I. Which student learning outcomes were assessed?  We have selected two learning outcomes to assess this year. These learning outcomes are related to the goals articulated by the Department of Chemistry, College of the Sciences, and Central Washington University as described below. The relevant goals are provided at the bottom of this section.

Student Learning Outcome 1. Apply the standard technical information and perform experimental techniques of analytical, biochemistry, inorganic, organic, and physical chemistry. This year we are assessing this outcome for the areas of analytical chemistry, organic chemistry, and biochemistry. This is the third year that we have examined student learning outcomes in the area of analytical chemistry, the second year that we have examined outcomes in the organic chemistry area, and the first year that we looked at the biochemistry area. In future years we will continue to expand our assessment efforts to the remaining areas of chemistry. This departmental outcome is related to department goal #1, COTS goal #1, and to university strategic goal #1.

Student Learning Outcome 4. Use computers and the modern software of the discipline. This is the first year that we have examined this learning outcome. This departmental outcome is related to department goal #1 and goal #3, COTS goal #1, and university strategic goal #1.

Relevant Goals

Department of Chemistry:
  Goal #1. To provide quality education in chemistry through courses and programs on campus or off campus
  Goal #3. To facilitate this learning experience with modern equipment and laboratories, computer technology, cooperative research and service to the local community, the central Washington area and to the state

College of the Sciences:
  Goal #1. Provide for an outstanding academic and student experience in the College of the Sciences

Central Washington University:
  Goal #1. Maintain and strengthen an outstanding academic and student life on the Ellensburg campus
II. Who was assessed? Students receiving a B.S. in Chemistry during 2008/09. Three students graduated with this degree during this time period. Two of the three B.S. recipients completed all requirements for an American Chemical Society (ACS) approved degree in chemistry.

III. How were student learning outcomes assessed?

Overview

Our assessment of student learning outcomes is based on an examination of the portfolios of students who graduated in the preceding academic year, results of an exit survey, and results of an alumni survey. A brief description of each tool follows.

Student portfolio. All chemistry majors are required to compile a portfolio before graduating. Completion of the portfolio is a requirement of CHEM 488, Undergraduate Colloquium. The portfolio includes an unofficial copy of their transcript, a compilation of all grades received on American Chemical Society (ACS) standardized exams, a copy of the abstract for their CHEM 488 oral presentation to the department, a copy of a laboratory report that showcases their ability to write in the style of the profession and their ability to use modern computer software, and a copy of a research report if undergraduate research was carried out.

Exit survey. Students complete an exit survey as part of CHEM 488. A copy of this survey is included as Appendix A.

Alumni survey. Every five years the Chemistry Department administers a survey by mail to recent graduates. In March 2009 a survey was sent to students graduating with degrees in Chemistry during the period 2004-2008. A copy of the survey is included as Appendix B. The survey is anonymous; responses of those students graduating in 2008 cannot be isolated, neither can student responses be separated by degree type.

Student Learning Outcome 1

Apply the standard technical information and perform experimental techniques of analytical, biochemistry, inorganic, organic, and physical chemistry.

Standard of mastery/criterion of achievement:

1. Graduates maintain 2.0 gpa overall and 2.25 gpa within the major.

Overall GPAs for this group of students ranged from 2.23 to 3.73, with 3.70 as the median and 3.22 as the mean. GPAs within the major ranged from 2.26 to 3.85, with 3.55 as the median and 3.22 as the mean. This criterion of achievement was clearly met.
2. ACS exams consistent with national averages

The Chemistry Department administers ACS standardized exams at the end of all appropriate courses. This year we examined the exam scores in the areas of analytical chemistry, organic chemistry, and biochemistry. This is the third year in a row that we have examined the scores in the analytical area, including Analytical Chemistry and Instrumental Analysis exams. These exams are administered at the end of Quantitative Analysis (CHEM 332) and Instrumental Analysis (CHEM 452), respectively. This is the second year that we have examined the scores in the organic area. The organic chemistry exam is administered in CHEM 363, at the end of the year long Organic Chemistry sequence. This is the first year that we have examined the scores in the biochemistry area. The biochemistry exam is administered at the end of CHEM 432, the second quarter of the two quarter Biochemistry sequence. This course is not required for the B.S. in Chemistry, but does serve as an upper level elective. For each exam the individual student scores were compared with the national mean and standard deviation provided by the ACS (Table 1). Standardized exam scores for General Chemistry are included for comparison, as well as grades received by this group of students in general, organic, and analytical chemistry, and biochemistry courses (Table 2).

Table 1. Student scores on ACS standardized exams in comparison with national results

<table>
<thead>
<tr>
<th>Area of Chemistry</th>
<th>Exam</th>
<th>2 std dev below mean</th>
<th>1 std dev below mean</th>
<th>1 std dev above mean</th>
<th>2 std dev above mean</th>
<th>mean percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>General Chemistry*</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>Analytical</td>
<td>Analytical Chemistry</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Instrumental Analysis</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>76</td>
</tr>
<tr>
<td>Organic</td>
<td>Organic Chemistry**</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>Biochemistry***</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>49</td>
</tr>
</tbody>
</table>

*Scores not available for one transfer student.
**Scores not available for one transfer student.
***Not required for B.S. in Chemistry.
Table 2. Average grade for courses in areas assessed

<table>
<thead>
<tr>
<th>area</th>
<th>CHEM course(s)</th>
<th>average grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Chemistry</td>
<td>181, 182, 183, 181Lab, 182Lab, 183Lab</td>
<td>3.12, 2.97</td>
</tr>
<tr>
<td>Analytical Chemistry</td>
<td>332</td>
<td>3.10</td>
</tr>
<tr>
<td></td>
<td>332Lab</td>
<td>2.67</td>
</tr>
<tr>
<td></td>
<td>452</td>
<td>3.33</td>
</tr>
<tr>
<td></td>
<td>452Lab</td>
<td>3.67</td>
</tr>
<tr>
<td>Organic Chemistry</td>
<td>361, 362, 363, 361Lab, 363Lab</td>
<td>2.54, 3.50</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>431, 432, 431Lab</td>
<td>2.50, 4.00</td>
</tr>
</tbody>
</table>

3. All students' portfolio components will be rated at satisfactory or higher.

Because we focused on the analytical and organic chemistry, and biochemistry areas for this assessment period, we did not rate all portfolio components.

Student learning outcome 4

*Use computers and the modern software of the discipline.*

At a minimum, computer skills should include the ability to use word processing software, spreadsheets, on-line literature searching tools, and instrument-related software. Desirable skills include the ability to use software for drawing chemical structures and mathematical equations, software for molecular modeling, and software for carrying out statistical or numerical analysis.

Standard of mastery/criterion of achievement:

1. All students receive a grade of C+ or better in laboratory courses within the major.

   The chemistry laboratory curriculum requires students to use a majority of the software listed above. Of the 30 laboratory grades recorded for these three students, 24 were C+ or higher. Although this criterion of achievement was not met, the data is positive. Two of the three students in this group did extremely well in their laboratory courses.
Table 3. Laboratory grades received

<table>
<thead>
<tr>
<th>Laboratory grade</th>
<th>Number received</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>14</td>
</tr>
<tr>
<td>A-</td>
<td>4</td>
</tr>
<tr>
<td>B+</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
</tr>
<tr>
<td>B-</td>
<td>2</td>
</tr>
<tr>
<td>C+</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>C-</td>
<td>0</td>
</tr>
<tr>
<td>D+</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
</tr>
<tr>
<td>D-</td>
<td>1</td>
</tr>
</tbody>
</table>

2. All students receive grades of C+ or better in CHEM 388 and CHEM 488.

CHEM 388 and 488, Undergraduate Colloquium, are one credit courses culminating in a presentation to the department based on either laboratory or literature research. The CHEM 388 presentation takes the form of a poster, while the CHEM 488 presentation is an oral presentation accompanied by computer generated slides (Powerpoint). All three students received an A in CHEM 388. Two students received an A for their work in CHEM 488 and the third student received a B. This criterion of achievement was clearly met.

3. The research or lab report component in the students' portfolio will be rated at satisfactory or higher with respect to computer skills.

Student portfolios were examined for evidence of particular computer skills. All student portfolios included a copy of the abstract for the student's presentation for CHEM 488, Undergraduate Colloquium. All but one portfolio contained copies of reports written for laboratory courses. Five of the eleven portfolios contained copies of research reports. Students were instructed to provide evidence of computer skills, but were not given a list of particular skills that should be demonstrated. Therefore the portfolios can only be used as evidence for the acquisition of a particular skill, but not evidence against.

The three portfolios provided ample evidence of proficiency with word processing software and demonstrated the ability to carry out a literature search. Two out of three provided evidence of spreadsheet proficiency. Two portfolios provided evidence of the ability to work with instrument-related software. One demonstrated the ability to use chemical structure drawing software and two demonstrated the ability to use software to write mathematical expressions. Two portfolios provided evidence for the use of software for statistical or numerical analysis.
III. What was learned?

**Student Learning Outcome 1.** *Apply the standard technical information and perform experimental techniques of analytical, biochemistry, inorganic, organic, and physical chemistry.*

As required, all graduates maintained higher than a 2.0 overall gpa and higher than a 2.25 gpa for courses within the major. According to this criterion, the B.S. recipients satisfied Student Learning Outcome 1.

This year we examined student scores on the ACS standardized exams in the area of analytical and organic chemistry, and biochemistry, as well as introductory general chemistry. Exam scores in all the areas of analytical chemistry and biochemistry are comparable to the national norms, with mean percentile rankings of 42% and 49%, respectively. The mean percentile ranking in Instrumental Analysis was 76%, indicating a very strong performance by this group of students. Scores in the organic area are only available for two of the three students and both fall within one standard deviation below the mean, with a mean percentile ranking of 40%. This follows a pattern that we have seen in past years: student performance on the ACS exams tends to improve as they progress through our program, and performance in the area of organic chemistry is not as strong.

Two years ago a deliberate effort was made to increase expectations in our analytical chemistry courses, increase emphasis on quantitative techniques in general chemistry, and to include more laboratory exercises based on biological and environmental applications. The results of these efforts are promising. Because the number of graduates in any given year is quite small, drawing firm conclusions based on data from only one or two years is not truly justified. However, we are encouraged and expect that this trend will continue. Similar efforts in the area of organic chemistry may be warranted.

**Student learning outcome 4.** *Use computers and the modern software of the discipline.*

The chemistry laboratory curriculum requires students to use computers and a variety of software packages including software for word processing, spreadsheets, instrument related software, software for drawing chemical structures and mathematical equations, and software for molecular modeling. Their grades indicate that this group of students performed at a high level in laboratory courses, which in turn implies that they have strong computer skills. Likewise, strong performance in the Undergraduate Colloquium courses (CHEM 88 and 488) indicates mastery of appropriate computer skills. Student-generated reports included in their portfolios provided additional evidence for familiarity with computers and chemistry-related software.
IV. What will the department do as a result of this information?

Student performance in the areas examined ranged from adequate to very good. No dramatic changes are planned for this degree program on the basis of the results presented here. We do plan to continue efforts begun in previous years (see below), and to continue to improve on an already strong program. The department plans to revise the BS with Biochemistry Emphasis degree so that it meets the requirements for an ACS approved degree. The plan includes addition of a third quarter of Biochemistry lecture and a second quarter of Biochemistry laboratory. These courses will provide a welcome update to the chemistry curriculum and will be available as upper level electives for students in the B.S. program.

In the past, the Chemistry Department has worked hard to provide students with access to computers and up-to-date software and to include the use of computers in the laboratory curriculum. The results presented here indicate that students are competent users of computers and chemistry-related software. The department will continue to devote resources to this area.

In future assessment reports the department will begin to compare the current year's data with previous years, looking for and tracking trends. Plans are also underway to make more extensive use of both entrance and exit surveys in our assessment plans.

V. What did the department do in response to last year's assessment information?

Several committee meetings and a part of the department's program review retreat were devoted to a discussion of last year's assessment results. The department decided to stay on track with respect to the changes in the analytical chemistry curriculum described above. Until last year, the Chemistry Department was understaffed in the area of organic chemistry. With the hiring of two new organic chemists, students have easier access to faculty members, increased opportunities for research in the areas of organic and bioorganic chemistry, and enjoy smaller lecture courses (35-45 students vs 70 students). The organic chemistry faculty have met several times this year to discuss curriculum, and to solidify common goals and standards. We hope that this will lead to higher levels of student achievement in the organic chemistry series. The organic faculty also decided that the current textbook does not meet the needs of the students and are in the process of selecting a new textbook for next year.
Appendix A, Exit Survey

Appendix B, Alumni Survey

CWU CHEMISTRY DEPARTMENT ~ RECENT GRADUATE SURVEY

Which program did you graduate from (circle one):      BA       BA Chem Teaching
BS       BS Biochem       MS

1. Employment or graduate school information: (Please include current position title, employment/school name, and a brief position description.)

2. For the specific components of your education in chemistry that are listed below, please rank each in terms of how well you believe it has prepared you for your current position:
   1 = did not significantly contribute to my preparation / skill set;
   5 = essential to my preparation / skill set

Lecture Courses      1 2 3 4 5
Laboratory Courses   1 2 3 4 5
Research Experience  1 2 3 4 5 n/a
Serving as a Teaching Assistant    1 2 3 4 5 n/a
Working with Faculty Advisor      1 2 3 4 5 n/a

If you wish, please use the space below to comment specifically on your choices above:
3. In your view, how well did your experience in the chemistry program at CWU prepare you for dealing with personnel and interpersonal communication issues in your current position:

   (1 = did not; 5 = substantial preparation)

   1  2  3  4  5

   Comments?

4. How do you feel your chemistry education compares with that of your peers from other institutions?

   (1 = below that of peers; 5 = superior to that of peers)

   1  2  3  4  5

   Please comment on your choice:

5. We are gathering data for graduating seniors. If you will be starting employment immediately after graduation, would you be willing to share your starting salary with us?

6. If you would like information included in the Chemistry Chronicle Newsletter, which can be accessed on the web at www.cwu.edu/~chem, please indicate below.