# ACS Guidelines for Chemistry in Two-Year College Programs

The following is an excerpt from the *ACS Guidelines for Chemistry in Two-Year College Programs*. American Chemical Society: Washington, DC. 2015.

The complete electronic version of the *ACS Guidelines for Chemistry in Two-Year College Programs* and additional information are available at www.acs.org/2YGuidelines.

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## 7. Development of Student Skills for Academic and Professional Success

In order to prepare students to enter the workforce or further their education, two-year college programs should provide experiences that go beyond chemistry knowledge alone to develop other critical skills necessary for effective and productive professionals. Strategies for helping students acquire skill sets needed for successful careers include offering courses dedicated to student skills, integrating student-skill-focused activities into regular curricular offerings, and engaging students in research and internship experiences. Regardless of the approaches used, programs should also assess student skills and adjust the curriculum as needed to maximize their development.

The curriculum should include the skills and knowledge of greatest importance to the program's partners. Hands-on experience should be emphasized and 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.

**7.1 Laboratory safety skills.** In order to prepare students for advanced coursework and the workplace, colleges must promote a safety-conscious culture in which students understand the concepts of safe laboratory practices and apply them at all times. Students must be trained in the aspects of modern chemical safety appropriate to their educational levels and scientific needs. A strong safety culture requires that

- A high degree of safety awareness is introduced during the first laboratory course and integrated into each lab experience thereafter

- Classroom and laboratory discussions stress safe practices
- Students are actively engaged in the evaluation and assessment of safety risks associated with laboratory experiences
- Safety understanding and skills are developed and assessed throughout the curriculum

Colleges should provide students with education and training that allows them to:

- Carry out responsible waste management and disposal techniques
- Understand and comply with safety regulations
- Properly use personal protective equipment to minimize exposure to hazards
- Understand the categories of hazards associated with chemicals (health, physical, and environmental)
- Use safety data sheets (SDSs) and other standard printed and online safety reference materials
- Recognize chemical and physical hazards in laboratories, assess the risks from these hazards, know how to minimize the risks, and prepare for emergencies

**7.2 Problem-solving and critical thinking skills.** Chemistry education should develop students' ability to objectively analyze and evaluate information—identifying information of value, integrating new facts into their existing body of knowledge, and developing appropriate solutions to problems. Students should be able to define problems clearly, develop testable hypotheses, design and execute appropriate experiments, analyze data, and draw appropriate conclusions. Students should use appropriate laboratory skills and instrumentation to solve problems while understanding the fundamental uncertainties in experimental measurements.

**7.3 Communication skills**. Effective communication is vital in all careers. Since speech and English composition courses alone rarely give students sufficient experience in the oral and written communication of technical information, the chemistry curriculum should include writing and speaking opportunities, and the chemistry faculty should evaluate them critically. Students should be able to:

- Present information in a clear and organized manner
- Create visual representations of complex data sets

- Write well-organized and concise scientific reports in a scientifically appropriate style
- Cite sources properly
- Use appropriate technology, such as poster preparation software, word-processing software, chemical structure drawing programs, and computerized presentations

**7.4 Team skills.** Solving problems and addressing chemical challenges often involves multidisciplinary teams, and teamwork and leadership skills are critical to success in the workplace. Students should be able to work effectively in a diverse group of peers, as both leaders and team members, to solve problems and interact productively.

As team members, students should learn to work toward a team goal, support teammates, and collaborate on the development of a group plan. Team members should be able to achieve a shared vision, provide productive ideas and feedback, carry out specific assignments, and trust other team members to do the same.

As team leaders, students should be able to provide a clear direction for the team, encourage team contributions, and synthesize individual contributions into a complete product. Team leaders should be able to resolve conflicts, inspire team members, and drive for results.

The faculty should incorporate team experiences in classroom and laboratory components of the chemistry curriculum. Team experiences should be structured so that all students have the opportunity to develop both leadership and team skills.

**7.5 Ethics.** Ethics should be an intentional part of the instruction in chemistry programs. Students should conduct themselves responsibly and be aware of the role of chemistry in contemporary societal and global issues.

Students should understand their responsibilities, both as students and future chemical professionals, to:[11]

- Serve the public interest and actively protect the health and safety of co-workers, consumers, and the community
- Present results of research or comments on scientific matters with

11 American Chemical Society. *The Chemical Professional's Code of Conduct;* American Chemical Society: Washington, DC, 2012. http://www.acs.org/content/acs/en/careers/career-services/ethics/the-chemical-professionals-code-of-conduct.html (accessed Sept 11, 2015)

care and accuracy, without unsubstantiated, exaggerated, or premature statements
- Advance chemical science, understand the limitations of their knowledge, and ensure that their scientific contributions, and those of their collaborators, are thorough, accurate, and unbiased in design, implementation, and presentation
- Remain current with developments in their fields and share ideas and information
- Keep accurate and complete laboratory records
- Maintain integrity in all conduct and publications and give due credit to the contributions of others
- Give respect and value to all classmates, educators, colleagues, and others, regardless of race, gender, age, religion, ethnicity, nationality, sexual orientation, gender expression, gender identity, presence of disabilities, educational background, employment history, or other personal attributes
- Understand the health, safety, and environmental impacts of their work
- Recognize the constraints of limited resources
- Develop sustainable products and processes that protect the health, safety, and prosperity of future generations

As role models, faculty and staff members should exemplify ethics in their scholarship and professional conduct.

**7.6 Chemical information acquisition and management skills.** Essential student skills include the ability to retrieve information efficiently and effectively by searching the chemical literature, to evaluate technical articles critically, and to manage many types of chemical information. Students must be instructed in effective methods for performing searches and assessing their quality using keywords, authors, abstracts, citations, patents, and structures and substructures. Two-year college programs should provide ready access to technical databases with sufficient depth and breadth of the chemical literature for effective searching. Students' ability to read, analyze, interpret, and cite the chemical literature as applied to answering chemical questions should be assessed throughout the curriculum.

Instruction should also be provided in data management and archiving, record keeping (electronic and otherwise), and managing citations and

related information. This includes notebooks, data storage, information, and bibliographic management and formatting.

Faculty should consider the development of chemical information skills an evolutionary process that is best integrated throughout the curriculum, beginning with finding specific information and maturing to an ability to critically assess information on broader topics. Additionally, undergraduate research and/or individual or group projects provide excellent opportunities for development and assessment of literature searching and information management skills.

**7.7 Career preparation.** Students should learn skills associated with identifying and pursuing employment opportunities, such as networking, resume-writing, and interviewing. Students should be cognizant of and prepared for the conditions they will experience upon employment. Activities such as internships, research, job-shadowing, job-based simulations, and mentorships can provide the necessary exposure; programs should identify these or other opportunities that will best serve the long-term career interests of their students.