Assessment and Improvement Report: 2015

Department: Chemistry

Assessment Coordinator: James Vyvyan (committee chair), Greg O’Neil, Elizabeth Raymond

Master Assessment Plan for All Three Degree Programs

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.

<table>
<thead>
<tr>
<th>Assessment Measures</th>
<th>SLO’s Assessed</th>
<th>Use of the Information</th>
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<tbody>
<tr>
<td>1. Written research proposals in capstone courses</td>
<td>7, 8, 9, 11</td>
<td>Apply communication rubric developed by CUE. Identify 1-2 areas that can be improved.</td>
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<tr>
<td>2. Oral presentations in capstone courses</td>
<td>7, 9, 11</td>
<td>Apply communication rubric developed by CUE. Identify 1-2 areas that can be improved.</td>
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<td>3. ACS exams (organic, p-chem)</td>
<td>1(a-f), 6</td>
<td>Where possible, break down results into the 6 sub-categories under chem outcome 1 as well as itemizing those questions that require a range of quantitative skills, for outcome 6. Use these data to identify 1-2 areas that can be improved.</td>
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<tr>
<td>4. Online HW questions from general &amp; organic chem</td>
<td>1(a-f), 6, GUR comp. 3</td>
<td>ID HW questions related to each of the 6 sub-categories under chem outcome 1. Also ID questions that require a range of quantitative skills, for outcome 6. Require all instructors of Chem 12X courses to incorporate these questions into their HW assignments. At the end of the year, meet regarding the aggregated data and identify 1-2 areas that can be improved.</td>
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<td>5. Senior exit survey</td>
<td>1-11, GUR comp. 1,3</td>
<td>Ask students’ opinions of how well each program objective was reached in Likert scale format. Compare with learning outcomes data above (#’s 3, 4) to identify 1-2 areas that can be improved.</td>
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<td>6. Alumni survey</td>
<td>1-11, GUR comp. 1,3</td>
<td>Ask graduates’ opinions of how well each program objective was reached in Likert scale format. Compare with learning outcomes data above (#’s 3, 4) to identify 1-2 areas that can be improved.</td>
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<td>7. Writing samples from WP courses + debriefing</td>
<td>7, GUR comp.1</td>
<td>All instructors of WP courses during the academic year share 3-5 writing samples that exhibit a broad range of writing skills from their course with all faculty (or a sub-committee?). Using the writing rubric created by CUE, and/or other rubric(s) designed by chem faculty, the group analyzes these samples and identifies 2-3 strengths and 2-3 weaknesses.</td>
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<td>8. Instructor/TA observations of students during upper division labs</td>
<td>3,4,9</td>
<td>Instructors and/or TAs of upper division labs select 5-6 students, representing a range of abilities, to observe on the last day of lab, using a rubric developed by chem faculty. These instructors then meet to discuss 1-2 skills that can be improved.</td>
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9. Student work samples from advanced elective courses + debriefing 1(g-j),2,5  Instructors of advanced elective courses that address competency 2 (chemistry & society) share 3-4 samples of student work (such as a final paper) that exhibit a broad range of abilities from their course with all faculty (or a sub-committee?). Using rubric created by chem faculty, the group analyzes these samples and identifies 2-3 strengths and 2-3 weaknesses.

10. Tracking other majors/minors completed Indirect measure 10 Collect data from Banner about whether (and which) other majors or minors students who complete the B.A. chemistry degree also complete. Modify advising documents to help students better identify complementary degrees and programs.

Student Learning Outcomes Assessed This Year:

<table>
<thead>
<tr>
<th>Assessment Measures</th>
<th>SLO’s Assessed</th>
<th>Degree Program</th>
<th>Results</th>
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</table>
| Online HW questions from general chemistry | 1, 6 | B.S. Chem, B.A. Chem, B.S. Biochem | We tracked pre- and post-instruction scores on selected online homework questions in all sections of Chem 121, 122, and 123 (general chemistry I, II, and III) during the 2014-15 academic year. The pre-assessment was given as a stand-alone homework assignment at the beginning of each class, and each question from the pre-assessment was administered via follow-up homework assignments as the material was introduced in class. We analyzed these data by the SLO they represented: either sub-components of SLO 1 (a-d are the only elements of SLO 1 taught in the Chem 12X series) or to SLO 6, further disaggregated by the content knowledge related to the quantitative reasoning skills (1a-d).

The differences we saw between students’ performance on the various outcomes were small, in part due to the way the online HW is administered and graded (multiple trials, with grade based on how many trials it took to get it correct). However, comparing this year’s results with last year’s, we no longer see markedly lower performance on SLO 1d: student understanding of kinetics, thermodynamics and equilibrium. The improvement in this area is at least partly due to increased emphasis (through student centered activities) on this subject area by chemistry C-Core faculty teaching in the general chemistry sequence. |

| Results from ACS Physical Chemistry Exam | 1a-1e, 3c, 6 | B.S. Chem, B.A. Chem | We tracked post-instruction scores on the standardized ACS Physical Chemistry Exam, which all BS chemistry and BA chemistry majors take, most in their last year. Again, we disaggregated these data by the SLO the various questions represented: either sub-components of SLO 1 (a-e), SLO 3(c), or SLO 6. We tracked both students’ performance related to the national average, as well as the overall percentages of students getting each question correct. We tracked both measures both for the 2014-15 academic year only, and over the past 6 years (2010-14). |
As a whole, students did better than the national average on all questions but the margin comparing WWU students to the national average was smaller for the quantitative items (outcome 6). Examination of overall results for WWU students suggests this difference is because the national average is higher on these outcomes, not because our students are doing worse on them. Overall, results suggest students struggle the most with outcomes 1a-c and their associated calculations.

Changes based on assessment findings:

(Please note: changes based on assessment findings are NOT required this year, but the department/program should plan carefully to implement and report on changes made next year, based on the results of this year’s assessment.)

The chemistry department will devote time during upcoming department meetings to discuss plans for improvement in the areas identified above, as well as discussing which SLOs will be assessed in the coming year. A separate group composed of instructors of physical chemistry courses will also meet to discuss how to support students more in learning the concepts and associated calculations represented by outcomes 1a-c.

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 Engineering, as well as Huxley. Most of the WWU chemistry participants have identified the Chem 12X series as a focus of their work. These faculty have made significant changes to their learning outcomes, pedagogical strategies, and formative assessment systems in their courses in the past year, and plan to share these efforts with the rest of the department in the upcoming year. The assessment committee will help this group (and the department) look for evidence of the effectiveness of their continuing efforts to help improve student learning across all three department degree programs.

At the meeting between WP instructors and the assessment committee at the end of the 2013-14 AY, attendees developed the recommendation that each WP class focus deeply on a different part of writing a scientific paper; e.g. abstract, experimental section, etc. Instructors would coordinate goals such that expectations for students are common between classes and learning outcomes are developed in a coherent fashion. Instructors would collaborate to determine how the problem areas specified above would receive special attention in each course. While this did not occur during the 2014-15 AY, we intend to work on assessing student writing skills (SLOs 7, 9, 11) this year.