Exploring the ACS Guidelines and Expectations for the First Two Years of Chemistry

Monday, July 28, 2008
20th Biennial Conference on Chemical Education

Co-sponsored by the Committee on Professional Training and the Society Committee on Education

INTRODUCTION

SEGMENT 1

8:10 a.m. General Chemistry Experiences at Two-Year and Four-Year Programs
John Clevenger and Will Polik

SEGMENT 2

8:55 a.m. Foundation Chemistry Laboratory Experiences
Doug Sawyer and Cynthia Larive

9:25 a.m. Break

9:35 a.m. Discussion (Foundation Chemistry Laboratory Experiences)

SEGMENT 3

10:00 a.m. Integrating and Assessing Student Skills
Joel Shulman and Uni Susskind

CLOSING REMARKS

Visit www.acs.org/cpt for the ACS Guidelines and Evaluation Procedures for Bachelor’s Degree Programs.

Exploring the ACS Guidelines and Expectations for the First Two Years of Chemistry

Committee on Professional Training (CPT)
Society Committee on Education (SOCED)
Objectives

• Sharing revisions
  – in place for four-year programs
  – under development for two-year programs

• Exploring opportunities
  – improving the first two-years of chemistry
  – facilitating student transfer

• Obtaining input
  – two-year guidelines revisions
  – guidelines supplements
  – future programming
Participants

- Are you on the faculty in a…
  - Bachelor’s degree program?
  - two-year program?
- Do you teach…
  - general chemistry?
  - organic chemistry?
  - analytical chemistry?
  - physical chemistry?
  - inorganic chemistry?
  - biochemistry?
Committee on Professional Training

- Planned for major revision of ACS *Guidelines and Evaluation Procedures for Bachelor’s Degree Programs* in 2004
- Sought broad input from chemistry community during 2005
- Proposed revisions and sought feedback in 2006
- Developed draft guidelines and sought feedback in 2007
- Released new ACS Guidelines in March 2008
Goals of the Revision

The revision of the ACS Guidelines and Evaluation Procedures for Bachelor’s Degree Programs sought to…

• Simplify the ACS guidelines and procedures for approval of chemistry programs

• Provide greater flexibility to approved departments for designing certified degrees

• Encourage innovation and improvement in curriculum and pedagogy by approved departments

• Define faculty and infrastructure attributes that support excellent undergraduate chemistry programs
Revisions to Guidelines for Four-Year Programs

New features and language:
• Foundation courses (equivalent to 5 one-semester courses)
• In-depth courses (equivalent to 4 one-semester courses)
• Laboratory requirement (400 hours beyond general chemistry)
• Student skills
• Program self-evaluation
Society Committee on Education

- Formed task force to consider revisions to the *ACS Guidelines for Chemistry Programs in Two-year Colleges* in Spring 2005
- Conducted an informal study in Fall 2005
- Solicited input on how best to align guidelines
- Solicited feedback on goals of revision in Winter 2007/08
- Solicited feedback on proposed changes in Spring 2008
- Will begin soliciting feedback on draft revisions in Fall 2008
- Will release new guidelines in Spring 2009
Goals of the Revision

The revision of the ACS *Guidelines for Chemistry Programs in Two-Year Colleges* seeks to…

- Reflect changes in pedagogy, technology, and accountability
- Facilitate student transfer
  - by aligning with the new *ACS Guidelines and Evaluation Procedures for Bachelor’s Degree Programs* (2008)
  - by calling for communicating with receiving institutions
- Provide a more useful resource for strengthening programs
  - by offering guidance for ongoing curricular change
  - by offering guidance for improving the working environment
Proposed Revisions to Guidelines for Two-Year Programs

- Alignment of sections with guidelines for Bachelor’s programs (order and content, as appropriate)
- Inclusion of sections on
  - transfer students
  - undergraduate research
  - student skills
  - student mentoring and advising
  - program self-evaluation
  - partnerships
- Emphasis on professional development
- Vision of excellence
Symposium Schedule

8:00 a.m. Opening remarks
8:10 a.m. General Chemistry Experiences at Two-Year and Four-Year Programs
           John Clevenger and Will Polik
8:55 a.m. Foundation Chemistry Laboratory Experiences
           Doug Sawyer and Cynthia Larive
9:25 a.m. Break
9:35 a.m. Discussion (Foundation Chemistry Laboratory Experiences)
10:00 a.m. Integrating and Assessing Student Skills
            Joel Shulman and Uni Susskind
10:45 a.m. Closing remarks
Related Symposia

Monday, July 28

2:00 p.m.   S29: New ACS Guidelines for Bachelor's Degree Programs: Changes in Requirements and Procedures
            Persimmon Room

2:00 p.m.   S32: Using the ACS Guidelines for Chemistry Programs in Two-Year Colleges to Enhance Chemistry Programs and to Facilitate Student Transitions
            Hoosier Room
General Chemistry Experiences at Two-Year and Four-Year Programs

Will Polik
Professor, Hope College
Chair, Committee on Professional Training

John Clevenger
Emeritus Professor, Truckee Meadows Community College
Chair, Society Committee on Education (SOCED) Task Force on the ACS Guidelines for Chemistry Programs in Two-Year Colleges
Objectives

• Sharing revisions related to general chemistry
  – in place for four-year programs
  – under development for two-year programs

• Exploring opportunities
  – improving general chemistry
  – facilitating student transfer

• Obtaining input
  – Key concepts and laboratory skills for general chemistry
  – Strategies for articulation and transfer of general chemistry
Definition

• General chemistry is the chemistry course for science and engineering majors
General Chemistry…

according to the *ACS Guidelines and Evaluation Procedures for Bachelor’s Degree Programs*

• Serves the needs of a varied audience – general public, science majors, and professional chemists
  – Provides common background
  – Allows for maturation of students in chemical topics, mathematical skills and laboratory skills
General Chemistry...

according to the *ACS Guidelines and Evaluation Procedures for Bachelor’s Degree Programs*

- Serves the needs of professional chemists
  - Ensures knowledge of basic chemical concepts and competency in basic laboratory skills
  - Prepares for foundation course work
    - Analytical chemistry
    - Biochemistry
    - Inorganic chemistry
    - Organic chemistry
    - Physical chemistry
General Chemistry...

according to the *ACS Guidelines and Evaluation Procedures for Bachelor’s Degree Programs*, ensures that students know and have

- **Basic chemical concepts**
  - Stoichiometry, states of matter, atomic structure, molecular structure and bonding, thermodynamics, equilibria, and kinetics

- **Basic laboratory skills**
  - Safe practices, keeping a notebook, use of electronic balances and volumetric glassware, preparation of solutions, chemical measurements using pH electrodes and spectrophotometers, data analysis, and report writing
General Chemistry Courses…

according to the *ACS Guidelines and Evaluation Procedures for Bachelor’s Degree Programs*

- Reflect the diversity of institutions and students
- Could range from a full-year course, to a one-semester course, to waiving the course requirement for very well-prepared students
Requirements and Characteristics

- Are not described by the *ACS Guidelines and Evaluation Procedures for Bachelor’s Degree Programs*
- Should be defined by institutions
- Should be coordinated with chemistry programs that are a significant source of transfer students via regular communication
Two-year College Curricula…

according to the draft revisions of the ACS Guidelines for Chemistry Programs at Two-Year Colleges

• Are driven by the needs of students and the mission of the institution

• Reflect two specific areas of need:
  – Students who require general education in scientific method, but do not require science for their ultimate academic and career goals
  – Students for whom chemistry is part of their career path
General Chemistry…

according to the draft revisions of the ACS *Guidelines for Chemistry Programs at Two-Year Colleges*

- Provides a common background in basic chemical concepts
- Develops competency in basic laboratory skills
- Leads to common outcomes
Basic Chemical Concepts…
according to the draft revisions of the ACS Guidelines for Chemistry Programs at Two-Year Colleges, include

• Stoichiometry
• States of matter
• Atomic structure
• Molecular structure and bonding
• Thermochemistry
• Equilibria
• Kinetics

Note: these are the same concepts included in the ACS Guidelines and Evaluation Procedures for Bachelor’s Degree Programs
Basic Laboratory Skills…

according to the draft revisions of the ACS Guidelines for Chemistry Programs at Two-Year Colleges, include

- Laboratory safety
- Keeping a notebook
- Use of electronic balances and volumetric glassware
- Preparation of solutions
- Chemical measurements using pH electrodes and spectrophotometers
- Data analysis
- Report writing

Note: these are the same skills included in the ACS Guidelines and Evaluation Procedures for Bachelor’s Degree Programs
Common Outcomes…

according to the draft revisions of the ACS Guidelines for Chemistry Programs at Two-Year Colleges, include

• Basic chemical concepts
• Strength in quantitative problem solving
• Competency in basic laboratory skills
• Preparation for higher-level course work
• Maturation of students knowledge of chemistry
• Data analysis
• Report writing
Communications with receiving institutions…

according to the draft revisions of the ACS Guidelines for Chemistry Programs at Two-Year Colleges

- Ensure that curricula of both institutions are coordinated
- Convey educational background and academic goals of students
- Focus efforts on assisting students with successful transitions
  - Students are better served by program articulation than course articulation
  - Students need to be counseled to take courses in patterns comparable to those at receiving institutions
    - Chemistry
    - Math and physics
    - General education
Breakout Session

1. Assemble into groups of 4-6 people and introduce yourselves
2. Select a Time-Keeper and a Secretary for your group
   Time-Keeper: Keep group on-task to produce an answer in 15 minutes
   Secretary: Record group conclusions and report out one key point
3. Based on the symposium talks and your collective experience, answer the selected question
4. For the first 15 minutes, the Secretary will record key points
5. During the final 15 minutes, the Secretary will proceed to a microphone and report out ONE key point (that has not already been reported out by another group)
6. Turn in the sheet at the end of reporting out
Breakout Questions

Given the variety of students in and approaches to general chemistry, how do faculty…

a) Ensure that students are prepared for foundation course work?

b) Facilitate the articulation and transfer of general chemistry courses?
The Foundation Laboratory Experience

Doug Sawyer
Professor and Math / Science Division Chair, Scottsdale Community College
Society Committee on Education (SOCED) Task Force on the ACS Guidelines for Chemistry Programs in Two-Year Colleges

Cindy Larive
Professor, University of California – Riverside
Vice Chair, Committee on Professional Training
Foundation Chemistry Courses

• Provide a common background for certified chemistry graduates across the 5 areas of chemistry: Analytical, Biochemistry, Inorganic, Organic and Physical Chemistry

• Students should have coverage equivalent to a 3-credit semester course in each area (or 8 quarters total)

• Guidelines provide flexibility in the mechanism for foundation content coverage
  – The first course in a “standard” two-semester course sequence; students take the second semester as an in-depth course
  – A one-semester foundation course covering the breadth of topics in an area, whether or not it is followed by an in-depth course in that area
Why have a laboratory?

- Students acquire essential chemistry skills
- Important concepts reinforced
- Students become familiar with common laboratory equipment and instrumentation
- Vehicle for enhancing other skills such as team work
Laboratory Experience

• ACS Guidelines require 400 hours beyond introductory chemistry
• Undergraduate research can count for 180 hours, if a comprehensive written report is prepared
• Lab course work should cover 4 of the 5 foundation areas
• Can be distributed between the foundation and in-depth levels

Should include:

– Synthesis of molecules
– Measurement of chemical properties, structures, and phenomena
– Hands-on experience with modern instrumentation
– Computational data analysis and modeling
Small Group Activity

• Pick a laboratory experience
  – Organic, Analytical, Physical, Inorganic, Biochemistry
• List the minimum skills students should acquire
• List the concepts that must be reinforced with the lab experience
• List the associated activities
• List the minimum required equipment
## Foundation Laboratory

<table>
<thead>
<tr>
<th>Minimum Skills</th>
<th>Minimum Concepts</th>
<th>Laboratory Activities</th>
<th>Minimum Equipment</th>
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</table>
Large Group Activity

For each spreadsheet:

- Are any essential skills or concepts missing?
- Could any of the activities be accomplished using computer simulations?
- Is the equipment list complete? Could anything be omitted?
Integrating and Assessing Student Skills

Joel Shulman
Adjunct Professor, University of Cincinnati
Committee on Professional Training

Uni Susskind
Emerita Professor, Oakland Community College
Society Committee on Education (SOCED) Task Force on the ACS Guidelines for Chemistry Programs in Two-Year Colleges
What do we mean by “student skills?”

Can be termed:

- Process skills
- Soft skills
- Employability skills
- Non technical professional competencies

Characteristics:

- Generic and transferable
- Marketable and lifelong
- Wide applications that go beyond course content alone
Examples of Student Skills and Abilities

• Laboratory safety
• Chemical literature skills
• Communication, both oral and written
• Team skills
• Professional ethics and social responsibility
What is new in the ACS Guidelines for Bachelor’s Degree Programs?

The Committee on Professional Training will now look at

- Whether chemistry programs are developing these skills in their graduates
- How they are doing this
- How they assess success in doing it

These skills will also be included in the proposed revisions to the Guidelines for Chemistry Programs in Two-Year Colleges.
Laboratory Safety Skills: A Lifelong Impact

HAZARDS occur daily!

Lab safety teaches students about:
- Minimizing hazard risks and what to do when they occur
- How to use prudent practices and protective equipment

Ultimately, lab safety skills teach students to:

- Create a safer/healthier environment for all
- Live safer, healthier, longer lives
What do students need to demonstrate in a 4-yr program? In a 2-year program?

LABORATORY SAFETY

“Students [should] understand the concepts of safe laboratory practices and how to apply them.”

- Begin safety awareness in the first lab course
- Understand responsible handling, storing and disposal techniques
- Comply with safety regulations
- Understand and use MSDSs
- Recognize and minimize potential chemical and physical hazards in the laboratory
Library and Information Literacy

“Set of abilities requiring individuals to recognize when information is needed, and have the ability to locate, evaluate, and use effectively the needed information.”

American Library Association (ALA)
What do students need to demonstrate in a 4-year program?

CHEMICAL LITERATURE SKILLS

“Students should learn how to retrieve specific chemical information from the chemical literature.”

• Determine and access needed information
• Retrieve specific information
  – Journal articles, reviews, handbooks, etc.
  – Use of *Chemical Abstracts* (when appropriate)
• Use both library and electronic sources
• Evaluate technical articles critically
What do science-major students need to demonstrate in a 2-year program?

CHEMICAL LITERATURE SKILLS

- A familiarity of the organization of chemistry books in the library and how to use library tools and library services
- An understanding of the content of standard reference works, e.g., *Handbook of Chemistry and Physics*, *Lange’s Handbook of Chemistry*, *Merck Index*
- A knowledge of current periodicals and journals
- Techniques of manual and on-line literature searching

Students usually partner with librarian or faculty member to learn the elements of information literacy.
Written and Oral Communication

• “Effective communication is vital to a scientist.”
• Industry, where 46% of new bachelor’s graduates go,* has identified “outages,” especially
  – Communication skills
  – Team skills

* C&EN, June 2, 2008, p. 52
What do students need to demonstrate in a 4-year program?

COMMUNICATION

- Present information in a clear and organized manner
- Use appropriate technology (e.g., poster preparation, PowerPoint, word processing, chemical drawing programs)
- Write well-organized and concise reports in a scientifically appropriate style
- Respond effectively to questions in an oral presentation
What do students need to demonstrate in a 2-year program?

COMMUNICATION

Show competency in writing and oral presentations by:

• Being concise; using simple words and short sentences
• Following rules of grammar and spelling correctly
• Using your own words; or quoting verbatim using quotation marks and acknowledging your source.
• Using words correctly; avoiding jargon
“The ability to work in multidisciplinary teams is essential for a well-educated scientist.”

- Enhances student learning
- Is social, less competitive—not a solo race
- Allows for sharing of ideas; increases listening, learning, and communication skills
- Develops cooperation and reciprocity
- Uses active/interactive learning techniques
- Stimulates interpersonal collaboration
- Develops people skills

Industry uses the team approach to solve problems
What do students need to demonstrate in a 4-year program?

TEAM SKILLS

In a four-year program students need to:

• Work effectively in a group to solve scientific problems
• Be able to lead portions of an activity and be effective followers
• Interact productively with a diverse group of peers
What do students need to demonstrate in a 2-year program?

TEAM SKILLS

In a two-year program students should be able to:

• Work together to complete a specific task: e.g., perform a lab experiment, write a report, prepare a position paper. Student’s performance can be assessed individually or as a group.

• Be a productive member of a study team to promote one another’s learning and success.
Ethics

- Chemistry, like any discipline, has a social structure with a code of practices that govern acceptable/unacceptable behaviors.
- Progress in chemistry, as in all sciences, relies on complete honesty, openness, trustworthiness, and reproducibility of experimental results.
- ACS has recognized the importance of ethics in chemistry by
  - Adopting an ACS Code of Conduct
  - Constituting a new Council Committee on Ethics
What do students need to demonstrate?

PROFESSIONAL ETHICS & SOCIAL RESPONSIBILITY

“Ethics should be an intentional part of the instruction in a chemistry program.”

• Display high personal standards and integrity
• Demonstrate an awareness of contemporary issues related to chemistry
• Recognize applications of chemistry in industrial, governmental, and/or societal settings
How can chemistry programs impart and assess these skills and abilities?

Incorporate them into existing courses throughout the curriculum

• Design a culture of safety into all lab courses
• Consciously design team projects
• Require some use of literature search in early chemistry courses
• Include writing and speaking opportunities throughout the curriculum
• Emphasize the absolute importance of ethics. As role models, faculty should exemplify ethical conduct in all their professional activities.
How can chemistry programs impart and assess these skills and abilities?

- Develop separate “mini” courses
  - Safety
  - Writing and/or use of the literature
  - Ethics
  - Capstone seminars

- Use advanced courses to assess skills
  - A senior lab course
  - Poster session based on project, with literature component
  - Undergraduate research: a unique opportunity to develop and assess many of the student skills
    - Team skills
    - Written and oral reports
    - Critical use of literature
Breakout Session

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Breakout Questions

What challenges do you face in imparting and assessing student skills in

• A four-year curriculum?
• A two-year college transfer curriculum?
Exploring the ACS Guidelines and Expectations for the First Two Years of Chemistry

Thank you for attending!

(Please return your worksheets before leaving)

Comments and questions can be sent to:

CPT@acs.org

or

CommCollChem@acs.org
Related Symposia

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