ACS Chemistry for Life®

CPT
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CPT OPEN MEETING

We invite you to attend the CPT open meeting at the 255th ACS National Meeting in New Orleans, Louisiana, from 4:00pm to 5:00pm on Sunday, March 18, 2018. The location is not yet available. Please check the CPT web page (www.acs.org/cpt) later for details.

PhD Luncheon Looks into Current Practices for the Professional Development of Graduate Students

The ACS hosted a luncheon for representatives from more than thirty PhD-granting departments at the 254th ACS national meeting in Washington DC. This biannual event is an opportunity for members of the Committee on Professional Training (CPT) to discuss common issues with department chairs of PhD-granting departments.

The most recent luncheon addressed developments in professional development activities for graduate students, a topic of continuing interest. Many departments are offering the "Preparing for Life After Graduate School" program available through the ACS, in which the workshop addresses career options for PhD chemists in academia, government and the private sector. Other departments offered an internally organized course on career options, featuring outside speakers from a variety of career paths. It was agreed that students should be exposed to multiple options, including nontraditional employment. Individual development plan (IDPs) for graduate students and postdoctoral associates are made available in many departments. IDPs are not typically required by graduate programs, and in some departments are used as a companion to other advising resources.

It was agreed that at the beginning of a semester required training for graduate students, who are appointed as teaching assistants (TAs), should focus on preparedness and leadership as instructors. Suggestions for best practices included role playing of scenarios encountered in labs and recitations, including those related to safety. Some departments offer more extensive training courses that include teaching methods and teaching portfolio development for graduate students interested in academic careers. TA coordinators should provide meaningful evaluation and feedback, which can include individual meetings with the graduate students as appropriate.

Other soft skills including time management, diversity issues, and professional ethics are taught in non-technical skills modules offered in some departments. Graduate students host visiting speakers in many departments as a networking opportunity. Technical skills such as scientific writing, fellowship and grant proposal writing, and database searching can also form components of the graduate curriculum. Conference presentations are strongly encouraged and many institutions offer financial support for graduate student travel to meetings. One innovative idea was a technology project management certificate program that facilitates an alternative career path for students leaving the PhD program with a Masters' degree. Alternatively, arrangements can be made with the institution's

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CPT ESSAY:

Green Chemistry is Safer Chemistry

Chemical health and safety professionals roughly divide their regulatory work into addressing two sets of concerns: Environmental Protection Agency (EPA) requirements and Occupational Safety and Health Administration (OSHA) concerns. EPA regulations focus on practices in the chemical enterprise that protect human health and the environment. On the other hand, OSHA regulations address "in lab" and "in plant" hazards in order to protect lab and factory personnel as they conduct chemical work. Thus, the emergence of "green chemistry" as an approach to the practice of chemistry since about 2000 largely impacts the EPA side of this balance. This article connects these two areas by describing the ways in which "green chemistry is safer chemistry."

Green chemistry is often characterized by the "Twelve Principles of Green Chemistry" (Table 1) that were first outlined in the seminal publication in the field in 1998 by Anastas and Warner[1]. A review of these Principles with an eye towards lab safety education reveals that adhering to many of these principles that protect the environment also supports safer lab and industrial practices.

Specifically, Principles 4 (Design safer chemicals and products), 3 (Design less hazardous chemical syntheses), and 5 (Use safer solvents and reaction conditions) create a safer lab environment as a matter of definition. Principles 6 (Increase energy efficiency) and 9 (Use catalysts) address reaction conditions that are expected to be milder (with regard to temperature and pressure) and, therefore, safer. Principle 12 (Minimize the potential for accidents) describes the desire to avoid major incidents at chemical plants that would lead to significant releases to the environment. However, this also necessarily creates a safer environment for those who work at the plant.

It is important to remember that not all green chemistry strategies are inherently safer.

Other principles are less directly connected to lab and plant safety but, when followed, will likely lead to safer environments for workers as well the environment. Examples of these are Principle 8 (Avoid chemical derivatives) and Principle 1 (Prevent waste) which necessarily removes hazardous substances in the lab. Principle 11 (Analyze in real time to prevent pollution) can lead to a safer lab environment since real time analysis can identify abnormal conditions that can become hazardous operator.

To complete the list, it seems a stretch to connect lab safety to Principles 7 (Use renewable feedstocks), 10 (Design chemicals and products to degrade after use) and 2 (Maximize atom economy) although, in the ideal case of 100% atom economy, there are no wastes and, therefore, no hazards from those wastes.

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TABLE 1.
The Twelve Principles of Green Chemistry[2]

1. Prevent waste.
2. Maximize atom economy.
3. Design less hazardous chemical syntheses.
4. Design safer chemicals and products.
5. Use safer solvents and reaction conditions.
6. Increase energy efficiency.
7. Use renewable feedstocks.
8. Avoid chemical derivatives.
9. Use catalysts, not stoichiometric reagents.
10. Design chemicals and products to degrade after use.
11. Analyze in real time to prevent pollution.
12. Minimize the potential for accidents.

Online Courses and Virtual Laboratories Survey Results

The 2015 ACS guidelines emphasize the use of hands-on, supervised laboratory experiences in the undergraduate curriculum. They also indicate that courses taught online should provide at least the same skill development and content as the corresponding face-to-face experience. Recognizing the continued development of online, remote, and virtual teaching platforms, a survey of ACS-certified programs was conducted regarding the use of these strategies. The goal of the survey was to obtain information on the current use of these strategies, and offer insight into potential pressures motivating their use or adoption. 240 programs responded to the survey. Of these, 1/3 offered either online lectures or remote/virtual labs.

Highlights of the survey:

- Online courses represent a small fraction of course offerings – only in two types of courses (chemical safety, non-majors courses) are a significant fraction (i.e., >10%) of students taught online.
- 74% of respondents indicate that online teaching requires more development time than in-classroom teaching, while 90% indicate that online and in-classroom courses include the same extent of content.
- 48% of respondents indicate that on-line courses have sufficient faculty-student interaction, while 27% indicate insufficient faculty-student interaction, and 21% indicate as unknown.
- 25% of respondents indicate that on-line courses have sufficient student-student interaction, while 28% indicate insufficient student-student interaction, and 41% indicate as unknown.
- 56% indicate that faculty members are satisfied with online course delivery.
- The use of remote and virtual labs is reported by only 4% of respondents. Of these, the primary use is made in courses for non-majors.
- For those using virtual labs, 55% report that the level of learner satisfaction is the same as in hands-on instruction, while 56% indicate that virtual laboratories have sufficient faculty-student interaction.
- Regarding the driving forces/important factors in the development of online courses, 81% of respondents cite allowing for distance learning, 71% cite providing flexibility for students with work/family commitments. 56% indicate that cost-saving is not an important factor.
- Regarding the driving forces/important factors in the development of remote or virtual labs, 50% cite allowing for distance learning, while 67% indicate that cost-saving is not an important factor.

The goal of the survey was to obtain information on the current use of these strategies, and offer insight into potential pressures motivating their use or adoption.

- 41% of respondents report feeling pressure to expand offerings of online courses, with the primary rationale being allowing for distance learning (31%), cost-saving (23%), and affording flexibility for students with work/family commitments (17%).

The results of the survey indicate that the use of online courses, remote laboratories and virtual laboratory experiments is still modest in undergraduate chemistry programs and largely confined to courses that are not taken by chemistry majors. The fact that roughly a quarter of the respondents who use on-line courses or remote labs state that these approaches give insufficient opportunity for faculty-student and student-student interaction is of concern as the ACS Guidelines speak to the importance of such interactions in the undergraduate curriculum. ■

Announcements

Preparing for Life After Graduate School: A Career Development Workshop from ACS

This two-day workshop is designed to inform chemistry graduate students and postdocs about their career options and how to prepare for them:

- Examining careers for PhD chemists
- Describing careers in business and industry
- Knowing critical non-technical skills
- Finding employment opportunities

To bring this workshop to your department, see www.acs.org/gradworkshop or contact GradEd@acs.org; 202-872-8734.

This program is supported by the Graduate Education Advisory Board, with members appointed by CPT, SOCED, and YCC.

Current Practices for the Professional Development of Graduate Students

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College of Education for students to qualify for a teaching certificate in conjunction with the MS in Chemistry.

Early engagement of graduate students with the ACS has also been encouraged by some departments, including networking with the Younger Chemists Committee (YCC) and the Graduate Student Symposium Planning Committee (GSSPC). It was noted that several ACS technical divisions, such as the Division of Polymer Chemistry, sponsor Student Chapters that provide networking, career development, and opportunities to graduate students and postdoctoral associates. Sponsorship of such chapters in additional divisions would strengthen the mission of preparing graduate students for successful careers. ■

Green Chemistry is Safer Chemistry

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It is important to remember that not all green chemistry strategies are inherently safer. In some instances, a catalyst or other substituted chemical that leads to a greener reaction may introduce new hazards. As in all cases, good hazard recognition and risk assessment of reactants, solvents, and wastes – even including life cycle analysis – should be performed to determine the safest, and greenest, strategy for a particular process.

Inserting green chemistry into the practice of chemistry and into the undergraduate curriculum is a change that will likely be embraced by the chemical industry and the EPA since this leads to safer local and global environments and long-term economic benefits. That this change also leads to safer working environments for researchers and plant employees is a bonus. Leveraging this connection between green chemistry and chemical safety will increase student engagement in their chemistry courses while providing important research skills to use as their career develops in the 21st Century. ■

[1] P. ANASTAS and J. WARNER. *Green Chemistry: Theory and Practice*, Oxford University Press, New York, 1998. Environmental Protection Agency. Green Chemistry, Twelve Principles of Green Chemistry

[2] https://www.epa.gov/greenchemistry/basics-green-chemistry#twelve

Announcements

The Committee on Professional Training and the ACS staff thank* Cathy Nelson *for her* 34 years of service *and congratulate her on her retirement.

A Individual Development Planning Tool for Graduate Students and Postdocs
(now fully mobile compatible)

ChemIDP™
A career planning tool for chemical scientists

ACS introduces ChemIDP™, a free and dynamic individual development planning tool designed to help graduate students and postdoctoral scholars in the chemical sciences plan and prepare for rewarding careers.

- ChemIDP™ provides guidance and career suggestions customized to an individual's values, skills, and ambitions. Users can develop and strengthen their professional and technical skills all while they set goals and explore over 45+ careers!
- Access this free site with your phone or desktop at ChemIDP.org.

Certificates Available for ACS-Certified Graduates

Chemistry majors who receive a baccalaureate degree from an ACS-approved program and complete a curriculum described in the ACS Guidelines may be certified to the Society for membership purposes by the head or chair of the approved program. If you would like to have certificates available for presentation to your certified graduates, please contact the office by email at cpt@acs.org.

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Symposium on *Implementing ACS Safety Education Guidelines*; 255th National Meeting and Exposition, March 18-22, 2018, New Orleans, LA

Laboratory work is a critical component in the chemistry curriculum. Students need to develop a solid foundation in the basic principles and concepts of laboratory safety and then deepen their knowledge as they progress in their education. To develop a safety ethic and work safely in 21st century chemistry laboratories, students need to go beyond learning chemical safety as set of rules and begin to understand the "why" behind safety so that they are empowered to identify safety issues and make decisions that reflect informed safety values and knowledge. ***The Guidelines for Chemical Laboratory Safety in Secondary Schools and The Guidelines for Chemical Laboratory Safety in Academic Institutions*** (https://www.acs.org/content/acs/en/chemical-safety/guidelines-for-chemical-laboratory-safety.html) were developed by the American Chemical Society to assist educators in developing innovative programs which integrate safety education throughout the high school, undergraduate and graduate curriculums.

Please join us at this symposium in New Orleans to find out about all the available ACS resources and hear others discuss how they have integrated the Guidelines and chemical safety into their programs.

Sponsored by the **Division on Chemical Health and Safety** and co-sponsored by the **Division of Chemical Education and Committee of Chemical Safety**

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