Central Washington University

Assessment of Student Learning Outcomes
Degree Program Report

College: COTS Department: Chemistry
Program: graduate Degree: MS
Prepared by: Robert Rittenhouse Academic Year of Report: 2014/15

1. What student learning outcomes were assessed this year, and why?

In answering this question, please identify:

- the specific student learning outcomes that were assessed
- reasons for assessing the outcomes, with the outcomes written in clear, measurable terms
- which CWU Strategic Plan Outcome do the student learning outcomes relate to?

For the 2014/2015 academic year, the chemistry department assessed two of the five outcomes identified in the department's SLO Assessment Plan for the MS degree:

Outcome #1: Chemistry MS students will "master and apply technical information from graduate level courses, and independently perform advanced experimental techniques and data analysis".

Outcome #3: Chemistry MS students will "demonstrate critical thinking skills that utilize qualitative and quantitative problem solving".

The first of these outcomes is closely tied to the technical competence of our MS graduates, in terms of knowledge and skills deemed necessary to function as a chemist in industry or to transition into a doctoral level graduate program. On the last page of the MS degree assessment plan (see Appendix 1) the department's 6 year projection of outcomes to be assessed shows that Outcome #1 will be assessed every year. The other outcomes will be assessed on a rotating basis. This level of attention on Outcome #1 reflects the priority that the chemistry department places on technical competence.

The ability to reason scientifically and apply critical thinking skills to solve problems and find answers to questions is a crucial component of conducting research. The chemistry faculty and staff like to think that our curriculum encourages and requires students to enhance their critical thinking ability, but, as a reality check, we are reporting on our efforts to assess student ability in this area (outcome #3).

The chemistry outcome #1 is closely tied to the CWU Strategic Plan Outcome 1.1.1 and also relates to Outcomes 1.1.3 and 3.1.1. Although the development of critical thinking skills is not addressed specifically in any of the CWU Strategic Plan Outcomes, the chemistry outcome #3 does relate to the CWU Strategic Plan Outcome 3.1.1, since critical thinking skills are an important component of successful student scholarship and research.

2. How were the student learning outcomes assessed?

A) What methods were used?

Concisely describe each specific method used in assessing student learning outcomes. For each assessment method specify:

- If that assessment method was direct (e.g. exams) or indirect (e.g. focus groups)
- If the assessment method assessed performance, knowledge, and/or attitudes
- The specific standard of mastery (criterion) against which you will compare your results. For example, "at least 85% of students pass the senior exit exam"

The methods of assessment and criteria of achievement specified in the MS degree SLO Assessment Plan for the two outcomes listed above overlap considerably. They differ mostly in the specific items taken from faculty evaluation instruments for student research proposals and theses. Due to the nature of the outcomes being assessed, all of the methods presently used are intended to assess student performance and knowledge gained.

The following assessment methods were chosen for their relevance to the outcomes and the availability of data:

Table 1

Chemistry MS Outcome Assessed	Method of Assessment	Direct or Indirect	Criterion of Achievement	Who was assessed
#1	Mean cumulative GPA and range by graduation year for 11 MS graduates over the period 9/2010 – 8/2015	Direct	All graduates meet or exceed a 3.0 cumulative GPA.	11 MS students graduating within a 5-year period from 9/2010 through 8/2015
#1 (all courses) #3 (for selected relevant courses)	Mean GPA, by course, for all MS students taking graduate level content courses during the 2014/15 school year	Direct	The mean GPA, by course, for MS students taking graduate content (non-research) courses is at least 3.0.	10 students enrolled in the MS degree program during 2014/15
#1 & #3 (different items on evaluation forms)	Faculty committee member evaluations of MS students' research proposals and theses for 2014/15	Indirect	All students receive a ranking of 3 or higher (5 max) for appropriate item on evaluation forms.	5 MS students wrote and presented research proposals and/or defended theses during 2014/15
#3	Evidence of student scholarship: numbers of students co-authoring peer-reviewed publications and giving presentations at regional and national conference	Indirect	(not yet established)	10 students enrolled in the MS degree program during 2014/15

B) Who was assessed?

- The population assessed
- The number of students assessed (e.g., 53)
- Survey or questionnaire response rate (if appropriate)

Populations of students assessed by each method are listed with the method in **Table 1** above. Due to the small population of Chemistry MS students, some of the data analyzed and reported represents the MS students graduating within a 5-year period from 9/2010 through 8/2015.

C) When was it assessed?

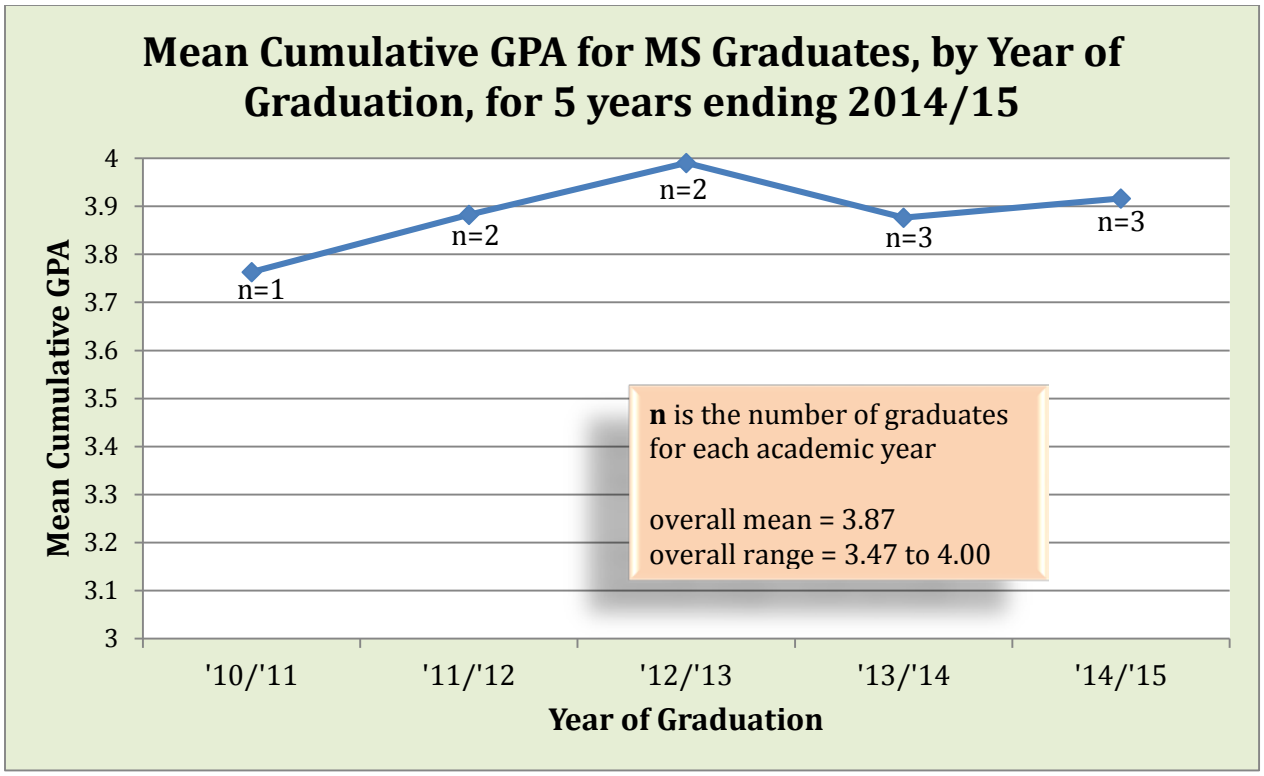
- When did the assessment take place (was it at the end of the degree, as students entered the program or during a specific term?)

Assessment data was collected and analyzed at the end of the 2014/15 academic year for the MS students enrolled in one or more terms during the 2014/15 academic year, except as noted in **Table 1** under (A) above, where data applies only to MS graduates. In that case, the data was accumulated over a 5 year period to improve the statistical validity (larger sample size).

3. What was learned?

- Were the standards of mastery met?
- Report results in specific qualitative or quantitative terms, with the results linked to the student learning outcomes you assessed, and compared to the standard of mastery (criterion) you noted above
- Include a concise interpretation or analysis of the results

As seen in the graph and legend below, all of the 11 MS graduates over the 5-year period from 9/2010 through 8/2015 have maintained a cumulative GPA well above 3.0 . The lowest cumulative GPA is 3.47; the highest is 4.00.



Four 3-credit graduate level content courses were taught over the 2014/15 academic year. The 1-credit "Current Topics in Chemistry" course was taught twice with different instructors and content, with a combined enrollment of nine graduate students. Although a few qualified undergraduates also enrolled in these courses, the data summarized in the table below includes only graduate students.

Table 2

Graduate Level Content Course	No. credits	No. students enrolled	Mean GPA
Chem 505 Current Topics in Chemistry	1	9	3.81
Chem 581 Quantum and Computational Chemistry	3	6	3.78
Chem 561 Organic Reaction Mechanisms	3	6	3.67
Chem 512 Biochemical Toxicology	3	4	3.48
Chem 550 Advanced Analytical Chemistry	3	5	3.66

The graduate content courses taught in 2014/15 were demanding high-level courses, especially the 3-credit courses, which require considerable critical thinking skills applied to problem solving. For every course, the mean GPA for the graduate students in the class exceeds the 3.0 criterion of achievement given in **Table I** for both Outcomes #1 and #3 by a significant margin. Generally, graduate student cumulative GPA's are quite high, assisted upwardly by grades for research credit. Therefore, it's interesting and reassuring that the grades for students in challenging content courses also indicate a high level of student commitment and performance.

The evaluations of the learning outcomes by the faculty who work most closely with the graduate students as research mentors and members of thesis committees provides very detailed feedback on specific outcomes closely tied to student success in fulfilling the requirements for the MS degree. Over the past few years, the graduate faculty have developed and used two evaluation tools, a Thesis Assessment Tool and a similar Research Proposal Assessment Tool. Copies of these evaluation forms are attached to this report as an appendix.

The items and sub-items on these assessment tools that are most relevant to the two outcomes assessed in this report are given below, along with the mean numerical response from faculty committee members for each student on a scale of 1 to 5, where 1=unacceptable, 3=proficient, and 5=excellent.

For outcome #1 (students will "apply technical information and independently perform advanced experimental techniques and data analysis"), the evaluation results for theses of three graduates and for research proposals of two non-graduating students for 2014/15 are summarized in the two tables below for **item 1** on the survey instrument.

For outcome #3 (students will "demonstrate critical thinking skills that utilize qualitative and quantitative problem solving"), the results for the relevant **item 3** are summarized for the faculty evaluation of theses and research proposals in the tables below.

Taken together, the two evaluation summaries assess the technical competence and critical thinking skills of five students, three of whom defended their theses and graduated in the spring of 2015.

Table 3

n=2

Evaluation of written Research Proposal by members of thesis committee		
item 1.->	"Student applies technical information"	
	sub-item	mean score
	(i) Background, Context, Methods	**4.17**
item 3. ->	"Student demonstrates critical thinking skills"	
	sub-item	mean score
	(i) Question-Hypothesis	**4.38**
	(ii) Results, Discussion, Conclusion	**4.21**

Table 4

n=3

Evaluation of written Thesis by members of thesis committee		
item 1.->	"Student applies technical information"	
	sub-item	mean score
	(i) Background, Context, Methods	**4.17**
item 3. ->	"Student demonstrates critical thinking skills"	
	sub-item	mean score
	(i) Question-Hypothesis	**4.25**
	(ii) Results, Discussion, Conclusion	**4.19**

None of the five students assessed using this method received any evaluation scores below 3. Clearly, the specified *criterion of achievement* has been met for both outcomes #1 and #3 for the third method of assessment listed in Table 1 (evaluation of written theses and research

proposals). Since the research proposal requirement must be achieved well before the thesis requirement, the difference in mean scores for either item between the two requirements could be taken as a measure of improvement. In the data presented here, no statistically significant conclusion can be drawn.

In chemistry, an important component of scholarship is the sharing of significant results obtained from one's research. Both technical competence and critical reasoning skills are required to perform quality research worth talking (or writing) about. Though not currently listed in the SLO Assessment Plan for the MS degree program as a method of assessment for either of the outcomes reported on here, we feel it is worth mentioning that in 2014/15 four graduate students were co-authors of peer-reviewed publications. In addition, there were three oral presentations given by graduate students at CWU's SOURCE symposium and two graduate students gave presentations at the national American Chemical Society conference in Denver. Max Wallace, from the Diaz research group, presented a paper at an international conference.

In summary, the results of the four methods of assessment that were used are consistent in supporting the conclusion that our students are currently achieving the intended outcomes: (1) to master the technical content of graduate level chemistry courses and be able to apply this understanding in the performance of scholarly research, and (2) to effectively apply critical thinking skills in qualitative and quantitative problem solving.

4. What will the department or program do as a result of that information?

- Note specific changes to your program as they affect student learning, and as they are related to results from the assessment process
- If no changes are planned, please describe why no changes are needed
- In addition, how has/will the department report the results and changes to internal and/or external constituents (e.g., advisory groups, newsletters, forums, etc.)

As the assessment results reported on here seem to indicate that the MS degree program is achieving the outcomes assessed, there doesn't appear to be any obvious need to fix something that isn't broken. Over the past three years, the chemistry department has strengthened its commitment to the graduate program by developing new degree options to attract more students, and to increase the academic depth and breadth of the program by offering more courses per year. By all accounts this effort seems to be paying off.

Though useful, this assessment cycle has revealed limitations of our current assessment methods. We presently have no standardized tool (exam) or method that facilitates comparison between our MS degree programs and similar programs offered by chemistry departments at other institutions. Also, we currently have no direct instrument that can be used to determine the extent to which the MS curriculum improves the critical thinking capacity of the students.

We consider the MS SLO Assessment Plan to be a working document, and are committed to an annual process of critique and revision. Next year, we plan to give consideration to the outcomes, themselves, and how we might characterize desired attitudes and develop methods to assess for these attitudes.

The chemistry department currently has no advisory groups, but does stay in touch with its alumni via an annual alumni newsletter.

5. What did the department or program do in response to previous years' assessment results, and what was the effect of those changes?

- Describe any changes that have been made to improve student learning based on previous assessment results
- Were those changes effective?
- Discuss any changes to your assessment plan or assessment methods

The outcomes assessed in last year's SLO assessment report were Outcome #1 and Outcome #2 (MS students will " write and speak clearly in the language and style of the discipline"). Though the results of last year's assessment didn't indicate the need for any curriculum changes, two follow-up measures were recommended for 2014/15. The first was to look more carefully at graduate student performance in content courses. This has been accomplished in this report by providing mean GPA's, by course, for all content courses. The second measure relates to Outcome #2 and recommends that "The graduate faculty should consider whether the writing and speaking skills objectives are made sufficiently clear to students early in the program, and how these skills may be encouraged in coursework prior to the research proposal experience". To be honest, the assessment coordinator now realizes that he dropped the ball on communicating the second measure to the department's Graduate Committee. This will be rectified.

Several changes were made to the MS degree SLO assessment plan in spring 2015. Outcome #1 was revised to distinguish between the learning that takes place from coursework and the ability to apply the learning in the performance of research. Assessment methods and criteria of achievement were revised for all outcomes to be more specific and relevant to each outcome, and to take advantage of new data sources.

6. Questions or suggestions? Contact Tom Henderson (henderst@cwu.edu) or Bret Smith (bpsmith@cwu.edu)

The chemistry department is open to advice and suggestions as to how to more effectively assess the quality and value of the learning experience it makes available to its students.

Appendix

Proposal Assessment Tool
M.S. Chemistry Program
last revs. June 2011

CHEM 589/700 Proposal Evaluation Form Committee Members

Student Name _____
Evaluator Name _____ **circle one: Committee Member**
Committee Chair

A. Written Proposal Evaluation (CHEM700)

Date _____

Please rate the following elements of the written proposal using the following 5 point scale. Add comments as needed.

	Scale*: 5=Excellent	4	3=Proficient	2	1=unacceptable	
Student Learning Outcomes and Assessment Elements						
1. Student applies technical information.						
(i) Background, Context, Methods	5	4	3	2	1	N/A
2. Student writes clearly in the language and style of the discipline.						
(i) Format, Spelling and Grammar	5	4	3	2	1	N/A
(ii) Graphs, Statistics, Other Data	5	4	3	2	1	N/A
3. Student demonstrates critical thinking skills.						
(i) Question-Hypothesis	5	4	3	2	1	N/A
(ii) Predictions, Anticipated Results	5	4	3	2	1	N/A
4. Student retrieves and critically analyzes chemical literature.						
(i) Supporting Literature for elements in 3.	5	4	3	2	1	N/A
5. Practice health and safety protocols that are integral to the discipline.						
(i) If applicable, appropriate protocols in the methods section.	5	4	3	2	1	N/A
Comments						

*Note: A 3 on the scale means that a student has shown proficiency in that particular criterion. A 5 should be reserved for the truly exceptional.

Thesis Assessment Tool
M.S. Chemistry Program
Last revs. June 2011

CHEM 589/700 Thesis Defense Evaluation Committee Members

Student Name _____
Evaluator Name _____ **circle one: Committee Member**
Committee Chair

A. Written Thesis Evaluation (CHEM700)

Date _____

Please rate the following elements of the written thesis using the following 5 point scale. Add comments as needed.

Scale*:
5=Excellent 3=Proficient 1=unacceptable

Student Learning Outcomes and Assessment Elements						
1. Student applies technical information.						
(i) Background, Context, Methods	5	4	3	2	1	N/A
2. Student writes clearly in the language and style of the discipline						
(i) Format, Spelling and Grammar	5	4	3	2	1	N/A
(ii) Graphs, Statistics, Other Data	5	4	3	2	1	N/A
3. Student demonstrates critical thinking skills.						
(i) Question-Hypothesis	5	4	3	2	1	N/A
(ii) Results, Discussion, Conclusion	5	4	3	2	1	N/A
4. Student retrieves and critically analyzes chemical literature.						
(i) Supporting Literature for elements in 3.	5	4	3	2	1	N/A

Comments

*Note: A 3 on the scale means that a student has shown proficiency in that particular criterion. A 5 should be reserved for the truly exceptional.