DOCUMENT RESUME

ED 180 535 JC 800 008

AUTHOR Edwards, Sandra J.

TITLE Science Education in Two-Year Colleges: Earth and Space.

INSTITUTION California Univ., Los Angeles. ERIC Clearinghouse for Junior Coll. Information.; Center for the Study of Community Colleges, Los Angeles, Calif.

SPONS AGENCY National Science Foundation, Washington, D.C.

PUB DATE Jan 80

GRANT NSF-SED-77-18477

NOTE 87p.

EDRS PRICE MF01/PC04 Plus Postage.

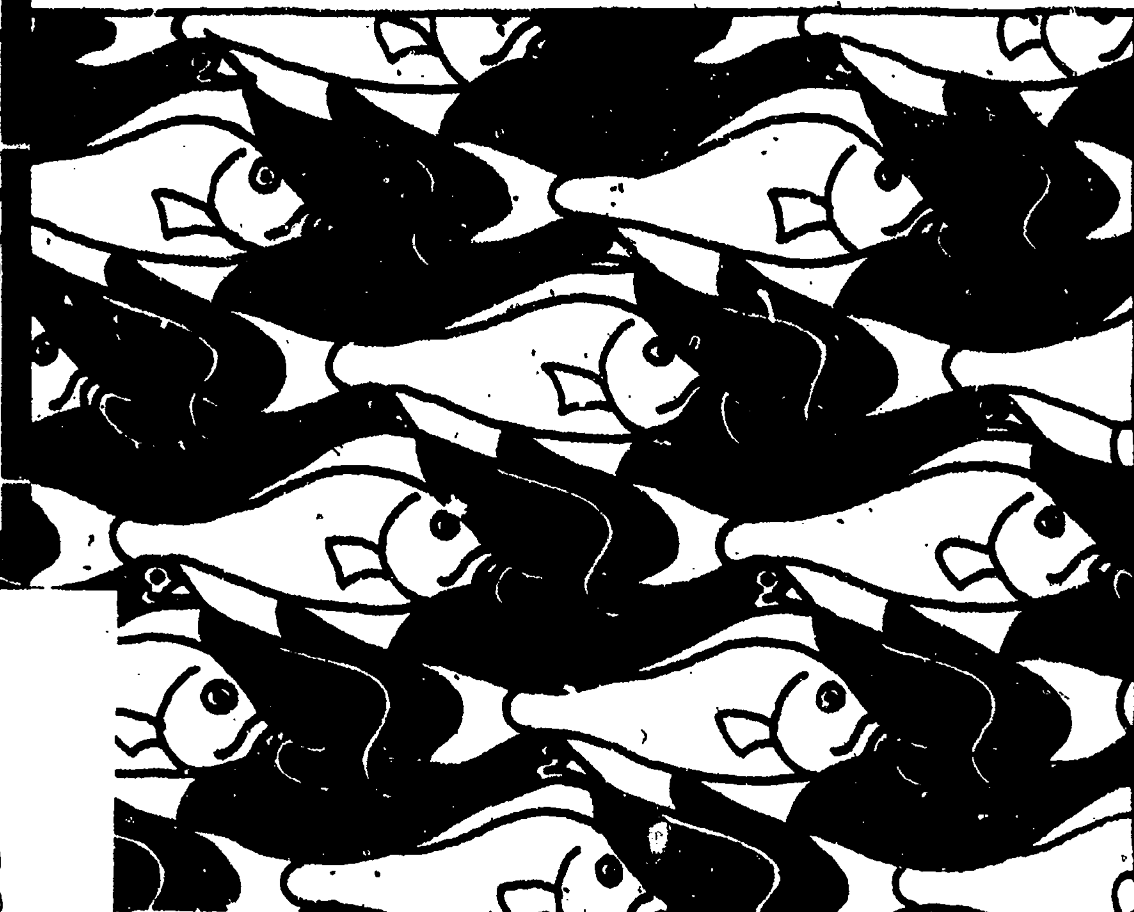
DESCRIPTORS Astronomy; College Credits; Community Colleges; Course Content; Course Objectives; Courses; Curriculum Development; Curriculum Problems; Curriculum Research; *Earth Science; Geography; Geology; Grading; Instructional Materials; Interdisciplinary Approach; *Junior Colleges; Literature Reviews; Meteorology; National Surveys; Oceanology; Program Evaluation; Questionnaires; Remedial Programs; *Science Curriculum; *Science Instruction; Science Teachers; *Space Sciences; Teacher Characteristics; Teaching Methods; Vocational Education

ABSTRACT

This four-part report examines earth and space science education as revealed in the findings of a study, in which a literature review, an analysis of curriculum data, and a survey of science instructors were undertaken to explore science instruction at two-year institutions. Part I discusses the difficulties encountered in developing earth and space science curricula relevant to diverse student needs, and then analyzes the earth and space science offerings listed in 175 college catalogs and class schedules. Part II explores earth and space science instructional techniques, emphasizing individualized instruction in investigative laboratories, and then discusses class size, instructional mode, use of class time, instructional materials, grading practices, and course competencies and goals as revealed in a survey of 46 earth and space science instructors. Part III provides a profile of these instructors and discusses teacher satisfaction with course materials, support services, and working conditions. Part IV presents summary conclusions pointing out an increased awareness of the needs of non-transfer students in earth and space science curriculum planning. The report concludes with a list of recommendations and a lengthy bibliography. (JP)

Science Education in Two-Year Colleges

EARTH AND SPACE



Center for the Study of Community Colleges

and

ERIC® Clearinghouse for Junior Colleges

SCIENCE EDUCATION IN TWO-YEAR COLLEGES:

EARTH AND SPACE

by

Sandra J. Edwards

January 1980

Center for the Study of Community Colleges

and

ERIC Clearinghouse for Junior Colleges
University of California
Los Angeles 90024

The material was prepared with the support of National Science Foundation Grant No. SED 77-18477. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of NSF.

PREFACE

This monograph is one of a series of twelve publications dealing with the sciences in two-year colleges. These pieces are concerned with agriculture, biology, chemistry, earth and space sciences, economics, engineering, integrated social sciences and anthropology, integrated natural sciences, mathematics, physics, psychology, and sociology. Except for the monograph dealing with engineering transfer programs, each was written by staff associates of the Center for the Study of Community Colleges under a grant from the National Science Foundation (#SED 77-18477).

In addition to the primary author of this monograph, several people were involved in its execution. Andrew Hill and William Mooney were instrumental in developing some of the procedures used in gathering the data. Others involved in tabulating information were Miriam Beckwith, Jennifer Clark, William Cohen, Sandra Edwards, Jack Friedlander, and Cindy Issacson.

Field Research Corporation in San Francisco, under the direction of Eleanor Murray, did the computer runs in addition to printing the instructor survey employed in that portion of the project dealing with instructional practices. Bonnie Sanchez of the ERIC Clearinghouse for Junior Colleges and Janice Newmark, Administrative Coordinator of the Center for the Study of Community Colleges, prepared the materials for publication. Carmen Mathenge was responsible for manuscript typing. Jennifer Clark did the final compilation of the various bibliographies for each monograph.

Florence B. Brawer coordinated the writing activities and edited each of the pieces. Arthur M. Cohen was responsible for overseeing the entire project.

In addition to these people who provided so much input to the finalization of this product, we wish to thank David Menke of California State University at Northridge and John Bowen of Cuesta College who reviewed the manuscript and Ray Hannapel and Bill Aldridge of the National Science Foundation, who were project monitors.

Arthur M. Cohen
Project Director

Florence B. Brawer
Publications Coordinator

SCIENCE EDUCATION IN TWO-YEAR COLLEGES: EARTH AND SPACE

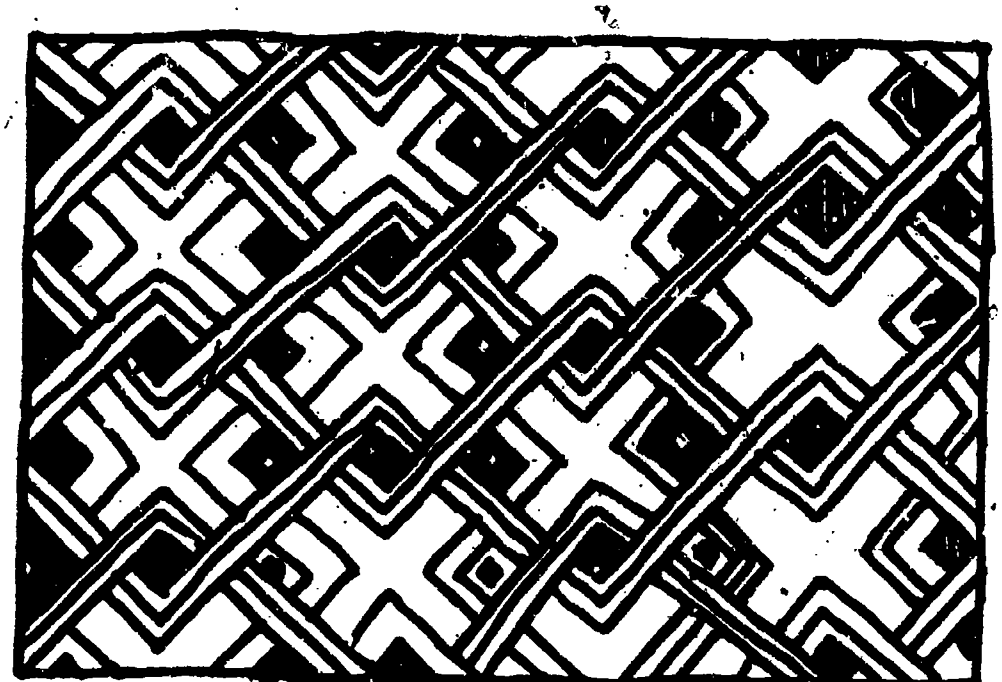
Earth and space science impinge on our daily life. The energy-producing potential of the earth's surface has become the subject of raging national debate by politicians, the oil industry, and the general public. The weather affects our daily activity. Space and ocean exploration continue unceasingly and territorial disputes are as prevalent today as they have been historically. This amount of activity places an important educational responsibility on the earth and space sciences.

Two-year colleges are an important setting for earth and space science education. They enroll one-third of all students in higher education--more than four million students. According to most recent figures, 40 percent of all first-time, full-time students attend two-year colleges. When part-time students and students enrolling in the two-year college concurrently with or subsequent to their enrolling in a senior institution are taken into account, the number of first-year students taking two-year college courses approximates two-thirds of all college freshmen.

In response to its open-door policy, an extremely diverse student population attends the community college. They enroll in a wide range of courses and programs (transfer, occupational, remedial, community service, and terminal degree). This size and diversity have implications for earth and space science education, for structuring the earth and space science curriculum, and for presenting earth science material to students.

As part of a National Science Foundation (NSF) sponsored study of science education in community, junior and technical colleges in the United States, this monograph explores earth and space science education. The study, conducted by the Center for the Study of Community Colleges, was designed to provide a comprehensive picture of science curriculum and in-[illegible] A literature review of the most important reports of two-year colleges' science education was conducted to determine what was already known about curriculum and instruction in the sciences. Curriculum data (e.g., programs, course offerings, and prerequisites) for the 1977-78 academic year were gathered from the catalogues and class schedules of a representative national sample of 175 colleges. A sample of science instructors for the 175 sample colleges were surveyed to determine instructional practices and to obtain some information about the faculty. This information was collected to serve as a basis for investigating developing trends in science education and to document the current college efforts in various fields of study.

The areas within earth and space science which are treated in this monograph are geography, geology, astronomy, oceanography, meteorology, and interdisciplinary earth science. Since more materials were available in geology than in other areas, the literature review is dominated by that field. The Journal of Geological Education provides the most fertile arena for information. Periodically the journal provides a listing of resources and references in the earth sciences (Wall & Wall, 1974, 1975a, 1975b). The Journal of Geography offers geographers examples and suggestions of teaching approaches. Astronomy, however, does not have a single forum for information on astronomy education. Each of the disciplines does have committees and task forces that examine curricular and instructional issues, e.g., the Council on Education in the Geological Sciences sponsored by the American Geological Institute (e.g., Holland, 1971) and the Commission on College Geography sponsored by the Association of American Geographers. The status of earth sciences in a particular state may also occasionally be treated (Baker, 1976; Musa, 1970). In addition, annotated bibliographies have been published (Mayer & Wall, 1972a,b,c).



PART I

EARTH AND SPACE SCIENCE CURRICULUM

Any consideration of curriculum must take into account several features that distinguish the comprehensive community college from four-year institutions. The first characteristic concerns the multiple missions of the two-year college. In addition to programs designed for students transferring to four-year colleges, programs are provided for terminal students interested in general education, for students in occupational or vocational fields, for students requiring remedial work to prepare to enter transfer or occupational programs, and for non-degree students desiring cultural, recreational, or community interest courses.

A second distinctive feature of the community college is the transformation in its student body. For example, the number of students enrolled in occupational programs has increased from 13 percent in 1965 to 50 percent in 1976 (AACJC, 1976) and Lombardi (1978) even notes that "it is not unusual to find colleges, even entire state systems, where occupational enrollments exceed transfer enrollments" (p. 1). The number of students participating in non-credit courses or programs increased over 100 percent in one year (1.5 million in 1975 and 3.2 million in 1976). The fact that in 1976 as many student enrolled in non-credit as credit programs (Lombardi, 1978) provides further evidence of these changes occurring in community college programming. Changes in the composition of the student population itself include increases in the number of part-time students, students over twenty-five, women returning after extended absence, senior citizens, students from minority groups, and academically "underprepared" students (Knoell, 1973). Traditional full-time students entering the community college directly from high school account for only 20 percent of the enrollments.

A third distinctive characteristic of the community college concerns the nontraditional course-taking patterns of its students. The community college curriculum no longer reflects the classical, coherent, integrated, planned programs; students drop in and step out, change majors, and begin programs without completing them (Cohen, 1979).

These characteristics pose dilemma for the earth science curriculum. Who should the curriculum serve? Should separate introductory courses be offered for majors and nonmajors? Should earth science courses be geared toward the transfer institutions or be adjusted for less academically prepared students? The literature begins to indicate how the earth sciences have addressed these questions. The report of the Curriculum Study data, which follows, compares these data with findings reported in the literature.

THE LITERATURE

Geology

While a student at the University of Edinburgh in 1825, Charles Darwin attended a field lecture of Professor Jameson that so bored him he was moved to write, "the sole effect produced on me was the determination never as long as I lived to read a book on geology or in any way study the science." Since then, geology instructors have gone to great lengths to interest and excite their students in the science, and geological educators today are still largely responsible for their students' decisions to continue in the field.

Rhodes (1975) provides a good overview of the factors influencing geological education: changes in employment trends, financial stringency, general college enrollment declines, increased accountability, decline in students' overall high school preparation and grade inflation. In the late 1950s, peak oil reserves caused layoffs of exploration geologists, which was then geology's major source of employment. This can probably be pinpointed as the beginning of the trend to seek jobs in academia, and the expansion of departments at a much greater pace than student need (Tomikel, 1972).

The launching of Sputnik directed governmental attention to science education but funds were channelled into physics, chemistry, and mathematics. A decrease in geology majors and cutbacks in course offerings followed. The Council on Education in the Geological Sciences (CEGS) looked into ways and means to bring about an improvement in undergraduate geological education. This program, conducted by the American Geological Institute, became one of the most important sources of information, evaluation, and the development of educational materials for Earth Science in the 1960s. In addition, the Earth Science Curriculum Project's (ESCP) attempt to create a potential geology major pool among high school students opened up a new area of employment for teachers (Romey, 1970, 1971, 1972) and was partly responsible for a rise in undergraduate geology students in the mid-1960s. In the late 1960s financial stringency forced geology's economic dependence on general studies and departments of education (Tomikel, 1972). The energy crisis along in the 1970's demands an increase in individuals with a sound geology background (Henderson, 1974a).

Within the college departments, other factors influenced the curriculum. A survey of CEGS on vital skills to geologists and their self-rated competence pointed out many areas of strength and weakness in courses and programs (Reeves & Delo, 1970). The trend toward quantification made mathematics skills more important and interdepartmental solutions to problems resulted in interdisciplinary courses and programs. In the late 1960's the social revolution was reflected in a greater flexibility in instruction and experimentation with course scheduling, attracting many students who otherwise would never have attempted a geology class. Changes in departmental emphases in the 1970's were caused by recent advances and societal need for specialists, especially in such areas as water resources, materials research, economic, urban, and environmental geology.

Under the auspices of the Council on Education in the Geological Sciences, Bowen (1972) and Rhodes et al. (1971) each provide perspectives on the development of geological curriculum. In addition, the Earth Science Teacher Preparation Project (1972) describes innovative curriculum developments. Issues discussed include: departmental requirements in courses and credit hours, core program offerings, the role of related sciences (Rhodes et al., 1971), degree of permissable specialization, articulation with four-year transfer institutions (Dennison, 1972), current necessary skills, and anticipated future needs (Reeves & Delo, 1970).

According to Ridky and Stoever (1978), "despite the fact that more than one hundred and fifty million dollars has been spent over the past two decades in federally stimulated science course improvement programs, there continues to be an obvious absence of a definable and well founded model of curriculum development" (p. 67). For which students should classes be designed? Decisions need to be made to decide whether to excite the general humanities student with the philosophical concepts of geological time and the effects of the search for minerals on human history or to provide a rigorous scientific and mathematical base for continuing majors. Further debate centers around whether separate courses should be offered for majors and nonmajors (Hay, 1972).

What does the geology curriculum in the two-year college look like? According to Roth's (1969) survey of 186 two-year colleges, the most common geology courses are physical geology (73%), historical geology (68%), survey of geology (36%) and minerology (19%). Similar figures were reported by Qutub and Brehman (1972) who found that of the 906 two-year colleges responding to their survey most offered physical geology (65%) and historical geology (53%); minerology was offered by 12 percent. Specialized courses in response to current national concerns are also available in the first two years of undergraduate work and serve to attract many students to the departments.

In 1962 less than 10 percent of all colleges offered oceanography, while in 1968 more than a third did. Largely responsible for this were the funds supplied to oceanography by the National Science Foundation in the form of grants. In 1972, 13 percent of two-year colleges offered such a course (Qutub & Brehman, 1972). Decreasing course offerings were mainly in the economic geology sphere, or courses dealing with the search for energy and mineral resources and accompanying techniques (Tomikel, 1972), although Skehan (1973) felt that they will be most important courses in the 1980s and '90s. A decline in courses such as map-reading can be attributed to their incorporation into other classes, mainly in the form of laboratories (Tomikel, 1972).

A survey by Hendrix and Suttner (1978) found that field courses have been essentially the same since 1967, except in terms of costs and enrollment, which were both up sharply. Sylvester's (1977) survey, however, revealed a de-emphasis on field geology and decreasing course offerings. Qutub and Brehman (1972) report that 14 percent of the two-year colleges they surveyed offered field geology. Cameron (1973) felt that since there are very few paleontology majors the course should be designed more for the general public. He found that student enrollments increased 400 percent by changing the course title to "History of Life" and dropping the introductory geology and science requirements, and eliminating the detailed memorization of morphological terms and selected genera. Only 5 percent of the colleges in Qutub and Brehman's (1972) two-year college sample offered paleontology.

In the long-term view, the numbers of necessary courses and credit hours decrease whenever geology is unpopular with students or offers little opportunity in the job market (Tomikel, 1972). At most institutions a year each is required in the cognate sciences of physics, chemistry, and math (Rhodes, 1971). In fact most lower division courses for the major are not geology courses at all but these basic sciences or breadth courses. Transfer students find a particular problem in being out of sequence with the four-year institutions, which often have differing requirements and emphases, some of which their first college cannot even provide.

The introductory course. By far the most important geology class is the introductory course, or the physical/historical sequence. Except in petroleum producing regions, Thornton (1972) reports this type of course often is the only geology offering. Madeley (1978) lists the objectives of the course for the general student as making students better observers of surface processes, having experience of using topography and aerial photographic maps, creating more conducive conditions for the development of mineral and fossil fuel resources, and making a better generation of land builders. There is a trend to constantly reevaluate the scheduling and instructional format of the physical geology course. A major problem is whether to offer the physical course separately from the historical course (Zenger, 1972) or combine them together in a year-long program (Roth, 1969; Rudolpho, 1972). The history referred to in historical courses generally deals with earth processes and life changes through time, but a trend has been noted by Rhodes (1971) to emphasize the historical development of the discipline and the contribution of science to mankind. Historical geology offerings have remained generally unchanged in the last two decades (Tomikel, 1972).

Since most two-year college programs are designed for general education (Roth, 1969) and since 95 to 98 percent of students in introductory geology do not plan on majoring or becoming professional in geology (Keller, 1973), it is difficult to know how rigorous a foundation for future study should be provided for future scientists, or what amount of humanities-oriented or current interest material should be included in the course. Laboratories may become largely irrelevant when the nonmajor type of student is considered (Rhodes, 1971).

A great amount of flexibility in programming is offered to attract students (Romey, 1969), such as one-unit, five-week packages (Rhodes, 1971), minicourses (Fleischer & Wilson, 1975; Schmidt & Carpenter, 1975), student-centered (tutorial) introductory courses (Romey, 1972b), separate classes for nonmajors (Hay, 1972; Keller, 1973), and interdisciplinary programs (Rhodes, 1971). Traditional course material can be topic-centered, such as Cazeau and Storber's (1976) "Great Mysteries of the Earth" or can instruct by involvement in an outside project of real importance in such fields as land use planning (Fetter & Hoffman, 1975). Reports by the creators of these scheduling innovations indicate their success in terms of increased student enrollment.

Geography

Although physical geography often is the only type of geography included in an examination of earth sciences (Qutub & Brehman, 1972; Wall, 1973b), our study includes the entire range of geographical offerings. The most comprehensive study of geography in the two-year college was undertaken by the Panel of Geography in the Two-Year College (1970) sponsored by the Association of American Geographers. The Panel found that the profile of geography at the two-year college is similar to that found in the lower division of the four-year college. A strong emphasis exists on such introductory themes as physical, cultural, world regional, and economic geography.

The Panel conducted its study by surveying 855 two-year college presidents. Seventy-seven percent responded and the Panel suspected that the nonrespondents, which tended to be small and/or church-related colleges with limited programs, did not offer geography. They concluded that 48 percent (407 colleges) offered one or more geography courses in 1968-1969. Geography had the highest level of representation in states where the two-year college is strongest: California, Florida, Illinois. The West/Southwest and Southeast accounted for the most geography courses (61%), while the North Atlantic region offered the fewest.

When they assessed the number of scheduled geography courses, the Panel found that physical, world and regional, cultural, and economic geography accounted for 73 percent of courses taught in the designated order. A study by the Commission on College Geography, 1966-1967 indicated that the courses constituted the same hierarchy in frequency of offerings as the Panel's study. Eighty-two percent of geography enrollments were in these four types of courses.

Two-year college geography curriculum developers face several dilemmas. For example, should themes developed and principles and facts presented in introductory courses provide for the general education of the transfer student, the terminal student, or both? Should the material be oriented to professional needs of students earning baccalaureates rather than toward general education? Should this be accomplished through differing courses or in single courses? The Panel's recommendations begin to tackle these dilemmas. (For an example of how these recommendations have been implemented in one two-year college see McDannold, 1977). The Panel also cites examples of types of course offerings that represent various approaches to meeting the needs of the unique student population. For example, to meet the general education needs of certain terminal schools a "World Patterns" course has been offered for potential air lines employees, and an urban focus to geography was adopted in courses for auto mechanics, architectural drawing, and cosmetology students.

Astronomy

Only a few figures indicate the scope of astronomy in the two-year college. Thornton's (1969, 1972) small, but national, sample indicated that 43 percent of the colleges offered astronomy in 1966 compared to 55 percent in 1972. Qutub and Brehman (1972) found 37 percent of their sample of 906 two-year colleges offered astronomy. The discussions of astronomy, however, are usually not geared to the two-year colleges, specifically as evidenced by the literature review conducted by Wall (1973a).

The National Academy of Science set up the Astronomy Survey Committee in 1969 to develop a ten-year plan for astronomy's future. One important conclusion about the future concerned the expense of astronomy education; the curriculum implication of this expense was that in reality astronomers do not need extensive undergraduate requirements in astronomy (Greenstein, 1973). Thus, as in geology, this conclusion indicates the importance of cognate sciences in an astronomy program.

Studies generally indicate a need for astronomers that is not being filled by educational programs (Astronomy: Too attractive science, 1975; Berendzen, 1970). In 1975 the National Academy of Science made recommendations to combat this situation (Astronomy: Too attractive science, 1975).

The value of planetariums appears central to a discussion of astronomy curriculum (King & Breuder, 1977; Ortell, 1977; Reed, 1970; Roberts, 1970) although Thornton (1972) found that "even colleges with planetariums offer limited transfer courses in astronomy" (p. 232). Astronomy's part in the two-year college curriculum that serves nondegree students who take courses for interest or general education may also be undertaken by adult education programs in planetariums. Downing (1972) conducted a survey of 145 planetariums in the United States and Canada to determine the extent of adult education programs. He found that the presence of adult education directors was important to the existence of programs.

Oceanography

In 1970 a conference on training of marine technicians in the two-year colleges considered all aspects of marine technology program development. Descriptions of 21 programs were included in the conference report (Gille & Pratt, 1971). A detailed examination of marine technology programs in California was undertaken which was presented in terms of its national implications for developing this type of program in 1968 (Chan, 1968). Not only is oceanography part of vocational programs, but it is taught in two-year colleges as part of the transfer curriculum and adult education; the latter includes such areas as sailing, boat building, scuba diving, and marine biology (Philp, 1978). Thirteen percent of the 906 two-year colleges responding to Qutub and Brehman's (1972) survey offer a course in oceanography.

Summary

The overriding concern of the curriculum in earth and space sciences is meeting the needs of the diverse student. In pinpointing the realities of instituting new geology programs, Dennison (1972) describes the danger all the earth and space sciences may confront in developing curriculum: "Almost invariably, rather than reflecting a genuine concern about the educational mix of an idea, faculty discussion of curricula reflect open or thinly veiled concern about senior faculty or teaching assistant jobs, departmental power on campus, or potential enrollments in departments. A very real pressure exacts to increase the popularity of introductory geology even if quality is jeopardized" (p. 4).

METHODOLOGY FOR THE CURRICULUM STUDY*

Sample

The first step in studying the curriculum in two-year colleges was to assemble a representative sample of colleges. The technique used in this study produced a balanced sample of 175 two-year colleges. (See Appendix A for a list of participating colleges by region.) An earlier study conducted for the National Endowment for the Humanities by the Center for the Study of Community Colleges had already assembled a sample of colleges balanced by college control, region, and size. Using this sample as the initial group, the presidents of these colleges were also invited to participate in the National Science Foundation funded study. Acceptances were received from 144 of these colleges.

*For a complete methodology of this study, see Hill and Mooney, 1979 (ED 167 235).

At this point a matrix was drawn with cells representing nine college size categories for each of six regions of the country. Using the 1977 Community, Junior and Technical College Directory (AACJC, 1977), the ideal breakdown for a 175-college sample was calculated. The remaining 31 colleges were selected by arraying all colleges in the underrepresented cells and randomly selecting the possible participants. Table 1 shows how close our sample is to the percentage of the nation's two-year college population. The list of participating colleges is found in Appendix A.

Table 1

Percentage Breakdown of 175-College Sample Compared to National Percentages by Size, Region and Control

	Size by Enrollment								
	1-499	500-999	1,000-1,499	1,500-2,499	2,500-4,999	5,000-7,499	7,500-9,999	10,000-14,999	15,000 plus
National Percentage	15	18	13	17	17	8	5	5	4
Sample	13	16	13	17	19	9	5	6	4

	Region					
	Northeast	Middle States	South	Mid-West	Mountain Plains	West
National Percentage	7	13	32	21	10	17
Sample	6	12	31	22	13	16

	Type of Control	
	Public	Private
National Percentage	84	16
Sample	84	16

Procedure

College catalogs and class schedules for the 1977-1978 academic year were obtained from each of the 175 participating colleges. (A list of participating colleges by region may be found in Appendix A.) The curriculum phase of the project utilized a unique system for analyzing, classifying and reporting the course offerings. The Course Classification System for the Sciences (CCSS)* in Two-Year Colleges was developed specifically for this project to deal with science courses in terms of both the unique features of the two-year colleges and the traditional science disciplines.

The general structure of this system and the procedure for classifying a course are briefly described here as a preface to the detailed description of the categories within earth and space sciences. Based upon the catalog course description, each science course listed in the catalog was placed into one of six major curriculum areas: agriculture, biological sciences, engineering sciences and technologies; mathematics and computer sciences; physical sciences; and social and behavioral sciences. These areas were chosen because they closely reflect the instructional administrative organization of two-year colleges as well as the organization of national and international science agencies, such as the National Science Foundation.

The second level of classification was executed primarily by the major subject field disciplines within the broad area. Courses were included within this classification scheme based on their content and intended audience (e.g., major field, degree objective).

The earth and space science categories within physical sciences are organized as follows:

Geography

- Introductory and General
- World and Regional
- Physical
- Cultural
- Economic and Political
- Environmental
- Cartography, Photogrammetry, and other map-related

*See Hill and Mooney (1979) for the complete CCSS system.

Geology

- Introductory and General
- Regional and Field
- Physical
- Historical
- Mineralogy
- Paleontology
- Environmental
- Geomorphology

Interdisciplinary Earth and Space Science
Astronomy
Meteorology and Climatology
Oceanography and Limnology

Appendix B contains more detailed descriptions of each classification. Independent study courses and courses not carrying college credit were omitted from this study.

After all the science courses were classified, class schedules for the 1977-1978 academic year were inspected, and the number of sections offered (day, evening, and weekend credit courses) for each term were determined. Prerequisite requirements and instructional mode (e.g., lecture, lecture-laboratory) were also ascertained from the catalogs.

RESULTS

Earth and Space Offerings

Earth and space sciences account for five percent of the total science curriculum in the 1977-1978 academic year compared to two percent of science courses reported in the National Science Foundation Study (1969) conducted in the 1966-1967 academic year (Table 2). Geography accounts for 39 percent of the earth and space sciences; geology is the next largest area, comprising 30 percent of these courses. Astronomy has a 14 percent share, followed by interdisciplinary courses, meteorology and climatology, and oceanography and limnology in rank order (see Table 3 and Appendix C for further elaboration).

Eighty-four percent of the colleges surveyed listed at least one earth and space sciences course in their catalog. Seventy-four percent listed geography, which exceeds the 48 percent figure obtained by the

Table 2

Science Instruction in the Two-Year Colleges, 1977-78 Academic Year

Type of Course	Percent of Colleges Listing This Type Course in Catalog (n=175)	Percent of Colleges Listing This Type Course in Class Schedule (n=175)	Percent of Total Science Courses Listed on Schedule (n=15,084)	Percent of Total Science Sections Listed on Schedule: Lecture (n=49,275)	Laboratory (n=16,550)
Agriculture and Natural Resources	67	61	6	3	6
Biology	100	100	13	11	33
Engineering	87	86	20	11	30
Mathematics and Computer Sciences	99	99	22	33	
Chemistry	97	97	8	5	17
Earth and Space	84	79	5	4	4
Physics	91	89	6	3	10
Interdisciplinary Natural Sciences	93	89	4	3	
Anthropology and Interdisciplinary Social Sciences	79	67	3	3	
Psychology	100	99	6	12	
Sociology	100	100	4	8	
Economics	99	99	4	6	

Table 3

Earth and Space Sciences in the Two-Year Colleges, 1977-78 Academic Year*

Type of Course	Percent of Colleges Listing This Type Course in Catalog (n=175)	Percent of Colleges Listing This Type Course in Class Schedule (n=175)	Percent of Total Courses Listed on Schedule (n=733)	Percent of Total Sections Listed on Schedule: Lecture (n=1771)	Percent of Total Sections Listed on Schedule: Laboratory (n=658)	Percent of This Type Course Having a Prerequisite
Geography	74	65	39	39	13	18
Geology	49	43	30	27	60	40
Interdisciplinary Earth & Space Science	25	22	7	9	10	22
Astronomy	45	37	15	14	8	35
Meteorology & Climatology	19	15	5	4	4	21
Oceanography & Limnology	17	11	6	6	6	26

Note: 1. 147 colleges (84% of sample) list one or more earth and space sciences in the college catalog.

2. 138 colleges (79% of sample) list one or more earth and space sciences in schedules of classes.

*For more detailed information on geography and geology see Appendix C.

Panel of Geography in the Two-Year College (1970) for the year 1968-1969.

In geography, while physical and world/regional geography have maintained their position during the last 10 years as most frequently offered, introductory/general and economic/political geography have declined popularity. Cultural geography is more frequently offered, and map-related courses also account for a significant portion of the geography curriculum in two-year colleges (see Table 4).

Physical geology continues to be the most frequently offered geology course, followed by historical geology, introductory/general, and regional/field. Although all the geology areas except historical geology have shown increases over the last 5 to 10 years, introductory/general geology has grown the most. Astronomy shows no change over the last five years, while meteorology and oceanography are offered by fewer colleges (see Table 4). Perhaps the latter two areas have been incorporated into other more general courses. One note of caution: The Center data used for comparison present the number of colleges listing these courses in their class schedules rather than in the college catalog, because the schedules are closer to the actual course offerings. Roth (1969) and Qutub and Brehman (1972) do not indicate whether their data represent actually offered courses or catalog listings. Significantly fewer colleges offered earth and space science in 1977-1978 than listed them in their catalogs (see Table 3).

Prerequisites

Table 3 also indicates the number of prerequisites expected of students enrolling in earth and space science courses. Geology has the most prerequisites; historical geology accounts for many of these requirements (74 percent of this type of course have a prerequisite). Astronomy has the next highest prerequisite requirement (35%). Geography has the fewest with half of cartography, photogrammetry, and other map-related courses (51%) requiring a prerequisite (see Appendix C, Tables C1 and C2, for further breakdown of geology and geography prerequisites).

Table 4

Comparative Studies of Earth Science Offerings

Geography Courses Offered	Association of American Geographers, 1970* (n=636)	Center Study 1977-1978 (n=284)
Introductory & General	12	7
World & Regional	24	25
Physical	24	21
Cultural	12	18
Economic & Political	14	8
Environmental		2
Cartography, Photogrammetry, and other map-related		16

Colleges Offering Geology	Roth, 1969 (n=286)	Qutub & Brehman, 1972 (n=906)	Center Study 1977-1978 (n=76)
Introductory & General	30		43
Regional & Field	25	14	36
Physical	55	65	29
Historical	47	50	71
Minerology	14	13	47
Paleontology	5	5	16
Environmental			7
Geomorphology			9
			4
Astronomy		37	37
Meteorology & Climatology		24	15
Oceanography & Limnology		13	11

*Represents about 65-70% of actual number of courses.

Region, Size, and Control

Table 5 shows the distribution of earth and space science by college region, size, and control (the states included in each region are explicated in Appendix A). Both size and control appear to have a direct relationship with the number of colleges offering a specific earth and space science discipline; larger colleges are more likely to have offerings of every type than smaller colleges. Public colleges offer more courses in all areas. The number of colleges offering geography and geology increases as we move west across the country. The most offerings in all areas are in colleges in the West, except interdisciplinary earth and space sciences which colleges in the Midwest and Northeast are proportionately more likely to offer. The higher number of colleges in the West offering earth science courses may result more from the predominance of large colleges (52%) in that region than from regional differences. (See Appendix C, Tables C3 and C4, for further breakdowns of region, size, and control of geography and geology).

Table 5

Percentage of Two-Year Coll[illegible] Offering Earth and Space Science by Region, Size, and Control*

	N	Region						Size			Control	
		Northeast	Middle States	South	Mid-West	Mountain Plains	West	Small <1499	Medium 1500-7499	Large >7500	Public	Private
Distribution of the Sample	175	11	21	54	38	23	28	72	78	25	147	28
Geography	113	18.2	57.1	57.4	60.5	65.2	89.3	45.8	61.5	76.0	66.7	25.0
Geology	76	27.3	23.8	29.6	34.2	43.5	85.7	23.6	46.2	88.0	49.0	7.1
Astronomy	65	9.1	38.0	18.5	23.7	39.1	78.6	16.7	33.3	80.0	36.7	14.3
Interdisciplinary Earth Sciences	39	27.3	14.3	13.0	44.7	13.0	25.0	18.1	21.8	44.0	26.5	7.1
Meteorology & Climatology	26	--	--	7.4	9.3	8.7	57.1	4.2	14.1	48.0	17.9	--
Oceanography & Limnology	19	9.1	4.8	7.4	3.7	--	57.1	2.8	14.1	40.0	16.3	--

*For more detailed information on grography and geology, see Appendix C.

PART II

INSTRUCTION

THE LITERATURE

While reports of instructional approaches abound, it remains unclear whether any particular teaching methodology is superior to the others. Yet, constant re-evaluation of course content and instructional methodology goes on, perhaps partly stimulated by Rudolpho's (1972) observation that the antagonism felt by students toward science "is a harvest of ill will caused by the unimaginative and lazy teaching of introductory science" (p. 23).

The choice of instructional methodology depends to some extent on the goals and objectives of instruction. In geology, for example, a survey by Tomikel (1972) revealed that the primary goal of undergraduate geological educators was the development of skills for further academic work. Other goals included the training of employable geologists whose expertise would not be so easily outdated. Many educators indicate the importance of teaching the principles of the scientific method of observation and conceptions of how earth processes work than to encourage fact gathering and memorization. The question with regard to instructional techniques that remains overriding is: How can the goals and objectives of earth science education be best achieved, given the unique and diverse students in the two-year college?

One source for the answer to this query is the professional journals and literature. As previously mentioned, the Journal of Geological Education periodically publishes listings of resources and references, which include examples of instructional innovations (e.g., Wall & Wall, 1974, 1975a, 1975b). In addition, the Journal of Geological Education itself reports on instructional experimentation. Likewise, the Journal of Geography documents the use of various instructional approaches. The Panel of Geography on the Two-Year College included appendices with a bibliography of educational media, plans for geography classrooms, and listings of maps and equipment for geography classrooms. The Task Group on Education in Astronomy set up by the American Astronomical Society is a source of information on teaching in astronomy (Hoff & Wenzel, 1973; Vershuur, 1973). The American Journal of Physics devoted its June 1973 issue to astronomy education. The American Biology Teacher provides a source of teaching suggestions on oceanography and marine biology.

One of the most frequently discussed instructional approaches is individualized instruction. The individualized approach (Bybee, 1970) comes in many forms: self-paced learning (Almeida, 1974; Mott, 1978), audiotutorial approach (Brantley, 1974; Fenner, 1970; Mott, 1977), audiotutorial approach with an audiovisual component (Cranson, 1975; Marlow, 1974; Sweet, Bates & Maccini, 1971), or Personalized System of Instruction (PSI) (Biernie[illegible] & Zeilik, 1976; Zeilik, 1974).

Also involved in the individualized approach tradition that includes the programmed instruction of the 1950s and the development of the audiotutorial system in the 1960s, is the minicourse or module approach

(DeAnza, 1974; Fleischer & Wilson, 1975; Postlethwait & Russell, 1971; Romey & Dean, 1971; Schmidt & Carpenter, 1975). Postlethwait (1969) enumerates the advantages of the minicourse to include not only more flexibility for students to meet their needs and instructors to organize their courses, but as an aid to more specific diagnosis of student weaknesses, as portable to allow interchange among schools and as easily updated to accommodate additions to earth and space science knowledge. Yet, a drawback to the individualized approach is that the affective factors of social interaction, which play an important role in education, are neglected (Fenner, 1970). The adequacy of two-year college students' motivation, communication and study skills has also been questioned, since the individualized systems require self-discipline (Davis & Farrand, 1977).

Individualized learning can meet laboratory needs, as well as providing the subject content for a course (Bybee, 1970). Investigative laboratories have been advocated, which relates in part to attempting to stimulate student creativity and critical thinking (Hoff, 1970; Rhodes, 1971; Romey, 1972b) and in part to a concern over the quality of scientific inquiry (Kitts, 1972; Weitz, 1972). In geology, at least, the increase in laboratories has tended to shift course credit values from three to four units (Tomikel, 1972). In astronomy the laboratory tends to be the planetarium and its effectiveness serves as a subject of much discussion (King & Breuder, 1977; Kruglak, 1973; Ortell, 1977; Reed, 1970; Roberts, 1970).

Other approaches to earth sciences involve the use of television (Los Angeles Community College District, 1974) and other audiovisual aids (Moche, 1973). Interdisciplinary courses may combine the earth sciences to focus on a particular topic, such as the environment (Mork & Alexander, 1975; Stannard, 1973) or may combine an earth science discipline with another physical science (Brantley, 1974), the sciences and social sciences (Butzek & Carr, 1976; DeAnza, 1974), or the humanities (Geography and English, 1975; Moran, 1976).

Students

In 1972 Romey wrote "if science was made completely elective, I firmly believe that enrollments in all introductory science classes would fall drastically" (p. 44, 1972b). In geology, however, the majority of students are taking courses for the nonprofessional, liberal arts, or general interest reasons (Bowen, 1972; Henderson, 1974a; Roth, 1969). A shortage exists in the number of geology majors; in 1967-1968 Roth found that only 1.8 percent of two-year college students who were enrolled in geology courses were geology majors.

Enrollment in geology in the two-year colleges tripled between 1961-1962 (Roth, 1969) to over 26,000 students. Tomikel (1972) partly attributes this to the employment market; Pauel, Larson and VandenAvond (1969) predicted future increases resulting from more high school exposure to the earth sciences as a result of the secondary school earth science curriculum project (ESCP). With the energy crisis, this situation is heightened (Henderson, 1974a). The number of women in geosciences appears to be on the increase; Henderson (1974b) reported a 28-percent increase between 1973 and 1974 compared to a 3-percent increase for men. Over half the women who major in geology find employment in educational institutions, mostly as high school earth sciences teachers, while men are more likely to work in industry (Women Geoscientists Committee, 1976). Minorities are even scarcer; Henderson (1974a) reported that 180 departments out of more than 400 did not have even one minority geology major. Minorities accounted for 3.2 percent of all undergraduate majors in the field.

The Panel on Geography in the Two-Year College (1970) reports a jump in enrollment from 48,000 students in 1966-1967 to 62,761 students in 1968-1969 with the addition of 175 new public two-year colleges. Brook (1977) reports on the concern about student attitudes towards geography. Enrollment figures were not found for the other earth and space science disciplines.

METHODOLOGY FOR THE INSTRUCTOR SURVEY

The same random sample of 175 colleges employed in the Curriculum Study was used in the study assessing instructional practices in the sciences (Appendix A). Each college president who agreed to participate in the study was also asked to name a contact person at the school, who was given the title "on-campus facilitator." All communication and correspondence between the Center for the Study of Community Colleges and the sample schools was conducted through the 175 on-campus facilitators. Once the college catalogs were obtained from each school, Center staff read each course description in the catalog and put courses in the appropriate category according to the Course Classification System for the Sciences.*

The next step in the process involved counting the science course offerings in the Fall, 1977, day and evening schedules of classes. Each college's schedule was reviewed one section at a time. Using the course list developed from the college catalog, research assistants could determine which courses were properly categorized as science courses for inclusion in the study. Each science course section was then underlined. A list was developed for each college showing the courses that were offered and the number of sections of that course listed in the schedule of classes.

Individual class sections were selected by drawing every thirteenth section in each of the six major science areas. After randomly selecting the first college, the system was automatically self-randomizing.

Every thirteenth section pulled off the schedule was recorded on a checklist for the facilitator at each school. This checklist included the name of the instructor listed as teaching the section, the course title, section number, and the days and time the class met. A copy of this checklist was kept at the Center to tally the surveys as they were received.

A survey form (Appendix D) for each instructor was mailed to the campus facilitator, together with instructions for completing the questionnaire and a return envelope addressed to the same facilitator. The return envelope had the instructor's name listed as the return address and was clearly marked "Confidential.". This enabled the on-campus

*See Hill and Mooney (1979) for a complete report c⁻ the system.

facilitator to keep an exact record of who had responded without opening the envelope. This technique guarantees confidentiality to the respondent while also enabling the facilitator to follow up on the retrieval of surveys from nonrespondents.

Questionnaires were mailed to 1,683 instructors. Because the surveys were mailed out between February 20 and April 10, 1978 (after completion of the Fall term), 114 surveys were not deliverable due to faculty dismissal, retirement, death, etc. An additional 77 section had been cancelled. Of the 1,492 deliverable surveys, 1,275 were returned, a response rate of 85.5 percent. Questionnaires were retrieved from 100 percent of the faculty samples at nearly 69 percent of the colleges. Table 6 shows the relationship between completed surveys in the different disciplines and the total number of class sections offered in these disciplines in the 1977-1978 academic year.

RESULTS

Of the 1,275 responses, 46 were from earth and space science instructors. The relationship between the distribution of earth and space science sections in academic year 1977-1978 and the responses of earth and space science instructors to our class section survey is shown in Table 7.

Students

Earth and space sciences courses tend to be slightly larger than the average science courses. According to the instructor survey an average of 33.5 students initially enrolled and 25.9 (77.3% of students who enrolled) completed the earth and space science sections surveyed in Fall 1977, compared to 31.8 average initial enrollment and 25.3 completion (78.9% of students who enrolled) in the total sample. The other physical sciences, chemistry and physics averaged 27.1 initial enrollments but had a higher completion rate of 22.4 students or 82.7 percent.

The literature indicates a concern to promote women in the earth and space sciences. Our enrollment and course completion data indicate that

Table 6

Percentage of Instructor Surveys Returned from Each Discipline Compared to the Percentage of Courses Offered in that Discipline

Discipline	Returns on the Class Section Survey--% of Total (n=1,275)	77-78 Academic Year--% of total lecture sections (n=49,275)
Agriculture	3.0	3.0
Biology	12.5	10.5
Chemistry	6.4	5.1
Earth/Space	3.6	3.6
Engineering	11.3	11.0
Interdisciplinary Natural Science	2.3	2.7
Interdisciplinary Social Science & Anthropology	2.4	3.0
Math/Computer Science	30.8	32.5
Physics	3.5	3.2
Psychology	11.2	11.6
Sociology	7.4	8.1
Economics	5.4	5.6

Table 7

Percentage of Instructor Surveys Returned from Earth and Space Science Instructors Compared to the Percentage of Courses Offered in that Discipline

	Percentage of Lecture Sections 1977-78 Academic Year	Percentage of Responses to Instructor Survey
Geography	39.5	37.7
Geology	26.7	32.6
Other Earth & Space Science (Incl. astronomy, oceanography, meteorology	33.8	30.4

in comparison to the other physical sciences, chemistry and physics, earth and space sciences enrolls more women (14.8 per section compared to 10.6), and that women have a slightly higher completion rate in the earth sciences (77% compared to 76.4% in the physical sciences). Earth and space sciences have a lower number of women enrolling in their sections compared to the sciences in general (41.2% of the enrolled earth and space students are women compared to 49.8% of the total). In addition, fewer women complete earth and space science courses than the average science classes (77% compared to 83%). Participation of men (59%) in earth and space sciences courses and completion rates (69%) are higher than average science courses where 50 percent of the students enrolled are men and 64 percent complete the section, but not as high as found in the other physical sciences where 61 percent of the students are men and 85 percent of the men complete the section.

Virtually all the earth science instructors in our sample (93.5%) indicated that their course was "parallel to a lower division college level course at a transfer institution." Over three-fourths (76.1%) of the respondents designed their courses for transfer nonscience majors. Both of these findings were higher than responses by the instructors in any other science field. The earth sciences courses also tend more frequently than other sciences to be designed for general education for nontransfer, nonoccupational students (30.4%) and for further education or personal upgrading of adult students (60.9%). A disproportionately low number of earth science instructors designate their courses for occupational students.

Instructional Mode

Data obtained from the catalogs and schedules (see Table 8) indicate that instructional modes in geology are distributed fairly evenly over lecture only courses (27%), lecture-laboratory courses (31%), and courses that include a field component (36%). Lecture courses (79%) predominate in geography; lecture-laboratory courses (15%) represent the only other sizeable type of instructional approach. Map-reading courses tend to

Table 8

Percentage of Courses of This Type by Instructional Mode (by percentage)

	Lecture Only	Lecture-Lab	Lecture-Field	Lecture-Lab-Field	Lab Only	Other
Astronomy	55	13	15	2	16	
Geography	79	15	4		1	1
Introductory & General	100					
World & Regional	93	1	5			3
Physical	77	15	3		2	2
Cultural	94	2	2			
Economic & Political	100					
Environmental	57		28			14
Cartography, Photogrammetry, & other map-related	29	65	4		2	
Geology	27	31	11	25	6	
Introductory & General	38	31	10	13	8	
Regional & Field	33	20	30	17		
Physical	19	36	4	30	9	
Historical	16	35	5	37	7	
Minerology	22	44	17	17		
Paleontology	38		25	38		
Environmental	62		12	12	12	
Geomorphology	33	33	33			
Interdisciplinary Earth & Space Sciences	56	31		4	2	6
Meteorology & Climatology	68	15	3	6	6	3
Oceanography & Limnology	45	33	12	7	2	

include the heaviest preponderance of laboratories, which corroborates a trend noted by Rhodes (1971). More than half (55%) of the astronomy courses are lecture courses with the other courses nearly equally distributed between lecture-laboratory, laboratory-only, and courses with a field component. Meteorology and climatology are generally taught through lecture sections (68%) with some courses including laboratory (15%) and some including field components (9%). Oceanography and limnology courses are mostly lecture (45%), a third include laboratory, and nearly one-fifth (19%) have field work associated with them. The analysis did not indicate any significant use of individualized approach, but this may have just not been listed in the catalogs and schedules.

Use of Class Time

The Instructor Survey asked the faculty about the percent of class time they devoted to certain activities (see Table 9). Since lecture sections were sampled, it is not surprising to find that virtually all instructors devoted time to their own lectures. For the earth and space scientists, lectures account for approximately half of class time (53.8%) which is comparable to the social sciences (51.3%), but more than the physical sciences (39%). The other most frequently reported class activities were class discussion (84.4%) and quizzes and examinations (89.1%). The use of media is similar to that of the social scientists, while the use of quizzes and examinations more closely resembles the testing practices of the chemists and physicists. The earth science instructors are more likely to include field trips among their class activities (32.6%) than their physical science (2.4%) and social science colleagues (8.6%). Thirty percent or more of the earth science instructors indicate use of laboratory activity. Although this activity is heavily used by the physical scientists, generally the earth science instructors are slightly more likely to devote class time to laboratory practical examinations and quizzes.

Table 9

Allocation of Class Time Reported by Science Instructors (by percent)

	Earth & Space Sciences (n=46)	Other Physical Sciences (n=127)	Social Sciences (n=337)
Devoted Class Time to:			
Their own lectures	97.8	96.1	99.7
Guest lectures	17.4	6.3	25.5
Student verbal presentation	10.9	7.5	39.8
Class discussion	84.8	79.5	94.7
Viewing/listening to media			
Simulation and gaming	4.3	2.4	18.7
Quizzes and examinations			
Field trips	32.6	2.4	8.6
Lecture/demonstration experiments	30.4	59.8	19.9
Laboratory experiments by students	37.0	82.7	7.4
Laboratory practical examinations and quizzes	28.3	22.8	3.3

Use of Instructional Materials

Over 70 percent of earth and space science respondents used the following instructional materials: films (82.6%); slides (82.6%); maps, charts, illustrations, and displays (86.9%); three-dimensional models (78.3%); overhead projected transparencies (71.7%); and scientific instruments (71.7%). Their use of slides exceeds their social science and physical science colleagues, although the agriculture and biology instructors also indicate heavy use of them.

Nearly two-thirds of the earth science (65.8%) instructors develop their own slides. Except for the use of films, earth scientists resemble their physical science colleagues more closely in the use of these teaching aids. In addition, nearly one-third of the earth science respondents indicated use of single concept film loops (32.6%), filmstrips (30.4%), and audiotapes/slide/film combinations (32.6%).

The Instructor Survey queried science faculty concerning their use of reading materials. Earth and space science was no exception among science disciplines in its heavy reliance on textbooks; virtually all earth and space science instructors used them (97.8%). The average number of pages required (362) falls between the reading loads required by the social scientists (388) and the physical scientists (283). More than three-quarters of the earth science instructors (78.3%), compared to 62 percent of the other science faculty, use syllabi and handout materials. More than half of this instructor group (58.7%) use laboratory materials and workbooks, which falls short of the biology (80%) and physical science (81.9%) requirements of these materials. Approximately one-quarter of the earth and space science instructors included collections of readings (23.9%) and journals and/or magazines (26.1%) in course readings.

Grading Practices

Eighty-seven percent of the faculty utilized ABCDF grading, and ten percent employed ABCD/no credit; pass/fail grading schemes were not employed. The physical scientists (82.7%) seem to adhere more strictly to the traditional ABCDF system than the social scientists (73.9%).

The earth scientists rely heavily on quick score objective tests for grade determinations; 82.6 percent of the sample count this type of test for more than 25 percent of student grades, and earth sciences was the only discipline where all instructors used objective tests for student evaluation. Essay examinations are used by over half of these instructors (60.8%), and more than one-third count participation in class discussion (37%), papers written outside of class (39.1%), homework assignments (41.3%), and laboratory reports (34.8%) in grade determinations. Fewer earth science instructors include regular class attendance as an evaluation criterion than any other faculty group.

Earth science instructors make more use of multiple response as a testing technique than any other science discipline (89.1%). Around 40 percent of the instructors frequently use completion (39.1%) and essay questions (41.3%).

Desired Student Competencies

It is important to understand what student abilities earth science instructors evaluate. The emphasis is not on mastery of a skill as it is for chemistry and mathematics instructors; only 21.7 percent of the earth science instructors consider this "very important" compared to 70.7 percent of the chemists and 87.5 percent of the mathematicians. Acquaintance with concepts of the discipline is considered very important by 87 percent of the earth science faculty. The recall of specific information and understanding the significance of certain works is important to virtually all the earth science respondents; it is very important to over half (52.2%), as is the ability of students to synthesize course contents.

Course Goals

The Instructor Survey attempted to ascertain instructors' course goals by asking them to select qualities they want their students to achieve. Table 10 compares the responses of earth science instructors with their physical science and social science colleagues. The lack of

Table 10

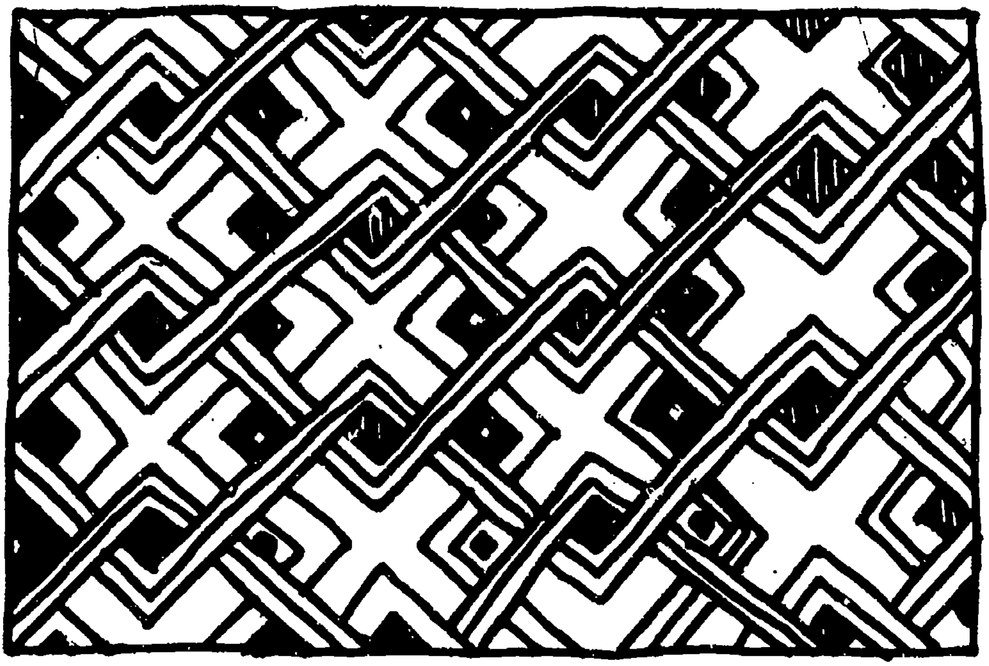
Instructors' Course Goals

Response to Question: Of the Four Qualities Listed Below, Which One Did You Most Want Your Students to Achieve?	Earth & Space Science (n=46)	Other Physical Science (n=127)	Social Science (n-337)
First set of four			
Understand interrelationships between science and society	65.2	20.0	43.6
Understand scientific research and literature	--	--	3.9
Apply principles to solve qualitative and quantitative problems	28.3	67.5	48.4
Proficiency in lab methods and techniques	6.5	9.0	1.2
Second set of four			
Relate knowledge to real world systems	58.7	31.5	1.8
Understand principles, concepts of the discipline	30.4	59.1	25.2
Appreciate/understand scientific method	6.5	4.7	<1>
Gain hands-on field experience in practice	4.3	3.9	1.5
Third set of four			
Learn to use tools of research in science	6.5	10.2	3.6
Gain qualities of mind useful in further education	19.4	29.9	22.6
Understand self	32.3	<1>	29.7
Develop the ability to think critically	38.7	22.3	43.3

emphasis on appreciating/understanding scientific method among those surveyed in the Center's study contradicts Holland's (1971) conclusion. Earth science instructors were the highest of any group of science faculty in desiring that students "gain qualities of mind useful in further education" and among the highest in desiring students to "understand the interrelation between science and society" (58.7%). This finding supports the results of Tomikel's survey (1972). His finding indicating the emphasis on employability relates to the number of earth science instructors who express concern in students developing the ability to relate knowledge to real world systems (58.7%)

Out-of-Class Activities

Compared to other science areas, earth science instructors responded that out-of-class activities were strongly encouraged. Not many required attendance at these activities, but they were recommended. Among the activities suggested were on-campus films (50%), television programs (58.7%), outside lectures (54.3%), field trips (56.5%), and museums/exhibits (47.8%).



PART III

THE FACULTY

LITERATURE

Since earth and space science courses seldom warrant a full-time instructor in any area of specialization, it is not surprising that Roth (1969) found 60 percent of two-year colleges have a one-instructor department. The result is that the earth science instructor often teaches a subject without the benefit of adequate professional training equivalent to a major or minor (Panel on Geography in the Two-Year College, 1970; Roth, 1969). The Panel found that for 40 percent of instructors geography constituted 40 percent of their teaching load; for 29 percent, more than 80 percent of their load. Mayer (1974), reviewing requirements in earth sciences teacher preparation programs found little progress in adoption of national recommendations for an interdisciplinary approach. Murton (1968) characterized the two-year college geography instructor as a "crusading loner" and often a "pedagogical greenhorn."

In 1969 one-tenth of the geography instructors were part-time (Panel on Geography, 1970); in Roth's (1969) study 18 percent of the schools had only a part-time instructor in geology. Women face obstacles. As mentioned previously, over half the women geologists find employment in education, mostly at the high school level (Women Geoscientists Committee, 1976) and women astronomers also encounter obstacles in their profession (Women astronomers face obstacles in profession, 1975).

Most geology and geography instructors have master's degrees (Panel on Geography, 1970; Qutub & Brehman, 1972; Roth, 1969). One-third of the geography instructors have done graduate work, although less than one-tenth have a doctorate. Forty percent of the instructors report a major in geography, one-tenth a minor (Panel on Geography, 1970). Around 20 percent of two-year college geology instructors have earned a doctorate (Qutub & Brehman, 1972; Roth, 1969). These researchers also found a large percentage of the instructors did not major in geology, Roth (1969) reporting one-third and Qutub and Brehman (1972), 60 percent. Roth (1969) also noted that 40 percent of the geology instructors earned their degrees more than 10 years ago.

These data suggest the need for continual instructor updating, a concern also expressed by the geographers (Panel on Geography, 1970). Roth (1969) found further that only 28 percent of the instructors had attended a National Science Foundation Institute, and that their last attendance averaged five and a half years ago. Another problem faculty face, as documented in geology by Roth (1969), is inadequate teaching materials, and lecture and laboratory facilities.

METHOD

The center's Instructor Survey yielded 1,275 responses from science instructors (see Appendix C for a copy of this survey). Forty-six earth and space science instructors responded to questions concerning faculty demographics, activities, and working conditions. The development and distribution of the Instructor Survey are described in the preceding section.

RESULTS

Degree Attainment

Nearly 20 percent of the earth and space scientists (19.6%) hold doctorates. Although doctorate attainment among this faculty group is higher than the average (14.5%), it does not reach the number of earned doctorates among the other physical science instructors (33.9%). Most of the remaining earth and space science instructors have master's degrees (71.7%), a figure which is similar to both Roth's (1969) and Gutub and Brehman's (1972) findings (see Table 11).

Table 11

Percentage of Instructions at Each Level of Degree Attainment, Employment Status, and Teaching Experience

	Earth and Space Science (n=46)	Physical Science (n=127)	Social Science (n=337)
Degree Attainment			
Bachelor's	4.3	1.6	4.2
Master's	71.7	64.6	77.8
Doctorate	19.6	33.8	16.9
Employment Status			
Full-time	82.6	78.1	73.3
Part-time	8.7	10.2	16.0
Chairperson/Administrator	2.2	4.7	3.9
Teaching Experience			
0-2 Years	10.9	12.6	12.5
3-10 Years	46.6	51.2	60.2
Over 10 Years	41.3	45.7	20.8

Employment Status and Teaching Experience

Earth and space science has the highest percentage of full-time faculty (82.6%) of any other science discipline, although over three-quarters of all the physical science instructors are full-time. The earth and space science instructors tend to be among the most experienced instructors; 41.3 percent have taught at the two-year college over 10 years (Table 11).

Course Materials

Virtually all the earth science instructors had at least some say in the choice of course materials, and 82 percent had total say. Yet, these instructors were a bit more dissatisfied than their science colleagues with textbooks (40% expressed desire to change), laboratory materials and workbooks (37%), reading collections (27%), and syllabi and handout materials (20%). Faculty satisfaction levels have decreased since the National Science Foundation (NSF) study (1969), conducted in 1966-1967, which indicated that 83 percent of the earth science instructors were satisfied with the textbooks used; 56 percent of the earth and space science respondents to our Instructor Survey reported satisfaction with textbooks. The dissatisfaction does not appear attributable to faculty control over choice of materials. Textbooks may be unsuitable for a number of reasons: reading levels of students are declining and this may affect their ability to use existing textbooks, the expectations of the textbook material in terms of student science preparation may no longer match the student heterogeneity, and the increase and changes in earth and space science knowledge may render the textbooks obsolete.

Use of Support Services

The availability of support services can be an important factor in providing an effective course. Our data indicate that earth science instructors generally have more clerical assistance, test scoring facilities, and library/bibliographic assistance available to them than other physical science instructions. Two-thirds of the earth science faculty have media production assistance, and over half have tutoring services available. Although this assistance is not fully utilized, earth science instructors do tend to make more use of available resources, particularly clerical help and tutors (see Table 12). Further investigation would be necessary to determine if the available assistance was appropriate for faculty needs. The discrepancy between availability of services and their use indicates that the services provided may not have been entirely suitable.

Working Conditions

Faculty were asked to indicate what it would take to improve their courses. Table 13 lists responses to this question. Over half the earth science instructors indicated their desire for students better able to handle course material (56.5%) and availability of more media (56.5%). These responses provide further evidence of the need to realign earth and space science instruction to meet diverse student abilities, learning styles, and motivations.

Corroborating Roth's (1969) conclusion of 10 years ago that more continuing education is needed, almost half of our sample indicated that instructor release time would contribute to course improvement. More than one-fourth of the earth science respondents also desired professional development opportunities for instructors (30.4%), better laboratory facilities (30.4%), and more clerical assistance (28.3%). Earth scientists are not as concerned about smaller classes as their social science colleagues nor about stricter prerequisites as their physical science colleagues

4,

Table 12

Availability and Use of Support Services

Support Service	Assistance Available			Assistance Utilized		
	Earth & Space Science (n=46)	Physical Sciences (n=127)	Social Science (n=337)	Earth & Space Science (n=40)	Physical Sciences (n=127)	Social Sciences (n=337)
Clerical help	87.0	83.0	87	80	69	76
Test scoring facilities	76.1	54	56	39	18	34
Tutors	54	55	40	35	24	25
Readers	11	14	20	2	9	5
Paraprofessionals	20	22	6	11	6	7
Media production	67	70	73	48	36	50
Library/bibliographic assistance	76	67	75	50	36	50
Laboratory assistants	35	53	87	33	48	6

Table 13

Percentage of Responses to Question: Although This Course May Be Very Effective, What Would Make it Better? (Check All That Apply)

Item (in rank order)	Earth & Space Science (n=46)	Physical Sciences (n=127)	Social Sciences (n=337)
Students better prepared to handle course material	56.5	40.2	53.1
Availability of more media	56.5	23.6	45.7
Instructor release time	48.0	44.9	40.9
Professional development opportunities for instructors	30.4	24.4	31.2
Better laboratory facilities	30.4	39.4	12.2*
More clerical assistance	28.3	18.9	19.3
Smaller classes	19.6	20.5	38.0
More interaction with colleagues/ administrators	19.6	18.1	22.6
More reader/paraprofessional aides	13.0	20.5	15.7
Stricter prerequisites	10.9	44.9	22.8

Less than 10% responded to the following items:

- less interference from colleagues/administrators
- large classes
- more freedom to choose materials
- changed course description
- different goals and objectives

*Mostly attributable to psychology.

49

PART IV

SUMMARY AND RECOMMENDATIONS

This section includes a summary of the most important findings concerning earth and space sciences from the Center for the Study of Community Colleges' study of curriculum and instruction. Several recommendations are also made that bear on the implications of the data.

The Center for the Study of Community Colleges undertook its study of science education in the two-year colleges to document the current curricular structure and instructional practices in the various fields of study. Data were gathered in the 1977-1978 academic year, including a classification scheme and information on frequency of course offerings, course prerequisites, and instructional modes. In addition, an Instructor Survey provided data on the types of instructional methodology and materials utilized by two-year college earth and space science instructors.

Earth and space sciences, composed of geology, geography, astronomy, oceanography, and meteorology, constitute five percent of the two-year college curriculum. Although this is a small percentage, it reflects an increase from the two percent found by the National Science Foundation (1969) ten years ago. Clearly, the issues under the purview of the earth and space sciences, such as those concerning energy resources, establish its importance beyond its size as an academic discipline.

The Earth and Space Science Curriculum

An important question emerges in considering the state of the earth science curriculum in the two-year college. Do the earth and space sciences respond to the unique characteristics of the community college? At the outset of this monograph the distinctive features of the two-year college were identified as the diversity of college missions, the heterogeneity of the student population, and the nontraditional student course-taking patterns. Although parallels between two-year college earth science programs and four-year college programs indicate that earth sciences still cling to their transfer function, the data do indicate an increasing awareness of the two-year college's uniqueness.

Geography comprises nearly 40 percent of the two-year college earth science curriculum, geology 30 percent, astronomy 15 percent, followed by interdisciplinary earth sciences and space sciences (7%), oceanography (6%), and geology. The growth in introductory/general geology, however, indicates that geologists may be directing more attention towards the nonmajor student who does not require the degree of specialization needed by the transfer major student. In geography the domination of physical and world/regional geography continues with an increase in cultural geography. Map-reading courses represent a significant share of the geography curriculum, perhaps indicating student needs for more technical skills. Astronomy is offered by 37 percent of the colleges surveyed, a percentage that appears relatively stable. The decreases in colleges offering meteorology and oceanography may indicate that these subject areas do not warrant detailed treatment, but may better be offered as part of more general courses.

The large colleges, colleges in the West, and public colleges tend to offer the greatest variety of earth science courses. The dominant college characteristic to consider is probably college size, since over half of the colleges in the West are large, and few of the private colleges are large; thus, it is only when a college has a large pool of students that more specialized courses are justified. Otherwise presentation of the most central earth science themes may suffice for the two-year college population.

Approximately 30 percent of earth and space science courses require a prerequisite; of these geology has the highest proportion. The question geology must ask is whether prerequisites are warranted or whether they unnecessarily perpetuate the student image of geology as a difficult subject (Wilson, 1969). Prerequisites may also be weighed against the faculty concern expressed in the instructor survey over students' ability to handle course materials.

Instructional Practices

Data derived from the Instructor Survey support the emphasis on transfer curriculum. While 94 percent of the surveyed instructors report their course parallels "a lower-division college level course at a transfer institution," over three-quarters of the instructors designed their courses for transfer nonscience majors. Yet, significant percentages of these respondents also viewed their courses as designed for nontransfer, nonoccupational students and for students who seek further educational or personal upgrading. The emphasis on the nonscience major indicates the extent to which a single course adequately serves diverse students.

Enrolling an average of 33.5 students per section, earth science classes tend to be larger than other science sections. Student completion rates are comparable to other sciences, although fewer women tend to enroll and complete earth sciences than average (the sample included social sciences and biology, which enroll more women than the physical sciences).

Data on the instructional mode of the courses, obtained in the Curriculum Study, suggest that although lecture courses predominate, the laboratory plays an important role in earth sciences. Laboratory sections account for only four percent of total science laboratories, but they are included in nearly one-quarter (22%) of the earth science classes. Laboratories are used in all the various disciplines considered, although in geography they are mostly confined to map-related courses. Field experiences are often included in geology (25%) and to some extent in astronomy (15%) and oceanography and limnology (12%).

Other-than-lecture class time is devoted primarily to class discussion (85% of the respondents), viewing media (80%), and quizzes and examinations (89%). As already indicated, field trips (33%) are more likely to be included in earth science courses than in social or physical science courses. Of the media presented by this faculty group, 83 percent use slides most heavily and nearly two-thirds make their own slides. Earth science faculty also report frequent use of films (83%), maps, charts, illustrations, and displays (87%), three-dimensional models (78%), overhead projector transparencies (72%), scientific instruments (72%). Earth science instructors rely heavily on textbooks (98%) and syllabi/handouts (78%) for reading material. This variety of instructional material represents an effort to impart information which may appeal to varied student learning approaches.

Earth and space scientists in the two-year college rely on the more traditional grading practice of ABCDF (87%), with a few using ABCD/no credit (10%) rather than pass/fail grading schemes. Objective tests provide much of the basis for grade determination; 83 percent use this evaluation method for more than 25 percent of the course grade. Earth science instructors use multiple response questions more than faculty in any other science discipline. In assessing student competencies, "acquaintance with concepts of the discipline" (87%), "understanding the significance of certain works" (67%), and "synthesizing course content" (52%) are viewed as very important, although the recall of specific information was also considered very important by over half the respondents. The data did not indicate the precise balance between conceptual and specific knowledge that the instructors wanted to transmit to their students.

The instructor goals reflect a general education focus. Over half were concerned that their students achieve "qualities of mind useful for further education," an understanding of "the interrelation between science and society," and the ability to "relate scientific knowledge to real world systems." Goals involving gaining more technical expertise were not as often selected as important. In line with the general education, real world focus earth science instructors recommend a variety of out-of-class activities, films, television programs, lectures, and field trips.

Earth Science Faculty

In addition to the items dealing with instructional practices, questions in the Instructor Survey allow us to derive a profile of two-year college earth science instructors. This faculty includes a relatively high percentage of individuals with doctorates (20%), who are mostly full-time (83%), and among the most experienced two-year college teachers (41% have taught for over 10 years). They are slightly more dissatisfied with textbooks and other reading material than their science colleagues, although virtually all of them had at least some say in the selection of the materials. Most of these instructors have support services available to them, including clerical services, media assistance, test scorers, and library and bibliographic assistance; yet, these services are not maximally utilized, indicating they may not be totally adequate.

Earth science instructors rank the need for students better prepared to handle course material and the availability of more media first (56.5%) as most important in course improvement. This is followed by instructor release time (48%), professional development opportunities for instructors (30.4%), and better laboratory facilities (30.4%). Combined with the faculty dissatisfaction with reading materials and support services, these items seem to indicate ways of more effectively dealing with diverse student abilities, learning styles, and motivations. The Center study indicates the attempts to cope with the multiple missions of the two-year college in course design. When this task is combined with the scientists' need to continually update their knowledge, the two-year college earth and space science instructor is faced with a formidable challenge.

Recommendations

In light of the findings of the Center's study the following recommendations are made or reiterated for college administrators, curriculum planners, counselors, researchers and policymakers to support the faculty course developer in addressing two-year college students' needs for earth and space science education.

1. Types of students who enroll in earth sciences should be identified and courses designed concomitant with their aspirations and needs.

2. Further research on instructional materials suitable to different learning approaches and to students with academically deficient skills is needed.

3. Replication of transfer courses, which tend to be technical, theoretical, and somewhat abstract, should be supplanted by more nontechnical, applied, and relevant courses for students not majoring in an earth or space science discipline, such as interdisciplinary courses.

4. Textbook publishers need to produce materials consistent with student objectives and competencies.

5. Earth and space science themes can be included in non-earth science courses in the form of modules or short courses.

6. Noncredit courses can serve as a vehicle to present earth and space [illegible] of community interest (noncredit courses were

not considered in our study but must be considered in light of the growth of this area in the community college, see Copeland, 1975).

7. The factors that contribute to faculty meeting the needs and objectives of two-year college students include a combination of relevant preservice pedagogical training; professional development opportunities, and faculty initiative. The college administration can encourage the latter two items through offering faculty fellowships, instructional development grants, summer pay, release time, or sabbatical time.

8. The professional development of faculty should be promoted to keep them current about new developments in the field of biology. Disciplinary associations can provide information, planning programs, and inform instructors about special events, new teaching methodologies, and training opportunities. A two-year college forum may be needed, but, meanwhile, other publications can continue to provide faculty with current information, e.g., the Journal of Geological Education, the Journal of Geography, and the Journal of College Science Teaching.

Recommendations such as those listed here are often ignored because of fiscal constraints. Yet, the urgency of issues addressed by the earth and space sciences demands creative attempts to improve its offerings. Studies, such as the one reported here, need to be replicated to keep earth science practitioners aware of the salient issues that need in-depth treatment. The Center's study can be judged successful if it stimulates new efforts by the earth and space scientists to address the unique and challenging demands of the two-year college.

REFERENCES

Almeida, S. P. Self-paced astronomy. Science Education, 1974, 58(1), 23-28.

American Association of Community and Junior Colleges. Fact sheets on two-year colleges. Washington, D.C.: American Association of Community and Junior Colleges, 1976.

American Association of Community and Junior Colleges. 1977 community, junior and technical college directory. Washington, D.C.: American Association of Community and Junior Colleges, 1977.

Astronomy: Too attractive science. Science News, 1975, 107(13), 206-207.

Baker, V. R. The status of earth science education in Arkansas (Doctoral dissertation, University of Arkansas, 1967). Dissertation Abstracts International, 1967, 28, 137A. (University Microfilms No. 67-8704)

Berendzen, R. E. On the career development of astronomers in the United States. Bulletin American Astronomical Association, 1970, 2, 262-266.

Bieniek, R. J., & Zeilik, M. Follow-up study of the PSI astronomy course. American Journal of Physics, 1976, 44, 695-595.

Bowen, J. E., et al. Introductory geology: Aspects and options. Washington, D.C.: American Geological Institute, 1972.

Brantley, W. T. A comparison of the audio-tutorial with the lecture-demonstration method for producing student achievement in college level physical science survey classes covering physics and astronomy (Doctoral dissertation, University of Southern Mississippi, 1974). Dissertation Abstracts International, 1974, 35, 6526A. (University Microfilms No. 75-09576)

Brook, D. L. Students' attitudes toward geography. Journal of Social Studies Research, 1977, 1, 60-69.

Butzek, J. C., & Carr, G. Interdisciplinary education in a cluster college. Morton Grove, Illinois: Oakton Community College, 1976. (ED 128 064)*

Bybee, R. W. The effectiveness of an individualized approach to a general education earth science laboratory. Science Education, 1970, 54, 157-161.

Cameron, B. Paleontology for both geology and liberal arts majors. Journal of Geological Education, 1973, 21, 56-61.

---

*A number in parentheses, preceded by "ED," refers to an Educational Resources Information Center (ERIC) document available from the ERIC Document Reproduction Service, Box 190, Arlington, Virginia 22210, or viewed in any library that has the ERIC collection.

Cazeau, C. J., & Storber, G. Great mysteries of the earth: A new geology course. Journal of Geological Education, 1976, 24, 102-103.

Chan, G. L. The education and training of marine technicians. Washington, D.C.: American Association of Junior Colleges, 1968. (ED 025 238)

Cohen, A. M. Issues in curriculum formation. New Directions for Community Colleges, 1979, 7(1, No. 25), 101-111.

Copeland, P. H. Geology in continuing education at the community college level (Doctoral dissertation, Arizona State University, 1975). Dissertation Abstracts International, 1975, 36, 2571A. (University Microfilms No. 75-25,370)

Cranson, K. R. An openended audio-visual-tutorial earth science course. School Science and Mathematics, 1975, 75(5), 445-449.

Davis, R. M., & Farrand, E. A. A modified system of individualized instruction in biology: Rethinking individualized instruction at the community college level. Journal of College Science Teaching, 1977, 6, 152-153.

DeAnza College. DeAnza Summer College By the Sea. Evaluation report, 1974. Cupertino, Calif.: DeAnza College, 1974. (ED 100 469)

Dennison, J. M. Financial survival in curricular design and introductory course options. In John E. Bowen et al., Introductory biology: Aspects and options. Washington, D.C.: American Geological Institute, 1972.

Downing, G. L. A normative survey of planetarium directors in the United States and Canada to determine current practices in adult education and opinions regarding selected adult learning principles (Doctoral dissertation, University of Wyoming, 1972). Dissertation Abstracts International, 1972, 33, 134-A. (University Microfilms No. 72-13,020)

Earth Science Teacher Preparation Project. The cutting edge . . . or how to innovate and survive. Washington, D.C. American Geological Institute, 1972.

Fenner, P. (Ed.). Audiotutorial instruction: A strategy for teaching introductory college geology. Washington, D.C. Council on Education in the Geological Sciences, 1970.

Fetter, C. W., & Hoffman, J. I. Land use planning experiment for introductory earth science courses. Journal of Geological Education, 1975, 23, 23-34.

Fleisher, P. J., & Wilson, P. C. Minicourse program at SUCO: A liberal arts earth science supplement. Journal of Geological Education, 1975, 24, 463-468.

Geography and English: An interdisciplinary approach to the city. Journal of Geography, 1975, 74, 463-468.

Gillie, A. C., & Pratt, A. L. Marine technology programs: Where are we and where are we going? Washington, D.C.: American Association of Junior Colleges, 1971. (ED 062 111)

Greenstein, J. L. The future of astronomy. Journal of College Science Teaching, 1973, 3(2), 102-106.

Hay, E. A. The introductory course in geology: How many? In J. E. Bowen et al. Introductory geology: Aspects and options. Washington, D.C.: American Geological Institute, 1972.

Henderson, B. C. Student enrollment rises somewhat and recruiting intensifies. Geotunes, 1974, 19(11), 20-21. (a)

Henderson, B. C. Women and other minorities counted. Geotunes, 1974, 19(12), 21-23. (b)

Hendrix, T. E., & Suttner, L. J. An assessment of field courses in geology. Journal of Geological Education, 1978, 26, 160-164.

Hill, A., & Mooney, W. Methodologies employed in a study of science instructional programs in two-year colleges. Los Angeles: Center for the Study of Community Colleges, 1979. (ED 167 235)

Hoff, D. B. A comparison of a directed laboratory versus an inquiry laboratory versus a non-laboratory approach to general education college astronomy (Doctoral dissertation, University of Iowa, 1970). Dissertation Abstracts International, 1970, 31, 2755A. (University Microfilms No. 70-23,889)

Hoff, D., & Wenzel, D. G. Astronomy education. American Journal of Physics, 1973, 41, 578-580.

Holland, F. D., Jr. Report on the Council on Education in the Geological Sciences. Journal of College Science Teaching, 1971, 1(2), 45-47.

Keller, W. D. Teaching geology one to non-science majors in college. Journal of Geological Education, 1973, 21, 52-55.

King, M., & Breuder, R. L. Brevard Community College: Instructional innovation for the space age. Community and Junior College, 1977, 45, 7-9.

Kitts, D. B. The philosophical foundations of the investigative approach. In J. F. Bowen et al., Introductory geology: Aspects and options. Washington, D.C.: American Geological Institute, 1972.

Knoell, D. (Ed.). Understanding diverse students. New Directions for Community Colleges, 1973, 1(3, No. 3, whole issue).

Kruglak, H. Laboratory activities for introductory astronomy. Journal of College Science Teaching, 1973, 3(2), 117-121.

Lombardi, J. Resurgence of occupational education. Topical paper no. 65. Los Angeles: ERIC Clearinghouse for Junior Colleges, 1978. (ED 154 872)

Los Angeles Community College District. Instructional television progress report 1971-1974. Los Angeles: Los Angeles Community College District, Division of Educational Planning and Development, 1974. (ED 112 966)

Madeley, H. M. In defense of physical-historical geology course sequences. Journal of Geological Education, 1978, 26, 92-93.

Marlow, L. D. The development and assessment of an audio-tutorial laboratory program serving college-level introductory earth science (Doctoral dissertation, Southern Illinois University, 1973). Dissertation Abstracts International, 1974, 34, 5593A. (University Microfilms No. 74-06226)

Mayer, V. J. Requirements in earth science teacher preparation programs: 1965-1974. Science Education, 1976, 60, 223-234.

Mayer, V. J., & Wall, C. A. A bibliography of research literature in earth science education. Columbus, Ohio: The Ohio State University, 1972. (a)

Mayer, V. J., & Wall, C. A. A bibliography of dissertations and theses in earth science education. Columbus, Ohio: The Ohio State University, 1972. (b)

Mayer, V. J., & Wall, C. A. Research in earth science education: An annotated bibliography. Columbus, Ohio. ERIC Center for Science, Mathematics, and Environmental Education, 1972. (c)

McDannold, T. A. The policy recommendations of the Association of American Geographers as reflected in the Ventura County Community College. Ed.D. Practicum, Nova University, 1977. (ED 148 432)

Moche, D. L. Audiovisual aids for astronomy and space physics at an urban college. Physics Teacher, 1973, 11, 409-413.

Moran, J. M. Climate and history - an alternative science distribution course. Journal of College Science Teaching, 1976, 6, 33-34.

Mork, J. J., & Alexander, C. S. Interaction between man and environment. An experimental college course. Journal of Geography, 1975, 74(4), 212-222.

Mott, C. J. A decade of experimentation with the audiotutorial system. Paper presented at the Annual Conference of the International Congress for Individualized Instruction, November, 1977. (ED 154 803)

Mott, C. J. Achievement of women in a self-paced earth science course. Community College Frontiers, 1978, 6(2), 4-5.

Murton, C. S., Jr. The preparation of junior and community college geography instructors. Journal of Geography, 1968, 67, 156-160.

Musa, Y. The status of earth science in Illinois. Journal of Geological Education, 1970, 18, 163-165.

National Science Foundation. Junior college teachers of science, engineering, and technology, 1967. Washington, D.C.: Government Printing Office, 1969. (ED 028 768)

Ortell, E. D. The value of the planetarium as an instructional device. Unpublished doctoral dissertation, Nova University, 1977. (ED 152 370)

Panel of Geography in the Two-Year Colleges. Geography in the Two-Year Colleges. Washington, D.C.: Association of American Geographers, 1970.

Pauel, R. A., Larson, A. C., & VanderAvond, R. Predicting the effect of ESCP on introductory college geology courses. Journal of Geological Education, 1969, 17, 47-53.

Philp, M. J. Learning on Big Bay. Community and Junior College Journal, 1978, 48(6), 30-33.

Postlethwait, S. N. Time for minicourses? CUEB News, 1969, 5, 4-6.

Postlethwait, S. N., & Russell, J. D. Minicourses--the style of the future? In J. G. Creager & D. L. Murray (Eds.), The use of modules in college biology teaching. Washington, D.C.: The Commission on Undergraduate Education in the Biological Sciences, 1971.

Qutub, M., & Brehman, T. R. Junior college geology. Geotunes, 1972, 17, 23.

Reed, G. F. Is the planetarium a more effective teaching device than the combination of the classroom chalkboard and celestial globe? School Science and Mathematics, 1970, 70, 487-492.

Reeves, R., & Delo, D. M. (Eds.). Requirements in the field of geology. Washington, D.C.: American Geological Institute, 1970.

Rhodes, F. H. T., et al. Undergraduate geology: A strategy for design of curricula. Washington, D.C.: Council on Education in the Geological Sciences, American Geological Institute, 1971.

Rhodes, F. H. T. Geological education: Future trends and prospects. Journal of Geological Education, 1975, 23, 150-154.

Ridky, R. W., & Stoever, E. C., Jr. A modern curriculum in historical perspective. Journal of Geological Education, 1978, 26, 67-68.

Roberts, D. Education under the stars. Junior College Journal, 1970, 40 21.

Romey, W. D. The need for flexibility in introductory geology. Journal of Geological Education, 1969, 17, 193-195.

Romey, W. D. ESCP: A project in transition. The American Biology Teacher, 1970, 32, 343-347.

Romey, W. D. The earth science educational program. Journal of Geological Education, 1971, 19, 119-123.

Romey, W. D. Operational humanism: The earth science teacher preparation project. Journal of College Science Teaching, 1972, 1(4), 38-40.

Romey, W. D. Student centered introductory geology. In J. E. Bowen et al., Introductory geology: Aspects and options. Washington, D.C.: American Geological Institute, 1972. (b)

Romey, W. D., & Dean, W. E. Minicourses: A vehicle for introducing flexibility into large science classes. Journal of Geological Education, 1971, 19, 14-20.

Roth, E. S. Geology in the junior colleges (Doctoral dissertation, University of Southern California, 1969). Dissertation Abstracts International, 1969, 30, 501A. (University Microfilms No. 69-13,076)

Roth, E. S. Junior colleges. Geotunes, 1969, 14, 17-18.

Rudolpho, K. S. Physical content of the introductory course must be determined by our teaching goals. In J. E. Bowen et al., Introductory geology: Aspects and options. Washington, D.C.: American Geological Institute, 1972.

Schmidt, G. L., & Carpenter, J. R. Alternative models for large group introductory earth science courses: Minicourse model. Journal of Geological Education, 1975, 23, 155-159.

Skehan, J. W. The role of geological education in creating the new American of the year 2000 A.D. Presidential address, National Association of Geology Teachers. Journal of Geological Education, 1973, 21, 3-7.

Stannard, K. M. An interdisciplinary approach to environmental learning. Journal of College Science Teaching, 1973, 3, 139-141.

Sweet, W. C., Bates, R. L., & Maccini, J. A. An audiovisual tutorial laboratory. Journal of Geological Education, 1971, 19, 107-111.

Sylvester, A. U.C. Santa Barbara's why course in field geology. Journal of Geological Education, 1977, 25, 54-57.

Thornton, J. W., Jr. The community junior college (2nd ed.). New York: John Wiley & Sons, Inc., 1966.

Thornton, J. W., Jr. The community junior college (3rd ed New York: John Wiley & Sons, Inc., 1972.

Tomikel, J. Trends in American geological education during the critical years: 1954-1969. Pittsburgh: Allegheny Press, 1972.

Verschuur, G. L. Astronomy education and the TGEA. Journal of College Science Teaching, 1973, 3, 116.

Wall, C. A. A review of research related to astronomy education. School Science and Mathematics, 1973, 73, 653-669. (a)

Wall, C. A. Recent trends in earth science education. Contemporary Education, 1973, 44, 325-330. (b)

Wall, C., & Wall, J. Resources and references in earth sciences. Journal of Geological Education, 1974, 22, 32-24.

Wall, C., & Wall, J. Resources and references in earth sciences. Journal of Geological Education, 1975, 23, 9-11. (a)

Wall, C., & Wall, J. Resources and references in earth sciences. Journal of Geological Education, 1975, 23, 172-175. (b)

Weitz, J. L. ESCP and introductory geology in colleges and universities. In J. E. Bowen et al., Introductory geology: Aspects and options. Washington, D.C.: American Geological Institute, 1972.

Wilson, J. T. Some aspects of the current revolution in earth sciences. Journal of Geological Education, 1969, 17, 145-150.

Women astronomers face obstacles in profession. Physics Today, 1975, 28, 119.

Women Geoscientists Committee. Career choices for women - the geosciences. Journal of Geological Education, 1976, 24(3), 74-77.

Zeilik, M. A PSI astronomy course. American Journal of Physics, 1974, 42(12), 1095-1100.

Zenger, D. H. Considerations of content and approach in teaching historical geology. In J. E. Bowen et al., Introductory geology: Aspects and options. Washington, D.C.: American Geological Institute, 1972.

APPENDIX A

Region 1 NORTHEAST

Connecticut

Greater Hartford
Mitchell
Quinebaug

Massachusetts

Bay Path
Bunker Hill
Mt. Wachusett

Maine

University of Maine/
Augusta

New Hampshire

New Hampshire Tech.
White Pines

New York

Cayuga County
Genesee
Hudson Valley
North Country

Vermont

Champlain
Vermont Col. of
Norwich U.

Region 2 MIDDLE STATES

Delaware

Delaware Tech. & C.C./
Terry Campus
Goldey Beacom

Maryland

Dundalk
Hagerstown
Harford
Howard
Villa Julie

New Jersey

Atlantic
Middlesex County

Pennsylvania

Allegheny County/Boyce Campus
Delaware County
Harcum
Keystone
Northampton County
Northeastern Christian

West Virginia

West Virginia Northern
Potomac State

Region 3 SOUTH

Alabama

James Faulkner State
John C. Calhoun State
Lurleen B. Wallace State
Northwest Alabama State

Arkansas

Central Baptist
Mississippi County
Westark

Florida

Brevard
Edison
Florida
Palm Beach
Seminole
Valencia

Georgia

Atlanta
Bainbridge
Clayton
Floyd
Georgia Military
Middle Georgia
South Georgia

Kentucky

Southeast

Mississippi

Itawamba
Mary Holmes
Mississippi Gulf Coast/
Jefferson Davis Campus
Pearl River
Southwest Mississippi
Wood

North Carolina

Chowan College
Coastal Carolina
Edgecombe Tech.
Halifax City Tech.
Lenoir
Richmond Tech.
Roanoke-Chowan Tech.
Wake Tech.

South Carolina

Greenville Tech.
University of South Carolina/
Lancaster

Tennessee

Jackson State
Martin
Morristown
Shelby State

Texas

Angelina
Lamar University/Orange Branch
San Antonio
Vernon Regional
Weatherford

Virginia

Central Virginia
Northern Va./Alexandria
New River
Southern Seminary
Tidewater
Thomas Nelson
Wytheville

Region 4 MIDWEST

Illinois

Central YMCA
Danville
Highland
Kishwaukee
Lincoln Land
Oakton
Waubonsee
William Rainey Harper

Iowa

Clinton
Hawkeye Institute of Technology
Indian Hills
Iowa Lakes
Marshalltown
Southeastern

Michigan

Bay de Noc
Delta
Kalamazoo Valley
Kirtland
Monroe County
Oakland
Suomi

Minnesota

Austin
North Hennepin
Northland
University of Minnesota Tech.
Willmar

Missouri

St. Paul's
Three Rivers

Nebraska

Metropolitan Tech.
Platte Tech.

Ohio

Edison State
Loraine County
Northwest Tech.
Shawnee State
Sinclair
University of Toledo
  Comm. and Tech.

Wisconsin

District One Tech.
Lakeshore Tech.
Milwaukee Area Tech.
University Center System/
  Sheboygan
Western Wisconsin Tech.

Region 5 MOUNTAIN PLAIN

Colorado

Arapahoe
Community College of Denver
  Auraria Campus
Morgan
Northeastern

Kansas

Barton County
Central
Coffeyville
Hesston
St. John's

Montana

Miles

North Dakota

North Dakota St. Sch.
  of Science

Oklahoma

Connors State
Hillsdale Free Will Baptist
Northern Oklahoma
South Oklahoma City
St. Gregory's

South Dakota

Presentation

Utah

College of Eastern Utah
Utah Tech.

Wyoming

Central Wyoming

Region 6 WEST

Alaska

Ketchikan

Arizona

Cochise
Pima

California

American River
Butte
Citrus
College of San Mateo
College of the Desert
College of the Sequoias
Fresno City College
Hartnell
Lassen
Los Angeles Pierce
Mendocino
Merced
Mt. San Jacinto
Saddleback
San Bernardino Valley
San Diego Mesa
Santa Rosa

Nevada

Clark County

Oregon

Chemeketa
Mt. Hood
Umpqua

Washington

Green River
Lower Columbia
Peninsula
South Seattle

APPENDIX B

GEOGRAPHY

Includes courses and programs dealing with the study of the surface of the earth; its division into continents and countries; and the climate, plants, animals--including humans, natural resources, inhabitants, and industries of the various divisions. Categories include physical; cultural, economic, and environmental geography as well as regional geography on any scale, local to world. Also includes all courses in the curriculum such as cartography, photogrammetry, topographic mapping, and noncelestial navigation which consider the preparation or interpretation of maps or aerial photographs.

- Introductory and General Geography
- World and Regional Geography
- Physical Geography
- Cultural Geography
- Economic and Political Geography
- Environmental Geography
- Cartography, Photogrammetry, and other Map-Related Courses
- Other Geography Courses

INTRODUCTORY AND GENERAL GEOGRAPHY

The study of geography as a field combining significant ideas from physical, cultural, and economic geography. Includes both introductory courses designed for general students and principles courses, which integrate topics from the various subdisciplines of geography for students majoring in a social or earth science or closely related field.

WORLD AND REGIONAL GEOGRAPHY

The study of various regions including the geographical environment, human activities, land use patterns, resource appraisal and problems of physical, cultural, political and economic differences. Includes courses that study the whole world, a major region of the world, the United States, a region of the U.S., a state, a local region, and the national parks. Courses are designed for students majoring in a social science, earth science, or regional studies program, or students who have a special interest in the region.

PHYSICAL GEOGRAPHY

The study of the physical features of the earth, including earth-sun relations; maps; elements and controls of climate; landforms, erosion, and deposition; water resources; vegetation associations; and soil types. Most courses are designed for majors in an earth science or social science; however, many such courses are used by others to satisfy a general education requirement.

CULTURAL GEOGRAPHY

The study of the cultural elements of the earth including population distribution, settlement types and patterns, land and resource utilization, transportation and commerce. Major subgroups are cultural and human geography but historical and population geography are also included. Most courses are designed for majors in a social science or an earth science or to satisfy a general education requirement.

ECONOMIC AND POLITICAL GEOGRAPHY

The study of the principal world economic activities from a geographical viewpoint, including the national and international utilization of natural resources, manufacturing, trade, and transportation and related cultural and natural factors. Also includes the political view of geography. Most courses are designed for majors in a social science or business related field.

ENVIRONMENTAL GEOGRAPHY

Study of the patterns and forms of mankind's changing use of and adjustments to the earth's environments. Also includes urban and rural geography: the study of the sociological, psychological, and economic forces at work in urban or rural places from a spatial, geographic perspective.

CARTOGRAPHY, PHOTOGRAMMETRY AND OTHER MAP-RELATED COURSES

The study and utilization of maps and charts including the theory and fundamental techniques of compiling, delineating, and reproducing cartographic components, considering layout, design and symbolization; and cartographic drafting and lettering techniques using a variety of media and materials. Includes photogrammetry, the process of making maps or scale drawings by aerial or other photography, and topographic mapping, the art of graphically representing on a map the exact physical configuration of a place or region. Also includes the interpretation of maps, aerial photos, topographic maps and similar materials and the use of maps in navigation. Includes introductory courses in these fields and specialized courses for environmental science, forestry, civil engineering, military science and related technology students.

OTHER GEOGRAPHY COURSES

Includes courses not easily placed above, such as travel geography courses designed primarily for travel industry students, place name geography, and geographical analysis.

GEOLOGY

Includes courses and programs dealing with the history of earth and its life, especially as recorded in rocks, and encompassing the structure, composition, origin, distribution and modification of materials upon and within the earth. Also includes the application of chemical, physical, mathematical and engineering principles to the exploration for and extraction of economically important minerals from the earth. Classification into the categories is based on whether the course is general in nature, regional or environmental in approach, physical or historical in emphasis, or is primarily concerned with a specific subdiscipline of geology such as mineralogy, paleontology, or geomorphology.

- Introductory and General Geology
- Regional and Field Geology
- Physical Geology
- Historical Geology
- Mineralogy
- Paleontology
- Environmental Geology
- Geomorphology
- Other Geology Courses

INTRODUCTORY AND GENERAL GEOLOGY

The study of geology as a field combining significant ideas from physical and historical geology such as an introduction to the materials, structures and processes (e.g., vulcanism, earthquakes, erosion) at work on and within the earth as indicated by the rock and fossil record. Includes introductory courses designed for general or technology students as well as the principles courses, which integrate topics from the various subdisciplines of geology.

REGIONAL AND FIELD GEOLOGY

The study of the physical and historical geology of a given geographical (e.g. California) or geological region (e.g. the Great Basin Province) including the geomorphology and geological record. Includes some locally oriented courses and others dealing with national parks as well as field geology courses. Courses are generally designed for students with a specific interest in the subject or region, rather than to satisfy the science requirement for general education or meet a specific requirement for a science or technology major.

PHYSICAL GEOLOGY

The study of materials and structures of the earth, rocks and their mineral composition; agents of erosion (rivers, winds, glaciers); and forces of change (volcanoes, earthquakes). May include experience with minerals, rocks, earth structures and topographic map interpretation. Most courses are designed for majors in geology or related fields; however, many such courses are used by other students to satisfy a general education requirement. Includes physically oriented courses designed for engineering, forestry, and technology students.

HISTORICAL GEOLOGY

The study of the geologic history of the earth and its inhabitants as indicated by the rock and fossil record. May include experience with fossil life, stratigraphy and sedimentation. Most courses are designed for majors in geology or related fields; however, some such courses are used by other students to satisfy a general education requirement.

MINERALOGY

The study of inorganic substances (e.g. ores) and some of organic origin (e.g. coal and petroleum) occurring naturally in the earth, including their physical properties (color, hardness, crystalline structure, etc.) and their chemical composition. May include experience in location and identification or ore minerals and gemstones. Includes courses designed for science and specific technology majors as well as those designed for students with an avocational type interest in rocks and minerals. Science and technology courses in this category often have some combination of chemistry, physics and geology prerequisites whereas the interest-centered courses do not.

PALEONTOLOGY

The study of the prehistoric forms of life through the study of plant and animal fossils including the morphologic, systematic, and ecological aspects of invertebrate fossils and the uses of fossils in stratigraphic work.

ENVIRONMENTAL GEOLOGY

The study of the interrelationships between geologic processes, earth materials and man including such topics as geologic hazards (landslides, mudflows, earthquakes, etc.), environmental impact of mineral extraction, mineral resources, and geologic problems related to massive urbanization.

GEOMORPHOLOGY

The examination of world land-forms and an analysis of their origins and nature, with emphasis on the processes relating to their development and on their environmental implications.

OTHER GEOLOGY COURSES

Includes courses not easily placed above, such as geophysics.

OTHER EARTH AND SPACE SCIENCES

Includes courses and programs concerned with a descriptive study of the heavenly bodies, the atmosphere of the earth and the oceans and other natural bodies of water as well as interdisciplinary studies involving any combination of the disciplines of astronomy, geography, geology, meteorology, and oceanography. Also includes courses which emphasize the application of chemistry, physics, and mathematics to an understanding of the heavenly bodies, the atmosphere and the oceans and technology courses closely related to those sciences. Categories include astronomy, meteorology and climatology, oceanography and limnology, plus an interdisciplinary earth-space science grouping.

Interdisciplinary Earth and Space Science
Astronomy
Meteorology and Climatology
Oceanography and Limnology

INTERDISCIPLINARY EARTH AND SPACE SCIENCE

The interdisciplinary study of materials, energy and resources in the areas of geology (the solid earth and its interior), meteorology and climatology (the atmosphere), oceanography and limnology (the hydrosphere), geography (the environment of the earth in space and time) and astronomy (the solar system and other heavenly bodies). Primarily includes introductory courses for nonscience majors with a wide variety of combinations of the above disciplines found in the courses.

ASTRONOMY

The study of the heavenly bodies (fixed stars, satellites, planets and comets), their nature, distribution, magnitudes, motions, distances, periods of revolutions, ellipses, composition, etc. Includes both the descriptive type introductory courses for nonscience majors and courses concerned with the application of the principles of physics, chemistry and mathematics to the study of the heavenly bodies. Separate observation and instrumentation courses and celestial navigation courses are included, as are cosmology and extraterrestial life courses. These courses are intended primarily for nonscience majors and students with strong interests in these areas but are not part of an astronomy major.

METEOROLOGY AND CLIMATOLOGY

The study of the earth's atmospheric phenomena, involving the analysis of weather variations and the regional distributions of climates over the surface of the earth. Includes primarily introductory courses for nonscience majors although some specialized aviation weather courses are included.

OCEANOGRAPHY AND LIMNOLOGY

The study of the oceans (oceanography) and bodies of fresh water (limnology) including the chemical and physical properties and processes of seawater and fresh water bodies and the water masses, circulation and measurement techniques. Includes both the descriptive type introductory courses for nonscience majors and courses concerned with the application of the principles of physics, chemistry and mathematics to the study of these bodies of water. Separate field and instrumentation courses and marine technology courses are included. Although some courses include selected biological topics, courses that are primarily marine biology are placed in the 28 series. These courses generally lack prerequisites unless they emphasize the application of scientific principles, field measurement and evaluation, or marine technology.

APPENDIX C

Table C1

Geography in the Two-Year Colleges, 1977-78 Academic Year

Type of Course	Percent of Colleges Listing This Type Course in Catalog (n=175)	Percent of Colleges Listing This Type Course in Class Schedule (n=175)	Percent of Total Geography Courses Listed on Schedule (n=284)	Percent of Total Geography Sections Listed on Schedule: Lecture (n=699)	Percent of Total Geography Sections Listed on Schedule: Laboratory (n=87)	Percent of This Type Course Having a Prerequisite	Percent of Courses of This Type by Instructional Mode: lec only	lab only	lec-lab	lec-field	other
Introductory and General	16	12	7	8	0	0	100				
World & Regional	40	30	25	21	3	16	93		1	5	
Physical	39	32	21	37	47	7	77	2	15	3	3
Cultural	33	28	18	18	2	8	94		2	2	2
Economic and Political	24	12	8	5	0	5	100				
Environmental	7	4	2	2	0	14	57			28	14
Cartography, Photogrammetry, and Other Map-Related	23	17	16	8	47	51	29	2	65	4	
Other	6	2	2	1	0	100					

Note. 1. 130 colleges (74% of sample) list one or more geography courses in the college catalog.

2. 113 colleges (65% of sample) list one or more geography courses in schedules of classes.

Table C2

Geology in the Two-Year Colleges, 1977-78 Academic Year

Type of Course	Percent of Colleges Listing This Type Course in Catalog (n=175)	Percent of Colleges Listing This Type Course in Class Schedule (n=175)	Percent of Total Geology Courses Listed on Schedule (n=217)	Percent of Total Geology Sections Listed on Schedule: Lecture (n=473)	Percent of Total Geology Sections Listed on Schedule: Laboratory (n=392)	Percent of This Type Course Having a Prerequisite	Percent of Courses of This Type by Instructional Mode: lec only	lab only	lec-lab	lec-field	lec-lab-field
Introductory and General	20	17	18	18	16	22	38	8	31	10	13
Regional and Field	14	11	13	10	5	35	33		20	30	17
Physical	36	32	32	46	52	26	19	9	36	4	30
Historical	29	22	20	15	17	74	16	7	35	5	37
Mineralogy	13	7	8	6	5	50	22		44	17	17
Paleontology	6	3	2	2	1	57	38			25	38
Environmental	5	4	4	2	1	50	62	12		12	12
Geomorphology	3	2	1	2	2	50	33		33	33	
Other	2	1	(<1)	(<1)	(<1)	100					100

Note. 1. 86 colleges (49% of sample) list one or more geology courses in the college catalog.

2. 76 colleges (43% of sample) list one or more geology courses in the schedules of classes.

Table C3

Percentage of Two-Year Colleges Offering Geology, by Region, Size, and Control in 1977-1978

	N	Region						Size			Control	
		North-east	Middle States	South	Mid-West	Mountain Plains	West	Small <1499	Medium 1500-7499	Large >7500	Public	Private
Distribution of the Sample	175	11	21	54	38	23	28	72	78	25	147	28
Total Geology	76	27.3	23.8	29.6	34.2	43.5	85.7	23.6	46.2	88.0	49.0	7.1
Introductory and General	30	18.2	--	11.1	10.5	26.1	35.7	8.3	11.5	28.0	17.0	--
Regional and Field	19	--	--	1.9	13.2	4.3	53.6	4.2	15.4	44.0	14.3	--
Physical	56	--	23.8	20.4	26.3	17.4	85.7	15.3	28.2	80.0	35.0	7.1
Historical	39	--	9.5	11.1	18.4	21.7	57.1	16.7	15.4	68.0	23.1	--
Mineralogy	12	--	--	1.9	2.6	8.7	28.6	2.8	2.6	28.0	8.8	--
Paleontology	5	--	--	1.9	2.6	4.3	7.1	1.4	2.6	8.0	4.1	--
Environmental	7	9.0	--	--	5.3	--	14.3	--	1.3	24.0	17.0	--
Geomorphology	4	--	--	--	--	--	10.7	1.4	--	8.0	13.6	--

Table C4

Percentage of Two-Year Colleges Offering Geography in 1977-1978 by Region, Size, and Control

	N	Region						Size			Control	
		North-east	Middle States	South	Mid-West	Mountain Plains	West	Small <1499	Medium 1500-7499	Large >7500	Public	Private
Distribution of the Sample	175	11	21	54	38	23	28	72	78	25	147	28
Total Geography	113	18.2	57.1	57.4	60.5	65.2	89.3	45.8	61.5	76.0	66.7	25.0
Introductory and General	12	9.1	--	24.1	18.4	8.7	7.1	13.9	15.4	12.0	16.3	10.7
World and Regional	30	--	42.9	16.7	31.6	8.7	57.1	15.3	34.6	56.0	31.3	7.1
Physical	32	--	23.8	18.5	36.8	4.3	78.6	15.3	32.1	64.0	35.4	--
Cultural	28	--	19.0	16.7	21.1	17.4	64.3	13.9	21.8	56.0	29.9	3.6
Economic and Political	12	--	19.0	7.4	15.8	4.3	17.9	1.4	15.4	28.0	12.2	--
Environmental	4	--	--	--	2.6	--	17.9	--	2.6	16.0	4.1	--
Cartography, Photogrammetry & Other Map-Related	17	--	4.8	13.0	2.6	30.4	39.3	12.5	14.1	20.0	19.0	--
Other	7	9.1	4.8	--	--	--	7.1	1.4	2.6	8.0	2.0	3.6

Center for the Study of Community Colleges
INSTRUCTOR SURVEY

Your college is participating in a nationwide study conducted by the Center for the Study of Community Colleges under a grant from the National Science Foundation. The study is concerned with the role of the sciences and technologies in two-year colleges — curriculum, instructional practices and course activities.

The survey asks questions about one of your classes offered last fall. The information gathered will help inform groups making policy affecting the sciences. All information gathered is treated as confidential and at no time will your answers be singled out. Our concern is with aggregate instructional practices as discerned in a national sample.

We recognize that the survey is time-consuming and we appreciate your efforts in completing it. Thank you very much.

1a. Your college's class schedule indicated that in Fall, 1977 you were teaching:

(Course) ______________________ 11-13 (Section) ______________________

If this class was assigned to a different instructor, please return this survey to your campus facilitator to give to the person who taught this class.

If the class was not taught, please give us the reason why, and then return the uncompleted survey form in the accompanying envelope.

b. Class was not taught because: (explain briefly) ______________________

____

____

Please answer the questions in relation to the specified class.

2. Approximately how many students were initially enrolled in this class? Males ________ 14-16

Females ________ 17-19

3. Approximately how many students completed this course and received grades? (Do not include withdrawals or incompletes.) Males ________ 20-22

Females ________ 23-25

4. Check each of the items below that you believe properly describes this course:

a. Parallel or equivalent to a lower division college level course at transfer institutions . . . . ☐ 1 26

b. Designed for transfer students majoring in one of the natural resources fields (e.g., agriculture, forestry) or an allied health field (e.g., nursing, dental hygiene, etc.) . . . . ☐ 2

c. Designed for transfer students majoring in one of the physical or biological sciences, engineering, mathematics, or the health sciences (e.g., pre-medicine, pre-dentistry) . . . . ☐ 3

d. Designed for transfer students majoring in a non-science area . . . ☐ 4

e. Designed for occupational students in an allied health area . . . . ☐ 5

f. Designed for occupational students in a science technology or engineering technology area . . . . ☐ 6

g. Designed as a high school make up or remedial course . . . . . ☐ 7

h. Designed as a general education course for non-transfer and non-occupational students . . . . ☐ 8

i. Designed for further education or personal upgrading of adult students . . . . ☐ 9

j. Other *(please specify)*: ______________________________ ☐ 0

5a. Instructors may desire many qualities for their students. Please select the one quality in the following list of four that you most wanted your students to achieve in the specified course.

1) Understand/appreciate interrelationships of science and technology with society . . . . ☐ 1 27

2) Be able to understand scientific research literature . . . . ☐ 2

3) Apply principles learned in course to solve qualitative and/or quantitative problems . . . . ☐ 3

4) Develop proficiency in laboratory methods and techniques of the discipline . . . . ☐ 4

b. Of the four qualities listed below, which one did you most want your students to achieve?

1) Relate knowledge acquired in class to real world systems and problems . . . . ☐ 1 28

2) Understand the principles, concepts, and terminology of the discipline . ☐ 2

3) Develop appreciation/understanding of scientific method . . . . ☐ 3

4) Gain "hands-on" or field experience in applied practice . . . . . ☐ 4

c. And from this list, which one did you most want your students to achieve in the specified class.

1) Learn to use tools of research in the sciences . . . . ☐ 1 29

2) Gain qualities of mind useful in further education . . . . ☐ 2

3) Understand self . . . . ☐ 3

4) Develop the ability to think critically . . . . ☐ 4

6a. Were there prerequisite requirements for this course? Yes ☐ 1 No ☐ 2 30

b. IF YES: Which of the following were required? (CHECK AS MANY AS APPLY)

1) Prior course in the same discipline taken in high school ☐ 1 . . college ☐ 7 31

2) Prior course in any science taken in high school ☐ 2 . . college ☐ 8

3) Prior course in mathematics taken in high school ☐ 3 . . college ☐ 9

4) Declared science or technology major . . . . . . ☐ 4

5) Achieved a specified score on entrance examination . ☐ 5

6) Other *(please specify)*: ______________________ ☐ 6

7. **Over the entire term, what percentage of class time is devoted to each of the following:**

a. Your own lectures	______ %	32/33
b. Guest lecturers	______ %	34/35
c. Student verbal presentations	______ %	36/37
d. Class discussion	______ %	38/39
e. Viewing and/or listening to film or taped media	______ %	40/41
f. Simulation/gaming	______ %	42/43
g. Quizzes/examinations	______ %	44/45
h. Field trips	______ %	46/47
i. Lecture/demonstration experiments	______ %	48/49
j. Laboratory experiments by students	______ %	50/51
k. Laboratory practical examinations and quizzes	______ %	52/53
l. Other *(please specify)*: ______	______ %	54/55

Please add percentages to make sure they agree with total

TOTAL: 100 %

8. **How frequently were each of the following instructional media used in this class?**

Also check last box if you or any member of your faculty developed any of the designated media for this course.

	Frequently used	Occasionally used	Never used	Developed by self or other faculty member	
a. Films	☐ 1	☐ 2	☐ 3	☐ 4	56
b. Single concept film loops	☐ 1	☐ 2	☐ 3	☐ 4	57
c. Filmstrips	☐ 1	☐ 2	☐ 3	☐ 4	58
d. Slides	☐ 1	☐ 2	☐ 3	☐ 4	59
e. Audiotape/slide/film combinations	☐ 1	☐ 2	☐ 3	☐ 4	60
f. Overhead projected transparencies	☐ 1	☐ 2	☐ 3	☐ 4	61
g. Audiotapes, cassettes, records	☐ 1	☐ 2	☐ 3	☐ 4	62
h. Videotapes	☐ 1	☐ 2	☐ 3	☐ 4	63
i. Television (broadcast/closed circuit)	☐ 1	☐ 2	☐ 3	☐ 4	64
j. Maps, charts, illustrations, displays	☐ 1	☐ 2	☐ 3	☐ 4	65
k. Three dimensional models	☐ 1	☐ 2	☐ 3	☐ 4	66
l. Scientific instruments	☐ 1	☐ 2	☐ 3	☐ 4	67
m. Natural preserved or living specimens	☐ 1	☐ 2	☐ 3	☐ 4	68
n. Lecture or demonstration experiments involving chemical reagents or physical apparatus	☐ 1	☐ 2	☐ 3	☐ 4	69
o. Other *(please specify)*: ______	☐ 1	☐ 2	☐ 3	☐ 4	70

9. Which of the following materials were used in this class? CHECK EACH TYPE USED. THEN, FOR EACH TYPE USED, PLEASE ANSWER ITEMS A-D.

	A.	B.			C.		D.			
		How satisfied were you with these materials?			Did you prepare these materials?		How much say did you have in the selection of these materials?			
Check Materials Used	How many pages in total were students required to read?	Well-satisfied	Would like to change them	Definitely intend changing them	Yes	No	Total say	Selected them but had to verify with a chairperson or administrator	Was member of a group that selected them	Someone else selected them
☐ 1 Textbooks	______ 13-15	16 ☐ 1	☐ 2	☐ 3	17 ☐ 1	☐ 2	18 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 2 Laboratory materials and work-books	______ 19-21	22 ☐ 1	☐ 2	☐ 3	23 ☐ 1	☐ 2	24 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 3 Collections of readings	______ 25-27	28 ☐ 1	☐ 2	☐ 3	29 ☐ 1	☐ 2	30 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 4 Reference books	______ 31-33	34 ☐ 1	☐ 2	☐ 3	35 ☐ 1	☐ 2	36 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 5 Journal and/or magazine articles	______ 37-39	40 ☐ 1	☐ 2	☐ 3	41 ☐ 1	☐ 2	42 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 6 Newspapers	______ 43-45	46 ☐ 1	☐ 2	☐ 3	47 ☐ 1	☐ 2	48 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 7 Syllabi and handout materials	______ 49-51	52 ☐ 1	☐ 2	☐ 3	53 ☐ 1	☐ 2	54 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 8 Problem books	______ 55-57	58 ☐ 1	☐ 2	☐ 3	59 ☐ 1	☐ 2	60 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 9 Other *(please specify)* ______	______ 61-63	64 ☐ 1	☐ 2	☐ 3	65 ☐ 1	☐ 2	66 ☐ 1	☐ 2	☐ 3	☐ 4

91

10. Please indicate the emphasis given to each of the following student activities in this class.

	Not included in determining student's grade	Included but counted less than 25% toward grade	Counted 25% or more toward grade	
a. Papers written outside of class	☐ 1	☐ 2	☐ 3	67
b. Papers written in class	☐ 1	☐ 2	☐ 3	68
c. Quick-score/objective tests/exams	☐ 1	☐ 2	☐ 3	69
d. Essay tests/exams	☐ 1	☐ 2	☐ 3	70
e. Field reports	☐ 1	☐ 2	☐ 3	71
f. Oral recitations	☐ 1	☐ 2	☐ 3	72
g. Workbook completion	☐ 1	☐ 2	☐ 3	73
h. Regular class attendance	☐ 1	☐ 2	☐ 3	74
i. Participation in class discussions	☐ 1	☐ 2	☐ 3	75
j. Individual discussions with instructor	☐ 1	☐ 2	☒ 3	76
k. Research reports	☐ 1	☐ 2	☐ 3	77
l. Non-written projects	☐ 1	☐ 2	☐ 3	78
m. Homework	☐ 1	☐ 2	☐ 3	79
n. Laboratory reports	☐ 1	☐ 2	☐ 3	80
o. Laboratory unknowns and/or practical exams (quantitative and qualitative)	☐ 1	☐ 2	☐ 3	12
p. Problem sets	☐ 1	☐ 2	☐ 3	13
q. Other *(please specify)*: ________	☐ 1	☐ 2	☐ 3	14

11. Examinations or quizzes given to students may ask them to demonstrate various abilities. Please indicate the importance of each of these abilities in the tests you gave in this course. (CHECK ONE BOX FOR EACH ITEM)

	Very important	Somewhat important	Not important	
a. Mastery of a skill	☐ 1	☐ 2	☐ 3	15
b. Acquaintance with concepts of the discipline	☐ 1	☐ 2	☐ 3	16
c. Recall of specific information	☐ 1	☐ 2	☐ 3	17
d. Understanding the significance of certain works, events, phenomena, and experiments	☐ 1	☐ 2	☐ 3	18
e. Ability to synthesize course content	☐ 1	☐ 2	☐ 3	19
f. Relationship of concepts to student's own values	☐ 1	☐ 2	☐ 3	20
g. Other *(please specify)*: ________	☐ 1	☐ 2	☐ 3	21

12. What was the relative emphasis given to each type of question in written quizzes and examinations? (PLEASE RESPOND BY CHECKING ONE OF THE THREE BOXES FOR EACH ITEM.)

	Frequently used	Seldom used	Never used	
a. Multiple response (including multiple choice and true/false)	☐ 1	☐ 2	☐ 3	22
b. Completion	☐ 1	☐ 2	☐ 3	23
c. Essay	☐ 1	☐ 2	☐ 3	24
d. Solution of mathematical type problems where the work must be shown	☐ 1	☐ 2	☐ 3	25
e. Construction of graphs, diagrams, chemical type equations, etc.	☐ 1	☐ 2	☐ 3	26
f. Derivation of a mathematical relationship	☐ 1	☐ 2	☐ 3	27
g. Other *(please specify)*: ________	☐ 1	☐ 2	☐ 3	28

13. **What grading practice did you employ in this class?**

ABCDF	☐ 1	29
ABCD/No credit	☐ 2	
ABC/No credit	☐ 3	
Pass/Fail	☐ 4	
Pass/No credit	☐ 5	
No grades issued	☐ 6	
Other ______ *(please specify)*	☐ 7	

14. **For each of the following out-of-class activities, please indicate if attendance was required, recommended or neither.**

	Attendance required for course credit	Attendance recommended but not required	Neither required nor recommended	
a. On campus educational type films	☐ 1	☐ 2	☐ 3	30
b. Other films	☐ 1	☐ 2	☐ 3	31
c. Field trips to industrial plants, research laboratories	☐ 1	☐ 2	☐ 3	32
d. Television programs	☐ 1	☐ 2	☐ 3	33
e. Museums/exhibits/zoos/arboretums	☐ 1	☐ 2	☐ 3	34
f. Volunteer service on an environmental project	☐ 1	☐ 2	☐ 3	35
g. Outside lectures	☐ 1	☐ 2	☐ 3	36
h. Field trips to natural formation or ecological area	☐ 1	☐ 2	☐ 3	37
i. Volunteer service on education/ community project	☐ 1	☐ 2	☐ 3	38
j. Tutoring	☐ 1	☐ 2	☐ 3	39
k. Other *(please specify)*: ______	☐ 1	☐ 2	☐ 3	40

15a. **Was this class conducted as an interdisciplinary course?**

Yes	☐ 1	41
No	☐ 2	

b. **IF YES, Which other disciplines were involved?** ______________________
(please specify)

____

______________________ 42

43

16. **Were instructors from other disciplines involved . . .**

	YES	NO	
. . . in course planning?	☐ 1	☐ 2	44
. . . in team teaching?	☐ 1	☐ 2	45
. . . in offering guest lectures?	☐ 1	☐ 2	46

17a. Which of these types of assistance were available to you last term? CHECK AS MANY AS APPLY.

b. Which did you utilize? CHECK AS MANY AS APPLY.

	a. Assistance was available to me in the following areas	b. Utilized
a. Clerical help	47- ☐ 1	48- ☐ 1
b. Test-scoring facilities	☐ 2	☐ 2
c. Tutors	☐ 3	☐ 3
d. Readers	☐ 4	☐ 4
e. Paraprofessional aides/instructional assistants	☐ 5	☐ 5
f. Media production facilities/assistance	☐ 6	☐ 6
g. Library/bibliographical assistance	☐ 7	☐ 7
h. Laboratory assistants	☐ 8	☐ 8
i. Other *(please specify)*: ________________	☐ 9	☐ 9

18. Although this course may have been very effective, what would it take to have made it better? CHECK AS MANY AS APPLY.

- a. More freedom to choose materials ☐ 1 49
- b. More interaction with colleagues or administrators ☐ 2
- c. Less interference from colleagues or administrators ☐ 3
- d. Larger class (more students) ☐ 4
- e. Smaller class ☐ 5
- f. More reader/paraprofessional aides ☐ 6
- g. More clerical assistance ☐ 7
- h. Availability of more media or instructional materials ☐ 8
- i. Stricter prerequisites for admission to class ☐ 9
- j. Fewer or no prerequisites for admission to class ☐ 1 50
- k. Changed course description ☐ 2
- l. Instructor release time to develop course and/or material ☐ 3
- m. Different goals and objectives ☐ 4
- n. Professional development opportunities for instructors ☐ 5
- o. Better laboratory facilities ☐ 6
- p. Students better prepared to handle course requirements ☐ 7
- q. Other *(please specify)*: ________________ ☐ 8

Now, just a few questions about you . . . .

19. **How many years have you taught in any two-year college?**

- a. Less than one year . . . ☐ 1 — 51
- b. 1-2 years . . . ☐ 2
- c. 3-4 years . . . ☐ 3
- d. 5-10 years . . . ☐ 4
- e. 11-20 years . . . ☐ 5
- f. Over 20 years . . . ☐ 6

20. **At this college are you considered to be a:**

- a. Full-time faculty member . . . ☐ 1 — 52
- b. Part-time faculty member . . . ☐ 2
- c. Department or division chairperson . . . ☐ 3
- d. Administrator . . . ☐ 4
- e. Other *(please specify)*: ____________ . . . ☐ 5

21a. **Are you currently employed in a research or industrial position directly related to the discipline of this course?**

Yes ☐ 1 — 53
No ☐ 2

b. **IF YES:** For how many years? ________ 54-55

c. **If previously you had been employed in a related industry or research organization, please indicate the number of years:** ________ 56-57

22. **What is the highest degree you presently hold?**

- a. Bachelor's . . . ☐ 1 — 58
- b. Master's . . . ☐ 2
- c. Doctorate . . . ☐ 3

IMPORTANT INSTRUCTIONS

Thank you for taking the time to complete this survey. Please seal the completed questionnaire in the envelope which is addressed to the project facilitator on your campus and return it to that person. After collecting the forms from all participants, the facilitator will forward the sealed envelopes to the Center.

We appreciate your prompt attention and participation in this important survey for the National Science Foundation.

Arthur M. Cohen
Principal Investigator

Florence B. Brawer
Research Director

APPENDIX E

Supplementary Bibliography

Astronomy

Ivey, R. C. Astronomy for liberal arts majors. Physics Teacher, 1973, 11(2), 89-91.

Motto, V. J. Mathematical astronomy. Two-Year College Mathematics Journal, 1975, 6(1), 21-26.

Somerville, W. B. University astronomy in relation to physics. Physics Education, 1972, 7(2), 103-106.

Strope, M. B., & Braswell, A. L. A comparison of factual teaching and conceptual teaching in introductory college astronomy. Journal of Research on Science Teaching, 1966, 4, 95-96.

Wertz, J. R. Building an extensive liberal arts astronomy program. American Journal of Physics, 1974, 42(9), 730-736.

Zeilik, M. Astrology in introductory astronomy course for non-science specialists. American Journal of Physics, 1973, 41(8), 961-968.

Geography

Ball, J. M., et al. Experiments in teaching college geography: A report to the profession. Professional Geographer, 1972, 24(5), 350-361.

Cassano, S. J. Experiential learning: The use of student volunteers. Community College Social Science Quarterly, 1975, 5, 31-32.

Chanlier, R. H., & Chanlier, P. S. Geographic and environmental illiteracy among educated Americans--an appraisal. Science Education, 1970, 54, 281-286.

Elam, W. W. The needs and scope of geographic education. American Geographical Perspectives, 1974, 34, 14-18.

Johnston, R. S. Geography and social sciences: Once more into . . . but briefly. Geographical Education, 1975, 2, 305-306.

Lamne, A. J. The use of models in geography classrooms. Journal of Geography, 1977, 76(2), 66-68.

McKee, J. O. Status of geography at the institutions of higher learning in Mississippi. Mississippi Geographer, 1973, 1(1), 9-16.

McNee, R. B. A proposal for a new geography course for liberal education: Introduction to geographic behavior. New approaches in introductory college geography courses. Washington, D.C.: Commission on College Geography, Association of American Geographers, 1967.

Murray, A. C. Some suggestions for teaching introductory urban geography. Journal of Geography, 1977, 76, 253-265.

Towler, J. O., & Brenchley, D. L. Geography and environmental education. Journal of Geography, 1975, 74, 521-525.

Geology

Baldwin, B. The creative curriculum. Journal of Geological Education, 1970, 18, 91-93.

Capper, M. R. (Compiler). Instructional objectives for a junior college course in geology. Los Angeles: ERIC Clearinghouse for Junior Colleges, 1969. (ED 033 696)

Hendrix, T. E., & Fox, W. T. Experimental approaches to the introductory geology course. Journal of Geological Education, 1965, 813, 137-142.

Holmes, C. D. Geology and liberal education. Journal of Geological Education, 1969, 17(4), 142-144.

Purdy, L. (Compiler). Instructional objectives for a junior college course in physical geology. Los Angeles: ERIC Clearinghouse for Junior Colleges, 1972. (ED 067 081)

Oceanography

Awkerman, G. L., et al. Priorities in ocean science study. Science Education, 1974, 58(4), 449-456.

Chanlier, P. S. A case for oceanography at the inland school. Science Education, 1971, 55, 15-20.

Marshall, N. Oceanography, the new frontier for the twenty-first century. Science Teacher, 1973, 40(8), 16-19.