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ABSTRACT

Engineering instruction is examined as revealed in a study of science education at two-year colleges which involved a review of the literature, an analysis of the catalogs and class schedules of 175 institutions, and a survey of 144 engineering instructors. The report first presents a general profile of engineering technology education based on the literature review, considering curriculum, articulation, student recruitment, instructional practices, and student and faculty characteristics. Findings from the catalog and schedule analysis are then presented for eight disciplinary areas: (1) general engineering; (2) engineering graphics and design; (3) civil engineering; (4) electrical technology; (5) materials technology; (6) mechanical engineering; (7) industrial engineering; and (8) aeronautical, automotive, and combustion technology. This analysis focuses on course offerings, prerequisites, and objectives; lecture/laboratory format; intended audience; and differences between public and private colleges. Next, the report discusses course enrollment and completion rates and examines several areas related to instructional practices, including utilization and selection of instructional materials, student evaluation criteria, grading, out-of-class activities, and interdisciplinary approaches. Findings concerning the working conditions of faculty and their characteristics are then presented, followed by summary conclusions and recommendations for instructional improvement. A bibliography and the questionnaire are appended. (JP)

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SCIENCE EDUCATION IN TWO-YEAR COLLEGES: ENGINEERING

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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. Each of the monographs 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.

Daniel Rosenthal, Emeritus Professor of Engineering at UCLA, contributed much information about the problems of curriculum and progress of engineering students who transfer to four-year colleges and universities. Frank Gourley, Arthur Cavano, Lois Greenfield, Ron Pare, Lawrence Wolf, and Ernest Weidhaas of the Publications Committee of the Technical College Council of the American Society of Engineering Education, reviewed an earlier draft of the monograph and contributed many helpful ideas which were incorporated into this report.

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. Jennifer Clark did the final compilation of the various bibliographies for each monograph. William Cohen designed the cover.

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 [illegible] provided so much input to the finalization of this monograph [illegible] to thank Ray Hannapel and Bill Aldridge of the National Scie[illegible]ation, who were project monitors.

Arthur M. Cohen
Project Director

Florence B. Brawer
Publications Coordinator

SCIENCE EDUCATION IN TWO-YEAR COLLEGES: ENGINEERING

Two-year colleges enroll one-third of all students in higher education--more than four million people. According to most recent figures, 40 percent of all first-time, full-time students attend these institutions. 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 freshmen.

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

This monograph, as part of a National Science Foundation (NSF) sponsored study of Science Education in America's community, junior, and technical colleges, explores engineering education. The study, conducted by the Center for the Study of Community Colleges, was designed to provide a comprehensive picture of science curriculum and instruction. A literature review of the most important studies 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) from the 1977-1978 academic year were gathered from the catalogs and class schedules of a representative national sample of 175 colleges. A random sample of science instructors in the 175 colleges were surveyed to determine instructional practices and to obtain some information on the science faculty. This information was collected to serve as a bases for investigating the developing trends in science education and to document the current college efforts in various fields of study.

This monograph begins with a look at engineering curriculum followed by examinations of instructional practices and by a discussion of the faculty. Recommendations for strengthening engineering education are reported in the final section.

PART I
ENGINEERING CURRICULUM IN COMMUNITY COLLEGES

Three distinguishing characteristics of the comprehensive community college of the 1970s must be taken into account when considering the status of engineering education in that institution. The first of these characteristics concerns the multiple missions of the community college. It offers programs for transfer students in different major fields; non-transfer students desiring a general education; students in occupational and technical programs; educationally "underprepared" students needing remedial courses required for entry into the college's transfer or occupational programs; and non-degree oriented students desiring cultural, recreational, and community interest courses.

A second distinguishing characteristic of the community college is the massive transformation in the composition of its student body that has occurred in recent years. To illustrate, the percentage of two-year college students enrolled in occupational programs increased from 13 percent in 1965 to approximately 30 percent in 1970, and then to nearly

50 percent in 1976 (AACJC, 1976). In a recently completed review of occupational enrollment trends in the two-year college, Lombardi (1978) noted 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 has increased over 100 percent in one year (1.5 million in 1975 to 3.2 million in 1976). The importance of the phenomenal growth of continuing education enrollments in the community college curriculum becomes evident in the findings that in 1976 there were nearly as many students participating in non-credit courses as there were in credit courses (Lombardi, 1978).

Another major change that has now occurred in the two-year college concerns the composition of the student population itself. In the last decade there have been substantial increases in the percentage of community college students who fall into one or more of the following categories: over 25 years of age; women students returning after a prolonged absence; senior citizens; part-time students. Traditional full-time students entering the community college just after completing high school account for only about 20 percent of the enrollments in this institution.

A third distinguishing characteristic of the community college concerns the non-traditional course-taking pattern of its students. Much of the community college curriculum cannot accurately be viewed in classical terms; it is not a coherent integrated sequence of courses and experiences. In fact, regardless of how the programs are designed, they are not sequential at all for most of the students who enroll in them. A sizeable majority of students do not complete planned programs--vocational, transfer, academic major, or anything else. They drop in and out, changing majors, beginning programs, without completing them, using the institution as an ever present resource (Cohen, 1979).

Designing an engineering curriculum to meet the diversity of student talents and objectives presents the following dilemmas. Should the curriculum offerings serve the educational needs of the transfer student? The occupational student? The general education student? Or all three groups? Should separate introductory courses be offered to meet the unique needs of each group or should one course be geared toward satisfying general education objectives? Should the courses be as demanding as those found in the transfer institution or should they be adjusted to the less academically inclined? The ways in which these questions are answered have an important bearing on the number of students in each of the various educational objective/ability groups exposed to engineering education.

THE LITERATURE

SOURCES OF LITERATURE ON ENGINEERING TECHNOLOGY EDUCATION

The sources of literature on engineering education are primarily the U.S. Office of Education, the U.S. Department of Labor, masters' theses and doctoral dissertations, and descriptive reports from individual institutions (Fibel, 1972). The January 1972, November 1968, and in each May issue from 1975 through 1980 issues of Engineering Education are devoted to engineering technology.

In 1970 the American Society for Engineering Education (ASEE, 1972) conducted a study designed to inventory the current national effort in programs of two to four years duration in engineering technology education, assess the strengths and weaknesses of current educational practices in this domain, and suggest further efforts in this area. Major findings and recommendations of this national study of engineering technology in the United States are reported in the January 1972 issue of Engineering Education (Defore, 1972). Papers and research reports which were originally prepared as background information for the Advisory Committee of the Engineering Technology Education Study is also available (Defore, 1971). The papers in this collection provide information in the following areas: characteristics of associate degree engineering technology programs; examples of curriculum guides for associate degree engineering technology programs; topics covered in mathematics and physical science courses that are part of the associate degree engineering technology curriculum; accreditation of engineering technology curriculum; characteristics of student and faculty in associate degree engineering technology programs; certification of engineering technicians; and a study of associate degree engineering graduates on the job.

The November 1966 issue of Engineering Education includes a directory of engineering technology programs accredited by the Engineers' Council for Professional Development. Bibliographies of vocational/technical literature (Adams, 1972; Ellsworth, 1975; Fibel, 1972; Magisos & Stakelon, 1975; Williams, 1973) provide good sources for engineering technology material, although Fibel notes a paucity of research on the relationship between curriculum and students' on-the-job performance and advancement. Williams provides a comprehensive overview of studies on curriculum and instructional innovation in electrical-electronics. A wide range of reports, pamphlets, reprints, and books on engineering and engineering technology education can be obtained from the Publications Office of the Accreditation Board for Engineering and Technology in New York. Prior to 1980, this organization was called the Engineers' Council for Professional Development.

RESEARCH IN ENGINEERING TECHNOLOGY EDUCATION: AN OVERVIEW

Recent research in engineering technology education focuses on five areas: curriculum, articulation, recruitment of students, instructional practices, and student and faculty characteristics. Representative studies in each of these areas will be cited.

Curriculum. According to the American Society for Engineering Education (ASEE, 1972) the essential content of engineering technology curriculum must be mathematics, basic science, technical science, a technical specialty, and technical skills related to a particular area of engineering practice (p. 22). The components and time allocations recommended by ASEE for a two-year associate degree program in engineering technology are listed below:

Technical Studies (about one year)--This includes courses in the major technical specialties, related technical studies, and the technical sciences.

Basic Science Studies (about 1/2 year)--This includes courses in mathematics, applied mathematics, and the physical sciences.

Non-technical Studies (about 1/3 year)--This area includes courses in communications (English composition, speech, report writing), humanities, social studies, and other life-oriented subject matter.

Institutional Electives--This category includes courses needed to satisfy special institutional purposes.

The total amount of time needed to complete courses in all four categories should be two years (60 semester hours).

Also included in the final report of the ASEE-sponsored Engineering Technology Education Study is a list of desirable characteristics of associate degree engineering technology curricula. Among the recommendations listed were that community colleges should provide substantial numbers of graduates in engineering technology who will transfer to BA programs at the junior-year level; each specialized technology program (e.g., civil engineering technology, chemical engineering technology, electrical technology) should produce between 20 to 30 graduates annually; and engineering technology programs at the associate degree level should be undertaken only by those colleges that can support advanced production-type laboratories and a credentialed faculty. In most instances, these requirements could only be met by colleges with large enrollments.

Several studies focus on developing and/or describing the curriculum in a particular area of engineering technology. Hull (1979) reports on a U.S. Office of Education project that was designed to develop and test a curriculum for training energy conservation-and-use technicians (ECUT). In an effort to develop an ECUT program that would satisfy the needs of industry, and in a way that was readily adaptable by schools, the following five steps were taken: (1) a needs assessment was conducted; (2) an occupational analysis was made and the results of this analysis was used to design the curriculum; (3) instructional materials were developed and pilot tested; (4) the curriculum and instructional materials were field tested and revised; and (5) results of the project were disseminated to schools and employers. This model proved to be a very effective method of developing curriculum.

A description of the Science and Engineering Technician (S.E.T.) curriculum leading to an associate degree is provided by Wolf, Aldridge, and Mowery (1980). The SET curriculum is intended to be interdisciplinary with a balanced offering of chemistry, physics, mathematics, mechanical technology, and electronics technology. Among the claims advanced in support of the SET program is that it can appeal to non-traditional students, it leads to employment at the associate degree level, and graduates can continue their studies in this area at a transfer institution.

An important problem identified in the literature is the lack of consistency and uniformity among certain engineering technology programs and courses bearing common titles. Schon and Anderson (1977) found that there was a lack of uniformity among the California community colleges in their engineering technology and industrial technology programs. Although programs in each of these areas shared the same name, they differed in curriculum content and rigor. Several problems that resulted from these inconsistencies identified by Schon and Anderson are listed below.

> Articulation between community colleges and baccalaureate programs had to be dealt with individually, because uniform articulation policies could not be established. Employers of technicians could not adequately identify qualifications of graduates based on curriculum titles. Many companies therefore adopted the policy of out-of-state recruiting rather than chance the reliability of local graduates. Students were uncertain about the occupational goal and qualifications for employment a curriculum might provide. Matriculation among the community colleges and various programs bearing common titles was an uncertain hazard (p. 763).

To address these problems, a statewide study of engineering and occupational technology program was conducted. The findings of this study were used to develop a recommended curriculum for engineering technology and industrial technology programs. Outlines of the recommended curricula along with selected examples of topics of study are provided by Schon and Anderson (1977).

A topic that is receiving an increasing amount of attention in the engineering education literature is interdisciplinary courses. Based on his review of recent research in engineering education LeBold (1980) observed that:

> The increasing complexity of technical problems and their impact on society has resulted in rapid increases and proliferation of interdisciplinary courses and research efforts. At the undergraduate level, society problems have been emphasized, usually with team taught courses using faculty from engineering, management, social sciences, humanities, and fine arts (p. 407).

While there are many examples and discussions of interdisciplinary engineering courses in the literature (Cook, 1974; Goodwin & LeBold, 1975; Grayander, 1976; Hankins, 1977; Kent, 1978, Lawless & Pici, 1977), very little of this literature is focused on interdisciplinary courses in community colleges.

An interesting approach of integrating engineering technology into required English courses is described by Katz (1980). At Ward Technical College students are required to take two courses in English. The first course emphasizes expository writing in addition to the essay and short story. The second course concentrates on technical writing plus a study of the novel and drama. The technical research paper is a major part of this second course, which is offered in the fourth semester of the two-year engineering technology program. This requirement of having students in engineering technology programs write a comprehensive research paper has received favorable evaluations from students, faculty and employers. Faculty members in English and engineering technology reported that their understanding of the educational needs of engineering technology students increased as a result of this program.

Another curricular area which has received scant attention in the literature concerns programs and courses in engineering technology designed for the large segment of the community college population that is academically underprepared. One of the few available descriptions of a two-year college program designed for students who lack preparation in certain areas needed to succeed in technical programs is provided by Cavano (1975). At Fayetteville Technical Institute a three-quarter developmental studies program has been designed for students who need additional preparation before starting the college's technical curriculum. The program includes courses in English, mathematics, and physical sciences (with biology, chemistry, and physics alternatives). In addition to these courses, students in this developmental program are encouraged to take electives in such areas as study skills, typing, drafting, automotive, welding, and/or other manipulative-oriented courses. This program has been very successful in helping educationally underprepared students complete their associate and baccalaureate degrees in engineering technology.

<u>Articulation</u>. One development with important implications for the community college is the growth in the number and types of baccalaureate programs in engineering technology (Leavitt, 1974; Rinehart, 1973; Walkoff, 1969). Armsby (1966) reported that such programs were slowly

being introduced. The May 1977 Engineering Education special issue on engineering technology contains several articles on this subject (Byers, 1977; Moore & Will, 1977). Rinehart indicated that a sizeable number of four-year colleges in the United States either offered or were considering offering baccalaureate programs in technological areas and that many of these programs are planned with the associate degree recipient in mind. A historical perspective on the growth of associate and baccalaureate programs in engineering technology is available in Wolf (1977).

The growth of baccalaureate programs in engineering technology (B.E.T.) leads to the issue of articulation between two- and four-year colleges, which is an area that has received much attention from engineering educators (California State Coordinating Council for Higher Education, 1969; Corcoran et. al., 1977; Defore, 1974; Greenwald & Wecker, 1975; Levitt, 1977; Phelps, 1975; Wolf, 1977). For example, Greenwald and Wecker found that students in the northeast United States can expect to lose one to one-and-one-half years of credit transferring with a two-year associate degree in engineering technology to a four-year baccalaureate program in engineering.

Wolf (1977) reports on the results of a survey designed to test the agreement between representatives of two-year and four-year engineering technology programs on critical issues related to articulation. The results of this study reveal that both associate and baccalaureate degree engineering technology educators tend to agree on the following points: employment and transferability are not conflicting goals for associate programs; associate degree technicians are likely to continue their education; B.E.T. programs provide excellent transfer options for associate degree technicians from the standpoints of career relevance and student performance; and engineering programs, as opposed to B.E.T. programs, do not articulate well with associate degree technician programs (p. 273). Wolf concluded that a good framework for articulation exists between graduates of associate degree programs in engineering technology and B.E.T. programs but not B.S. programs in engineering. Wolf suggests that the barriers preventing engineering technology associate degree recipients from entering directly into B.S. programs in engineering may be artificial. The investigator pointed to the need for research on the characteristics of students in engineering and engineering technology programs.

Recruitment of students. Much attention has been focused on recruiting students, especially women, into engineering technology programs. Gourley (1973) describes a booklet that was designed to aid institutional personnel and others in publicizing the opportunities in engineering technology in North Carolina. This document focuses on such topics as opportunities available for engineering technicians in North Carolina, the relationship of engineering technicians to engineers, the engineering technician curriculum in North Carolina, educational experiences required for the engineering technician, continuing education possibilities for the engineering technician, and facts about the local educational institutions. A valuable feature in the journal of Engineering Education is a column on career guidance. Among the topics addressed in this column are "How to Interest Qualified Students in an Education in Engineering" (Strong, 1978); "A World for Women in Engineering" (Strong, 1977b); and "Company Contacts: A Survey of Industrial Guidance Activities" (Strong, 1977a). In this latter article results are summarized from a survey that was conducted to determine the kinds and extent of involvement in engineering and engineering technology guidance activities by 109 companies. This study revealed that industrial companies were involved in conducting plant tours, panels, and group discussions at the college and high school levels. Lectures, distribution of materials and film/slide presentations were used much less frequently. An important finding of this study was that only about a third as many companies were actively involved in engineering technology guidance activities as compared to engineering guidance.

It was recommended that "more communication was needed on explaining and differentiating between engineering and engineering technology programs, particularly in accurately describing the nature of the work and opportunities available in engineering technology. The public, high school faculty and counselors, as well as many industrial personnel offices are still confused as to the difference between engineering degrees and engineering technology degrees" (Strong, 1977a, p. 278).

Much attention has been directed toward the problems of recruiting and retaining women in engineering technology programs (Davis, 1975; O'Brien, 1977; Rudnick, 1978; Rudnick & Wallach, 1979). An excellent overview on methods of recruiting and retraining women in engineering technology programs is found in Rudnick. Topics addressed in this article include career awareness programs, role models, campus visits, educating the educators (guidance counselors, math, science and vocational instructors) in junior and senior high schools about engineering technology, the role of the technical institute in helping adult women prepare for rewarding careers in engineering technology, access to financial aid, and combating attrition. The Guildford Technical Institute Society of Women Engineering Technicians was established to stimulate interest among women in the field of engineering technology and to provide support for women engineering technician students already enrolled. A description of this successful program can be found in O'Brien.

Instructional practices. A substantial proportion of the literature in engineering education is concerned with research on instructional methods. An overview of recent research on instructional methods in engineering education is provided by LeBold (1980). The investigator found that the instructional methods that have received the most attention are the Keller Plan, computer aided instruction, computer-assisted evaluation, computer aided design, and aptitude treatment interactions. Student evaluation of instruction and testing and grading methods have also been researched.

Some attention has also been given to such instructional methods as case studies (Alic, 1977; Flammer, 1977); self-paced computer-assisted instruction in technical mathematics (Goodson, 1977); visual aids (Brainard, 1976; Jenkins, 1977); behavioral objectives (Adams & Munsterman, 1977); PSI (Heimback, 1979); and team teaching (Cook, 1974; Goodwin and LeBold, 1975; Lawless & Pici, 1977). It is important to note that very little of the literature in engineering education is concerned directly with engineering technology in community and junior colleges. This is a significant oversight in that the educational backgrounds and interests of many students attending community colleges are often quite different from those of students in four-year colleges and universities.

Student and faculty characteristics. LeBold's (1980) overview of recent research in engineering education also included studies on students and faculty. Research on students includes descriptions of incoming engineering freshmen; identification of their abilities, academic performance, and factors influencing their retention or attrition; assessments of employment, salary and involvement in continuing education activities of recent engineering graduates; and reviews of efforts made to attract and retain more women and minorities in engineering.

The percentage of community college students in occupational programs who complete associate degrees is very low nationwide (Cohen, 1979). One of the factors that may be contributing to this high attrition rate is that many students, once they acquired certain skills, seek full-time employment rather than complete the remainder of their degree program. The value that employers assign to the associate degree in engineering technology versus particular skills acquired as part of the degree program or training in a proprietary school is a topic in which research is needed.

A study reported by Edwards and Roberson (1980) provides some insights into the importance employers assign to the associate degree in engineering technology. Graduates of Wake Technical Institute's six engineering technology programs and their employers were surveyed to determine what each group considered the basic science and mathematics topics most needed by engineering technicians on the job. Results of this study showed that graduates were more supportive of a knowledge of basic science and mathematics topics while employers tended to support only those topics that were immediately useful in solving day-to-day problems. Edwards and Roberson attributed these differences in response patterns to the desire of engineering technicians to stay abreast of technological change, and the desire of employers to have employees who possess the knowledge and skills that contribute to immediate productivity.

LeBold (1980) found that much of the recent research on faculty in engineering has been concerned with opportunities and resources for continued growth and development of instructors. The topic of faculty qualifications has also received some attention in the engineering education literature. Results of a nationwide study of institutions with accredited engineering technology programs (Hart & O'Hara, 1976) showed that the two-year colleges gave more credit for professional registration and industrial experience in promoting and hiring their faculty than did the four-year colleges and universities. In terms of hiring practices, 64 percent of the two-year colleges which offered associate degrees in engineering technology indicated that the minimum educational requirement was a bachelor's degree but 84 percent noted that a master's degree was desirable. An NSF-sponsored study (National Science Foundation, 1978) on hiring of science and engineering faculty by two- and four-year colleges showed that in the academic year 1976-77 52 percent of the new hires in engineering at four-year institutions had doctorates or were likely to earn one within a year or two years of appointment. The corresponding figure at two-year colleges was only two percent.

Not evident within the literature is a global view of engineering education at the two-year college. Which fields of engineering are the most prevalent? How are prerequisites distributed among these engineering areas? What instructional modes predominate; for example, what percentage of courses have a laboratory component? Information on the current status of engineering technology in the community and junior college was obtained in the Center's study of science education. Results of the Center's study on curriculum are reported in Part II of this monograph. ~~The findings of the Center's curriculum study are presented in Part II.~~ Results of the Center's surveys of instructional practices and faculty appear in Parts III and IV. The major findings and recommendations of their study are summarized in Part V.

PART II

THE CURRICULUM STUDY

Sample

A representative national sample of 175 two-year colleges participated in the Center for the Study of Community Colleges' study of curriculum and instruction in the sciences (see Appendix A for a list of participating colleges by state). The sample, which comprises 15 percent of all colleges listed in the 1977 Community, Junior, and Technical College Directory (AACJC, 1977), was selected in the following manner.

Presidents of the 178 community colleges that participated in the Center's study of humanities education (Cohen & Brawer, 1977) were asked if they would be willing to take part in a similar project involving the sciences and social sciences. These colleges were selected randomly from all institutions listed in 1977 Community, Junior, and Technical College Directory (AACJC, 1977). Acceptances were received from 144 of these schools.

At this point the participating colleges were placed in a 9X6 matrix on the basis of size and geographical location. Using the 1977 Community, Junior, and Technical College Directory, the ideal size/region composition of a 175 college sample was determined. The remaining 31 colleges were selected by arraying all colleges in the under-represented categories and then randomly selecting the possible participants. The 175 colleges selected were found to be an accurate representation of the nation's two-year colleges on the basis of size, geographical location, and control (public vs. private).

Procedure

Catalogs for the academic year 1977-78 and class schedules for Fall 1977 through Winter 1978 were obtained from each of the 175 sample colleges. The college catalogs were gathered in order to obtain descriptions of the courses in terms of their prerequisites, content and students served. The class schedules were required in order to gain a more accurate count of what courses were being offered than could have been ascertained from the college catalogs. This is because many college catalogs list courses which have not met for several years.

All engineering technology courses appearing in the college catalogs and in the class schedules were placed into one of nine categories on the basis of their content and intended audience (e.g., major field, degree objective). Descriptions of the nine subject area categories and subcategories into which the engineering technology courses were classified are presented below.

General Engineering

Courses within this area provide a broad introduction to the fields of engineering and engineering technology by orienting students in these programs to engineering in general as well as specific fields such as mechanical and civil. This group also includes general engineering problems, courses that focus on problem solving techniques and tools, as well as some applications of fundamental physical science and mathematical principles to engineering systems.

Engineering Graphics and Design

The courses included herein are intended to develop within engineering and engineering technology students the abilities to portray and analyze engineering systems graphically; to interpret graphical presentations of engineering systems; and to apply the principles of mathematics, physics, chemistry and the engineering sciences to the design of specific components or total engineering systems. They include the engineering drawing and graphics courses plus descriptive geometry and design courses of all types, as well as such specialized courses as electronic drafting. The courses in this category include only those for the transfer engineering programs, the higher level electronic technology programs (ECPD accredited programs) and those that do not deviate considerably from these with respect to mathematics and science requirements. Excluded are courses for training draftsmen, for the less rigorous technical programs, and for the trades.

Engineering Drawing and Drafting

Engineering Graphics

Descriptive Geometry

Design

Electrical and Electronic Drafting

Other Graphics Courses

Civil Engineering

The courses included in this category are both elementary and advanced courses in surveying for engineering transfer students and civil engineering and surveying technology students as well as the service courses in surveying for programs such as forestry, building construction, architecture, etc.

Introduction to Surveying

General Surveying--Service Courses

Specialized and Advanced Surveying

Electrical/Electronic Technology

The Electrical/Electronic Technology category includes introductory and advanced level as well as specialized courses. The principles of electricity, both DC and AC, serve as the base for practically all courses in Electrical and Electronic Technology. Students served by these courses are primarily those in the electronic and electrical technology programs, although many service courses are included for other technologies as well as some trades. Transfer electrical and electronic engineering courses and more specialized electronics, e.g., communication and bio-medical, as well as electronics for industry are also included in this category. Courses emphasizing radio and television servicing, broadcast engineering, or maintenance and troubleshooting are not included. Also not included are courses emphasizing electromechanical systems--these courses are found in Mechanical Engineering.

Introductory Electrical Theory

Electrical Technology

Electrical Circuits

Introductory Electronics (Service)

Introductory Electronics (Technology)

Advanced Circuits

Specialized Electronics

Industrial Electronics

Other

Materials

This category contains courses concerned with the structure, properties and uses of various materials, as well as the testing and processing of these materials. The types of materials (metals, plastics, etc.) included depend on the emphasis of the program(s) for which the course is intended. These courses may be part of such programs as metallurgical engineering technology or other engineering technologies.

Properties and Uses

Testing

Processes and Materials

Metals--Metallurgy

Mechanical Engineering

This category encompasses courses covering mechanical principles such as statics, dynamics, fluids, and thermodynamics. It also includes courses on electromechanical systems and machine and structural design. These courses form part of mechanical engineering technology curricula and other programs which depend on knowledge of mechanical principles, such as architecture, air conditioning and refrigeration, and fire science.

General Mechanics

Statics, Strength of Materials, Structural Design

Dynamics, Kinematics, Mechanisms, Machine Design

Fluids, Hydraulics, and Pneumatics

Thermodynamics

Electromechanical Systems

Statics and Dynamics

Other

Industrial Engineering Technology

Courses within this category examine industrial engineering concepts utilized in industry, such as materials and processes used in manufacturing, quality control, precision measurement techniques, work achievement, and industrial safety. These courses are most often offered as part of an industrial technology program.

Industrial Engineering--Introduction

Manufacturing Materials and Processes

Quality Control

Metrology

Work Achievement (Time and Motion Studies)

Industrial Safety

Aeronautical, Automotive and Combustion Engineering

Courses included in this category are those which consider the theory and principles related to the design and operation of the engineering system characteristics of airplanes, space vehicles, and automobiles. Courses concerned with the combustion of various fuels in both stationary and mobile systems are also included. Specifically excluded are courses dealing with troubleshooting, servicing, maintaining or repairing of such systems, as well as training operators for them.

Aeronautical Engineering

Automotive Engineering

Combustion Engineering

Other Engineering and Technology Fields

This miscellaneous grouping includes more specialized areas of engineering and technology not widely found in the two-year colleges. The types of courses included are similar to the other categories but are concerned with mining and petroleum engineering as well as the nuclear, vacuum, optical and solar fields.

Mining Engineering and Technology

Nuclear Engineering and Technology

Optical Engineering and Technology

Petroleum Engineering and Technology

Solar Engineering and Technology

RESULTS

Engineering in Relation to Total Science Offerings

The relative emphasis given to engineering technology in relation to other areas of science in the two-year college curriculum can be determined from the data presented in Table 1. Here we find that in relation to the total science curriculum, engineering accounts for 20 percent of the courses, 11 percent of the class sections, and 30 percent of the laboratory sections. Engineering technology is the second largest area in the science curriculum in terms of the number of courses and laboratory sections offered.

Table 1

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

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

Engineering Offerings

A primary objective of this study was to identify the extent to which different areas of engineering are represented in the community college curriculum. Table 2 presents the percentage of the 175 sample colleges that listed at least one course in a given area of engineering during Spring 1977 through Winter 1978 day and evening class schedules. (Summer session was not included.) Also reported in this Table are the proportions of the total number of engineering courses and class sections accounted for by each of the nine subject area categories.

The data appearing in Table 2 reveal that 81 percent of the colleges listed at least one engineering course in their class schedules during the one-year time period considered. Over 70 percent of the colleges offered a course in Engineering Graphics/Design (77%), Electrical/Electronic Technology (73%), and Mechanical Engineering (71%). The percentage of colleges that offered a course in the remaining areas of engineering considered in this study were, in descending order--Civil Engineering (50%), Materials (46%), Industrial Engineering (41%), General Engineering (27%), Other Engineering Fields (10%), and Aeronautical, Automotive and Combustion (5%).

By far the largest area of engineering in the community college is Electrical/Electronic Technology. Over 40 percent of all class sections (41%) and laboratory sections (46%) offered in engineering are in this area. This is followed by Engineering Graphics and Design which accounts for 18 percent of all class sections and 25 percent of all laboratory sections in engineering during the academic year 1977-78.

College Size and Course Offerings

A further purpose of this study was to ascertain if institutional size is related to the range of engineering courses offered by community and junior colleges. In order to address this concern, the colleges were divided into three size categories on the basis of their enrollments: small (1-1,499); Medium (1,500-7,499); and Large (7,500 and over).

Table 2

Engineering in the Two-year Colleges

	Percent of Colleges Listing Courses in Class Schedule	Percent of Total Engineering Sections Listed on Schedule	
		Lecture	Laboratory
	(n=175)	(n=5,444)	(n=4,895)
General Engineering	27	2	1
Engineering Graphics and Design	77	18	25
Civil Engineering	50	6	7
Electrical/Electronic Techonology	73	41	46
Materials	46	6	5
Mechanical Engineering	71	17	11
Industrial Engineering	41	7	4
Aeronautical, Automotive, and Combustion	5	(1)	(1)
Other Fields	10	1	(1)

Notes. 1. 153 colleges (87% of sample) list one or more engineering courses in the college catalog.

2. 151 colleges (81% of sample) list one or more engineering courses in schedules of classes.

Table 3

Percent of Two-Year Colleges Offering a Course in an Engineering Area by Institutional Size

Engineering Area	Small (1-1,499) n=72	Medium (1,500-7,499) n=78	Large (7500+) n=25
General Engineering	17	27	48
Engineering Graphics and Design	56	86	96
Civil Engineering	39	62	92
Electrical/Electronic Technology	44	78	100
Materials	18	55	68
Mechanical Engineering	58	71	76
Industrial Engineering	14	53	68
Aeronautical, Automotive and Combustion	--	5	12
Other Fields	6	6	28

As shown in Table 3, a strong, positive, and expected relationship exists between institutional size and the percentage of colleges that offer a course in each of the engineering areas considered. That is, large colleges were much more likely to offer a course in any one engineering area than were the medium-sized colleges which were more likely to do so than the small colleges.

For example, a much greater percentage of the large colleges (92%) offered a course in the area of Civil Engineering than did the medium (62%) or small (39%) size colleges. This finding indicates that the selection of engineering courses available to students attending a large college is likely to be much greater than that available to students attending a medium or small institution.

Public vs. Private Colleges

The data presented in Table 4 demonstrate that public institutions are much more likely than private colleges to offer a course in each of the nine areas of engineering considered. In fact, only one-half of the private junior colleges offered a course in any area of engineering during the one-year time frame considered.

Table 4

Percent of Public and Private Two-Year Colleges Offering a Course in an Engineering Area

Engineering Area	Public (n=147)	Private (n=28)
General Engineering	27	18
Engineering Graphics and Design	84	25
Civil Engineering	65	7
Electrical/Electronic Technology	82	11
Materials	49	4
Mechanical Engineering	70	46
Industrial Engineering	48	--
Aeronautical, Automotive, Combustion	5	--
Other Fields	11	--
Total Engineering	94	50

Prerequisites

Two further objectives of this study were to determine the percentage of engineering courses that carry prerequisites and, relatedly, to identify the types of prerequisites that colleges require for entrance into their engineering courses. Information on whether or not a course carried a prerequisite was obtained primarily from course descriptions found in the college catalogs. Information on the general nature of the prerequisites was obtained in an Instructor Survey undertaken by the

Center for the Study of Community Colleges (the Instructor Survey is described in Part III).

Table 5

Percent of Courses in Engineering Categories with Prerequisites

Engineering Area	Percent of Engineering Courses Having a Prerequisite
Mechanical Engineering	75
Electrical/Electronic Technology	73
Civil Engineering	71
Other Fields	53
Engineering Graphics and Design	50
Materials	44
General Engineering	40
Industrial Engineering	35
Aeronautical, Automotive, and Combustion	20
Total Courses with Prerequisites	65

The data appearing in Table 5 demonstrate that the courses most likely to carry a prerequisite are those in Mechanical Engineering (75%), Electrical/Electronic Technology (73%), and Civil Engineering (71%). Overall, prerequisites are included in 65 percent of the engineering courses.

One of the items on the Center's Instructor Survey had engineering faculty indicate whether or not the course they were teaching carried a prerequisite and if so to identify the general nature of the requirement. The prerequisites specified by the largest percentage of the engineering instructors were, in descending order, prior courses in college mathematics (26%), completion of one or more engineering courses (26%), prior courses in high school mathematics (22%), and declared major in science or technology (17%).

Lecture vs. Laboratory Format

One of the objectives of this study was to identify the primary method of presenting course material to the learner. The format of the courses were obtained primarily from the course descriptions listed in the college catalogs. The most common format used in community colleges engineering courses are listed in Table 6.

Table 6

Percent of Courses Offered in Lecture and Laboratory Format

Engineering Area	Lecture Only	Lab Only	Lecture-Lab	Lecture-Lab Field Study	Other
General Engineering	54	14	30	--	3
Engineering Graphics and Design	4	20	74	--	3
Civil Engineering	13	--	70	12	5
Electrical/Electronic Technology	15	--	79	--	6
Materials	31	--	64	--	5
Mechanical Engineering	47	--	49	--	4
Industrial Engineering	50	--	44	--	6
Aeronautical, Automotive, and Combustion	20	--	80	--	--
Other Fields	53	--	47	--	--

Note. Other categories include individualized instruction and media-oriented instruction.

As shown in Table 6, the most common method of presenting engineering courses is through a combination of lecture and laboratory section. The lecture-laboratory approach is used to present over 60 percent of the courses in each of the following engineering areas: Aeronautical, Automotive, and Combustion (80%); Electrical/Electronic Technology (79%); Engineering Graphics and Design (74%); Civil Engineering (70%); and Materials (64%).

Lecture sections represent the second most common method of presenting engineering. This approach is used in about one-half of the courses in General Engineering (54%), Other Fields (53%), Industrial (50%), and Mechanical Engineering (47%). A much smaller percentage of courses in the other engineering areas considered were presented in a lecture section only format.

Civil Engineering is the only area in which any courses include a field component (12%). Few of the courses in any area of engineering were presented in such nontraditional forms as individualized instruction, television, or computer-assisted instruction.

Intended Audience for Course

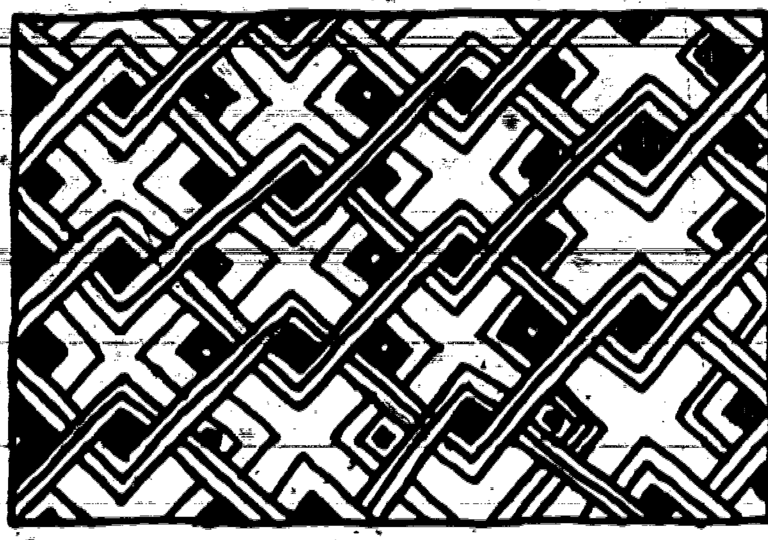
Insights into the extent to which community colleges are attempting to attract different student groups (e.g., transfer, general education, occupational, personal development) to participate in engineering education was obtained from the Center for the Study of Community Colleges' Instructor Survey (see Part III for methodology). In that survey, instructors were asked to describe the audience for whom their class was intented by checking one or more of the descriptive statements listed in Table 7.

Table 7

Intended Audience for Course
(In Percentages)

Course Designed for or Intended as:	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Parallel or Equivalent to Course at Transfer Institution	71	63	47	60	68
Transfer Students Majoring in a Natural Resource Field or an Allied Health Field	53	38	31	27	27
Transfer Students Majoring in a Physical or Biological Science, Engineering, Math, or Health Science	49	56	25	38	33
Transfer Students Majoring in a Non-Science Area	36	18	6	24	35
Occupational Students in an Allied Health Area	43	27	2	20	19
Occupational Students in Science Technology	14	31	83	51	30
Non-Transfer/ Non-Occupational	16	11	6	7	17
High School Make-up/Remedial	20	13	1	2	12
For Further Education/ Personal Upgrading	27	13	27	7	35

The data presented in Table 7 indicate that most of the engineering instructors in this sample described their course as intended primarily for occupational students in science technology programs (83%). A much smaller percentage of the engineering instructors described their course as parallel or equivalent to a lower division college level course at tranfer institutions (47%). It is important to note that engineering instructors were less likely than instructors in the total sample to describe their course as approprite for students attending college for continuing education-personal upgrading (35% vs 27%). Less than ten percent of the engineering faculty felt the course they were teaching was appropriate for transfer students majoring in a non-science area (6%), non-degree or certificate oriented students (6%), transfer students majoring in a natural resource or allied health field (3%), or occupational students in an allied health area (2%). Less than one percent of the engineering instructors said their course was offered as a high school make-up or remedial course.



PART III
INSTRUCTIONAL PRACTICES

As previously noted, most community colleges adhere to an open-admissions policy, admitting virtually anyone who wishes to enroll in their courses. One outcome of this admissions policy is that community college faculty members are often charged with providing instruction that is appropriate and meaningful to a group of students that varies considerably in terms of their backgrounds, educational goals, abilities, and attitudes toward learning. The range of students' academic abilities apt to be found in a single classroom is evidenced in the Thompson et al. (1967) observation that "...in the same classroom one finds students who have eighth grade aptitudes, and students who could qualify for admission to some of the best four-year universities" (p. 1). The variation in attitudes toward learning found among community college students is also reflected in Brown and Finch's 1973 observation that "there is a large percentage of students with lower middle class backgrounds who view intellectual activity as more or less irrelevant to everyday life, and who react in a very negative way against any activity which is not directly career-related or entertaining. On the other hand, there is a sizeable minority of students who can and will exploit every opportunity to learn" (p. 40).

Given this diversity in student aptitudes and motivation, it would seem important to have information on such questions as: What instructional methods are most effective for what types of students attending community colleges? Can all students adequately learn the subject content typically presented in an introductory course in engineering? And if not, what skills are needed to acquire this information? Surprisingly, the literature in engineering education pertaining specifically to community college students is silent on these issues. The findings of an intensive review of the published literature on instruction--whether in journals or in ERIC--indicate that little has been written concerning the teaching practices used by two-year college engineering instructors. One reason for this gap in the literature is apparent--community college instructors do not write about their professional activities, and researchers in the professional associations and universities have not shown much interest in filling this void. The Center's nationwide survey of the teaching practices of community college instructors presented in the following section will hopefully provide researchers and decision-makers with valuable information upon which they can direct their future efforts in this field.

SURVEY OF INSTRUCTORS' TEACHING PRACTICES

Method

A list of all science class sections appearing in the Fall 1977 day and evening class schedules was prepared for each of the 175 colleges participating in the Center's nationwide study of curriculum and instruction in the two-year college.* The class sections were then placed into one of the following six science categories: Agriculture; Biological Sciences.

*A more thorough treatment of the methodology used in this study is reported in Hill and Mooney (1979).

Engineering; Sciences and Technologies; Mathematics and Computer Sciences; Physical Sciences; and Social and Behavioral Sciences.

The sample of instructors to be surveyed was drawn from the list of class sections by selecting every thirteenth class that appeared in the Fall 1977 class schedules of the colleges involved. This procedure of selecting every thirteenth class section was performed independently for each of the six science areas noted above. Survey forms from the Center's sample were sent in the Winter of 1978 to campus facilitators. They were asked to distribute and collect these questionnaires from instructors who had taught a class section that Fall.

Questionnaires (see Appendix B for a copy of the questionnaire) were mailed to 1,683 instructors. Since the surveys were sent after the completion of the 1977 Fall term, a number of instructors (114) were no longer with the colleges and could not be reached. Also, 77 class sections were cancelled. Of the 1,492 surveys delivered, 1,275 were returned. This established an excellent response rate of 85.5 percent. Surveys were obtained from 144 instructors who were teaching an engineering course in Fall 1977.

It was felt that instructors in the natural and physical sciences would provide a more appropriate basis for comparison than would the instructors in mathematics and social sciences. Thus, in an effort to put into perspective the engineering instructors' responses to the survey items, their answers will be presented along with those of instructors teaching classes in biology, chemistry, and physics, as well as a composite score for the total sample.

RESULTS

Course Enrollment and Completion Rates

Analysis of course enrollment and completion rates showed that the average class size in engineering courses (23.5 students) was smaller than that found in other areas of science and substantially smaller than the average class size for the total sample (31.8 students). On the average, 82.1 percent of the 23.5 students who enroll in an engineering class complete it and receive a grade. The average completion rate for the total sample was 79.6 percent.

Table 8

Course Enrollment and Completion Rates for Sciences and Total Sample by Sex (In Percentages)

Category	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Number of males enrolled	13.0	15.9	19.8	17.7	16.3
Number of females enrolled	25.6	14.3	3.7	6.3	15.5
Number of males completing course	11.3	12.4	16.1	16.1	12.8
Number of females completing course	20.1	11.1	2.9	5.1	12.5
Total number of students enrolled in course	38.6	30.2	23.5	24.0	31.8
Percent of students completing course	81.1	77.8	82.1	88.3	79.6

There were nearly five times as many males enrolled in engineering courses as females (19.8 vs 3.7). In fact, engineering courses attracted fewer females than any of the other eleven science and social science areas considered in this study.

Instructional Modes

Faculty members were asked to indicate whether or not they used each of eleven instructional modes in their course. The data presented in Table 9 reveal that most engineering instructors still rely primarily on lectures (93.8%), class discussions (72.2%), and laboratory exercises (68.8%) to present information to their students. Demonstration experiments (41%), media (33.3%), student verbal presentations (18.8%), field trips (9.0%), simulation/gaming (5.6%) and guest lectures (2.8%) were used by a smaller percentage of the engineering faculty.

Table 9

Percent of Faculty Using Various Modes of Instruction

Mode of Instruction	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Own Lectures	96.9	97.6	93.8	93.3	94.4
Guest Lectures	11.3	8.5	2.8	2.2	11.8
Student Verbal Presentations	19.4	11.0	18.8	17.8	24.5
Class Discussion	70.6	82.9	72.2	73.3	81.3
Viewing Media	73.8	46.3	33.3	31.1	46.4
Simulation/Gaming	6.9	2.4	5.6	2.2	9.6
Quizzes/Examinations	88.8	96.3	75.7	82.2	88.1
Field Trips	18.8	1.2	9.0	4.4	10.0
Lecture/Demonstration Experiments	38.8	58.5	41.0	62.2	28.5
Laboratory Experiments by Students	73.1	80.5	68.8	86.7	33.7
Practical Examinations and Quizzes	58.1	26.8	31.9	15.6	18.2

<u>Instructional Materials</u>

Most engineering instructors (93.1%) used a textbook in their course. In addition to textbooks a substantially smaller number of these teachers used one or more of the following materials: laboratory materials and [illegible]books (65.3%), syllabi and handouts (59.7%), reference books ([illegible].9%), and journals/magazines (24.3%). These data are shown in Table 10.

Table 10

Percent of Faculty Using Various Types of Instructional Materials

Instructional Material	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Textbooks	96.3	97.6	93.1	91.1	94.5
Lab Materials and Workbooks	80.0	84.1	65.3	77.8	43.5
Collection of Reading	15.0	6.1	9.7	6.7	13.9
Reference Books	39.4	32.9	29.9	17.8	21.5
Journals/Magazines	38.1	23.2	24.3	6.7	25.2
Newspapers	11.3	7.3	4.2	2.2	11.1
Syllabi and Handout Material	74.4	75.6	59.7	51.1	62.1
Problem Books	6.3	37.8	5.6	20.0	9.7

Selection of Course Materials

Instructors were asked to indicate the extent to which they participated in the selection of the instructional materials they used in their course. The data appearing in Table 11 demonstrate that only 44 percent of the engineering instructors who used a textbook said that they had "total say" in its selection; 36 percent noted that they had "some say;" and close to 18 percent of the engineering instructors had their textbook selected by someone else. A higher percentage of the engineering faculty had "total say" in the selection of their laboratory workbooks (60.6%), collections of readings (71.4%), journals/magazines (80%), and syllabi and handouts (82.6%). Engineering instructors were similar to those in the total sample in terms of the amount of say they had in the selection of their course materials.

Table 11

Engineering Faculty Satisfaction and Degree of Influence in the Selection of Instructional Materials

Instructional Material	Materials[a] Satisfaction: Number Using Material	Well Satisfied	Would Like to Change	Materials Prepared by Instructor	Influence in Selection: Total Say	Some Say	Someone Else Selected Material
Textbooks	134	56.7	40.3	5.2	44.0	35.8	17.9
Laboratory Materials and Workbooks	94	57.4	36.2	41.5	60.6	21.3	14.9
Collection of Readings	14	64.3	14.3	28.6	71.4	14.3	----
Reference Books	43	79.1	14.0	4.7	74.4	11.6	7.0
Journal and/or Magazine Articles	35	82.9	5.7	8.6	80.0	2.9	8.6
Syllabi and Handout Materials	86	73.3	----	88.4	82.6	10.3	2.3

[a]Note. Percentages are based on the number of instuctors who used the material in question. The percentages do not add to 100 due to missing responses.

Satisfaction with Resource Materials

The data presented in the left hand side of Table 11 represents the percentage of engineering instructors who expressed satisfaction with the resource material they used in their class. Although the majority of instructors were satisfied with the resource materials they were using, 40 percent indicated that they would like to change their textbooks and 36 percent expressed some dissatisfaction with their laboratory materials and workbooks. This is in line with instructor responses in the total science sample.

Materials Prepared by Instructors

Instructors were asked to indicate whether or not they prepared instructional materials for their courses. The results presented in Table 11 indicate that 88 percent of the faculty prepared their own syllabi and handout materials. A sizeable percentage of the engineering instructors prepared their own laboratory materials and workbooks (41.5%) and collections of readings (28.6%).

Instructional Media

With the exception of overhead transparencies, engineering instructors were much less likely than those in the total sample to use the various forms of instructional media considered in this study. As evidenced in Table 12 the instructional media most commonly used by engineering instructors were overhead transparencies (47.2%), films (38.9%), and slides (24.3%). Less than 20 percent of the engineering instructors used any of the remaining forms of instructional media examined.

Table 12

Percent of Faculty Using Instructional Media

Media	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Films	75.0	54.8	38.9	51.1	50.2
Film Loops	41.3	19.5	6.3	4.3	13.9
Film Strips	31.3	15.8	13.9	8.9	19.0
Slides	75.7	29.3	24.3	15.6	29.7
Videotape/Slide/Film	33.2	26.7	15.3	4.4	18.6
Overhead Transparencies	41.9	25.9	47.2	20.8	40.8
Audiotapes, Cassettes, Records	27.6	23.1	7.6	13.3	19.9
Videotapes	30.0	14.6	14.6	11.1	19.2
Television	13.1	3.7	6.3	8.9	8.4

Knowledge Tested

Just over 80 percent of the engineering instructors noted that it was "very important" that their students demonstrate on their tests an acquaintance with the concepts of the discipline. Other competencies stressed by over fifty percent or more of the engineering faculty were as follows: understanding the significance of certain works, events, phenomena and experiments (63.9%); and mastery of a skill (59%). These results are reported in Table 13.

Table 13

Percent of Instructors Who Noted It Was "Very Important" That Their Students Demonstrate a Particular Skill on Tests

Learning Skill	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Mastery of a Skill	24.4	70.0	59.0	57.8	51.0
Acquaintance with Concepts of the Discipline	90.6	90.2	81.3	84.4	83.1
Recall of Specific Information	62.5	35.4	34.0	13.3	42.7
Understanding the Significance of Certain Works, Events, Phenomena, and Experiments	59.4	46.3	63.9	55.6	44.9
Ability to Synthesize Course Content	50.6	42.7	38.9	53.3	46.5
Relationship of Concepts Concepts to Student's Own Values	25.6	15.9	13.9	2.2	24.0

Examination Items

Over 70 percent of the engineering instructors said they frequently include solution of math problems on their examinations. A much smaller percentage called upon their students to construct graphs, diagrams, etc. (45.8%), respond to multiple choice items (35.4%), or provide written answers to completion items (34%), or essay questions (17.4%). These data are summarized in Table 14.

Table 14

Percent of Instructors Who "Frequently Used" a Particular Type of Examination Item

Examination Item	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Multiple	84.4	45.1	35.4	20.0	50.0
Completion	45.6	26.8	34.0	13.3	25.4
Essay	48.1	32.9	17.4	26.7	30.6
Solution of Math Problems	7.5	80.5	71.5	73.3	49.0
Construction of Graphs Diagrams, etc.	5.6	68.3	45.8	31.1	25.6

Grading Practices

The instructors in the Center's sample were asked to note the emphasis given to each of 14 course-related activities in determining students' grades. The data presented in Table 15 show that the three activities most commonly used by engineering instructors to determine 25 percent or more of their students' grades were essay exams (36.8%), quick-score objective tests (36.1%), and laboratory reports (32.6%). The engineering faculty were more likely than their counterparts in other disciplines to place a strong emphasis on completion of problem sets (18.1% vs 5.3%), homework (13.9% vs 6.5%), and workbook completion (11.8% vs 3.5%).

Table 15

Percent of Instructors Who Based 25 Percent or More of Grade on a Particular Activity

Grading Practice	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Papers Written Outside of Class	2.5	---	9.7	4.4	8.9
Papers Written in Class	4.4	---	7.6	2.2	4.9
Quick-score Objective Tests	71.9	61.0	36.1	42.2	59.6
Essay Exams	44.4	50.0	36.8	42.2	40.8
Field Reports	1.3	---	2.8	---	1.8
Oral Recitations	1.3	---	2.1	---	1.9
Workbook Completion	1.3	4.9	11.8	---	3.5
Regular Class Attendance	2.5	---	4.9	-0-	2.8
Participation in Class Discussions	1.3	---	4.7	2.2	1.9
Research Reports	.6	1.2	2.8	---	2.7
Homework	1.3	8.7	13.9	6.7	6.5
Laboratory Reports	11.3	40.2	32.6	26.7	10.4
Laboratory Exams	19.4	12.2	11.8	2.2	6.5
Problem Sets	1.3	3.7	18.1	6.7	5.3

Use of Out-of-Class Activities

The findings reported in Table 16 reveal that with the exception of field trips to industrial plants and research laboratories, engineering instructors in comparison to those in the total sample were less likely either to recommend or require their students to attend out-of-class course-related events in the nine activity categories considered. The most common out-of-class activities which the engineering instructors encouraged their students to view or attend were field trips (40.2%), tutoring (32.6%), and on-campus educational films (21.6%).

Table 16

Percent of Instructors Who Encouraged Their Students to Attend Out-of-Class Activities

Activity	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
On-Campus Educational Films	47.6	30.0	21.6	24.4	29.8
Other Films	43.8	23.2	13.9	8.9	24.9
Field Trips to Industrial Plants, Research Laboratories	28.8	24.4	40.2	15.6	20.9
Television Programs	60.1	25.6	6.3	26.7	33.5
Museums/Exhibits	28.2	8.5	4.2	11.1	12.6
Volunteer Service or Environment Project	10.0	4.9	8.3	4.4	8.8
Outside Lectures	46.2	35.3	18.1	22.2	30.5
Field Trips to Natural Formation or Ecological Area	29.4	7.3	2.1	2.2	11.3
Volunteer Services on Educational/Community Project	13.8	6.1	7.6	2.2	12.4
Tutoring	39.4	52.4	32.6	28.9	40.0

Interdisciplinary Courses

Instructors were asked to indicate whether the class they were teaching was conducted as an interdisciplinary course. The information appearing in Table 17 reveals that 17 percent of the engineering class sections surveyed were being conducted as interdisciplinary courses. The involvement of instructors from other disciplines was mostly in course planning (46%) and, to a much lesser extent, team teaching (8%) and offering guest lectures (13%).

Table 17

Percent of Science Offerings Conducted Interdisciplinary Courses

	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Interdisciplinary courses	8	6	17	11	10
Instructors from other disciplines involved in course planning	38	100	46	60	52
Instructors from other disciplines involved in team teaching	8	---	8	20	8
Instructors from other disciplines offering guest lectures	23	---	13	20	14

PART IV

FACULTY SURVEY

Method

The Center's Instructor Survey, which was returned by 1,275 instructors, 144 of which were teaching engineering, contained several items concerned with faculty demographics, activities, and working conditions. Data reported in this part of the monograph are based on the same sample of instructors and the same survey instrument described in the preceding section on instructional practices (Part III).

RESULTS

Degree Attainment

Engineering instructor's were much less likely than those in the total sample to hold a master's degree (59% vs 74.3%) or a doctorate (4.2% vs 14.5%). Just over 25 percent of the engineering instructors held bachelor's degrees--a figure that was over three times greater than that of the total sample. The remaining 11 percent of the engineering instructors either did not hold a college degree (2.1%) or did not responsed to the survey item.

Table 18

Percent of Instructors at Each Level of Degree Attainment, Employment Status, and Teaching Experience

	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Degree Attainment					
Bachelor's	5.6	1.2	25.7	2.2	8.3
Master's	75.0	63.4	59.0	66.7	74.3
Doctorate	17.5	35.4	4.2	31.1	14.5
Employment Status					
Full-Time	73.8	79.3	77.1	77.8	74.3
Part-Time	13.1	9.8	13.2	11.1	15.6
Chairperson/ Administrator	2.5	4.9	4.2	4.4	4.2
Teaching Experience					
0-2 years	11.9	11.0	11.1	15.5	12.7
3-10 years	53.8	54.9	48.7	44.4	55.6
Over 10 years	33.2	34.1	40.2	40.0	31.0
Employed in Research/ Industrial Position					
Yes	8.1	6.1	18.8	11.1	10.0
No	90.0	93.9	80.6	88.9	88.6

Employment Status

The data presented in Table 18 reveal that 77 percent of the engineering instructors were teaching full-time at their college, while 13 percent were doing so on a part-time basis. The remaining four percent of the respondents characterized themselves as department/division chairpersons or administrators. In terms of employment status, engineering instructors were generally similar to those in the comparison science groups and the total sample.

Teaching Experience

As shown in Table 18, close to one-half (48.7%) of the engineering instructors have been teaching at a community college between three and ten years, while an additional 40 percent have taught for eleven years or more. This latter figure was somewhat higher than that found for the total sample (40.2% vs 31%). The remaining eleven percent of the engineering faculty have been teaching at a community college for two years or less.

Previous Employment in Related Industry

Instructors were asked to indicate whether they had been employed in an industry or research organization related to the field in which they were teaching. As illustrated in Table 18, engineering instructors were more likely than those in the total sample to have the experience of working in an industry or research organization related to their teaching field (18.8% vs 10%).

Use of Support Services

Faculty members were asked to indicate whether in their class they used each of the eight support services listed in Table 19. Over 50 percent of the engineering instructors used college clerical help (59%), media production facilities (33.3%), library/bibliographic assistance (26.4%), and laboratory assistants (20.8%). With two exceptions--laboratory assistants and readers--engineering faculty were less likely than those in the total sample to take advantage of the various instructional support services provided.

Table 19

Faculty Use of College Instructional Support Services

Support Service	Biology (n=160)	Chemistry (n=82)	Engineering (n=144)	Physics (n=45)	Total (n=1275)
Clerical Help	76.9	69.5	59.0	68.9	69.1
Test-scoring Facilities	38.1	22.0	15.3	11.1	25.1
Tutors	37.5	53.7	18.8	31.1	35.9
Readers	3.8	11.0	6.9	6.7	5.4
Paraprofessionals	18.8	19.5	9.7	6.7	13.6
Media Production	54.4	40.2	33.3	28.9	37.9
Library/Bibliographic Assistance	52.5	42.7	26.4	24.4	34.4
Laboratory Assistants	49.4	57.3	20.8	31.1	19.9

Working Conditions

One of the items on the survey instrument asked faculty members to indicate what it would take to make their course better. The information summarized in Table 20 demonstrates that 45 percent of the engineering instructors noted that their class could be improved if they had students who were better able to handle the course material. Other changes desired by 30 percent or more of the engineering faculty were: instructor release time to develop course and/or materials (40.3%), better laboratory facilities (36.1%), availability of more media or instructional materials (33.3%), and stricter prerequisites for admission to class (31.9%).

Table 20

Percent of Engineering Instructors Desiring Change in a Particular Institutional Area

Institutional Area	Engineering	Total
More freedom to choose materials	6.3	9.4
More interaction with colleagues/ administrators	11.1	18.0
Less interference from colleagues/ administrators	4.2	4.3
Larger classes	14.6	8.3
Smaller classes	20.8	28.9
More reader/paraprofessional aides	10.4	13.3
More clerical assistance	16.0	17.2
Availability of more media or instructional materials	33.3	35.9
Stricter prerequisites for admission to class	31.9	30.5
Fewer prerequisites	.7	.5
Instructor release time to develop course and/or materials	40.3	38.0
Different goals and objectives	2.8	3.8
Professional development opportunities for instructors	26.4	24.5
Better laboratory facilities	36.1	21.2
Students better prepared to handle course requirements	45.1	53.0
Changed course description	7.6	5.6

PART V

SUMMARY AND RECOMMENDATIONS

This section includes a summary of the most important findings concerning engineering technology education 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 or 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 engineering technology instructors.

Engineering Curriculum

Engineering technology constitutes a significant portion of the two-year college science curriculum. Offerings in engineering technology accounted for 20 percent of all the science courses and 33 percent of the laboratory sections considered in this study. Based on these criteria, engineering technology is the second largest area in the two-year college science curriculum--mathematics is the largest area.

Overall, 87 percent of the colleges listed at least one engineering course in their class schedules during the one-year time period considered. Virtually all of the public community colleges but only one-half of the private institutions offer courses in engineering technology. Results from the Curriculum Study showed that college size is positively related to the number and range of engineering courses offered. Large colleges were much more likely to offer a course in any one engineering area than were the medium-sized colleges which were more likely to do so than the small colleges. The greater variety of course offerings found in large colleges may make them better able than smaller institutions to meet the varied needs of students attending two-year colleges. These data suggest that smaller colleges may have difficulty responding to a heterogeneous student body with appropriate offerings. Smaller colleges, however, may be more homogeneous, thus alleviating them of the necessity of offering a wide range of courses.

The most frequently offered courses are in engineering graphics and design, electrical/electronic technology, and mechanical engineering; courses in general engineering and aeronautical, automotive, and combustion are the least frequently offered.

Over 80 percent of the engineering faculty who responded to the Instructor Survey indicated that their courses were designed for students in occupational degree programs while just under 50 percent described their courses as parallel or equivalent to a lower division college level course at transfer institutions. Less than ten percent of the engineering faculty felt the course they were teaching was appropriate for transfer students majoring in a non-science area, non-degree or certificate oriented students, transfer students majoring in a natural resource or allied health field, or occupational students in allied health area. Although a large percentage of the students attending two-year colleges are academically underprepared, less than one percent of the engineering instructors said their course was offered as a high school make-up or remedial course. The findings along with the high percentage of engineering courses that carry a prerequisite indicate that relatively little effort is being made to attract non-majors into engineering technology courses.

Instructional Practices

The results of the Center's study on instructional practices showed that, on the average, 82 percent of the 23.5 students who initially enrolled in an engineering technology course completed it and received a grade. There were nearly five times as many males enrolled in engineering courses as females. In fact, engineering courses attracted fewer females (less than four) than any of the other eleven science and social science areas considered in this study.

The instructional approaches used by most of the two-year college engineering teachers appear to be rather traditional. They rely primarily on lecture and class discussion to transmit information to their students. Textbooks are the most widely used instructional material, but there is considerable dissatisfaction with them. This dissatisfaction may result from a combination of factors. First, there is a nationwide decline in student reading scores; the impact of this is very strong at the two-year college level and may in effect make many of the college texts unsuitable. Second, the available texts may presuppose a science and/or math background that is no longer valid, given today's heterogeneous student clientele.

Just over 80 percent of the engineering instructors indicated that it was "very important" that their students demonstrate on their tests an acquaintance with the concepts of the discipline. Other competencies stressed by engineering faculty were, in descending order, understanding the significance of certain works, events, phenomena, and experiments; mastery of a skill; ability to synthesize course content; recall of specific information; and relationship of concepts to student's own values. About one-third of the engineering instructors based their students' grades on the results of essay exams, quick-score objective tests, and laboratory reports. The engineering faculty were more likely than instructors in the other areas of science to place a strong emphasis on completion of problem sets, homework, and workbook completion.

In terms of examination items, ten percent of the engineering instructors said they frequently include solutions of math problems on their examinations. Less than half of the instructors frequently called upon their students to construct graphs, diagrams, etc., respond to multiple choice items, or provide written answers to completion items or essay exams.

Engineering instructors differed from those in the total sample in several areas. The former were less likely than the latter to indicate that their courses were appropriate for students in most of the colleges' constituency groups, to use a variety of instructional media, and to require or recommend their students to attend out-of-class course-related activities. Engineering instructors, on the other hand, were more likely than those in the total science sample to be involved in interdisciplinary courses.

Engineering Instructors

The results of the Center's Instructor Survey show that engineering instructors were much less likely than those in the total science sample to hold a master's degree (59% vs 74.3%) or a doctorate (4.2% vs 14.5%). Just over 25 percent of the engineering instructors held a bachelor's degree--a figure that was over three times greater than that of the total sample.

Close to half (47.8%) of the engineering instructors have been teaching at a community college between three and ten years while an additional 40 percent have taught for eleven years or more. Approximately three-fourths (77%) of the faculty teaching one or more engineering courses at the two-year college did so on a full-time basis. The remaining instructors were employed on a part-time basis (13.2%) or were serving in the role of chairperson/administrator (4.2%). Less than 20 percent of the engineering instructors had the experience of working in an industry or research organization related to their teaching field.

In terms of working conditions, the Center's study found that only 44 percent of the engineering instructors who used a textbook said that they had "total say" in its selection; the textbooks for 18 percent, however, were selected by someone else. Somewhat similar results were found concerning the selection of laboratory materials and workbooks.

Over 40 percent of the engineering instructors noted that their class could be improved if they had students who were better able to handle the course material. Other changes desired by 30 percent or more of the engineering faculty were: instructor release time to develop course and/or materials, better laboratory facilities, availability of more media or instructional materials, and stricter prerequisites for admission to class.

RECOMMENDATIONS

The suggestions presented in this report are based on a synthesis of the information gained from the literature reviews, Center studies of curriculum and instruction in the sciences, and its study of humanities education in the two-year college (Cantor and Martens, 1978). This latter study, which involved case studies of 20 diverse community colleges to identify the internal and external influences that shape the curriculum, is an extremely fertile source for suggestions on how instruction in the community college can be strengthened.

Expanding Enrollments for Non-engineering Technology Majors

Most community colleges adhere to an open-admissions policy, admitting virtually anyone who wishes to enroll in their courses. One outcome of this admissions policy is that the community college faculty members are often charged with providing instruction that is appropriate and meaningful to a group of students who vary considerably in terms of their educational backgrounds, goals, and attitudes towards learning. Surprisingly, an intensive review of the published literature on engineering technology education yielded little information on questions concerning course content, orientation, requirements, and methods of presentation for the various non-traditional and non-degree oriented students attending community colleges. Furthermore, the results of the Center's Curriculum Study showed that relatively few of the engineering courses were designed for students in non-engineering technology areas.

What can people in a position to influence engineering education in the two-year college do to expand the diversity of students who are exposed to their discipline? We recommend that:

1. Colleges offer courses that are in line with the educational aspirations and interests of students in each of the many groups they serve. The most obvious solution to this problem would be for two-year colleges to offer general, transfer, occupational, remedial and personal enrichment courses in a wide range of engineering areas. Unfortunately, few of the colleges (especially the middle-sized and small institutions) can afford the luxury of hiring faculty to teach such a wide variety of courses in engineering. However, departments could expand their course offerings through the use of self-instructional learning packages. For example, a two-year college could offer a course called "Engineering Technology I." Students who enrolled in this class could take such self-instructional courses on the uses and importance of engineering technology in such fields as nursing, sociology, history, economics, chemistry, and literature. One or two staff members would supervise the courses, and students would receive credit in the area of engineering they completed (e.g., "The Effects of Technological Change on Society").

2. Instructors introduce engineering modules or entire engineering courses into non-engineering programs. These short presentations could motivate a number of students who might not otherwise enroll in an engineering course.

3. Engineering faculty become involved in planning programs and courses with instructors in other academic and occupational areas. For example, engineering instructors and history instructors could develop and teach jointly a course in Technological Change in the Twentieth Century.

4. Faculty members make overt efforts to acquaint students into their classes. This can be done by describing their courses to non-engineering colleagues, who then, familiar with the content and the instructors, could recommend the courses to their students.

5. Faculty members encourage college counselors and program advisors to recommend that students in all program areas take an engineering technology course. Instructors may have to convince counselors to "sell" engineering to prospective students, especially women and minorities. Engineering faculty should work closely with counselors and serve as program advisors to assure that students interested in Engineering receive extensive counseling and guidance to

enable successful placement and performance in the program of their choice. This emphasis on counseling and constant monitoring of students is one way of increasing retention.

6. Engineering instructors offer their services as guest lecturers at the local secondary schools as a method of generating interest in engineering, and thus laying a foundation for the continuation of such interest at the college level. This awareness and interest in engineering can also be enhanced through publicity and exhibits. Increased articulation with secondary schools is especially important in that most students at this time are not exposed to engineering in these institutions.

7. Engineering faculty offer non-credit courses, lectures, and special-interest programs through the community service and continuing education divisions. The importance of attracting individuals participating in courses or programs not carrying credit becomes evident when one considers that in 1976 there were nearly as many students participating in non-credit courses (3.2 million) as there were in credit courses (3.9 million).

8. Instructors utilize the campus public information office to publicize their courses.

Designing Courses Appropriate for All Students

If engineering departments wish to increase their course enrollments, they will have to be more aggressive and imaginative in the methods they employ to attract new students. They will also have to be more skillful in devising effective instructional approaches to meet the diverse learning needs and objectives of students in each of the colleges' constituency groups. The success instructors have in meeting this challenge depends on their initiative, on opportunities for their professional development, and on the quality of their formal educational training in preparing them to teach in the two-year college. In order to offer engineering courses that are appropriate for all two-year college students we recommend that:

9. Disciplinary associations work to provide information on new courses and combinations of courses appropriate to the unique needs of individual students attending two-year colleges.

10. More research and sharing information be undertaken on questions concerning what the course content, orientation, requirements, and methods of presentation should be for the various non-traditional and non-degree-oriented students attending the two-year colleges.

11. Research be conducted on what instructional materials and approaches are appropriate for students who have poor language, reading, and math skills, as well as for those whose orientation to learning is much more practical and non-theoretical than that of traditional college students.

12. Textbook publishers and developers of educatonal technologies work with two-year college engineering instructors to produce materials that are consistent with students' educational competencies and objectives.

13. Instructors design engineering courses in line with the unique learning abilities, goals, and interests of students in each of the colleges' programs--general education, transfer, occupational, remedial, and continuing education. This can be achieved by offering separate courses for each of the colleges' constituency groups and/or through the use of specially developed learning packages as well as other individualized instruction techniques.

14. Faculty members be given additional opportunities to develop different instructional approaches suitable for different student groups. College administrators can contribute to the professional development of their instructors by offering faculty fellowships, instructional development grants, summer pay, release time to aid faculty in developing their own courses and instructional materials, and sabbatical leaves for studies appropriate to instructors' teaching fields.

15. Faculty members be given opportunities to discuss educational issues with representatives of companies that employ engineering technologists.

16. Disciplinary associations sponsor programs so that faculty members in two-year colleges will be apprised of special events in their fields, new approaches to teaching, and opportunities for special training.

17. Federal and state agencies provide engineering instructors with grants to develop specialized courses, learn about the latest developments in their field, and be exposed to engineering teachers from institutions other than their own.

18. University graduate departments in engineering technology develop training programs for current and prospective two-year college instructors. These programs should develop students' knowledge of engineering technology, pedagogical skills, familiarity with instructional technologies, and research competencies needed to test the effectiveness of various teaching techniques.

Studies, such as the one reported here, need to be replicated to keep engineering curriculum planners aware of the nature of the curriculum, especially in light of the changing demands within the field of engineering. The Center's study can be judged successful if it stimulates creative efforts by engineers and engineering technologists to address the unique and challenging demands of the two-year college.

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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. and C.C./
Terry Campus
Goldey Beacom

Maryland

Dundalk
Hagerstown
Harford
Howard
Villa Julie

New Jersey

Atlantic
Middlesex County

Pennsylvania

Allegheny County/Boyce
University of Maine/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

APPENDIX A (continued)

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 Va.
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

APPENDIX A (continued)

Michigan

Bay de Noc
Delta
Kalamazoo Valley
Kirtland
Monroe County
Oakland
Suomi

Minnesota

Austin
North Hennepin
Northland
Univer. of Minnesota Tech.
Wilimar

Missouri

St. Paul's
Three Rivers

Nebraska

Metropolitan Tech.
Platte Tech.

Ohio

Edison State
Lorain 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 PLAINS

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

APPENDIX A (continued)

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

460-006

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)** 31

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

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 workbooks	____ 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	☐ 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

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

13a. **What grading practice did you employ in this class?** 29

ABCDF	☐ 1
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?** 41

Yes	☐ 1
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

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