

# Department of Chemistry

## Student Outcomes Assessment Plan (SOAP)

### BS in Chemistry

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#### I. Mission

The main elements of this plan are:

- Big picture outcomes rather than content details (e.g. know SN2 reactions)
- Note the application of subject specific knowledge and skills in the introduction to outcomes. The subject specific stuff is important, but not directly evaluated.
- Outcomes aligned with ACS expectations and indexed in a way that eases ACS accreditation and annual reports
- Outcomes mapped to specific courses where they are covered using the number index for outcome, individual courses would map outcomes to specific assignments that would be scored with a rubric
- Assessment done in courses using department standard rubrics for lab notebooks, lab skills, complex problem solving, scientific writing, and oral/poster presentations as appropriate. Each outcome is tied specifically to one or more of the rubrics. Rubrics could be used for a specific course exam, assignment, problem, or a general instructor evaluation. In general, each rubric is used in at least one course early and one course late in the degree roadmap.
- Rubric data would be transferred to a department database (maybe using a secure web form) to facilitate subsequent evaluation by the assessment committee.

#### II. Student Learning Outcomes

The student learning outcomes are mapped to the American Chemical Society standards, as well as those for General Education.

##### *Student Learning Outcome 1- Problem Solving and Experimental Design*

*(ACS Standard 7.1, GE Standards 1 and 3)*

*Primary Assessment Instruments: Problem Solving Rubric*

*Primary Courses and Activities: 1AB, 129AB, 102, 111, 124, 156, 160H, 190, 190H*

1. Students will be able to apply their understanding of terminology, concepts, theories, and skills from the five chemical subdisciplines to solve problems by:
  - 1.1. Defining problems clearly
  - 1.2. Formulating appropriate hypotheses
  - 1.3. Designing and selecting experimental tests of their hypotheses

- 1.4. Analyzing and interpreting data, including the use of appropriate statistical evaluations
- 1.5. Drawing appropriate conclusions

*Student Learning Outcome 2 – Laboratory Skills*

*(ACS Standard 7.1, 7.3, GE Standards 2)*

*Primary Assessment Instruments: Laboratory Notebook Rubric, Laboratory Instructor Evaluation Rubric*

*Primary Courses and Activities: 1AB, 129AB, 102, 111, 124, 156, 160H, 190, 190H*

2. Students will demonstrate the ability to apply their understanding of terminology, concepts, theories, and skills from the five chemical subdisciplines to conduct experimental laboratory work of high quality by :
  - 2.1. Handling chemicals and other laboratory hazards in a safe and socially responsible manner. Specifically, students will demonstrate:
    - 2.1.1. Compliance with department safety procedures, waste disposal protocols, and good laboratory practice
    - 2.1.2. Be able to find, read, and interpret safety information and chemical properties found on material safety data sheets (MSDS)
    - 2.1.3. Safely handling hazardous chemicals and materials including caustic, reactive, ..., air sensitive, ... materials through the ability to recognize potential hazards and to select and use proper laboratory equipment, procedures, and personal protective equipment
  - 2.2. Keeping a clear, concise, and complete record of their laboratory work in a laboratory notebook.
  - 2.3. Recognizing and properly using common laboratory equipment including balances, synthetic glassware, volumetric glassware, electrodes and meters, spectrometers, and chromatography systems.
  - 2.4. Completing common laboratory tasks including the preparation of solutions from solid reagents and stock solutions, chemical synthesis, separation of mixtures, and characterization of small molecules.
  - 2.5. Evaluating, processing, and interpreting the reliability, significance, and meaning of laboratory data
  - 2.6. Communicating the purpose, results and significance of laboratory work in scientific written reports.

*Student Learning Outcome 3 – Chemical Literature and Reference Skills*

*(ACS Standard 7.2)*

*Primary Assessment Instruments: Oral Presentation Rubric, Poster Presentation Rubric, Written Report Rubric*

*Primary Courses and Activities: 129B, 111, 106, 123, 190, 160H, 190H, CCRS, and ACS meetings*

3. Students will demonstrate the ability to apply to identify, find, and use information appropriate to the subdisciplines of chemistry from common reference materials and the peer-reviewed literature:
  - 3.1. The Periodic Table
  - 3.2. Textbook Appendixes
  - 3.3. Reference Books including the CRC Handbook, Merck Index, ...
  - 3.4. Complete a review of literature pertaining to a specific problem or topic in the chemical subdisciplines or interdisciplinary areas using Sci-Finder or other CAS Search Techniques
  - 3.5. Read, Comprehend, and Evaluate a scientific journal article
  - 3.6. Critically evaluate science reporting in the common media including newspaper and magazines

*Student Learning Outcome 4 – Communication Skills*

*(ACS Standard 7.4)*

*Primary Assessment Instruments: Oral Presentation Rubric, Poster Presentation Rubric, Written Report Rubric*

*Primary Courses and Activities: 129B, 111, 106, 123, 190, 160H, 190H, CCRS, and ACS meetings*

4. Students will demonstrate the ability to clearly, effectively, and professionally communicate their scientific opinions, understanding and results in common formats including:
  - 4.1. Written reports with organization, grammar and style conventions, citation of other work, ... for chemical scientific writing (ACS Style Guide)
  - 4.2. Poster presentation including well organized, clear poster and the ability to discuss the poster professionally
  - 4.3. Oral presentations of technical information with or without visual aids such as PowerPoint

*Student Learning Outcome 5 – Collaborative and Team Work*

*(ACS Standard 7.5)*

*Primary Assessment Instruments: Laboratory Instructor Evaluation Rubric and Possible Future Group Work Rubric*

*Primary Courses and Activities: 1AB, 111, 124... 190H*

5. Students will demonstrate the ability to function effectively in collaborative and group work environments in lecture, study, and laboratory settings. This often includes the ability to work on a component of a larger project and connect their work with previous results.

*Student Learning Outcome 6 – Professional Ethics*

*(ACS Standard 7.6)*

*Primary Assessment Instruments: Laboratory Instructor Evaluation Rubric and Focus Groups*

6. Students will develop an ethic for participating as a responsible member of our community, society, and professional community during their degree. Progress in this area is tracked through the above assignments. Ethical principles and issues are discussed and expected in each chemistry course. Aspects of ethics discussed and emphasized as part of the above outcomes include:
  - 6.1. responsible handling of chemicals
  - 6.2. legal use and citation when using others work
  - 6.3. honesty in recording and reporting of laboratory results (scientific fraud)
  - 6.4. the avoidance of real or perceived conflicts of interest in scientific study

Faculty, staff, teaching assistants, and all students are expected to serve as examples of ethical and professional conduct to other students.

*Student Learning Outcome 7 – Curriculum*

*(ACS Curriculum Requirements)*

*Primary Assessment Instruments: ACS Standardized Exams*

7. Students will develop competence in broad areas of chemistry, biology, physics, and mathematics appropriate for their intended careers. For BS Chemistry students this will include demonstrated competence in general, organic, analytical, physical, inorganic, and biochemistry. For BA Chemistry students this will include demonstrated competence in general, organic, analytical, physical, and biochemistry along with a broad background in molecular biology, microbiology, cell biology, and genetics.

### III. Curriculum Map

Table 1 - Student Outcomes BS Chemistry Curriculum Map

	1Alec	1Alab	1Blec	1Blab	128A	128B	129A	129B	102	110A	110B	111	123	124	155	106
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1.1		X		X			X	X	X			X		X		X
1.2				X				X				X		X		X
1.3								X				X		X		X
1.4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2		X		X			X	X	X			X		X		X
2.1		X		X			X	X	X			X		X		X
2.1.1		X		X			X	X	X			X		X		X

	1Alec	1A1ab	1Blec	1B1ab	128A	128B	129A	129B	102	110A	110B	111	123	124	155	106
2.1.2		X		X			X	X	X			X		X		X
2.1.3		X		X			X	X	X			X		X		X
2.2							X	X	X			X		X		X
2.3		X		X			X	X	X			X		X		X
2.4		X		X			X	X	X			X		X		X
2.5		X		X			X	X	X			X		X		X
2.6								X	X			X		X		X
3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3.1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3.2	X	X	X	X			X	X	X	X	X	X	X	X	X	X
3.3							X	X						X		
3.4							X	X				X		X	X	
3.5													X	X	X	
3.6															X	X
4								X	X			X	X	X		X
4.1								X	X			X		X		X
4.2								X				X	X	X		
4.3												X				
5		X		X								X		X		X
6		X		X			X	X	X			X		X		X
6.1		X		X			X	X	X			X		X		X
6.2							X	X	X			X	X	X		X
6.3		X		X			X	X	X			X		X		X
6.4																
7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Many of these outcomes are covered in CHEM 190 Independent Study and other elective courses students may choose as part of their program.

Table 2 - Student Outcomes BA Chemistry Curriculum Map

	1Alec	1A1ab	1Blec	1B1ab	128A	128B	129A	129B*	102	108	153*	155	156
1	X	X	X	X	X	X	X	X	X	X	X	X	X
1.1		X		X			X	X	X				X
1.2				X				X					X
1.3								X					X
1.4	X	X	X	X	X	X	X	X	X	X	X	X	X
1.5	X	X	X	X	X	X	X	X	X	X	X	X	X

	1Alec	1A ab	1B ec	1B ab	128A	128B	129A	129B*	102	108	153*	155	156
2		X		X			X	X	X				X
2.1		X		X			X	X	X				X
2.1.1		X		X			X	X	X				X
2.1.2		X		X			X	X	X				X
2.1.3		X		X			X	X	X				X
2.2							X	X	X				X
2.3		X		X			X	X	X				X
2.4		X		X			X	X	X				X
2.5		X		X			X	X	X				X
2.6								X	X				X
3	X	X	X	X	X	X	X	X	X	X	X	X	X
3.1	X	X	X	X	X	X	X	X	X	X	X	X	X
3.2	X	X	X	X			X	X	X	X	X	X	X
3.3							X	X					
3.4							X	X			X	X	
3.5											X	X	X
3.6											X	X	X
4								X	X				X
4.1								X	X				X
4.2								X					
4.3													
5		X		X							X		X
6		X		X			X	X	X		X		X
6.1		X		X			X	X	X				X
6.2		X		X			X	X	X		X		X
6.3		X		X			X	X	X				X
6.4													
7	X	X	X	X	X	X	X	X	X	X	X	X	X

\* Though formally these are two of four optional courses, they are taken by the majority of BA Chemistry students.

Many of these outcomes are covered in CHEM 190 Independent Study and other elective courses students may choose as part of their program.

#### IV. Assessment Methods

##### A. Direct Measures

A set of common rubrics will be used for both grading and assessment at the program level. The intent is to use rubrics to help students understand departmental

requirements, to gauge student progress over time, and to provide a basis for faculty discussions concerning possible areas for program improvement.

1. The Problem-Solving Rubric will be applied to student work products in existing required courses.
2. A Laboratory Notebook Rubric will be used by instructors to provide feedback to students and assess the quality of the students' laboratory notebooks. Rubric data will be collected from courses early and late in the program and used to assess student progress during the course of study.
3. Students will be provided feedback in laboratory courses using the Laboratory Performance Evaluation Rubric, which will be completed by the laboratory instructor. The rubric will capture outcomes related to safe handling of materials and waste, proper use of common equipment, organizational skills, the ability to complete key tasks, and the ability to work without constant supervision. Results obtained on these rubrics will be summarized in courses early and late in the program.
4. A Written Report Rubric will be used by instructors to provide feedback to students on their lab reports. Rubric data will be collected from courses early and late in the program and used to assess student progress during the course of study.
5. Oral and poster presentations are required in several upper division courses and will be tracked using an oral presentation or poster presentation rubric. These results will be collated for outcomes assessment.
6. ACS Standardized Examinations. The American Chemical Society publishes standardized examinations aligned to the established curriculum in undergraduate chemistry. Students in select courses will complete the ACS standard exam as the course final exam or part of the final exam.

#### B. Indirect Measures

1. On a periodic basis the department will solicit feedback on graduate skills from alumni and their employers using either surveys or focus groups. These mechanisms may allow the department to reevaluate the target student outcomes to match changing needs in the chemistry community.
2. The department will ask for feedback from graduating students using surveys or focus groups to evaluate their perception of whether the degree has adequately prepared them for their chosen career. This may include job placement and graduate/professional school admission rates.
3. The department will periodically hold a focus group with existing chemistry majors and chemistry club members. This will provide an opportunity to identify emerging problems quickly before they show up in tracked data.
4. The department will periodically collect feedback from faculty and instructors on their perceptions of student strengths and weaknesses.

## V. Student Learning Outcomes X Assessment Methods Matrix

Table 3 - Student Outcomes Assessment Methods Map - Draft

	Problem Solving Rubric	Written Report Rubric	Oral Presentation Rubric	Poster Presentation Rubric	Laboratory Instructor Evaluation	Laboratory Notebook Rubric	Alumni and Employer Focus Group	Graduates Focus Group	Current Students Focus Group	Faculty and Instructor Focus Group	ACS Standardized Exams
1	X	X	X	X		X	X			X	
1.1	X	X	X	X		X				X	
1.2		X	X	X						X	
1.3		X	X	X						X	
1.4	X	X	X	X		X	X			X	
1.5		X	X	X		X	X			X	
2	X	X	X	X	X	X	X			X	
2.1					X		X			X	
2.1.1					X		X			X	
2.1.2					X	X	X			X	
2.1.3					X		X			X	
2.2					X	X				X	
2.3		X	X	X	X		X			X	
2.4	X	X	X	X	X		X			X	
2.5	X	X	X	X		X	X			X	
2.6		X								X	
3	X					X				X	
3.1	X					X				X	
3.2	X					X				X	
3.3	X					X				X	
3.4		X	X	X						X	
3.5		X	X	X						X	
3.6										X	
4		X	X	X			X			X	
4.1		X					X			X	
4.2				X			X			X	
4.3			X				X			X	
5					X		X			X	
6											

	Problem Solving Rubric	Written Report Rubric	Oral Presentation Rubric	Poster Presentation Rubric	Laboratory Instructor Evaluation	Laboratory Notebook Rubric	Alumni and Employer Focus Group	Graduates Focus Group	Current Students Focus Group	Faculty and Instructor Focus Group	ACS Standardized Exams
6.1					X		X			X	
6.2		X	X	X			X			X	
6.3		X	X	X	X		X			X	
6.4											
7											X

This table will be updated as part of the development and testing of new rubrics as outlined in the assessment timeline.

## VI. Assessment Timeline

2011-2012

During the 2011-2 academic year the department will pursue three main goals toward the implementation of this assessment plan:

1. Develop, standardize and test a laboratory instructor evaluation rubric
2. Develop, standardize, and test a problem solving rubric
3. Evaluate options for implementing an exit exam as a culminating experience for students in both programs

2012-2013

During the 2012-3 academic year the department will pursue three main goals toward the implementation of this assessment plan:

1. Begin tracking data using the laboratory instructor evaluation and problem solving rubrics
2. Begin tracking performance on ACS standard exams

3. Develop, standardize, and test a written report rubric

2013-2014

During the 2013-4 academic year the department will pursue three main goals toward the implementation of this assessment plan:

1. Begin tracking data using the written report rubric
2. Develop, standardize, and test an oral presentation rubric
3. Develop, standardize, and test a poster presentation rubric

2014-2015

During the 2014-5 academic year the department will pursue two main goals toward the implementation of this assessment plan:

1. Begin tracking data using the presentation rubrics
2. Develop, standardize, and test a laboratory notebook rubric

2015-2016

During the 2015-6 academic year and every four years thereafter the department will focus on reviewing performance data on the laboratory instructor evaluation and problem solving rubrics. This evaluation will focus on improving the rubrics and identifying possible solutions to any problems that have become evident in evaluating trends in the metrics these two rubrics provide.

2016-2017

During the 2016-7 academic year and every four years thereafter the department will focus on reviewing performance data on the written report rubric and ACS standard exams. This evaluation will focus on improving the rubric, improving the way we track exam performance and identifying possible solutions to any problems that have become evident in evaluating trends in the metrics these two rubrics provide.

2017-2018

During the 2017-8 academic year and every four years thereafter the department will focus on reviewing performance data on the oral and poster presentation rubrics. This evaluation will focus on improving the rubrics and identifying possible solutions to any problems that have become evident in evaluating trends in the metrics these two rubrics provide.

2018-2019

During the 2018-9 academic year and every four years thereafter the department will focus on reviewing performance data on the laboratory notebook rubric. This evaluation will focus on improving the rubric and identifying possible solutions to any problems that have become evident in evaluating trends in the metrics these two rubrics provide.

#### **VII. Closing the Loop – Summary Evaluation, Curriculum Adjustment, and Reporting**

The Assessment Committee will be responsible for collecting and summarizing assessment data each semester. Assessment results will be reported at regular department meetings. Near the end of each spring semester, a department meeting will be dedicated to reviewing assessment results, determining what changes, if any, the results suggest, and adjusting the next year's assessment activities as needed. The minutes of this meeting will provide the basis for the department chair's annual report on assessment activities.