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ABSTRACT

In November 1985, the American Chemical Society's (ACS's) Committee on Education invited 43 participants, including two- and four-year college chemistry teachers, administrators, and representatives from various agencies and the chemical industry, to identify issues affecting two-year college chemistry education and to make recommendations to agencies capable of addressing these issues. The conference was organized around 12 topics: two-year colleges today, two-year college chemistry students, chemistry faculty, curricular trends, chemical technology programs, teaching chemistry in two-year colleges, curricular guidelines, the use consultants for program development, administrative and financial support, articulation among colleges, National Science Foundation perspectives, and regional accreditation programs. Drawing from discussions held at the conference, this report presents recommendations to: (1) the National Science Board, concerning such topics as faculty growth and development, laboratory and instructional equipment, and curriculum improvement; (2) the ACS's Committee on Education, offering guidelines for chemistry education in the two-year colleges, consultation and outreach, and the development of public understanding of the sciences; (3) the governing bodies of the ACS; (4) the two-year colleges, concerning college faculty, administrators, and governing boards; and (5) other professional organizations. A list of conference participants is included. (EJV)

CRITICAL ISSUES IN TWO-YEAR COLLEGE CHEMISTRY

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The Two-Year College Chemistry Conference of the Division of Chemical Education, Inc. *generously provided partial financial support for the Conference and the distribution of this report.*

COVER—NORTHERN VIRGINIA COMMUNITY COLLEGE—ALEXANDRIA CAMPUS, J. PICKERELL

Introduction

The American Chemical Society Committee on Education periodically brings together recognized authorities in science education to discuss contemporary issues and to recommend future directions for the Society's endeavors. In November of 1985, 43 invited conferees met in Chevy Chase, Maryland, to identify critical issues in two-year college chemistry education, and to make recommendations to the agencies capable of addressing these issues.

The Participants

The individuals invited to the conference were selected to bring many years of diverse experience to the conference deliberations. The size, scope, and complexity of the issues necessitated bringing together delegates from every conceivable sector of two-year college science education. The two-year college chemistry teachers were joined by two-year college physics and biology teachers (representing their professional associations); four-year college chemistry teachers; part-time teachers; two-year college administrators (including a college president, a member of a board of trustees, a divisional dean, and a member of a state board for community college education); and representatives from teachers' unions, federal funding agencies, regional accrediting bodies, professional associations, and the chemical industry. The list of participants appears at the end of this report.

Two-Year Colleges Today—Connie Sutton-Odems
Two-Year College Chemistry Students—Lucy Pryde
Two-Year College Chemistry Faculty—Tamar Susskind
Curricular Trends in Two-Year Colleges—William Mooney
Chemical Technology Programs—Harry Hajian
Teaching Chemistry in Two-Year Colleges—Doris Kolb
Curricular Guidelines for Chemistry—Donald Jones
Using Consultants for Program Development—William Cook
Administrative and Financial Support—Edmund Bradford
Articulation among Colleges—Jeff Davis
National Science Foundation Perspectives—Robert Watson
Regional Accreditation Programs—Robert Swenson

***Figure 1.* Papers presented at the conference.**

The Program

The Society Committee on Education Task Force on ACS Involvement in the Two-Year Colleges organized the conference around 12 topics (see Figure 1). The Task Force also selected an expert in each topic and invited those persons to prepare a paper for presentation at the conference.

Following presentation of the papers, the participants separated into eight topical discussion groups to consider the information that had been presented. Each topical group (see Figure 2) developed a list of recommendations that addressed the issues raised during their deliberations. All conference participants met together on the final day of the meeting to discuss the eight lists of recommendations.

The lists of recommendations were eventually combined with several other recommendations received from individuals, sorted according to the group or body charged with implementation, and redistributed to the conference participants who assigned a priority rating to each recommendation. The recommendations that follow in this report are organized by groups, according to the implementation body. Within each group, the recommendations follow the order of priority assigned by the conferees.

It was apparent at the close of the conference that a great deal needs to be done to help two-year colleges meet the challenges of their expanding role in modern chemistry education. Much of the responsibility for these needed efforts falls squarely upon the shoulders of the faculty, administrators, and local governing boards of individual community colleges. The governing bodies for higher education in the states, too, must facilitate these efforts by encouraging and supporting improvements.

A great many of the issues raised during the conference are global in nature and can be addressed only by groups with nationwide influence. However, the American Chemical Society and the National Science Foundation can only establish programs, they cannot implement them. Unless individuals at the state and local levels take an active role in implementing these programs, there will be no improvement in two-year college science education.

Chemistry Courses for Science and Engineering Programs
Chemical Technology Programs
Chemistry Courses for Other Programs
Chemistry Faculty Issues
Financial Support for Programs
Industrial Articulation and Support
Four-Year College Articulation
Instruments and Computers

***Figure 2.* The discussion groups**

Recommendations of the 1985 Invitational Education Conference of the American Chemical Society:

ACS PHOTO, C. BORGFORD

Copies of the presented papers as well as communications from participants and other interested individuals are available at no cost. Write: Two-Year Colleges Program, American Chemical Society, 1155 Sixteenth Street, N.W., Washington, DC 20036.

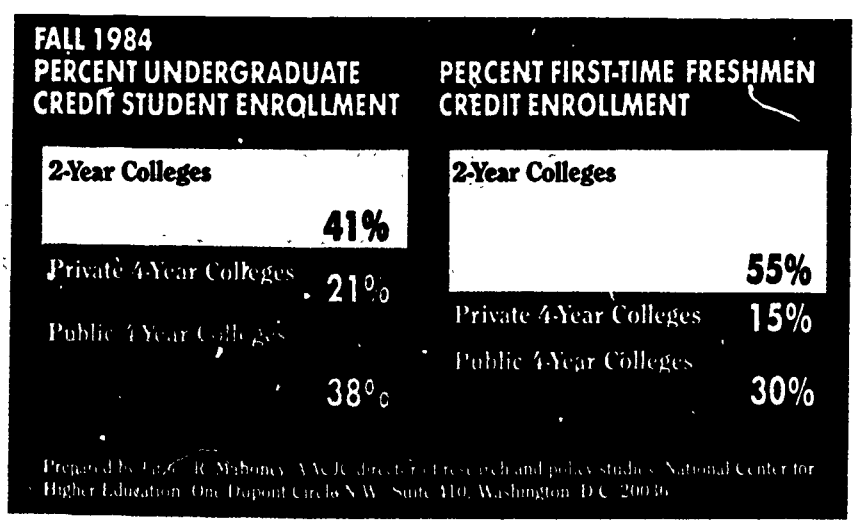
To the National Science Board

Two-year colleges constitute a significant segment of, and make a major contribution to, undergraduate science and engineering education in the United States. The magnitude of this contribution is reflected in the fact that two-year colleges presently enroll 41% of all undergraduate *credit* students, 55% of all first-time college freshmen, and more than 50% of all minority students.

Modern, comprehensive community colleges, regardless of their varied histories and public images, are today providing the first two years of postsecondary education for substantial numbers of students who eventually receive a baccalaureate degree. These graduates are the nation's next generation of scientists, engineers, and teachers. It cannot be in the country's best interest to neglect the all-important first years of their college education.

Three very serious problems undermine the ability of two-year college chemistry departments to fulfill their role as providers of high-quality science education for both transfer and technical students. These colleges:

1. Are frequently staffed with overworked faculty who have few resources for professional growth.
2. Are chronically plagued by inadequate laboratory and instructional equipment.
3. Are forced to accommodate large numbers of underprepared students.



These problems are of such magnitude that only the federal government, acting through the National Science Foundation in its role as the leader in science research and education, can affect the needed changes.

We call upon the National Science Board to recognize (a) the indispensable contribution that contemporary two-year colleges already make to undergraduate science and engineering education, and (b) their potential for greatly increasing that contribution provided they receive the guidance and support of the federal government at a level consistent with their current and potential role in educating America's next generation of scientists.

Community, technical, and junior colleges continue to provide the majority of American college students with their first experience in higher education. Two-year colleges enroll the largest share of undergraduates compared with private and public four-year colleges.

Community colleges are the first and best opportunity in postsecondary education for many students.

Faculty Growth and Development

We recommend that the National Science Foundation increase its level of activity in providing faculty development opportunities to college science teachers at minimum personal expense. Specifically, the NSF should

- support an expansion of the existing Institute for Chemical Education (ICE) that will enable ICE to provide in-service development for two-year college chemistry teachers;
- re-establish faculty development opportunities for college science teachers such as the College Science Improvement Program (COSIP), Chautauqua courses, and other programs for growth and renewal that are scheduled during times when faculty can participate; and
- establish programs to provide additional in-service education, via modern instructional delivery methods, to two-year college chemistry teachers who are unable to attend conferences and workshops.

Laboratory and Instructional Equipment

We recommend that the National Science Foundation increase its level of activity in supporting the acquisition of modern instrumentation in the two-year colleges. Specifically, the NSF should

- modify the Undergraduate Research Participation Program to encourage research by students (directed by two-year college faculty) in the two-year colleges,
- modify the College Science Instrumentation Program so that two-year colleges become eligible for funds,
- provide support for a number of regionally located and well-equipped, model science laboratories in two-year colleges,
- make umbrella grants to professional associations (or state two-year college agencies) which would then make smaller disbursements to individual colleges submitting proposals for the purchase of instruments costing under $3,000, and
- establish a program to support cooperative instrument repair services that could be used by a number of institutions in a geographic area.

Curriculum Improvement

We recommend that the National Science Foundation continue its support of exisiting programs in the new instructional technologies, such as Project Seraphim, and expand these efforts to specifically include material for use in two-year colleges. The Foundation should also establish new programs to take full advantage of modern electro-optical technologies, such as compact disks, teleconferencing, and videodisks, that would enable two-year colleges to bring enhanced learning opportunities to their students.

To the American Chemical Society Committee on Education

The Society Committee on Education (SOCED) is the ACS committee charged with establishing and monitoring the education policy of the Society. Because of its prominence in this area, the recommendations directed to SOCED are listed here, separate from those recommendations directed to other ACS governing bodies.

The Society Committee on Education has been an ardent supporter of programs for two-year college chemistry teachers for some time. This support became much more visible in 1984, when the Committee was instrumental in establishing the Two-Year Colleges Program within the ACS Education Division. The Two-Year Colleges Program publishes the *2YC Distillate*, a newsletter for two-year college chemistry teachers; collaborates in the preparation of guidelines for academic chemistry and chemical technology programs; and serves as a central mechanism for implementing the two-year college activities of the parent Society, its Division of Chemical Education, and other agencies operating in this area.

The 1984 report of the ACS Task Force for the Study of Chemistry Education in the United States, "Tomorrow," recommended that the Society take a more active role in two-year college chemistry education. In response to this, the Society Committee on Education established a Task Force on ACS Involvement in the Two-Year Colleges and devoted the 1985 Invitational Education Conference to the topic of issues in two-year college chemistry.

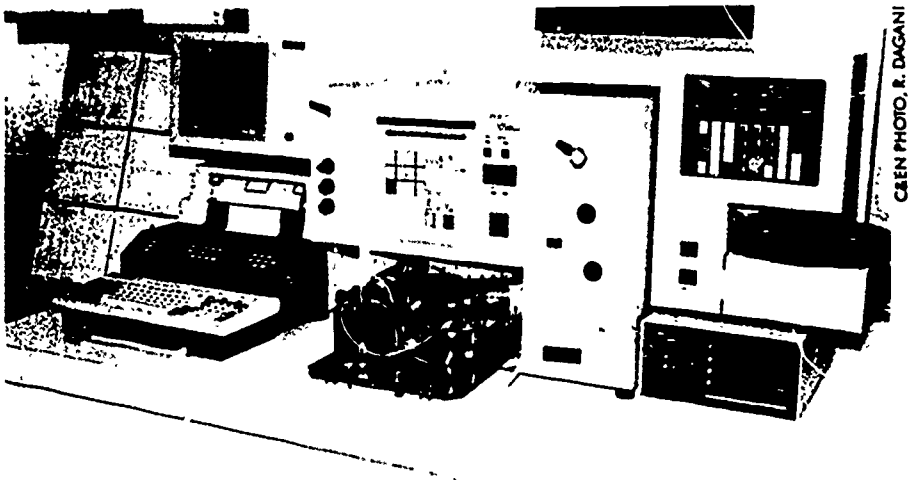
During the conference, it became apparent that the American Chemical Society is far and away the nationwide leader in two-year college science education. No other professional disciplinary organizations have the mechanisms in place to serve as the focal point for improvements in the science programs of two-year colleges. Because of this position, it is incumbent upon the Society, acting through its Committee on Education, to make every possible effort to implement the following recommendations.

Guidelines for Chemistry Education in the Two-Year Colleges

We recommend that the Society Committee on Education direct its Task Force on ACS Involvement in the Two-Year Colleges to include in its guidelines for chemistry education in the two-year colleges

- an emphasis on the need for a full complement of developmental courses, including an assessment and advising system, designed to prepare students for college-level chemistry courses;
- a strong recommendation urging colleges to adhere to stated prerequisites for enrollment in a course;
- a strong recommendation that colleges provide chemistry courses for groups of students with specific needs, such as individuals majoring in allied health, occupational or engineering technology, general education, or science and engineering;
- a series of chemistry curriculum monographs, developed in cooperation with other professional societies, to guide the teaching of chemistry courses for students not majoring in science or engineering;
- an emphasis on the need for colleges to offer all courses for science and engineering students at least once each academic year;
- a strong recommendation that colleges be flexible in terms of both time and curriculum in the scheduling of chemical technology courses so that these courses meet the needs of all students, whether they are enrolled full-time, part-time, or for continuing education;

Two-year college chemistry teachers average 18 to 20 contact hours each week. Professional development for these dedicated individuals must be accompanied by financial support for travel and coverage of classes.



C&EN PHOTO, R. DAGANI

The purchase and maintenance of modern laboratory equipment is presently impossible for many two-year colleges.

. . . the American Chemical Society is far and away the nationwide leader in two-year college science education.

• an emphasis on the need for chemical technology programs to have an advisory group made up of college faculty, high school faculty, and local industrial representatives;

• a recommendation that colleges follow the progress of their former chemical technology and transfer students as a significant aspect of their self-evaluation program;

• a strong recommendation that college administrators adopt and maintain comprehensive programs for faculty growth and renewal;

• a plan that encourages the involvement of both administrators and chemistry faculty in budgetary decisions affecting the chemistry programs and acknowledges their respective responsibilities associated with governance and formal authority; and

• a clear statement to assist the college community in establishing appropriate teaching loads and in allocating the support services necessary for quality chemistry instruction.

Once completed, we recommend that these guidelines be sent to the appropriate regional accrediting agencies for reference in their accrediting activities.

Consultation and Outreach

We recommend that the Society Committee on Education encourage the College Chemistry Consultants Service to expand its activities in the two-year college area so that it becomes a mechanism for implementing the above guidelines in the nation's two-year colleges. This can be accomplished by the Service

• including more persons experienced in two-year college chemistry education in its list of consultants,

• establishing a mechanism for training the consultants in the use of the guidelines for chemistry education in the two-year colleges, and

• publicizing the availability of the consultants and guidelines, and encouraging colleges to use the Service during self-studies.

Public Understanding of Science

We recommend that the Society Committee on Education further its efforts in increasing the public's understanding of science by encouraging the staff Education Division to identify funding sources and submit proposals for projects to

• develop a set of curriculum materials for a course on "chemistry and society," similar to the existing CHEMCOM project but adapted to the college level; and

• prepare a series of 15 to 20 videotapes of well-known chemists and excellent teachers presenting lectures on topics at the science/society interface.

Two-year college partnerships with elementary and secondary schools can make a substantial improvement in science education.

Multidisciplinary Conferences

We recommend that the Society Committee on Education convene a multidisciplinary conference to bring together representatives of the professional scientific societies of biology, chemistry, engineering, geology, mathematics, and physics. The goals of this conference should be to

- address the issues of poor preparation and placement of science students;
- prepare a program, to be presented at the meetings of the American Association of Community and Junior Colleges, that raises common concerns in the areas of faculty needs and educational priorities to college administrators;
- develop a position paper that encourages college curriculum committees to include a course on science/society issues in the requirements for graduation;
- prepare materials to inform faculty members about the limitations placed on administrators by local fiscal and policy constraints;
- prepare materials to inform the public and public officials about the importance of supporting science education in the schools; and
- prepare recommendations to federal agencies similar to those in this publication that are addressed to the National Science Board.

Comprehensive Survey of Two-Year Colleges

We recommend that the Society Committee on Education collaborate with the American Association of Community and Junior Colleges on a comprehensive survey of the nation's two-year colleges. This survey should collect data on

- assessment and placement testing programs in chemistry;
- developmental and remedial chemistry courses;
- service courses for allied health, engineering technology, and other occupational majors;
- courses for chemistry and other science and engineering majors;
- courses for nonscience and nonengineering majors;
- courses and programs for chemical technology;
- course enrollments and attrition rates;
- high school backgrounds of students;
- articulation agreements between two- and four-year colleges;
- programs to follow the progress of both chemical technology and transfer program graduates;
- the current state of, and need for, laboratory and instructional equipment; and
- especially effective learning aids and teaching techniques for presenting chemistry to nonscience and specific occupational majors.

The results of this survey should be widely and appropriately distributed.

Instrumentation and Professional Development

We recommend that the Society Committee on Education, within the scope of its mission and influence, assist the efforts of the National Science Foundation in addressing two of the most pressing problems in two-year college science education. Specifically, the Committee should

- work through appropriate agencies to urge instrument manufacturers to make every effort to reduce the cost of instrument repair, perhaps through tax deductions for contributions to academic institutions;
- encourage the staff Education Division to identify sources of equipment donations and cooperative instrument repair services, and to publish this information; and
- encourage the staff Education Division to expand its efforts in identifying professional development opportunities for two-year college chemistry faculty, and to continue to disseminate this information.

To the Governing Bodies of the American Chemical Society

One of the great strengths of the ACS is the tremendous diversity of its members. Their widely varying interests and areas of expertise enable the Society to attack problems on many different fronts. We believe that the Society's committees and divisions, even those with missions other than directly improving education, have much to contribute to the solution of the problems facing two-year college chemistry programs.

We recommend that the information collected by the Committee on Chemical Safety for the handling and disposal of hazardous materials be widely distributed among two-year college faculty members.

We recommend that the Committee on Grants and Awards establish an industrially sponsored award for excellence in teaching and for contributions to chemistry education at the two-year college level.

We recommend that the Committee on Professional Training include in its guidelines publications a specific discussion of the importance of regular interaction among the faculties of two- and four-year colleges serving the same area. We also recommend that CPT work with the Society Committee on Education to collect data on the successes and problems experienced by two-year college students who transfer to four-year schools.

. . . the Society's committees and divisions, even those with missions other than directly improving education, have much to contribute . . .

We recommend that the Committee on Technician Activities conduct studies, on a regular basis, to determine the desirable characteristics of chemical technology programs and the relationships these programs should have with other academic areas and with the chemical industry. An additional goal of these studies should be to determine the manpower needs of the chemical industry for chemical technicians.

We recommend that the Division of Analytical Chemistry develop and distribute a registry of individuals, knowledgeable about specific instruments, who can provide information to colleges on the purchase, maintenance, and repair of instruments.

C&EN PHOTO, W. WORTHY

Industrially sponsored awards have been very successful in recognizing and publicizing excellence in teaching at the high school level.

We recommend that the Division of Chemical Education, in conjunction with its Committee on Chemistry in the Two-Year Colleges, stage professional development activities during ACS national and regional meetings that are especially attractive to two-year college chemistry teachers. One component of these activities should be workshops that bring together representatives from the colleges' research offices, foundation offices, public communication offices, administrations, and chemistry faculties to share information about locating funds for chemistry departments.

We recommend that the members of the ACS Local Sections make every effort to bring two-year college chemistry faculty members into the mainstream of ACS activities. We also recommend that local section members work with the two-year colleges to establish advisory committees for academic chemical technology programs, and to establish mechanisms for continuing industrial education, job exchanges between industry and academe, cooperative education, and public understanding of chemistry projects.


K. WALTON

To the Colleges

Addressing the problems facing two-year college chemistry education may, to a large extent, require the intervention of organizations whose missions are national in scope. This is not to say, however, that there is not much to be done at the state and local levels. It is the responsibility of the individual colleges and their governing bodies to initiate and sustain activities that improve science education in the United States.

College Faculty

We recommend that chemistry teachers in two-year colleges establish advisory groups to bring together faculty members, industrial representatives, and administrators for the purpose of sharing needs and expectations. Faculties should work with ACS local sections to identify the industrial representatives for these advisory groups.

We recommend that chemistry teachers in two-year colleges establish ongoing programs with four-year college chemistry faculty to help minimize articulation problems for transfering students.

We recommend that chemistry teachers in two-year colleges participate regularly in continuing education to maintain and enhance their skills and knowledge.

We recommend that qualified chemistry faculty actively participate in developing and delivering continuing education programs for local industry.

Top right: With proper stimulation, inquisitive young minds will see chemistry as a positive aspect of education. Two-year colleges can help precollege teachers in this effort.

Participating in continuing education is a necessity, not a luxury.


C&EN PHOTO, W. WORTHY

College Administrators

We recommend that two-year college administrators and collective bargaining units encourage and support (both with funds and with the coverage of classes) the participation of faculty members in conferences, meetings, and other professional activities.

We recommend that two-year college administrators encourage their chemistry faculties to participate in regularly scheduled self-studies, perhaps with the help of the College Chemistry Consultants Service, especially in anticipation of reviews by external accrediting agencies.

College Governing Boards

We recommend that state boards of higher education establish criteria for implementing firm articulation agreements that will ensure that four-year colleges award appropriate credit for equivalent courses taken in a two-year college.

We recommend that state boards of education sufficiently fund two-year college chemistry programs so that they are able to satisfactorily prepare students for transfer to senior institutions or for immediate employment in occupations that require chemical training.

We recommend that state boards of education and teacher certifying agencies recognize the potentially valuable role of the two-year colleges in the retraining of kindergarten-through-twelfth-grade teachers; and that they establish programs that would enable the two-year colleges to contribute to the improvement of precollege education. These programs should provide funds for workshops, seminars, and short courses to be held at two-year colleges. The K-12 teachers should receive continuing education credit for completing this work. This credit should also be adequately recognized in salary and tenure decisions.

It is the responsibility of the individual colleges and their governing bodies to initiate and sustain activities that improve science education in the United States . . .

To Other Professional Organizations

Professional associations, academe, and industry can work together to increase the public's understanding of chemistry and all science.

Overcoming academe's natural resistance to change will require a leverage that can come only from a united effort . . .

The interdisciplinary nature of modern science education necessitates the cooperation of the scientific societies to accomplish genuine and lasting improvements in the preparation of the next generation of scientists and engineers. Furthermore, overcoming academe's natural resistance to change will require a leverage that can come only from a united effort of the scientific disciplines and accrediting organizations.

We recommend that disciplinary organizations such as the American Association of Physics Teachers, the National Association of Biology Teachers, the National Association of Geology Teachers, and the American Institute of Chemical Engineers convene critical issues conferences and develop guidelines and consultation programs similar to those being conducted by the Task Force on ACS Involvement in the Two-Year Colleges.

We recommend that the Triangle Coalition establish a two-year college program within its existing structure.

We recommend that the Commission on Postsecondary Accreditation, the American Association of Community and Junior Colleges, and the American Chemical Society cooperate in the formation of a task force to study ways in which the regional accrediting associations and the scientific disciplinary organizations can work together to improve the quality of two-year college science education through the regional accrediting process. This task force should investigate such techniques as increasing the use of science faculty and science divisional administrators on accrediting teams, encouraging self-studies of science programs as a part of an overall self-study, and using the discipline-oriented guidelines to assist in both the self-study and accrediting processes.

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