ACS Society Committee on Education
Task Force on Two-Year College Activities

Chemistry-Based Technology Degree Programs at Two-Year Colleges

Supplement to the *ACS Guidelines for Chemistry in Two-Year College Programs*

The *ACS Guidelines for Chemistry in Two-Year College Programs* provide a comprehensive model for high-quality chemistry education across a broad spectrum of two-year college transfer, chemistry-based technology degree, and support programs. Regardless of focus, all programs are encouraged to use the Guidelines as a starting point for the establishment and growth of excellent chemistry education. To ensure maximum flexibility, it is left to individual institutions to determine the most effective implementation of the Guidelines.

This supplement clarifies the use of the Guidelines for those institutions with chemistry-based technology degree programs. It is intended to provide additional guidance for any chemistry-based educational program whose primary goal is to prepare students to enter the workforce upon graduation. Titles for such programs vary, including Chemistry, Biotechnology, Chemical Technology, Environmental Technology, Forensic Technology, Laboratory Science Technology, Pharmaceutical Manufacturing Technology, and Process Technology.

Chemistry-based technology degree programs fill a unique niche in the technical workforce by developing the academic, technical, and employability skills of their students. In addition to the general and organic chemistry courses required by most transfer programs, chemistry-based technology degree programs may require analytical, instrumentation, or other specialty courses, such as biochemistry or laboratory safety. They may also require workplace experiences, such as internships or capstone projects.

Even though a program has a primary goal of preparing students to enter the workforce, it is often beneficial to ensure that its courses are transferable to four-year programs. Transferability adds flexibility to a program, enabling students and graduates to pursue a wider range of degrees and career paths. Transferability can also lay the groundwork for partnerships with four-year institutions. As described in Appendix I, partnering with other academic institutions supports the pooling of resources that benefit everyone. Completely transferable chemistry-based technology programs are designed to prepare students to enter the workforce upon graduation with associate degrees but offer students more flexibility. By working closely with employers, transfer institutions, and other community organizations, such programs can prepare students for fulfilling, chemistry-based technology careers.

Chemistry-based technology degree programs, like all two-year programs, are encouraged to use the *ACS Guidelines for Chemistry in Two-Year College Programs* as a framework for development of the institutional environment, faculty and staff, infrastructure, student skills, student mentoring and advising, and program self-evaluation and assessment. The Guidelines are applicable to chemistry education in all two-year colleges; however, additional clarification on the use of the Guidelines in developing partnerships, infrastructure, and curricula is provided in Appendices I-III of this supplement. Questions on applying the Guidelines in other aspects of chemistry-based programs can be directed to the ACS Office of Two-Year Colleges (1-800-227-5558, ext. 6108; 2YColleges@acs.org).

Appendix I. Partnerships

Strong chemistry-based technology associate degree programs are built on partnerships. In two years, these programs must cover a broad range of topics, including a foundation in general, organic, and analytical chemistry, instrumentation, and employability skills (such as safety, troubleshooting, and teamwork). Partnerships provide knowledge of the skills needed, resources to develop the necessary infrastructure, and, frequently, students for the program.

Chemistry-based technology degree programs should have an advisory board whose members have a vested interest in the success of the programs. The members should represent the institutions, organizations, and employers[*] partnering with the program. The advisory board is responsible for the development and maintenance of the program and its curriculum. The advisory board is also responsible for ensuring that the program keeps pace with the changing needs of employers.

Potential partners fall into four categories:

- ***Campus units (see also section 10.1 of the Guidelines)***
  Partnerships with other science-based programs and/or campus units can increase the effectiveness of chemistry-based technology programs and be mutually beneficial. Such partnerships can also lead to interdisciplinary activities that broaden the experience of both students and faculty. Additionally, partnering with other programs can boost enrollment and protect programs from termination in lean years.

- ***Employers (see also section 10.4 of the Guidelines)***
  At a minimum, chemistry-based technology programs should have an advisory board consisting of representatives from the employers that intend to hire the program graduates.[*] These can range from small local businesses to multi-site corporations, government agencies, or other employers. These partners identify the skills and knowledge program graduates will need to be competitive. They can also provide additional educational opportunities, such as internships, job shadowing, and site tours.

- ***Academic institutions (see also sections 10.2 and 10.3 of the Guidelines)***
  Depending on the program's goals, it may be beneficial to partner with other academic institutions. If students are to have the option to transfer to a four-year program, then the chemistry-based technology program should partner with the receiving program(s). Partnering with other two-year institutions can be useful for pooling resources. Partnering with K-12 institutions can help ensure that students are academically prepared for a smooth transition to college; such preparation can lead to increased graduation rates. Partnerships with other academic institutions can also provide an avenue for both outreach and recruitment.

- ***Community organizations (see also section 10.4 of the Guidelines)***
  Workforce development organizations are often intimately aware of trends in the workplace and hiring markets. Many communities also have other types of programs designed to engage students and unemployed or underemployed workers toward new careers. Chemistry-based technology degree programs should partner with community organizations that are particularly compatible with chemistry-based careers.

Partnerships should be mutually beneficial; all partners should contribute to and gain from the program. For example, employers who partner with the program can contribute knowledge of the skills students need in the workplace; they can also contribute used equipment, guest lecturers, scholarships, and mentors. In turn, they should gain the opportunity to hire employees who can transition to the workplace with little or no additional training. Such partnerships may result in opportunities for continuing education for current employees.

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[*] It is rare for program partners to be able to commit to hiring all program graduates. However, their input into the curriculum helps ensure that program graduates are good candidates for employment.

Appendix II: Program Infrastructure

The infrastructure for chemistry-based technology associate degree programs is determined, in part, by the needs of the employers. As with other types of programs, personnel, facilities, and equipment should be sufficient to meet the goals of the program. With chemistry-based technology degree programs, the program partners are sometimes able to provide some of the needed infrastructure.

Other aspects of the infrastructure that are unique to chemistry-based technology degree programs include the following:

- ***Faculty development (see also section 3.3 of the Guidelines)***
  In addition to advances in pedagogy and scientific specialties, instructors in chemistry-based technology programs need to stay current with changes in the workplace. Non-academic workplace experience is a key component of faculty development. Faculty should have opportunities for externships, job shadowing, and other workplace experiences with their program partners or other businesses. In some cases, workplace experience can be a deciding factor in the hiring process. Additionally, faculty should have opportunities to engage in the same types of professional development activities as employers; participation in professional societies, community organizations, and conferences enable faculty to make valuable connections with chemical professionals from industry and government.

- ***Facilities and equipment (see also sections 4.1 and 4.2 of the Guidelines)***
  Because of the importance of hands-on experiences (see Appendix III), chemistry-based technology degree programs typically need more equipment and laboratory space than academic and support programs. Depending on the focus of the program, specialty equipment may be needed; for example, a process technology program may need a pilot plant, while a biotechnology program may need gel electrophoresis equipment. There should be sufficient equipment for all students in the program, sufficient space for the equipment, and sufficient personnel to maintain the equipment.

- ***Student mentors and counselors (see also section 8 of the Guidelines)***
  All students benefit from communicating with counselors and advisors familiar with the academic and career opportunities available. Faculty mentors are also beneficial for guiding students through their studies. Students in chemistry-based technology programs should have the opportunity to work with mentors from the employers who are partnered with the program. Program graduates often make good mentors, since they are familiar with the transition from the classroom to the workplace.

The program's partners should be consulted in determining the appropriate faculty, support staff, facilities, and equipment for the program. In some circumstances, it may be possible for the program's partners to assist in the development of the necessary infrastructure. For example, partners may donate used equipment to the program or allow students access (either remote or on-site) to their equipment.

Appendix III: Curriculum and Experiential Opportunities

The curriculum of chemistry-based technology degree programs should be developed with input from the programs' partners. It should be evaluated and updated at least once a year to ensure that it continues to meet its partners' needs. Continual evaluation and development should enable the program to keep current with the changing workplace. Partners should assist in identifying critical shifts in employers' hiring needs, as well as avoiding "hot topics" that fade quickly.

Other issues to consider include the following:

- ***Curriculum development (see also section 5 of the Guidelines)***
  The specific skills and knowledge required by employers should be identified using a Developing A CurriculUM (DACUM) analysis, gap analysis with a set of customized skill standards, or other tools. If four-year programs are among the program partners, one or more representatives should also participate in the curriculum development.

- ***Course offerings (see also sections 5.3 through 5.11 of the Guidelines)***
  Courses should support the curriculum goals and be offered with sufficient frequency to enable a qualified student to complete the program in two years. While courses can be developed specifically to serve the degree program, courses developed for other programs are often sufficient. The use of courses that support more than one program helps keep course enrollments up during times when program enrollment is low.

- ***Technical and employability skills (see also section 7 of the Guidelines)***
  The curriculum should include the skills and knowledge of greatest importance to the program's partners. Hands-on experience should be emphasized; for example, if gas chromatography is part of the curriculum, students should have the opportunity to operate the chromatograph, as well as interpret the results. Non-technical employability skills, such as troubleshooting, searching and interpreting chemical literature, laboratory safety, communication, teamwork, and ethics should be integrated into the curriculum. Students should achieve a mastery of these and other skills required by employers prior to graduation.

- ***Internships and research opportunities (see also section 6 of the Guidelines)***
  The curriculum should include some type of long-term project, research, co-op, or internship (preferably one of the latter two). These types of experiences are best provided by the program partners, who will ultimately hire the program graduates. If such experiences cannot be arranged, on-campus internships and research projects may be arranged.

As with all programs, the curriculum and experiential opportunities should support the program goals. The goals should be developed with the program partners and should also take into account the needs of the students. For example, while students may wish to get jobs upon graduation, some may also seek higher degrees. Programs with such students should partner with four-year programs, as well as employers, in order to ensure that the degree program courses are transferrable.