

## Identification

Assessment Plan for the Chemistry Department in the College of Science and Mathematics at Colorado State University – Pueblo.

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## Mission, Goals and Student Learning Outcomes

- **What is the mission of the department and how does it relate to the school's mission?**

The chemistry department strives to provide intellectual and professional training for students in the field of chemistry and in support of the American Chemical Society charter "to encourage in the broadest and most liberal manner the advancement of chemistry in all its branches; the promotion of research in chemical science and industry, the improvement of the qualifications and usefulness of chemists through high standards of education to promote scientific interests and inquiry. This fits into the school's mission of offering "a broad array of baccalaureate programs with a strong professional focus and firm grounding in the liberal arts and sciences." Our extensive use of the standards developed by the American Chemical Society and by which our program is certified ensure we have a strong professional focus while promoting high standards of education along with research in chemical science.

- **What is the mission of the program and how does it relate to the department's mission?**

The program and the department missions are synonymous with respect to assessment.

- **What are the student learning outcomes and how do they relate to the program's mission?** Please see attached curriculum map to show which SLO's are addressed in which part of the curriculum.

### Learning Outcome One:

1. **Students will exhibit a comprehensive knowledge of the fundamental theories and concepts necessary in the chemical sciences.** This learning outcome is core to the program's mission of high standards of education.

- 2. Strategy:** The American Chemical Society (ACS), the premier professional association for chemists, has been heavily involved in determining the appropriate curriculum required to obtain the knowledge base and laboratory skills expected for B.S. chemistry graduates. The ACS only certifies rigorous programs based upon an extensive review of entire curriculum, with re-certification occurring every 5 years. The CSU-Pueblo Chemistry Department is certified by the ACS and adherence to those curricular guidelines will enable students to fulfill Learning Outcome One.
- 3. Assessment Methods:** The ACS Exams Institute provides standardized exams that cover all the major sub-disciplines within chemistry. The chemistry program uses these exams where appropriate (general, organic, physical, analytical, inorganic, and biochemistry). The Major Field Achievement Test (MFAT) is also required of all graduating seniors and is used to assess student knowledge in chemistry.
- 4. Criterion:** Faculty expect that students on average will score at or above the 50<sup>th</sup> percentile on both the ACS and MFAT standardized exams.
- 5. Program Improvements** Program improvements are focused on the organic curriculum have been implemented through the hire of a full-time tenure-track organic chemist. Additional improvements in the criterion to compensate for the large number of non-major students taking the ACS test in organic chemistry are planned.

#### **Learning Outcome Two:**

- 1. Students will exhibit the mathematical and problem-solving skills necessary in the chemical sciences.** This learning outcome is core to the program's mission of high standards of education.
- 2. Strategy:** The American Chemical Society (ACS), the premier professional association for chemists, has been heavily involved in determining the appropriate curriculum required to instill mathematical and problems solving skills for B.S. chemistry graduates. The ACS only certifies rigorous programs based upon an extensive review of entire curriculum, with re-certification occurring every 5 years. The CSU-Pueblo Chemistry Department is certified by the ACS and adherence to those curricular guidelines will enable students to fulfill Learning Outcome Two.
- 3. Assessment Methods:** The ACS Exams Institute provides standardized exams that cover all the major sub-disciplines within chemistry. The chemistry program uses these exams where appropriate (general, organic, physical, analytical, inorganic, and biochemistry). The Major Field Achievement Test (MFAT) is also required of all graduating seniors and is used to assess student knowledge in chemistry.

- 4. Criterion:** Faculty expect that students on average will score at or above the 50<sup>th</sup> percentile on both the ACS and MFAT standardized exams.
- 5. Program Improvements** Program improvements are focused on the organic curriculum have been implemented through the hire of a full-time tenure-track organic chemist. Additional improvements in the criterion to compensate for the large number of non-major students taking the ACS test in organic chemistry are planned.

### **Learning Outcome Three:**

- 1. Students will be able to research, review and understand the current chemical literature and be able to critically evaluate, write about and professionally present such material.** This learning outcome is core to the program's mission of high standards of education, primarily with respect to research (currency in the discipline) and promoting scientific inquiry.
- 2. Strategy:** Incorporation of scientific literature review, writing and presentation occurs throughout the required and elective curriculum especially in Chem 389, (Scientific Literature Review), Chem 401 (Advanced Organic), Chem 403 (Polymer), Chem 411, 412, 412L (Biochemistry I and II and Lab), Chem 419L (Instrumental Analysis Lab), Chem 421 (Advanced Inorganic), Chem 425 (Environmental), Chem 460 (Forensic Chem II), Chem 492 (Research), and particularly Chem 493 (seminar).
- 3. Assessment Methods:** Although aspects of Learning Outcome Three are incorporated into much of the curriculum, assessment of the third learning outcome takes place during the required senior seminar course, Chem 493 and in other higher level courses. All faculty are expected to attend the student's senior seminar and an evaluation tool is distributed to every member present.
- 4. Criterion:** Faculty evaluations of the senior seminar are pooled and included in the student's grade for the course which is compiled by the instructor of record. Evaluations are given on a 100-point scale and faculty expect students to achieve an average of 70 or better for satisfactory performance. A score of 90 or better in Chem 493 or similar upper level courses represents outstanding performance. Please see the attached rubric for expected performance levels.
- 5. Program Improvements:** Program improvements will be set based on the evaluation of data yet to be collected.

- **Are learning outcomes written as observable skills and abilities?**

Yes.

- **Are the outcomes discrete (i.e. non-overlapping)?**

The first two student outcomes are both assessed using similar tools, however they are not overlapping in that the first outcome is directed toward chemistry content while the second outcome is directed toward problem solving in chemistry. The third outcome deals with writing/presenting current chemical literature.

- **Are the outcomes limited in number to five or six but not more than eight?**

No, there are only 3 at this time.

- **What are the performance criteria?**

Please see the third bullet dealing with student learning outcomes.

- **What level of performance is expected of students for each criterion?**

Please see the third bullet dealing with student learning outcomes.

- **How are the learning outcomes communicated to department faculty and students, and to the community?**

The learning outcomes are incorporated into the text of the catalog which serve to inform the students and community. Faculty are additionally informed through at least one department meeting a semester where we talk about assessment, outcomes and results.

## Curriculum

- **Do the courses and their objectives, in aggregate, meet the outcomes for the program?**

Yes.

- **Does the curriculum provide opportunities for students to demonstrate they have learned the program outcomes?**

Yes, the students receive feedback from all the faculty comments of their seminar performance and for all classes that use the ACS exams, faculty members can provide scores and percentiles to the students. Additionally, the curriculum allows for independent research by students which demonstrate a mastery of the basic principles and problem solving techniques required of chemists.

## Assessment Methods

- **What assessment methods will be used to measure each of the learning outcomes?**

Please see the third bullet dealing with student learning outcomes.

- **Are descriptions of the assessment processes clear and detailed?**

The actual assessment process are fairly easy to complete, however, some clarification for expectations of the faculty in adhering to the assessment processes, especially concerning student learning outcome #3 could be improved. Not all faculty have been faithful in their attendance at the senior seminar series which limits the quality of the assessment.

- **Are the assessment processes explicitly linked to the student learning outcomes?**

This is true for outcomes number one and three, however, it is only implicitly linked to outcome number two. Student problem solving processes are difficult to assess and are linked to the results of the standardized exams since those tests incorporate both content and problem solving. The process could likely be made explicit if the percentage of questions that directly using problem solving techniques were desegregated from the content questions. At this time, however, it is impractical to do that with the ACS exams for all core courses and is impossible to do that with the MFAT exams since that is completely administered over the internet and we have no knowledge of the specific questions asked during each exam.

- **Are the means of assessment commensurate with the available resources?**

Currently, however future budgets may dictate that this is not the case. ACS exams are on the order of \$2/each and need to be replaced about once every 3 years for general chemistry (100 exams) and once every 5 years for the other core courses (80 for organic and 15 to 20 for the remaining courses) to remain current in the field. The MFAT exam is \$25/person and chemistry usually administers about 10 exams/year. Total expenses likely average about \$450/year for assessment. Currently all these expenses are incurred by the department operating budget which has not increased in many years.

- **What timetable will be implemented for each method, who is involved, and who is responsible for them?**

ACS exams will be administered as a whole or part of the final exam for core courses in the chemistry curriculum during finals week each semester. The MFAT will be administered during the final exam time for the seminar course each semester. Students who are double majors and elect to take a seminar course in another department will be contacted separately and arrangements made, preferably during the final semester of their

senior year. Assessment of the senior seminar will take place during the allotted class time each semester. Every faculty member teaching core chemistry courses will be involved in administering the exams. The department chair is responsible adhering to the assessment plan and for administering the MFAT and arranging alternative schedules when necessary.

- **Are multiple methods employed?**

Methods include nationally normalized standardized exams from two different testing agencies, and faculty assessment of every student is employed using a common assessment tool.

- **Are sufficient direct measures of student learning utilized?**

Yes. Student learning outcome number two is inferred from the data, however, further data mining could directly measure student learning of this as well.

- **Can these methods also be used for accreditation purposes?**

The chemistry program is certified by the American Chemical Society to offer a certified chemistry B.S. and these methods are currently used as part of the recertification process which occurs every 5 years.

- **How are students involved in the assessment process?**

Other than actually being assessed, students are only involved in the third student learning outcome where they are expected to attend and evaluate all the student seminars along with the faculty (however, only faculty assessments are used in evaluating the learning outcome at this time).

## **Assessment Results**

- **How are assessment results evaluated?**

Scores from the standardized exams are compared to the national norms. Seminar presentations are evaluated by the faculty using the evaluation tool attached. Written work is evaluated by the instructor.

- **How are faculty and students involved in interpreting and evaluating results, and developing strategies to improve the curriculum?**

Currently students are not directly involved in interpreting or evaluating results or developing strategies to improve the curriculum. However, exit interviews and student feedback form part of ACS reports on the continuation of the department's program

certification. Faculty are involved in setting the performance criteria and then developing strategies to improve the curriculum.

- **Are the results used to help the department achieve its program outcomes?**

The results are used to help determine what areas in the curriculum need to be looked at so that the student learning outcomes can be achieved and benchmarks met. Specifically, the results can point to the subdiscipline(s) within chemistry that may be needing improvement or curriculum changes to raise assessment evaluations to the level of the performance criteria set by the faculty.

- **How are assessment results used to improve the curriculum and program?**

By identifying areas that consistently do not meet the performance criteria, the faculty involved in teaching those areas can evaluate the curriculum to determine what specifically can be changed to improve student learning. Additionally, areas that are in need of improvement are discussed and brainstormed during the annual department retreat.

- **Are the results being used for budgeting and strategic planning?**

The results are not being used for budgeting at this time, the department budget covers phones, copier, office supplies and some cryogenics so there are no discretionary funds. Strategic planning focuses mostly on non-core types of courses and programs so although the results are used to try and improve the program, little long-term planning is done.

- **How are results disseminated to faculty, students, advisory boards, and administrators?**

ACS and MFAT results are compiled by the chair and are normally disseminated at the end of each semester to the faculty. Individual student scores on the tests and for the seminar are distributed to them promptly. Administrators see compilations of the results from department annual reports, and from the program review process.

- **Are students informed about their progress toward the learning outcomes?**

Indirectly when they receive the results of the assessment procedures. Outcomes of the ACS exams are given at the end of the semester the student takes the course. Outcomes of the MFAT are given to the student immediately upon completion of the exam. Outcomes of the seminar evaluation are given at the end of the semester the student takes the course.

## **Continuous Processes**

- **What processes are in place to ensure that the academic program assessment plan is periodically reviewed, evaluated and updated when appropriate?**

Department assessment activities are discussed during at least one department meeting annually, and more often if the results of the assessment procedures require it.

- **Who is responsible for initiating and supporting the on-going process of program improvement?**

Initiation and support for program improvements are a responsibility of the faculty, the department chair, the dean and the provost.

- **Who is responsible for ensuring that results from each year are the basis for action plans for the following year?**

Primary responsibility rests with the department chair and dean of the college.

## Chemistry Curriculum Map

	LO #1: Students will exhibit a comprehensive knowledge of the fundamental theories and concepts necessary in the chemical sciences	LO#2: Students will exhibit the mathematical and problem solving skills necessary in the chemical sciences	LO#3: Students will be able to research, review and understand the current chemical literature	LO#4: Students will be able to critically evaluate, write about and professionally present topics from the current chemical literature.
Chem 121/L	<ul style="list-style-type: none"> <li>• ACS Exam</li> <li>• Challenging Extra Credit Problems</li> </ul>	<ul style="list-style-type: none"> <li>• ACS Exam</li> <li>• Challenging Extra Credit Problems</li> </ul>	•	•
Chem 122/L	<ul style="list-style-type: none"> <li>• ACS Exam</li> <li>• Challenging Extra Credit Problems</li> </ul>	<ul style="list-style-type: none"> <li>• ACS Exam</li> <li>• Challenging Extra Credit Problems</li> </ul>	•	•
Chem 221/L	<ul style="list-style-type: none"> <li>• MFAT Exam</li> </ul>	<ul style="list-style-type: none"> <li>• MFAT exam</li> </ul>	•	•
Chem301/L	<ul style="list-style-type: none"> <li>• ACS Exam</li> <li>• Laboratory reports (written) test knowledge</li> <li>• Practical use of text material in industrial synthesis</li> <li>• MFAT Exam</li> </ul>	<ul style="list-style-type: none"> <li>• Specific questions on exams test problem solving</li> <li>• Laboratory experiments including forward and backward synthesis problems, multistep synthesis, kinetics and equilibria</li> <li>• MFAT Exam</li> </ul>	<ul style="list-style-type: none"> <li>• Literature searching required for experimental background preparation</li> </ul>	<ul style="list-style-type: none"> <li>• Discussion and test questions that deal with current literature topics. Not an extensive part of the class or lab.</li> </ul>
Chem 302/L	<ul style="list-style-type: none"> <li>• ACS Exam</li> <li>• Laboratory reports (written) test knowledge</li> <li>• Practical use of text material in industrial</li> </ul>	<ul style="list-style-type: none"> <li>• Specific questions on exams test problem solving</li> <li>• Laboratory experiments including forward and</li> </ul>	<ul style="list-style-type: none"> <li>• Literature searching required for experimental background preparation</li> </ul>	<ul style="list-style-type: none"> <li>• Discussion and test questions that deal with current literature topics. Not an extensive part of the class or lab.</li> </ul>

	<ul style="list-style-type: none"> <li>synthesis</li> <li>MFAT Exam</li> </ul>	<ul style="list-style-type: none"> <li>backward synthesis problems, multistep synthesis, kinetics and equilibria</li> <li>MFAT Exam</li> </ul>		
Chem 317/L	<ul style="list-style-type: none"> <li>ACS Exam</li> <li>MFAT Exam</li> </ul>	<ul style="list-style-type: none"> <li>Statistical Analysis of Sample Data Sets</li> <li>ACS Exam</li> <li>MFAT Exam</li> </ul>	•	•
Chem 321	<ul style="list-style-type: none"> <li>ACS Exam</li> <li>MFAT Exam</li> </ul>	<ul style="list-style-type: none"> <li>ACS Exam</li> <li>MFAT Exam</li> </ul>	•	•
Chem 322	<ul style="list-style-type: none"> <li>ACS Exam</li> <li>MFAT Exam</li> </ul>	<ul style="list-style-type: none"> <li>ACS Exam</li> <li>MFAT Exam</li> </ul>	•	•
Chem 419/L	<ul style="list-style-type: none"> <li>ACS Exam</li> <li>Apply concepts in Lab</li> <li>Presentations/Lab Reports</li> <li>MFAT Exam</li> </ul>	<ul style="list-style-type: none"> <li>ACS Exam</li> <li>Analysis of collected lab data.</li> <li>MFAT Exam</li> </ul>	<ul style="list-style-type: none"> <li>Experimental design of their own laboratory analysis</li> </ul>	<ul style="list-style-type: none"> <li>Lab Experiment presentations and reports</li> </ul>
Chem 493	•	•	<ul style="list-style-type: none"> <li>Students give a 50 minute seminar on a literature topic in chemistry.</li> <li>Evaluated by all faculty.</li> </ul>	<ul style="list-style-type: none"> <li>Students give a 50 minute seminar on a literature topic in chemistry.</li> <li>Evaluated by all faculty.</li> </ul>

# Chem 493: Seminar Assessment and Comments Rubric Categories

## Topic:

A Level	Topic is narrow enough to include specific material while having breadth of interest. Topic is highly chemical in nature.
B Level	Topic is good but either slightly too specific or too broad. Chemistry content is good.
C Level	Topic is too broad and may not contain enough chemistry
D Level	Topic contains little specific chemistry and is broad and non-specific or not appropriate for the audience.

## Content:

A Level	The presentation contains sufficient chemistry and is relevant to the topic, correct, well-documented and current. Excellent handling of post-seminar questions. Speaker exhibits an excellent command of the topic.
B Level	The presentation contains a good amount of material with minimal tangents or dated material. Handled most post-seminar questions well. Speaker exhibits a good command of the subject with minimal corrections needed.
C Level	Presentation content is lacking significantly in one or more areas. Content questions handled erratically with additional preparation by the speaker needed to master the topic.
D Level	Presentation had little to no chemistry and showed little preparation or documentation. Failure to address questions and speaker showed little to no understanding of topic.

## Organization:

A Level	Introduction provides a good overview and each topic flows naturally from the previous one. The presentation “tells a story” and at an appropriate level for the audience. Time management is excellent.
B Level	Introduction pertinent and attracted the audiences attention. A few transition problems and/or limited disorganization. Time management is good.
C Level	The “story” is somewhat disorganized. Introduction, transitions and topic flow is not smooth or refined. Seminar is overly long or short.
D Level	No organization evident with the audience quite lost. Poor transitions and topic flow. Extremely poor time management.

## Presentation:

A Level	Presenter maintains excellent eye contact and appropriate strength of voice and engages the audience. Dress, posture pointer use and/or mannerisms are excellent. Speaks the presentation without reading slides.
B Level	Infrequent problems with voice tone, eye contact, posture, pointer use and/or mannerisms. Appropriate attire and audience engagement. Limited reading of slides.
C Level	Voice tone, eye contact, pointer use and/or mannerisms poor at times. Significant reading of slides. Attire and audience engagement needs improvement.
D Level	Consistently poor voice, eye contact, pointer use and/or mannerisms to the point of distraction for the listeners. Presentation was read.

## Graphics, Diagrams, Figures:

A Level	Graphics, diagrams, figures and tables are all appropriate to the presentation, correct, discussed in detail and are easy to read and follow.
B Level	Most graphics are readable and pertinent to the presentation and discussed adequately. Some modification/addition of graphical data would have made the presentation more effective.
C Level	Insufficient use of graphics, diagrams, figures, etc. Multiple visual aids difficult to read, insufficiently explained or superfluous to the presentation.
D Level	No visual aids presented when it would have been appropriate. Visuals presented are unreadable, illegible, inappropriate and/or not discussed.

## Use of PowerPoint:

A Level	All slides readable, attractive and well-organized. Color schemes/fonts appropriate and legible. Time spent on each slide appropriate. PowerPoint used as a tool for the presentation and not distracting from it. No typos or mistakes.
B Level	Most slides readable and generally follow presentation. Time spent on each slide could use slight improvement. Limited typos.
C Level	Some slides not readable or clear. Time management of slides poor. Numerous typos and/or mistakes on slides.
D Level	Overall slides not readable or clear and significant lack of organization on the slides evident. PowerPoint is a distraction rather than a presentation tool.

