Department: Chemistry

Assessment Coordinator: Emily Borda (committee chair), Marc Muniz, Betsy Raymond, Greg O’Neil

Departmental Mission
The chemistry department contributes to Western Washington University’s mission by fostering lifelong learning in the chemical and biochemical sciences through exceptional classroom, laboratory, and research experiences. Students participating in our program will master content and develop critical thinking and communication skills that will help them be scientifically literate citizens and prepare them for professional careers as scientists, educators, and health professionals. Chemistry students, faculty and staff contribute to the scientific enterprise and broader community through outreach and a program of student-focused scholarship and research that strives to be the strongest of its kind in the nation.

Department Student Learning Outcomes

Upon graduation, majors in all of our degree programs will be able to:
1. Understand and integrate fundamental chemical principles that unify all traditional and emerging areas of chemistry and biochemistry including:
   a. atomic theory
   b. molecular structure and bonding
   c. physical properties of molecules
   d. kinetics, thermodynamics and equilibrium
   e. reaction mechanisms
   f. chemical synthesis
2. Acquire detailed, in-depth knowledge from the traditional and emerging areas of chemistry and biochemistry and be able to integrate and apply these principles to solve complex scientific problems.
3. Acquire laboratory skills necessary to answer questions of chemical relevance, including:
   a. Understanding and demonstrating safe and effective laboratory practices.
   b. Understanding the theory behind and being able to interpret data generated by a variety of instrumental methods.
   c. Interpreting experimentally-generated data to reach a sound conclusion.
   d. Designing an experiment with proper controls to answer a scientific question.
4. Connect the theory learned in class with experiments and procedures performed in the lab, or reported in the scientific literature.
5. Be able to critically analyze chemistry-related claims and connect chemistry-related ideas to everyday and societal contexts.
6. Develop effective quantitative reasoning skills.
7. Effectively communicate scientific information in written and oral forms.
8. Work both individually and collaboratively with peers to advance the skills outlined above.

**B.S. in Chemistry (SLO 1-8 plus the following):**

9. Use primary literature to further their knowledge of advances in the fields of chemistry and biochemistry.

**B.A. in Chemistry (SLO 1-8 plus the following)**

10. Connect chemical principles and/or laboratory skills to areas of study outside of chemistry.

**B.S. in Biochemistry (SLO 1-8 plus the following and add “molecular biology” to all instances of “areas of chemistry and biochemistry” and change “chemical” to “biochemical” in SLO 1-8):**

1. Understand and integrate fundamental biochemical principles that unify all traditional and emerging areas of biochemistry and molecular biology including:
   
g. Macromolecular structure and bonding
   
h. The relationship between biomolecular structure and function
   
i. Physical properties of macromolecules
   
j. Integration of metabolism

3. Have acquired laboratory skills necessary to answer questions of biochemical relevance, including:
   
e. Developing hypothesis-driven experimental strategies.

11. Use primary literature to further their knowledge of advances in the fields of chemistry, biochemistry, and molecular biology.

**GUR Student Learning Outcomes**

3. Use quantitative and scientific reasoning to frame and solve problems

**Student Learning Outcomes Assessed This Year** (assessed during year 1 of cycle: 2014-2015)

1. Understand and integrate fundamental chemical principles that unify all traditional and emerging areas of chemistry and biochemistry including:
   
a. atomic theory
   
b. molecular structure and bonding
   
c. physical properties of molecules
   
d. kinetics, thermodynamics and equilibrium
   
e. reaction mechanisms
   
f. chemical synthesis

3. Acquire laboratory skills necessary to answer questions of chemical relevance, including:
   
a. Understanding and demonstrating safe and effective laboratory practices.
   
b. Understanding the theory behind and being able to interpret data generated by a variety of instrumental methods.
   
c. Interpreting experimentally-generated data to reach a sound conclusion.
   
d. Designing an experiment with proper controls to answer a scientific question.

6. Develop effective quantitative reasoning skills.
**“Closing the Loop”: Program Improvement Documentation • Evidence Form**

(This year’s assessment task is to document program improvements informed by SLO assessment and other evidence. Use this form to document your improvements and the evidence and discussion that informed them. Turn in this form with your annual report to your dean).

<table>
<thead>
<tr>
<th>Type of Change</th>
<th>SLOs Targeted for Improvement</th>
<th>Description of Program Improvement</th>
<th>Rationale</th>
<th>Evidence that will demonstrate if this change improves student learning.</th>
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| Faculty development, Pedagogy | 1, 6, 8 | Many instructors in the Chem 12X series are also participants in the *Change at the Core* (C-Core) project that aims to improve student learning in introductory science classes throughout the College of Science and Technology, as well as Huxley. All 6 WWU chemistry participants have identified the Chem 12X series as a focus of their work. In August 2015, participants met to refine their learning outcomes, pedagogical strategies, and formative assessment systems for their courses and implemented these changes during the 2015-16 academic year. They also met regularly during the academic year to share their learning materials and analyze student work that they generated. | The changes were motivated by research showing a clear benefit to students of active, student-centered learning strategies over traditional lecture (e.g. (Freeman et al., 2014)). C-Core participants were also motivated by anecdotal evidence of specific student difficulties discussed in our regular meetings and observed in analysis of student work. Participants paid special attention to issues of energy, which they recognize both from anecdotal evidence and previous assessment results to be difficult for students. | • Higher pre-post gains on online homework in general chemistry courses  
• Significant learning gains on the Quantum Chemistry Concept Inventory (QCCI) in physical chemistry classes using student-centered methods. The administration of this instrument is planned for the coming year as part of a research project.  
• Higher scores on the ACS physical chemistry exam compared to previous years  
• Anecdotal evidence of stronger student learning through exams, exit slips, class participation, etc. |
| Curriculum | 1, 6, 4 | In May, 2016 a General Chemistry Task Force was launched. Its task is to recommend revisions to the general chemistry curriculum (Chem 121-123) to improve its coherency and to better develop the “big ideas” students are expected to learn, by “unburdening” the curriculum. Recommendations regarding a new curriculum are expected by spring 2017. | The main motivations for these changes are anecdotal evidence of students not understanding core concepts when they reach upper-division classes combined with an increasing recognition by faculty, due in part to C-Core, of the importance of purposefully chosen learning targets combined with learning progressions to describe how these ideas are constructed. The idea of “less is more” is also supported by research (Luckie et al., 2012; Schwartz, Sadler, Sonnert, & Tai, 2008). Many C-Core participants (and other chemistry faculty) have also expressed that “content coverage” pressures are a barrier to implementing more time-consuming but more effective student-centered teaching practices in their classrooms. Finally, we have known for a long time that different faculty have different scope and sequences of content, which has made it hard for the TAs to teach labs effectively. | • Higher pre-post gains on online homework in general chemistry courses  
• Anecdotal evidence of stronger student learning through exams, exit slips, class participation, etc. |
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<tr>
<th>Curriculum</th>
<th>1</th>
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<tr>
<td><strong>Adopted a new text with topics categorized based on mechanisms for the 351-353 Organic Chemistry series.</strong></td>
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<td>Historically, organic chemistry textbooks have been separated by functional groups. This new textbook uses mechanisms to distinguish the different topics. Evidence from the publisher and others who have adopted the text suggest a better understanding of the key concepts that link together the different topics when using this approach. Reaction mechanisms are valued by organic chemistry faculty and features as one of our identified Student Learning Outcomes (1e). The book also includes a dedicated Synthesis chapter (Student Learning Outcome 1f).</td>
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<td>This text is to be first used starting Fall 2016. Evidence to assess an improvement in student learning following this change will include a comparison of student performance on the standardized ACS Organic Chemistry Exam (final exam for Chem 353).</td>
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<th>TA Support</th>
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<td><strong>Over the past year we have revised the roles of personnel involved in lab instruction. There is now a lead TA for every general chemistry (121-123) course. Lead TAs take care of many of the bookkeeping tasks (keeping attendance records, dealing with missed labs, etc.) the general chemistry coordinator had done previously. Also, chemistry faculty are now assigned to help the general chemistry coordinator teach practicum courses which provide weekly training for the TAs teaching general chemistry laboratories.</strong></td>
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<td>These changes were motivated mainly by the desire to take some administrative load off of the general chemistry coordinator and provide higher-quality TA training that goes beyond the mechanics of the labs.</td>
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| • Higher scores on post-lab assignments  
• Higher pre-post gains on online homework in general chemistry courses  
• Anecdotal evidence of stronger student learning through exams, exit slips, class participation, etc. |