

American Chemical Society

Advancing Graduate Education in the Chemical Sciences

*Report of the ACS Presidential Commission on
Graduate Education in the Chemical Sciences*

2012 ACS President Bassam Z. Shkhashiri
Professor of Chemistry, University of Wisconsin-Madison

Commission Member Dr. Jacqueline K. Barton
*Professor & Chair of Chemistry and Chemical Engineering,
Cal Tech*

Commission Member Dr. William F. Banholzer
Executive VP and CTO, Dow Chemical Company

President's Council of Advisors on Science and Technology
*March 15, 2013
Washington, DC*



ACS Climate Science Toolkit

Tools to better understand and communicate climate science



www.acs.org/climatescience

ACS Presidential Commission On Graduate Education In The Chemical Sciences

Charge Conclusions Recommendations

Commission Membership

Dr. William F. Banholzer, CTO, Dow Chemical
Dr. Jacqueline K. Barton, Professor of Chemistry, Cal Tech
Dr. Stacey F. Bent, Professor of Chemical Engineering, Stanford University
Dr. Ronald Breslow, Professor of Chemistry, Columbia University, Former ACS President
Dr. Gary Calabrese, Vice President, Science & Technology, Corning Inc.
Dr. Pat N. Confalone, Vice President, Global R&D, DuPont, ACS Board of Directors
Dr. Michael P. Doyle, Professor of Chemistry, University of Maryland
Dr. Larry R. Faulkner, President Emeritus, University of Texas (Chair)
Dr. Marye Anne Fox, Chancellor, UC San Diego
Dr. Joseph S. "Joe" Francisco, Professor of Chemistry, Purdue University, Former ACS President
Dr. Paul Houston, Dean, College of Sciences, Georgia Inst. Of Tech. (Executive Director)
Dr. Chad A. Mirkin, Professor of Chemistry, Northwestern University
Dr. Larry E. Overman, Distinguished Professor of Chemistry, UC Irvine
Dr. Hunter Ripley Rawlings III, President, Association of American Universities
Dr. Geraldine Richmond, Professor of Chemistry, University of Oregon
Dr. Richard H. Scheller, Executive Vice President, Genentech Research & Early Development
Dr. Joel I. Shulman, Professor of Chemistry, University of Cincinnati - formerly at Procter & Gamble
Dr. Peter J. Stang, Distinguished Professor of Chemistry, The University of Utah, Editor of JACS
Dr. Matthew Tirrell, Pritzker Director, University of Chicago Institute for Molecular Engineering
Dr. George M. Whitesides, Woodford L. and Ann A. Flowers University Professor, Harvard University
Dr. Mark S. Wrighton, Chancellor and Professor of Chemistry, Washington University, St. Louis
Dr. Mary Kirchhoff, Director, ACS Education Division (Staff Liaison)

Charge to the Commission

Answer two main questions:

- What are the **purposes** of graduate education in the chemical sciences?
- What steps should be taken to ensure that graduate education **addresses important societal issues** as well as the **needs and aspirations** of graduate students?

Major Tasks in the Charge

- Consider **fundamental, comprehensive, and systemic changes** suitable for graduate education in the chemical sciences.
- Suggest **actionable approaches for enhancing the quality** of graduate education at all institutions.

Charge to the Commission

Answer other, more particular, questions:

1. Is the current structure of different types of departments in the chemical sciences (chemistry, chemical engineering, chemistry and biochemistry, chemistry and chemical biology, chemical and biomolecular engineering, materials science, etc.) a strength or a weakness with respect to graduate education?
2. What are the employment issues for graduate students in both industrial and academic settings? Are we providing the right educational opportunities?
3. What are the financial support mechanisms for graduate education in the chemical sciences? Is the current mix the best one?

Charge to the Commission

Answer other, more particular, questions (continued):

4. Is the current profile of our graduates the correct one, not only in terms of domestic vs. international, but in terms of diversity along other axes as well? Do they have the proper background for the type of graduate education we want them to attain?
5. What are the expectations of graduate students; are our educational institutions meeting them; and what promises do they make to students, both explicitly and implicitly? In particular, what should be the lengths of the graduate student program and any subsequent postdoctoral training? And why is the attrition rate for PhD students in the chemical sciences as high as it is (only 62% finish within ten years).

Commission Report

- **Full Report**

- 60 pages of background, analysis, conclusions, recommendations
- Intended for publication only in downloadable electronic form

- **Summary Report**

- 20 pages, mainly conclusions and recommendations
- Available in print and downloadable electronic form

Both reports are available at
www.acs.org/gradcommission

Answers to the Big Questions

- Purposes of graduate education in the chemical sciences

“The primary purpose of graduate education is education. The proper first focus is to educate students to solve problems in society, including the effective education of the succeeding generations.”

- 10 purposes transcending the individual
- 6 purposes focused on the individual

- Addressing societal needs as well as the needs and aspirations of graduate students

- 9 particular points

The future of our society will be influenced by the quality of graduate education in the chemical sciences.

5 Conclusions, 32 Recommendations

- **The Educational Experience of Graduate Students**
- **Financial Support of Graduate Students**
- **Safety as a Culture**
- **Sustainability and Opportunity in Graduate Programs**
- **Postdoctoral Education**

Commission Report Audiences

- **Faculty, deans, provosts, presidents**
- **Policy makers and federal and state funding agencies and private foundations**
- **Industry leaders**
- **Graduate students and postdocs**
- **ACS**

The Educational Experience of Graduate Students

Conclusion 1:

Current educational opportunities for graduate students, viewed on balance as a system, **do not provide sufficient preparation** for their careers after graduate school.

Commission reaffirms the anchoring concept that a doctoral program in the chemical sciences must manifest traditional depth and must maintain a focus on mastery.

The Educational Experience of Graduate Students

Conclusion 1:

Current educational opportunities for graduate students, viewed on balance as a system, **do not provide sufficient preparation** for their careers after graduate school.

Commission reaffirms the anchoring concept that a doctoral program in the chemical sciences must manifest traditional depth and must maintain a focus on mastery.

But curricula need to be refreshed, and better-designed opportunities should exist for the development of critical professional skills.

The Educational Experience of Graduate Students

- **Greater departmental oversight** over the progress of their graduate students.
- Need for specific activities enhancing students' ability to:
 - **Communicate** complex topics to both technical and non-technical audiences and to effectively influence decisions,
 - **Learn new science** and technology outside prior academic training,
 - **Collaborate on global teams** and/or with global partners and clients,
 - **Effectively define, drive, and manage technical work** toward a practical, significant result, and
 - Clearly understand the **ethical conduct of research**.
- **Four years should be the target** for completion of the PhD, with the departmental median time less than five years.

The Financial Support of Graduate Students

Conclusion 2:

The system for the financial support of graduate students, as currently operated by private, institutional, state, and federal funds, is **no longer optimal for national needs**.

It rests too heavily on individual research grants and involves serious conflicts between the education of graduate students and the needs for productivity and accountability in grant-supported research.

The Financial Support of Graduate Students

- Funders should take steps toward decoupling more student-support funds from specific research projects.
- On a ten- to fifteen-year horizon, decouple the preponderance of student support.
- In the near term, engage in trial projects designed to prove out new mechanisms.
- Commission recommends “graduate program grants” to support graduate students. Analogous to training grants, but packaged with greater support for innovation in the educational program.
- Recommendations in this area are not mainly about more funding, but about improving the deployment of existing funding.

Safety as a Culture

Conclusion 3:

Academic chemical laboratories must adopt best safety practices. Such practices have led to a remarkably good record of safety in the chemical industry and should be leveraged.

Progress would afford better protection to students and other workers at all academic levels and would better prepare students to meet the natural expectations of their future colleagues and employers.

Safety as a Culture

- Safety as a culture must be consistently led by example in all graduate programs in the chemical sciences.
- Faculty members in the chemical sciences can and should take the lead toward best practices, and should advocate for support at the highest institutional levels.
- Leadership from the top of an institution is essential. Safety culture must not vary across institutions, and mechanisms for managing the associated costs cannot be left to individual departments or research groups.

Sustainability and Opportunity in Graduate Programs

Conclusion 4:

Departments should give thoughtful attention to maintaining a sustainable relationship between the availability of new graduates at all degree levels and genuine opportunities for them. Replication in excess is wasteful of resources and does injustice to the investment made by students and society.

Sustainability and Opportunity in Graduate Programs

- Departments should adjust program sizes in the light of truly attractive opportunities for graduates. This consideration should be paramount in determining the scale and balance of any program.
- A large undergraduate teaching need is not a sufficient justification for a large graduate program.
- Leaders in every graduate program are urged to reassess and to focus toward competitive advantages. There is too much similarity among the nation's graduate programs.
- To take advantage of the nation's whole talent pool, graduate programs must place an emphasis on attracting and empowering students from underrepresented groups.

Recommendations toward Policy Makers

- Funders should take steps toward decoupling more student-support funds from specific research projects.
- On a ten- to fifteen-year horizon, decouple the preponderance of student support.
- In the near term, engage in trial projects designed to prove out new mechanisms.
- Commission recommends "graduate program grants" to support graduate students. Analogous to training grants, but packaged with greater support for innovation in the educational program.
- Recommendations in this area are not mainly about more funding, but about improving the deployment of existing funding.

Recommendations toward ACS

- Transparency Initiative re program characteristics and placement outcomes.
- Develop one or more formal courses for the more explicit preparation of students who intend to seek academic employment.
- Survey representative graduate programs to ascertain organizational structures that best facilitate the educational goals.
- Undertake and make available periodic assessments, perhaps biennially, of the outlook for employment markets relevant to doctoral programs (5-10 year horizon).

ACS-Based Transparency Initiative

- Collect and publish aggregated, privacy-protected data, organized by graduate program, on post-degree outcomes for all graduates.
- Time-to-degree, types of job placements, salaries, and overall student satisfaction with the graduate experience and employment outcome.
- Provide prospective students with relevant information toward an informed decision in choosing a graduate school.
- Transparency should drive progress
 - In outcomes for students
 - In overall program quality and competitiveness

Postdoctoral Education

Conclusion 5:

Postdoctoral training and education is an extension of graduate education that is important for success in a variety of career paths, particularly for faculty appointments.

Postdoctoral associates should be treated as the professional scientists and engineers they are.

A postdoctoral appointment should be a period of accelerated professional growth that, by design, enhances scientific independence and future career opportunities.

Recommendations toward Policy Makers

- **Institutions, departments, and faculty mentors take greater responsibility for ensuring that postdoctoral associates develop professionally.**
- **All funding agencies require general mentoring plans of applicants seeking support for postdoctoral associates.**
- **Funding agencies become more receptive to requests for support of more senior research associates who are regular employees of research institutions.**
- **Foundations and other funding agencies re-explore programs for “teaching postdoctoral associates.”**

Thank You

Discussion