiences

A. What about the amount of material presented in the laboratory?

Too much ............( )

About right...........( )

Too little............( )

B. What do you believe to have been the most valuable about the laboratory experiences? (Please state.)

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

C. What do you believe to have been the least valuable about the laboratory experiences? (Please state.)

________________________________________________________________________
D. What changes in the laboratory experiences would you recommend?

E. Do you believe that the laboratory experiences are related with the lecture material?
   Closely..................( )
   Moderately well........( )
   Not closely related....( )

F. What was the value of the laboratory manual in this course?
   Very valuable........... ( )
   Of moderate value....... ( )
   Of little value......... ( )

G. What laboratory exercise (exercises) was (were) the most interesting? (Please state.)

H. What laboratory exercise (exercises) was (were) the least interesting? (Please state.)
IV. Attitudes Toward the Course.

Please list your attitudes (feelings) about the course.

A. What were your attitudes toward this course when it started?

In terms of passing the course, I was:

Concerned ............ ( )
Somewhat concerned ... ( )
Not concerned ........ ( )

I though it was going to be:

Difficult............ ( )
Of medium difficulty.. ( )
Easy ..................( )

I thought I:

Would dislike it ...... ( )
Could tolerate it ..... ( )
Would enjoy it ........ ( )

B. What are your attitudes toward the course now that it is almost completed?

In terms of getting a good grade, I am:

Still concerned........ ( )
Somewhat concerned.... ( )
Not concerned......... ( )

I think it is:

Difficult............. ( )
Of medium difficulty... ( )
Easy................... ( )
I believe I:

dislike it ........ ( )
can tolerate it .... ( )
enjoy it ........... ( )

V. Personal Information
A. Please list your age.
   ________ years
B. Please list your sex.
   Male ( )  Female ( )
C. How many total semester hours of credit did you complete before you enrolled in this course?
   less than 15........( )
   15 to 30............( )
   30 to 45............( )
   more than 45........( )
D. Please list your race.
   Black ( )  Hispanic ( )  White ( )  Other ( )
E. Please state your present major.
   __________________________ Undecided ( )
APPENDIX C

Course Content Inventory
COURSE CONTENT INVENTORY

Please check (✓) the appropriate answer for each question.

Earth Science Course Content (approx. 8 weeks)

1. Should the course emphasize:
   a. Physical Geology (✓)
   b. Historical Geology ( )
   c. Both ( )

2. Should the course include laboratory experiences?
   Yes (✓) No ( )

3. Should field trips (experiences) be included?
   Yes (✓) No ( )

From the topics listed below, please (1) check (✓) those topics you believe should be included in the Earth Science portion; (2) leave blank any topic you believe should not be included and (3) add any topic not included which you believe should be included.

1. Planet Earth
   Atmosphere ( )
   Hydrosphere ( )
   Lithosphere ( )

2. Minerals
   Physical properties ( )
   Chemical properties ( )
   Rock-forming silicates ( )
   Economic ( )

3. Rocks
   Rock cycle ( )
   Igneous ( )
   Bowen's Reaction Series ( )
   Sedimentary ( )
   Metamorphic ( )

4. Weathering
   Mechanical ( )
   Chemical ( )

5. Lithification ( )

6. Features of Sedimentary Rocks ( )

7. Vulcanism ( )
   Types of Volcanoes ( )

8. Diastrophism ( )

9. Glaciation ( )

10. Oceanography ( )

11. Topographic Maps ( )

12. Geologic Time ( )

13. Meteorology ( )

14. Continental Drift and Plate Tectonics ( )

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15. Laws of Geology ( )
   Uniformitarianism ( )
   Superposition ( )
   Intrusion ( )
   Faunal Succession ( )
16. Earthquakes ( )
17. Mountains and Mountain Building ( )
18. Additional topics which should be included.
   a. ________________  d. ________________
   b. ________________  e. ________________
   c. ________________  f. ________________

Space Science Course Content (approx. 8 weeks)

1. Should night observations be included?
   Yes ( )  No ( )

From the topics listed below, please (1) check ( ) those topics you believe should be included in this 8 week portion; (2) leave blank any topic you believe should not be included, and (3) add any topic not included which you believe should be included.

1. Motions of the Earth ( )
   Rotation ( )
   Revolution ( )
   Translation ( )
   Precession ( )
2. Earth's Coordinate System ( )
   Latitude and longitude ( )
   Time to arc conversions ( )
   Time and the International Date Line ( )
   Cause of the seasons ( )
3. Celestial Sphere ( )
4. Locating objects in Space ( )
   Azimuth-altitude ( )
   Right Ascension-Declination ( )
5. Meridian-Altitude Diagrams ( )
6. Laws in Astronomy ( )
   Universal Gravitation ( )
   Bode's Law to determine distance ( )
   Kepler's Laws of Motion ( )
   Inverse Square Law ( )
7. Computing revolutional and rotational velocity of a Planet ( )
8. Distance calculations using
Parallax
Parsec
Light year
Astronomical Unit

9. Solar System
Ptolemaic system
Copernican system
Retrograde motion
Theories about formation

10. Sun
Parts
Major features
Albedo
Solar eclipse

11. Stars
Types
Evolution of

12. Electromagnetic Spectrum
Wave equation
Types of Spectra

13. The Fusion Reaction
Proton-proton
Carbon

14. Planets
Motions
Characteristics
Escape velocity

15. Comets

16. Meteors
Classes of Meteorites

17. Moon
Characteristics
Surface features
Lunar eclipse
Tides
Phases

18. Galaxies
Types
Evolution of
Theories about formation

19. Additional topics which should be included.
a._____________________
b._____________________
c._____________________
d._____________________
e._____________________
f._____________________

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APPENDIX D

Letter for Course Content Inventory
I am conducting a survey of Community College Earth Science Instructors within the State of Michigan to try to arrive at some consensus as to the desired content of a course in Earth and Space Science for the non-science major. This course will be a one-semester course of 16 weeks of which 8 weeks will be devoted to Earth Science concepts, and the remaining 8 weeks to content in the area of Space Science or Astronomy. The tentative course will include 3 hours of lecture and a two-hour laboratory per week.

Please complete the following inventory and return in the self-addressed envelope provided. Thank you for your comments.

Sincerely,

Larry J. Fairbanks
Professor of Physical Science
Lake Michigan College
APPENDIX E

What do you believe to have been the most valuable about the lectures?
QUESTION: What do you believe to have been the most valuable about the lectures?

1. "The movie: it was mind-blowing. It made me sit up and pay attention as he went on to explain what I had just viewed."
2. "Clarifying material."
3. "An understanding which you cannot reach unless an explanation is given, which the lecture covers."
4. "The lectures were to help me on the test and on the quizzes. It did clear up some things that I did not understand."
5. "Explaining of facts helps us to understand difficult concepts."
6. "I didn't mind taking the quizzes. I thought they were valuable."
7. "The lecture on rock and minerals was most helpful. I understood better when it was carefully explained."
8. "The material covered in lecture corresponded with the book material and was very useful in the lab experiments."
9. "Explanation of difficult ideas or concepts are probably the most valuable things in a lecture period."
10. "The explanation of material and the visual aids to reinforce material."
11. No response given.
12. "Further explanation of the assigned reading and a time to question those things I don't understand."

13. "Learning better study habits."

14. "Majority of material on test came from the lecture."

15. "I like the way the material was presented. The hard stuff was made much easier to understand."

16. "Taking notes so that you don't have to spend an hour looking it up in books."

17. "Showing students how to identify rocks and doing the problems."

18. "The material was presented in such a way that it was clearly understood."

19. "99% of my notes were from lecture material. I learned much through this."

20. "Completeness of lectures on subject."

21. "In a lecture, if the concept is not understood, the instructor will review or present the same in a manner which will be absorbed."

22. "The lectures made it available for students to ask questions - they substantiated material in the book."

23. "The lectures covered every main point on the quizzes and tests (up to this point)."

24. "The explanations of things in understandable terms making it easier to relate to."

25. "I was more interested in the whole Astronomy section."

26. "Give a better understanding of how Geology and Astron-
omy relate to each of us."

27. "Repetition of all the important material helped to understand what I didn't know."

28. "What you lecture about really helps on the test."

29. "The lectures gave all the pertinent material and expanded on the workbook and explained items on the outline."

30. "You learn a lot of things that you didn't know or sometimes it clears up some misconceptions you might have about some things."

31. "Your ability to reach the students - it gives aid to the student as another means of learning the material. The lecture, I believe, would have been a loss had you not been teaching it."

32. "The materials covered."

33. "The equations and the way to work them."

34. "When you would verify an idea (fully show) by talking about the idea, then use films or slides to explain it."

35. "The way in which you stress the important material and repeat it over so that we can get it in our notes."

36. "The most valuable part is when difficult, or any, concepts are given and explained in more simple, comprehensive terms. Also, the quizzes and when questions are asked and discussed."

37. "Those areas that I could relate with or use in my own life (Examples - the basics of the Geology portion - minerals, etc., locations, and formations of rocks,"
also, basic astronomy facts."

38. "Lecture is important to gain a better understanding of the material, so all lecture was valuable. Lecture was made clearer by use of visual aids, etc."

39. "I learned most of the material given during lectures."

40. "I feel that I have gotten alot out of the lectures. Geology - rock formations; Chemistry - make-up; Astronomy - planets, stars, and a little on distance figuring."

41. "I enjoyed identifying the rock specimens. I also found the information on tides and the location of star constellations very interesting."

42. "Most of the material was learned from lectures than from reading the text."

43. "Mostly the Geology part. I really wasn't tuned in on Astronomy."

44. "The order in which the instructor presented material. A well done job - just too much in one semester."

45. "The way the material was presented. It was easy to take notes and get all the information."

46. "Presented facts which were explained well and gave insight into the lab experiences that were to follow."

47. "They were easy to understand, also, the mood was kept somewhat humorous - I didn't fall asleep. Definitions were precise, and the material was covered throughly. Questions were answered adequately. No
"garbage" (irrelevant material) was given us."

48. "Showing the relationships between lecture material covered and the experiments done."

49. "A great deal of material covered."

50. "The lecture material covered helped to explain better what we did in the lab and to give background material."

51. "The material covered on the Land-Office Grid."

52. "Giving the material in an easy to understand way."

53. "Diagrams on the board and the outline. The outline lets you know where you're at and gives you a point of reference. In lecture, the outline was followed closely."

54. "The way you make things concise and short and not giving us a lot of stuff we really don't need to know."

55. "Consider them to have been very informative. Many of my unanswered questions were answered here. I honestly feel that I could have used more."

56. "I feel the instructor is very good in giving lecture material."

57. "Information given."

58. "Well, we always got a lot of material and sometimes, if you didn't read, the lecture would help if one took notes."
APPENDIX F

What do you believe to have been the least valuable about the lectures?
QUESTION: What do you believe to have been the least valuable about the lectures?

1. "The math calculation. I'll remember a super nova or the Neap Tides but not how many parsecs to such and such."

2. "Things that were gone over and over."

3. "They are very valuable and necessary."

4. "I don't think that there was a least valuable lecture because there were things you talked about that I never knew about."

5. "Most of the points are valuable to understand the subject. Presentation of the facts in such a rapid way causes confusion."

6. "Nothing, but it was just too many of them."

7. "To me everything was valuable, lectures along with the slides help me for lab."

8. "Only that there's so much to cover, therefore, while taking notes you don't comprehend what you've written until you re-read them again."

9. All of the things in all the lectures are important and valuable."

10. In astronomy, I felt that the material could have been presented in a shorter time and more tests given.

11. No response given.

12. "I felt that all the lectures were valuable and well worth the time and effort to be there."
13. "None."

14. "Amount of material covered in each lecture, not the content."

15. No response given.

16. "When you just talk about it and don't use the board or overhead to explain."

17. "When the instructor goes over material 3 or 4 times for certain students."

18. "Interruptions by irrelevant questions from some students."

19. "Nothing."

20. "Sometimes assuming that students have basics and background in subject; math for me, but practicals for others."

21. "Over repetition of difficult material (however, even this was beneficial - but tended to be boring at the time)."

22. "Some material, especially in the Astronomy portion, was repeated too often."

23. "The repetition of subjects for me, but I believe it was helpful to many other students."

24. "Nothing."

25. "I ended up not being as interested in rocks as I thought I might be. I liked the calculating in Astronomy better."
27. "The slides."
28. "Sometimes I would get bored and tired."
29. "Even after going through my notes I cannot see any items that are not valuable — it's just that items like parallax do not seem to enter and stay in my mainstream of thought — I realize this is personal."
30. "Sometimes they get boring, if too detailed."
31. "The quantity of material presented. There was just not enough time to cover everything as well as I would have liked."
32. "Nothing."
33. No response given.
34. "Nothing. You do a complete job of giving a more complete realistic idea of how our world and universe is."
35. "16mm films."
36. "The least valuable part is when a great amount of material is given, just to memorize, and there is no time to think and comprehend what was written down."
37. "When the lectures got too detailed to comprehend in an hour's time (which wasn't very often)."
38. "The films; but I would not cut them out. They were just the least valuable to me."
39. "I got tired of listening and writing all the time."
40. "Some of the material such as formulas were a little out of hand. Problems — when done — should be
taken in as homework."

41. "Arc to time and figuring distance between planets. I still cannot see type of cleavage in rocks or tell their luster."

42. "None."

43. "Everything was valuable as far as I'm concerned. It just depends on whether an individual wants to attain the knowledge."

44. "Too much material which had to be covered and some I don't understand."

45. "I don't know."

46. "The fact that there is not enough room for student participation. However, this is not the fault of you, the teacher, as we could have done so if we wanted to."

47. "The portion in Astronomy on the spectrum, solar energy, etc., was a little too much in detail for this survey course."

48. "The Geology portion not related to the experiments conducted in lab."

49. "Not enough time for good notes."

50. "Too much time spent going over the same thing as in lab."

51. "I don't know."

52. "Can't really think of any."

53. "Sometimes too much material too quick. Probably could use a globe or map (visual aids) to kelp explain
lecture material."
54. "They seemed to be uninteresting at times, but most of it was really enjoyable."
55. "Not a thing."
56. "Nothing. I thought everything that was given was valid to remember."
57. "Too much information at once - tends to be a strain if you're not a stenographer."
58. "Lectures were very important for me. I can't find a thing to say about least important."
APPENDIX G

What changes would you recommend in the lecture portion of the course?
QUESTION: What changes would you recommend in the lecture portion of the course?

1. "Relieve some of the pressure. Stop the pop quizzes."

2. "Not really any needed - good as it is."

3. "None - the lectures are very good and provide necessary explanations."

4. "When you see the class not understanding something, stop and take time to go over it. Don't be in such a rush to finish the book or be on a schedule. Maybe just take things that are most important."

5. "Slow down."

6. "You give out too much material at one time. Give quizzes at a uniform time, like every week."

7. "A little more time. We didn't seem to have enough time to go over material."

8. No response given.

9. "No changes whatsoever. The lectures are extremely well presented and planned."

10. No response given.

11. "None."

12. "I can't really see any room for change - except maybe try to give more information."

13. "A slow-down of material in the Astronomy portion."

14. "Cut down on the amount given at any one time to allow for open discussion or clarification on every point that was given."
"Maybe more examples or demonstrations."

"Have more demonstrations."

"Have students who don't understand something see the instructor after class."

"More information, meaning that I would have preferred that you had gone into more detail in most areas."

"None."

"A quick 'Ascent of Man' type display of basics before continuing the normal lecture."

"A slower pace at the beginning of the course - developing into the pace at mid-term."

"Slightly less repetition and a full lecture (explanation) of the broad in the slides."

"More time for questions."

"None."

"Possibly spend more time on Astronomy than Geology."

"To restrict the Astronomy part of the course to a more specific area. Too broad of a subject to cover so many aspects."

"Not much change is needed. I am doing better than I thought. I can't complain."

"When students start to get bored, try to make the lectures a little more interesting, or stop for the day."

"To go a little slower and ask if there are questions as material is being given."

"There aren't any. I think it's fine just as is."
31. "Give more time to each phase of Physical Science."

32. "More films and slides."

33. "A couple more movies, more class discussion, if possible."

34. "Myself, I don't think you should change your lecture or lab."

35. "None."

36. "The one change would be to slow down on the difficult and memorization part of numbers and terms that will not even be mentioned or heard of again."

37. "Nothing. It was a compact, fact-filled portion that did a lot in a short amount of time."

38. "I think you did a fine job and I really got a lot out of the course through lecture. I like the way you make us take notes for it makes it stick better for me. Note: Lecture was important to me for you gave us the information we needed without the use of a book. Because of low funds, I could not afford a book, but my grade didn't suffer, for you covered what was necessary. Thank you."

39. "Have a few things to break up the monotony of lectures all the time; a field trip, etc."

40. "Should cut some of the material. Covered too much ground for the time given."

41. "You go to fast - I write in abbreviations to keep up with you and often can't decipher my notes afterwards."
42. "None."

43. "I think if you slowed down a little in your presentation of your lecture material, that people would obtain more knowledge and benefit more."

44. "Not as much material to be covered as it is now and review the material more."

45. "None."

46. "There is nothing I could recommend. I honestly thought they were carried out efficiently."

47. No response given.

48. "Concentrate more on the average or below average student's level in presenting the information and slow down the pace to somewhat match the pace of the students. What difference does it make whether you cover all of the assigned material if the retention of that material is lacking in the average student upon completing the course."

49. "More time for notes."

50. "Equalize the amount of time spent on both Geology and Astronomy."

51. "Less material to cover. More time on certain topics."

52. "Not really any change. Lectures were very well prepared and presented."

53. "Visual Aids - more slides."

54. "They have been quite sufficient."

55. "A bit more review of previously covered material if time would allow."
56. "None."

57. "Less rocks - more stars - also, don't put so much emphasis on attendance. Some people simply cannot come to every class session."

58. "Less material."
APPENDIX H

What do you believe to have been the most valuable about the laboratory experiences?
QUESTION: What do you believe to have been the most valuable about the laboratory experiences?

1. "The rocks to handle and see and become 'friends' with. I'd love a field trip to see a planetarium. I'd even go next semester if I didn't have to go."

2. "Without the laboratory exercises, Physical Science would be just a bunch of facts that would seem to have no real purpose."

3. "Especially in Geology, lab experiences are necessary in recognizing the various minerals and rocks."

4. "We broke down things and you learned from one another. The rocks and things and globes."

5. "It lets us discover first hand and work out problems. The experiments make your lectures have more meaning."

6. "The part where we get together and work."

7. "The maps, and the equipment that we used to draw eccentricity. The rock samples, which made me more aware of rocks and minerals."

8. "When I can see some things happening, I can better understand what's been explained in lecture and lab is a better time to get personal help."

9. "Application of the knowledge accumulated during the lecture and from the readings."

10. "In geology, I thought the continual exposure to the rocks and minerals to be excellent."
11. No response given.
12. "Being able to actually see and experience those different things that were lectured about."
13. "More experience in working things out by myself instead of just hearing it in lecture."
14. "First hand knowledge."
15. "Being able to see the things talked about in lecture."
16. "Doing the experiments and going over them."
17. "Identifying the rocks."
18. "Time was allotted to complete the experiments."
19. "Easier to learn material when you work out the exercises in lab."
20. "Study of rock and mineral samples, learning of the math."
21. "Reviewing and applying material presented in lectures."
22. "The most valuable portion of the labs was the mere use of the materials available. For example, the rock boxes and moon globes were very, very useful."
23. "Using the globes, so I could really understand longitude and latitude, working time and arc problems, working with rocks and minerals to learn the properties."
24. "A general explanation of how to go about doing things and then enough time to learn it yourself by doing."
25. "Actually working with the maps, doing problems, and examining the rocks."
26. "Learning rocks."
27. "Repetition."
28. "You learn how to do the different things."
29. "We saw demonstrations and items that probably, unless one is a Science major, we would never have cause to view, i.e. Celestial map, the moon, etc."
30. "You learn to use your mind to solve things. You have to work a little, not just use something off the top of your head."
31. "Lab aided the student to have a better understanding of the lecture portion. Without it, I doubt if the student would have understood or enjoyed the class."
32. "The laboratory experiments help to understand the lecture materials."
33. "Land office grid, how to find longitude and latitude, how to find stars, how to figure out what materials are in a rock."
34. "Your way of letting us see how problems are solved, working them, then showing specimens or films on how this could occur or how they found out it did."
35. "We were able to ask any number of questions about the material and Mr. Fairbanks was able to make clear the material he had covered in the lectures."
36. "The most valuable part was hearing and reading about a method or type of problem, and then being able to see how it actually works and can be done."
37. "Going more in depth on the areas brought out in lecture and having the time to do so."

38. "Was to put to practice what we had learned in lecture. This made things more clearer and helped me to understand and remember better."

39. "They gave me a better understanding of the material that we were covering - they were also fun (usually)."

40. "How to find stars and planets, etc. How they act upon each other."

41. "The use of the work globe and map reading."

42. "It gave you insight as to how a certain situation was done."

43. "The lab experiments with the rocks, and the topographic maps."

44. "The way the instructor was willing to give each student individual attention and the smaller number of students in the lab."

45. "It helps you understand the lecture material better."

46. "They help you to understand better, things that were covered in the lectures and brought to your attention things that you might have missed."

47. "We were able to work with the minerals, etc., directly. The time periods were long enough to allow for a thorough examination of the various materials. Our manuals were not checked - we worked on our own stimulus."
48. "Learning how to determine the different types of rocks and the minerals present in them."

49. No response given.

50. "Being able to see more clearly what was talked about in the lectures."

51. "Sometimes it helped you to understand what you didn't understand when you read it in a book."

52. "I enjoyed most the rock study portion. Now I can be more knowledgeable about the ones I collect."

53. "The first hand look at things. Laboratory is set up very nicely. Help of partners and freedom to move and talk."

54. "The most valuable, I think, is figuring out what was said in lecture."

55. "Practical usage of covered materials that could be accomplished in lab, especially the math formula problems."

56. "Being able to go thru lab experiments so they are made more understandable."

57. "Doing experiments on your own."

58. "I had a chance to see some of the things we talked about in lectures happen."
What do you believe to have been the least valuable about the laboratory experiences?
QUESTION: What do you believe to have been the least valuable about the laboratory experiences?

1. "It all had a reason."

2. "Blow pipe and bead tests."

3. "All lab experiments were important, but the Geology were a little more important than Astronomy."

4. "To me, the laboratory experiences were most important. So to tell the truth, there were no least valuable laboratory experiences."

5. "The class break---work through it and then discuss experiments with class afterwards."

6. "The flame test. That didn't make any sense to me at all."

7. "With some of the problems we had; by doing them myself and not having you explain them, I didn't learn as well as I should have."

8. "Too many problems of the same type."

9. "Everything is extremely effective. The use of teaching aids, review of difficult concepts, and application of the knowledge."

10. "In Astronomy, I believe more of the background could have been brought out in lecture so the student could see the relevancy of the lab exercises. I didn't feel that the Astronomy labs were as valuable for retention and reinforcement purposes as Geology was."

11. "Using our time to look for places on maps and globes."
12. "The time was too short. I felt the labs should be 3 hrs. long. Also, I think we could have broadened the areas of experiments."

13. "None."

14. "Time element involved makes the student rush in order to complete all phases of the laboratory experience."

15. "Not enough time sometimes."

16. "When we did do lab and then left after we finished without really understanding how or why we did it."

17. "I thought the lab was valuable in all areas."

18. "Lab partners."

19. "Can't think of any."

20. "Experiments; students attempt to duplicate the results listed in the workbook, with no comprehension of actual reasons or processes or results."

21. No response given.

22. "In the Astronomy portion, especially, the exercises were a bit too long."

23. "Constructing ellipses, working with land maps, (measuring river lengths)."

24. No response given.

25. "There was not really anything that wasn't valuable."


27. "The lab exp. with blow pipe and bead analysis."

28. "Doing the things and not understanding it."
29. "The math problems - because of my poor math."
30. "Nothing, really."
31. "None."
32. No response given.
33. "When we had to pick the most and the least valuable things in order to survive on the Moon."
34. "Nothing. I believe that you do a complete job of giving me a more complete realistic idea of how our world and universe is."
35. "The questions in particular by a few students who showed that they obviously had not studied the material at all."
36. "The least valuable part was the great length of some of the experiments involving a lot of repetition in finding the answers."
37. "Not that much, except when studying rocks and stars in an artificial atmosphere (box or globe) as opposed to getting outside and learning first hand about them."
38. "I would have to say the land office grid. It was neat to know, but I don't feel it was too valuable in pertaining to the class."
39. "We couldn't actually see the concepts of Astronomy at work. It might have helped if we could."
40. "Doing the work and not having it checked by the instructor."
41. "The last lab on craters and lunar mountains."
42. "Not enough discussion on the lab experiment."
43. "Everything was valuable as far as I'm concerned. It just depends whether an individual wants to attain the knowledge."
44. "Not enough time was spent in the lab."
45. "I don't know."
46. "I rather enjoyed them. Everything seemed valuable."
47. "A lot of my time was wasted when I wasn't 'in the mood' to work - perhaps I needed a push to get working once in a while."
48. "The lab practical test where I was forced to try to assimilate what I had learned about rocks and minerals and regurgitate that knowledge in such a short span of time."
49. "Two hours is a long time; students should take part more."
50. "The fact that such a large amount of time was spent studying the rocks and mineral specimens."
51. "I don't know."
52. "The light wave theories."
53. "The squeaky chairs making that awful sound."
54. "Some experiments were too short."
55. "The blow pipe experiment."
56. "I never learned a lot in lab, not because of the lab experiments, but because I learned thru lectures
and at home."

57. "Lab wasn't discussed much during lecture periods."

58. "There's nothing I can say about least important in lab."
APPENDIX J

What change in the laboratory experiences would you recommend?
QUESTION: What change in the laboratory experiences would you recommend?

1. "A field trip."
2. "Can't think of any."
3. "Maybe a little more time spent on identification of minerals and rocks."
4. "When you get things done, you should be able to leave."
5. "Increase the time or set up open lab with assigned experiments."
6. "Nothing."
7. "A little lecture in laboratory to individuals to make sure they are doing the right thing."
8. "none."
9. "Nothing."
10. "I would recommend that the lab manual be more complete so that the student has a more concise overview of the astronomy portion of the course. As I read the textbooks, I found more material than was necessary, but the lecture notes were too brief for review or as in my case, from obtaining from someone else when I was sick. I believe a similar arrangement of topics as covered under geology would aid this situation."
11. No response given.
12. "I think there was not enough time to fully appreciate and understand the astronomy portion. I think to
get the most out of these 2 subjects (Geol. and Ast.),
there really needs to be 2 separate courses."

13. "More experiments."

14. "Reduction on the size of the lab material to be
brought into perspective with a reduction in lecture
material also."

15. "Two labs a week."

16. "Have more follow-up work, so that we understand
what we did."

17. "None."

18. "More detailed lab manual in both Geology and Astronomy."

20. "Give only the procedure, have students themselves
describe the results, then give the desired results
after experiments."

21. "None."

22. "No major change, except the shortening of certain
Astronomy exercises."

23. "Not much. They are pretty well related to lecture
material."

24. "That it is made clear that partners will work together
and not go off on separate tangents (in order to
heighten the learning process)."

25. "Possibly a little more time, if possible, than just
the two hours one day a week."


27. "None."
28. "If you were finished with your lab, you should be able to leave."

29. "Match up lab partners - strong math background with weak math background rather than just let individuals choose their own lab partners."

30. "Maybe shorten labs to 1½ hours; 2 hours seems pretty long sometimes."

31. "Have a full time lab person there to discuss a lab problem. One teacher can't help (or individualize) that much with so many students."

32. "In Geology, there should be some field trips."

33. "Some field trips."

34. "None."

35. "None."

36. "None, except cut some useless repetition; but that may be necessary for many to learn."

37. "I would like to have had more field trip knowledge dealing with the Geology and Astronomy portions (if that were possible)."

38. "I would change nothing, you covered things well; helped me to understand clearer by doing."

39. "I'd recommend field trips every once in a while - especially for Astronomy so that we could see some of the concepts."
40. "Cut out the unimportant experiments."

41. "More use of lab equipment. Example - cutting stones. Even a demonstration would help. I think cleavage would be easier to recognize."

42. "None."

43. "None."

44. "No comments for this question because the instructor did a good job with the lab experiences."

45. "None."

46. "I would recommend that the Astronomy portion of the course be carried out like the Geology portion. Since it is harder, everything that is covered in the lecture should be reinforced in the lab."

47. "Add a little more stimulus for students to work, otherwise, the material was good and relevant."

48. "The elimination of a lab practical and the development of experiments that would have some relevance to today - possible a field trip type of thing to a museum or a rock collecting venture."

49. "Work alot closer together."

50. "Different experiments concerning Geology."

51. "None."

52. "None."

53. "New chairs. In the Geology portion, we probably could have gone outside and looked at actual rocks that we run across everyday."
54. "Make them a little longer."
55. "More plotting and formula problems."
56. "Maybe one or two field trips when we are studying Geology."
57. "More independently oriented for students."
58. "None."
APPENDIX K

Instructor Responses to the Course Content Inventory
### Instructor Responses to Course Content Inventory

#### Geological Area of Emphasis

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<th>Response Categories</th>
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<td>Historical Geology</td>
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"Should the course include laboratory experiences?"

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"Should field trips (experiences) be included?"

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"Should night observations be included?"

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APPENDIX L

Recommended Course Topics in Earth Science
# Recommended Course Topics in Earth Science

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APPENDIX M

Recommended Course Topics in Space Science

169
# Recommended Course Topics in Space Science

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Course Description

Course title: Earth and Space Science

Pre-requisites: None

Contact Hours: The course will include a total of 80 contact hours during the 16 week semester. There will be 3 hours of classroom activities and 2 hours of laboratory experiences each week.

Credit: 4 semester hours

Level: Designed for the non-science major to meet the Physical Science curricular requirement.

Catalog Description:

The Earth Science portion emphasizes an understanding of our planet. This understanding will include the relationship of geologic processes to the rock cycle and will give the individual a better appreciation of the effects of earth science on his life. The Space Science portion emphasizes an understanding and appreciation of the basic concepts of Astronomy and a study of our planet relative to our solar system, galaxy, and universe. The course will include correlated night observations, field experiences, and laboratory experiences.

Goals and Objectives

The goals (broad general statements of what the student is to do) of the proposed course in Earth and
Space Science are first subdivided into the major areas of cognitive and affective for each of the two areas. The objectives (specific things students should be able to do or know) are listed under each of the goals.

Course Syllabus

Earth Science topics having less than 55% selection by the instructors on the Course Content Inventory were omitted. For the Space Science topics, those topics having less than 50% selection by the instructors were omitted. The syllabus is in outline form and includes the laboratory experiences and suggested audio-visual materials. Week 1 would cover the physical and chemical properties of minerals (thru B2 of the syllabus). The first laboratory period would be an introduction to minerals. The associated audio-visual materials which could be used are coded on the outline. The code refers to the applicable audio-visual aid. For Week 1, the audio-visual aids are:

- AV-A-1 43 minerals
- AV-F-1 the 16mm film "Earth in Evolution"
- AV-B-la 35mm filmstrip "The Minerals"
- AV-B-lb 35mm filmstrip "Identification of Minerals"
- AV-C-2a 8mm film loop "Crystal Growth in Solution"
- AV-C-2b 8mm film loop "Crystal Growth from a Melt"
- AV-D-1c 35mm slides "Minerals and Crystals"
- AV-G-11 Stereogram book of "Rocks, Minerals, and Gems"
Laboratory Experiences

The suggested laboratory experiences are based upon student responses to the Attitude Inventory. Three open-ended response items appeared in the inventory dealing with the laboratory. These were: (1) What do you believe to have been the most valuable about the laboratory experiences? (Appendix H); (2) What do you believe to have been the least valuable about the laboratory experiences? (Appendix I); and (3) What changes in the laboratory experiences would you recommend? (Appendix J).

Audio-Visual Materials

The suggested audio-visual materials include, with each aid, the vendor supplying this material as well as the ordering number and price, if known.

Recommended Methodology

The following methodology is recommended for the course Earth and Space Science:

1. The principle instructional method will be the lecture method of presentation. This can be complemented by demonstrations and
other audio-visual materials as suggested on the syllabus.

2. The students should receive a copy of the syllabus minus the audio-visual materials. This student outline will help to guide the student. In place of the audio-visual materials should be included the reading assignments by page number where the student can find the material in the text. It is also recommended that additional textbooks or other resources be utilized and placed on reserve in the library. If the outline is followed, then the student knows at all times where he is and where he can find amplifying material to the lecture.

3. A copy of the instructor's goals and objectives of the course should be given to the students so they can clearly see the intent of the various parts of the course.

4. Gather data on the students. It is recommended that a 4" x 6" card be made up for each student including information about the student. Have the students bring a picture of themselves to be placed on the card. Information which is beneficial is age, phone number, prior science background, prior mathematics background, number of semester hours completed, and length of
time since the last science course. In addition, get the student's common name to be used for taking role. Often students prefer to be called Ted rather than Theodore. This also tends to create an informal classroom atmosphere where the students are less reluctant to ask questions or make comments.

5. Short quizzes should be given at least once each week. The first few quizzes should be fairly easy so that the student can build confidence in the interaction with the course. Success on quizzes tends to diminish the student's concern toward the difficulty of the course.

6. Provide a list of scheduled office hours to the students and emphasize that they should come in if there are questions or problems with the course.

7. Stress class attendance. Emphasize that class attendance is related to success in the course. In this context, role should be taken each time the class meets. The taking of role indicates to the student that the instructor does care about the student's success in the course.

8. Monitor the quizzes closely. Students having difficulty with the first few quizzes should be asked to come in to discuss them. The
quizzes can also tell the instructor what content material is difficult for the student and needs further explanation.

9. Provide time for and encourage the asking of questions by the students. Also encourage relevant comments by the students.

10. Periodically inject humor into the lectures. In addition, comments indicating the instructor's interest should be given. This will indicate to the students that science does not have to be a boring and dead subject, but rather interesting and alive. The instructor's attitude and behavior in the classroom tends to be contagious for the students.

11. Tests, when given, should be graded immediately and handed back the next class period. The non-science major needs this feedback as soon as possible. The test questions should be covered in class and the grading scale for the test should be given so that the student knows where he falls in the distribution. Students should know at all times their progress in the course.

12. The above recommendations will help to relieve the student's concern toward the difficulty of
the course. When this concern diminishes, then the student can begin to change the long-established "negative" attitudes to positive attitudes toward science.
GOALS AND OBJECTIVES

EARTH SCIENCE

1. **Cognitive Goals and Objectives for Students.**
   A. **Understands the language of minerals.**
   1. Distinguishes between the laboratory and field identification of minerals.
   2. Describes the physical and chemical properties of minerals including hardness, crystal shape, cleavage, fracture, color, streak, luster, specific gravity, striation, transparency, tenacity and others.
   3. Selects those properties of minerals which are diagnostic to the particular mineral.
   4. Differentiates between minerals based upon chemical composition.
   5. Identifies the diagnostic properties of the rock forming silicate minerals.
   6. Discriminates between the rock forming minerals and others.
   7. Recognizes 30 minerals by name based upon 3 or 4 diagnostic properties of each.

   B. **Applies concepts of the earth's formation and the rock cycle to life on earth today.**
   1. Perceives the earth today and relates the three rock families to the environment of formation.
   2. Understands how rocks are related to each other in the rock cycle.
   3. Differentiates between processes on the rock cycle.

   C. **Understands the formation of Igneous rocks and the method of classification.**
   1. Distinguishes between the 5 types of Igneous rock texture.
   2. Recognizes the rock forming silicate minerals in Igneous rock specimens.
   3. Identifies 10 Igneous rock specimens.
   4. Relates Igneous rock texture to either an intrusive or extrusive magma.
   5. Compares mineral content of Igneous rocks to order of crystallization.
   6. Demonstrates an understanding of the order of crystallization by recognizing porphyritic texture and naming phenocrysts.
D. Recognizes the importance of Sedimentary rocks to the environment of formation.
1. Distinguishes between the clastic and chemical Sedimentary rocks.
2. Relates the types of mechanical weathering to familiar objects and their disintegration.
3. Interprets a sample of Sedimentary rock to its formation.
4. Differentiates the chemical Sedimentary rocks into inorganic and organic.
5. Associates the Sedimentary rock with the type of lithification. (pressure, cementation)
6. Associates the features of Sedimentary rocks to the samples of Sedimentary rock.
7. Identifies 10 samples of Sedimentary rock based upon particle size and chemical composition.
8. Contrasts the above 10 samples with samples collected in this locale.

E. Integrates the Metamorphic rocks to the rock cycle and to the Igneous and Sedimentary rocks.
1. Identifies 10 Metamorphic rock specimens.
2. Relates the Metamorphic rocks to the parent Igneous or Sedimentary rock.
3. Associates the Metamorphic rocks to the agent of metamorphism which formed them.
4. Demonstrates an understanding of the agents of metamorphism by relating to orogeny—mountain building and magma intrusions.

F. Understands vulcanism and its effects on the Geomorphology of the earth.
1. Classifies volcanoes based upon shape and extrusion.
2. Relates intrusive and extrusive magma to the texture of Igneous rocks.
3. Distinguishes between products of an explosive eruption and the fragmental textured Igneous rocks.
4. Correlates the regions of volcanic activity with the zones of earthquakes and their relationships.

G. Appraises the laws of Geology.
1. Outlines geologic time into the hierarchy of eons, eras, periods and epochs.
2. Justifies the relationships between evolution and the environment.
3. Predicts the sequence of events of rock strata with intrusions based upon the laws of Geology.
4. Relates laws of Geology to one another and to geologic time.

H. Interprets features of the earth to topographic maps.
1. Describes parcels of land by the use of township and range.
2. Distinguishes between tax descriptions based upon township and range (fractional terms vs. metes and bounds).
3. Relates fractional descriptions of parcels to land acreage.
4. Correlates the land office grid to topographic maps.
5. Computes distances on topographic maps.
6. Recognizes the color scheme and map symbols on a topographic map.
7. Interprets surface features and profiles on a topographic map.

I. Understands the phenomena of earthquakes.
1. Distinguishes between the focus and epicenter of an earthquake.
2. Describes the magnitude scale (Richter).
3. Correlates the relationship between earthquakes and volcanic activity.
4. Identifies the major waves produced.
5. Interprets the effects and correlates with Geomorphology.

J. Recognizes the importance of glaciation to the field of Geology.
1. Describes the major types of glaciers.
2. Relates glacial deposits to type of Sedimentary rock which can be formed.
3. Interprets the glacial features and correlates with Geomorphology.

K. Interprets the continental drift theory.
1. Explains the evidence for continental drift.
2. Describes the ocean-floor topography.
3. Identifies the major plates in plate tectonics.
2. Affective Goals and Objectives.
   A. Recognizes the importance of earth science on our lives today.
   1. Develops an appreciation of the technique required to perform the laboratory tests of blow-pipe analysis, flame tests, and bead tests.
   2. Displays an awareness that modern society could not exist without the minerals and rocks from which metals and other essentials are extracted.
   3. Gains an appreciation of the vast amount of time required for evolution.
   4. Displays an interest in "the land" based upon understandings gained in class.
   5. Forms desirable attitudes that science can be enjoyable and is not something to stay away from.
   6. Develops an appreciation of how much more interesting vacations will now be since becoming aware of earth science concepts.

   B. Demonstrates relationships between earth science and other branches of science.
   1. Appreciates the use of testing equipment to differentiate the rock and mineral specimens.
   2. Gains an awareness of the contributions of noted scientists in the area of Geology.
   3. Develops insight into the inter-relationship between Geology, Physics, and Chemistry.
   4. Gains an interest in other areas of science from an exposure in earth science.
   5. Develops an appreciation of job opportunities in vocational areas such as stone cutters.
   6. Develops an interest into the inter-relationships of Geology and Astronomy.
   7. Gains insight into the realm of science in which the hypothesis and theory are more prevalent than the absolute law.

SPACE SCIENCE

   A. Understands the relationships between the terrestrial and the celestial sphere.
   1. Describes the basic motions of the earth (rotation, revolution, and precession.)
2. Compares the terminology of latitude and longitude to the right ascension and declination of celestial objects.
3. Recognizes 5 basic constellations in the northern hemisphere.
4. Demonstrates an understanding of time zones and the international date line.
5. Relates motions of the earth to the seasons and day and night.
6. Identifies the terms associated with the celestial sphere.
7. Explains the earth's equinoxes and solstices.
8. Compares the horizontal and vertical coordinates on the earth to the two coordinate systems in space.

B. Understands the interrelationship between Mathematics and space study.
1. Recognizes the concept of distance in space relative to the astronomical unit, parsec, and light year.
2. Solves problems in distance involving the parallax of stars.
3. Relates revolutional velocity to Newton's laws of motion both for planets and artificial satellites.
4. Distinguishes between the phenomena of light and the 3 types of spectra.
5. Correlates distances of objects based upon luminosity and the inverse square law.
6. Applies Kepler's three laws of motion in solving problems involving planets.
7. Associates brightness to the magnitude scale.

C. Recognizes concepts associated with our solar system.
1. Discriminates between the Ptolemaic and Copernican hypothesis of the solar system in the explanation of retrograde motion.
2. Identifies the members of the solar system.
3. Identifies the major features of our sun.
4. Compares the spectra of a star as to its classification as a specific type.
5. Relates type of star to temperature, fusion reaction and magnitude.
6. Differentiates meteors, meteroids, and the three major types of meteorites.
7. Compares the planets as to physical characteristics and properties.
8. Interprets difference as well as similarities between the planets and our natural satellite, the moon.
9. Relates the concepts of moon's phases, eclipses and tides to motions and distances.
10. Identifies the major features of the moon.

D. Integrates terrestrial phenomena to extraterrestrial phenomena.
1. Distinguishes the hierarchy of the universe and the place of the earth within this hierarchy.
2. Extends the understanding of our solar system and galaxy to other galaxies.
3. Differentiates between the spiral, elliptical and irregular galaxies.
4. Hypothesizes as to the evolution of galaxies and their relation to star clusters and nebulae.
5. Traces the evolution of a star from birth to death and interprets the sun's place in this sequence.
6. Describes the major theories regarding the formation of the earth and solar system.
7. Differentiates between the steady-state theory and the big-bang theory in the formation of the universe.

2. Affective Goals and Objectives.
A. Demonstrates relationships between the terrestrial and the celestial sphere.
1. Appreciates the use of Mathematics as a tool in the study of Astronomy.
2. Gains an awareness of the motions of the earth and their effect on his life.
3. Develops an appreciation of the contributions of astrologers and astronomers to our knowledge of today.
4. Develops insight into the vastness of space relative to the velocities attained during our travel to the moon.
5. Displays concern for those scientists who were killed because of their ideas of the day and to relate this to life today.

B. Appreciates the role of Astronomy and its affect upon our lives.
1. Displays an awareness of indirect measurement and the information which can be gained by it.
2. Forms skill in the use of indirect measurement from which valid deductions can be proposed.
3. Develops attitudinal changes that space science is interesting and not something to stay away from.
4. Increases the enjoyment of solving problems.
5. Instills an interest into the many areas which could be hobbies such as a rock hound, collecting meteorites, etc.
6. Develops an appreciation of how small man is relative to the solar system, milky way galaxy and the universe.
7. Forms an interest into the many unsolved mysteries of space.
8. Demonstrates self-discipline by waiting for all the facts to be in before drawing a conclusion.
COURSE SYLLABUS FOR EARTH AND SPACE SCIENCE

L = laboratory experiences
AV = audio-visual materials

I. Earth Science
   A. Geology
   B. Minerals

1. Physical properties
   a. Hardness
   b. Crystal shape
   c. Cleavage
   d. Fracture
   e. Color
   f. Streak
   g. Luster
      1) Types
         a) Metallic
         b) Non-metallic
   h. Specific gravity
   i. Striations
   j. Transparency
      1) Transparent
      2) Translucent
      3) Opaque
   k. Tenacity
   l. Others
      1) Taste
      2) Magnetism
      3) Fluorescence
      4) Radioactivity
      5) Index of refraction

2. Chemical properties
   a. Effervescence

3. Rock-forming Silicate Minerals
   a. Ferromagnesians
      1) Olivine
      2) Augite
      3) Hornblende
      4) Biotite
   b. Non-ferromagnesians
      1) Muscovite
      2) Orthoclase Feldspar
      3) Albite
      4) Anorthite
      5) Quartz

4. Oxide Minerals
   a. Types
5. Sulfide Minerals
   a. Types

6. Carbonates
   a. Types

7. Sulfates
   a. Types

8. Elemental Minerals

9. Economic Minerals AV-D-1e

10. Laboratory Analysis L-week 3
    a. Blowpipe test A-1
    b. Flame test AV-D-2c
    c. Bead test D-1b
    d. Chemical tests

C. Planet Earth AV-F-2
1. Three Main Parts AV-I-1
    a. Atmosphere
       1) Troposphere
       2) Stratosphere
       3) Ionosphere
    b. Hydrosphere
       1) Hydrologic cycle
    c. Lithosphere
       1) Crust
       2) Mantle
       3) Core

D. Rocks L-week 4 AV-A-2a, AV-F-3, AV-B-1c
1. Definition F-5, D-2a, D-2b
2. Rock Cycle
3. Igneous Rocks
   a. Definition
   b. Definition of:
      1) Magma
      2) Melt
      3) Crystallization
   c. Rock Texture
      1) Types
         a) Phaneritic or coarse grained
         b) Aphanitic or fine grained
         c) Glassy
         d) Porphyritic
            1) Phenocrysts
            2) Groundmass
         e) Fragmental
         f) Terminology of porphyritic vs. porphyry
   d. Breakdown of Igneous rocks on texture and mineral composition
   a. Definition AV-B-1d, D-2c
   b. Weathering AV-B-2a, F-4
   c. Weathering F-6

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1) Two main types
   a) Mechanical AV-L-2, AV-D-4a
      (1) Types
         (a) Effects of unloading AV-D-4b
             -1- Folds
             -2- Faults
             -3- Joints
         (b) Crystal growth
         (c) Frost action
         (d) Thermal expansion and contraction
         (e) Root wedging
         (f) Animals
         (g) Sand blasting by the wind
         (h) Ice erosion
      b) Chemical
         (1) Oxidation
         (2) Reduction
         (3) Hydration
      c) Particles derived from chemical and mechanical weathering
         (1) Wentworth Size Scale
   c. Sedimentary rocks from clastic particles
      1) Conglomerate
      2) Breccia
      3) Sandstone
      4) Shale
   d. Sedimentary rocks derived from chemical inorganic AV-F-7
      1) Limestone
         a) Travertine
         b) Oolitic
      2) Evaporites
         a) Rock Salt
         b) Rock Gypsum
         c) Anhydrite
   e. Sedimentary rocks derived from chemical organic AV-F-16
      1) Coal
         a) Peat
         b) Lignite
         c) Bituminous
      2) Limestone
         a) Coquina
   f. Lithification
      1) Definition
      2) Two main types
         a) Pressure or compression
         b) Cementation
g. Features of Sedimentary rocks AV-D-4b
1) Bedding
2) Ripple marks
3) Mud cracks
4) Vugs
5) Nodules
6) Concretion
7) Geodes
8) Fossils
9) Facies

5. Metamorphic Rocks L-week 6 AV-A-2c, AV-B-1e F-8, D-2d
a. Definition
b. Metamorphism
1) Defined
2) Agents
   a) Deforming pressures
   b) Heat
   c) Chemically active fluids
c. Two basic groups of metamorphic rocks
1) Foliated
   a) Slate
   b) Schist
   c) Gneiss
2) Non-foliated
   a) Marble
   b) Quartzite
   c) Anthracite - coal

E. Vulcanism (Igneous Activity) L-week 7, AV-A1 A2, AV-B-2e, AV-D-4g
1. Types
   a. Intrusive
   b. Extrusive
2. Classification of volcanoes
   a. As to extrusion
      1) Explosive
         a) Products of explosive eruptions
            (1) Bombs
            (2) Blocks
            (3) Cinders
            (4) Ash
            (5) Pumice
         b) Effects
            (1) Dry fog
            (2) Nuee ardente (fiery cloud)
      2) Quiet flows
b. As to shape
   1) Shield
   2) Composite
   3) Cinder cone

F. Earthquakes AV-F-7
   1. Focus and epicenter AV-F-8
   2. Magnitude (Richter scale)
   3. Seismology
      a. Seismograph
      b. Seismogram
   4. Waves
      a. Primary
      b. Secondary
      c. Surface
   5. Effects

G. Glaciation AV-B-2c
   1. Types of Glaciers AV-D-4c
      a. Valley AV-D-4d
      b. Piedmont
      c. Ice sheets
   2. Ice movement
   3. Ice erosion and deposition AV-L3
      a. Glacial drift
      b. Glacial till
         1) Moraines AV-L-4, L-5
         2) Outwash plains

H. Laws in Geology AV-D-2e
   1. Uniformitarianism
   2. Superposition
   3. Intrusion
   4. Faunal Succession

I. Geologic Time Scale AV-D-2f
   1. Eon
      a. Era
         1) Period
            a) Epoch

J. Land Office Grid L-week 8
   1. Locating objects by township and range

K. Topographic Maps AV-G-9, G-10, G-12
   1. Profile construction
   2. Map symbols
   3. Distance determination
   4. Relief determination

L. Continental Drift (Plate Tectonics) AV-H-1
   1. Geological evidence AV-L-1
      a. Geographic fit
      b. Paleomagnetism
   2. Ocean-floor topography
      a. Continental shelves
b. Deep-ocean floors
c. Mid-ocean ridges

3. Plate model
   a. Six major plates
   b. Convection currents

II. Space Science
A. Astronomy and Space Science  L-week 9 AV-E-1a
   AV-M-1
   1. Definition and area encompassed E-1b
      a. Conceptual difference between astronomy and astrology

B. Terrestrial Sphere (Earth) AV-D-3a
   1. Motions of the Earth AV-G-1
      a. Rotation AV-C-1c, C-1f
      b. Revolution
      c. Precession
   2. Definitions and concepts associated with terrestrial sphere
      a. Great circle AV-D-3a
      b. Small circle
      c. Equator
      d. Latitude/parallels of latitude
      e. Longitude/meridians of longitude
      f. International date line and time

C. Celestial sphere (sky) L-week 10 AV-G-2
   1. Definitions and concepts
      a. Based on celestial equator
         1) Celestial poles
         2) Celestial equator
         3) Hour circles
         4) Vernal equinox
         5) Astronomical latitude
         6) Ecliptic
      b. Based on Celestial Horizon
         1) Zenith
         2) Nadir
         3) Celestial horizon
         4) Vertical circles

D. Locating objects in space AV-B-3f
   1. Azimuth-altitude system
      a. Definitions of azimuth-altitude
      b. Sample problems
   2. Equatorial system
      a. Definitions
         1) Right ascension
         2) Declination
E. Mathematics as a tool in Astronomy L-week 11  
   AV-B-3a, B-3b
1. Law of universal gravitation (Newton)
2. Direct measurement of distance AV-F-10
   a. Parallax determinations B-3a
      1) Parsec B-3b
      2) Light year
      3) Astronomical Unit
3. Indirect measurement of distances AV-F-14
   a. Luminosity and inverse square law

F. Solar System
1. Historical hypotheses L-week 12 AV-D-3c
   a. Ptolemaic AV-G-2 AV-J-1
   b. Copernican
   c. Explanation of retrograde motion
2. Members of: AV-B-3c
   a. Sun AV-D-3d
      1) Parts AV-F-11
         a) Photosphere
         b) Chromosphere
         c) Corona
      2) Main features AV-L-7
         a) Granules
         b) Spicules
         c) Solar prominances
         d) Sunspots
         e) Flares
      3) Stars AV-D-3e
         a) Electromagnetic spectrum AV-G-5
         b) Spectra AV-F-15
            (1) Continuous AV-F-13
            (2) Bright line
            (3) Absorption
         c) Major types and designation
4) Sources of solar energy
   a) Proton-proton reaction
5) Kepler's laws of motion L-week 13
   a. First law - characteristics of ellipse AV-E-1a
      (1) Perihelion E-1b
      (2) Aphelion
   b. Second law - law of areas
      (1) Eccentricity
   c. Third law - harmonic law
   d. Application of laws
6) Constellations AV-D-3g
   (identification) AV-F-9, AV-G-5, G-7
   b. Planets AV-B-3d, C-1b
      1) Motion (rotation-revolution) AV-G-6
2) Division into AV-L-9, AV-J-2
   a) Inferior vs. superior
   b) Outer vs. inner
3) Characteristics of individual planets
   c. Comets
      1) Definition AV-B-3e, AV-L-9, H-1
      2) Meteors vs. meteorites vs. meteoroids
      3) Types of meteorites
         a) Aerolites
         b) Siderites
         c) Siderolites
   d. Moon L-week 14, AV-G-3, G-4
      1) Characteristics AV-C-1a, AV-D-3b
         a) Rotation/revolution
         b) Diameter/density
         c) Perigee/apogee
      2) Surface features AV-L-8, AV-G-8
         a) Maria
         b) Mountains
         c) Craters
         d) Rays
         e) Rills
         f) Scars
         g) Valleys
      3) Phases L-week 15 AV-G-3
      4) Lunar eclipse G-4
      5) Lunar latitude and longitude
      6) Lunar rocks AV-H-2

G. The Earth's position in the Universe
1. Milky way galaxy
   a. Solar system
      1) Planet earth

H. Galaxies L-week 16 AV-N-1
1. Types
   a. Spiral AV-D-3f, AV-F-12, AV-L-6
   b. Elliptical
   c. Irregular
2. Theories regarding
3. Evolutionary sequence
4. Star clusters and nebulae

I. Evolution of stars
1. Sequence of events from nebulae to black dwarf

J. Origin of earth and solar system
1. Theories regarding
   a. Random capture hypothesis
   b. Encounter, 2 star hypothesis
   c. Proto-planet hypothesis
   d. Nebular hypothesis

K. Cosmology AV-D-3f
1. Steady-state theory
2. Big-bang theory
LABORATORY EXPERIENCES

Week 1  Introduction to Minerals
Week 2  Field Identification of Minerals
Week 3  Laboratory Identification of Minerals
Week 4  Igneous Rocks
Week 5  Sedimentary rocks
Week 6  Metamorphic rocks
Week 7  Field trip on rocks and minerals
        Laboratory Practical Examination on Rocks and Minerals
Week 8  Land Office Grid and Topographic Maps
Week 9  Terrestrial Sphere - Locating Objects on the Earth
Week 10 Celestial Sphere - Locating Objects in Space
Week 11 Night Observation/Planetarium visitation
Week 12 Celestial Sphere
Week 13 Kepler's Laws of Motion
Week 14 The Earth's Moon - Lunar Features
Week 15 The Earth's Moon - Phases, Tides and Eclipses
Week 16 Night Observation/Planetarium visitation
A. Specimen Box of Rocks and Minerals (43 rocks and 43 minerals) from Wards Natural Science Estab.
P.O. Box 1712
Rochester, New York 14603

List of the Minerals and Rocks

1. Minerals

1. Quartz var. Jasper
2. Sulfur
3. Quartz var. Amethyst
4. Graphite
5. Augite
6. Olivine
7. Quartz var. Chert
8. Pyrite
9. Calcite
10. Gypsum var. Selenite
11. Gypsum var. Alabaster
12. Gypsum var. Satin Spar
13. Galena
14. Quartz var. Rose Quartz
15. Quartz var. Milky Quartz
16. Dolomite
17. Anhydrite
18. Chalcopyrite
19. Hornblende
20. Magnetite
21. Muscovite
22. Asbestos
23. Garnet
24. Fluorite
25. Bauxite
26. Hematite
27. Plagioclase Feldspar (Albite/Anorthite)
28. Chlorite
29. Biotite
30. Apatite
31. Corundum
32. Limonite
33. Cassiterite
34. Orthoclase Feldspar (Microcline)
35. Halite
36. Quartz var. Rock Crystal
2. Rocks

(Igneous)

1. Basalt
2. Gabbro
3. Obsidian
4. Pumice
5. Muscovite Biotite Granite
6. Porphyritic Rhyolite
7. Hornblende Andesite Porphyry
8. Diorite
9. Obsidian with Cristobolite
10. Granodiorite
11. Augite Syenite
12. Peridotite
13. Volcanic Tuff
14. Porphyritic Granite
15. Granite Porphyry
16. Rhyolite Porphyry
17. Andesite
18. Diorite Porphyry

(Sedimentary)

19. Coal-Bituminous
20. Oolitic Limestone
21. Gray Limestone
22. Shale
23. Sandstone
24. Coal-Peat
25. Conglomerate
26. Travertine Limestone
27. Breccia
28. Coquina Limestone
29. Coal-Lignite
30. Banded Sandstone
31. Fossiliferous Shale

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(Metamorphic)

| 32. | Quartzite |
| 33. | Biotite Gneiss |
| 34. | Coal-Anthracite |
| 35. | Granitoid Gneiss |
| 36. | Garnetiferous Mica Schist |
| 37. | Marble-coarse grained |
| 38. | Gray Slate |
| 39. | Chlorite Schist |
| 40. | Marble-fine grained |
| 41. | Graphite Schist |
| 42. | Red Slate |
| 43. | Mica Schist |

**B. Filmstrips from Wards**

1. **Materials of the Earth's Crust** (Set of 6 filmstrips) #71W2000 Color $40.00
   - The minerals
   - Identification of Minerals
   - Igneous Rocks
   - Sedimentary Rocks
   - Metamorphic Rocks

2. **Geomorphology** (set of 6 filmstrips) #71W2100 Color $40.00
   - Weathering and Erosion
   - Streams and Rivers
   - Glaciers
   - Mountain Building
   - Volcanism
   - Lakes and Oceans

3. "**Astronomy: Solar System and Beyond**" (Set of 6 filmstrips) #71W2700 $40.00
   - Astronomical Measurement I
   - Astronomical Measurement II
   - The Sun
   - Planets in Motion
   - Meteors, Comets, and Asteroids
   - The Geography of the Universe

**C. 8mm Film loops from Wards Natural Sci. Establ, Inc.**

1. **Astronomy film loops** (Set of 6) #74W1201T $130.00
   - Moon - motion and phases
   - Planetary motion
   - Earth: Rotation and revolution
   - Seasons
   - Time and dateline
   - Day and night

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2. Crystals - (Set of 3-8mm film loops)
   a. Growth in Solution  #74W2011T  $19.95
   b. Growth from a Melt  #74W2012T  $19.95
   c. Optical Properties  #74W2013T  $19.95

D. Daylight Projectible - 35mm slides from Denoyer-Geppert Audio Visuals Times Mirror
1. Minerals (240 slides in 3 carousels covering 6 topics)
   Carousel 1
   a. Field identification of minerals (slides 1-40)
   b. Laboratory analysis of minerals (slides 41-80)
   Carousel 2
   c. Minerals and Crystals (slides 1-40)
   d. Radioactive Minerals (slides 41-80)
   Carousel 3
   e. Minerals of Economic Importance (slides 1-40)
   f. Optical Properties of Minerals (slides 41-80)
2. Examining the Earth's Crust: A Study of Rocks
   (240 slides in 3 carousels covering 6 topics)
   Carousel 1
   a. Rock identification (slides 1-40)
   b. Igneous Rocks and Vulcanism (slides 41-80)
   Carousel 2
   c. Sedimentary Rocks (slides 1-40)
   d. Metamorphic Rocks (slides 41-80)
   Carousel 3
   e. The rock record (slides 1-40)
   f. Rocks and the Geologic time scale (slides 41-80)
3. 35mm slides from Norton Scientific, P.O. Box 1212
   Reno, Nevada (1971, Cat. 104).
   a. Series A (37 slides) Earth $27.72
   c. Series C (39 slides) Solar System and Physical Nature of Planets 29.25
   d. Series D (15 slides) Sun 11.25
   e. Series E (37 slides) Stars 27.75
   f. Series F (16 slides) Galaxies and Cosmologies 12.00
   g. Series G (35 slides) Constellations 26.25
4. 35mm Slides from Wards Nat. Sci. Estab. (200 individually selected slides) #173W1000 set $200.00
   a. Weathering (Chemical and Mechanical)
   b. Erosional and Depositional Features
   c. Alpine Glaciation
   d. Continental Glaciation
   e. Work of the Wind
   f. Diastrophism
   g. Volcanism
   h. Ind. slides of rock and mineral specimens

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E. Overhead Transparencies from Wards Nat. Sci. Estab.
1. Set Dyna View
   a. Astronomy Set 1 (11) #76W3010 $54.50
   b. Astronomy Set II (10) #76W3020 53.00

F. 16mm Films to be used. U. of Mich. Film rental
   Rental Fee
   1. "The Earth in Evolution" - 11 minutes - color $4.00
   2. "World is Born" - 20 minutes - color 7.00
   3. "Rocks for Beginners" - 16 minutes - color 5.75
   4. "Rocks that form the Earth's Crust" - 16 minutes - color 5.75
   5. "1955 Eruption of Kiluea" - 11 minutes - color 4.00
   6. "Rocks that Originate Underground" - 23 minutes - color 7.50
   7. "Hidden Earth" - 27 minutes - color 8.50
   8. "Mountain Building" - 10 minutes - Black and White 2.25
   9. "Constellations, Guides to the Night Sky" - 11 minutes - Color 4.00
   10. "Astronomer" - 16 minutes - color 5.75
   11. "Nearest Star" - 27 minutes - color 8.50
   12. "Realm of the Galaxies" - 19 minutes - color 7.00
   13. "What are Stars Made Of" - 16 minutes - color 3.25
   14. "Charting the Universe with Optical and Radio Telescopes" - 13 minutes - color 4.50

General Electric Educational Films
Corporations Park, Building 705
Scotia, New York 12302

Purchase Price

15. "Properties of Light" 20 minutes - color $220.00

Shell Film Library
450 N. Meridian St.
Indianapolis, Indiana 46204


G. Globes and Maps
4. Moon Maps - Rand McNally and Co., $2.45, #22-4400
   AMS 3768III Series V762
   Benton Harbor, Mich.
13. Seasonal Star Charts - No. 33W 1460, Wards Natural Science Estab.

H. 35mm slide/sound filmstrips from Educational Materials and Equipment Company, P.O. Box 17, Pelham, N.Y. 10803
   1. Meteorites and the Dynamic Earth - 1974
   2. The Earth's Moon and its Rocks - 1974

I. 35mm filmstrip from Scholarly Audio-Visual, Inc.
   1. C-6436 - The Earth's Atmosphere

J. 35mm slides from Edmund Scientific Co., Edscorp Bldg., Barrington, New Jersey 08007
   1. P 42, 350 - Solar System (20 slides) $6.95
   2. P 42, 351 - Planets from Space (18 slides) $6.95

K. Crystal kit from Edmund Scientific Co.
   1. 70, 336 Crystal Making Kit $19.75

L. Correlated Study Units of 35mm slides from Hubbard Scientific Co., Northbrook, Illinois
   Geology - 1972
   1. VMB-753 Mountain building (20 slides)
   2. VEF-752 Erosional Features (20 slides)
   3. VGU-751 Glaciation (20 slides)
   4. VLI-701 Landforms 1 (20 slides)
   5. VLM-702 Landforms 2 (20 slides)
   Astronomy - 1969
   6. VAG-286-Galaxies, Nebulae, Star Clusters (15 slides)
   7. VAS-287 Solar Phenomena (15 slides)
8. VLS - 296 Space Exploration - The Lunar Surface (20 slides)
9. VAM - 288 Moon, Planets, Comets (20 slides)

M. Astronomical Events Calendar from Optica b/c Company, 4100 McArthur Blvd., Oakland, Calif. 94619
   1. Calendar VAEC-P 200 for $2.00

N. Monthly Sky Charts from Abraham's Planetarium, Michigan State University, East Lansing, Michigan 48824
   1. Sky charts - must specify month desired 50 for $3.75