Assessment of Student Learning Plan (ASLP): Chemistry

2017-18 Academic Year

University of Southern Maine

A. College, Department, Date

College _Science, Technology and Health______________
Department __Chemistry ____________________
Date _*May 29, 2018*___________

B. Contact Person for the Assessment Plan

Name and title__Caryn Prudenté, Professor and Department Chair__

C. Degree Program

Name of Degree Program__ Chemistry (BS and BA) and Biochemistry (BS)___

D. Assessment of Student Learning: Program Assessment

Step 1: Identify the Student Learning Outcomes (SLO's)

a. *Do you have your student learning outcomes published on your department's website? Yes/**No***

   i. *If yes, please indicate the url: ______________________*
   ii. *If no, please list 3-5 of the most important student learning outcomes for your program. **What will students know by the end of your program?***

1. Students will have firm foundation in the fundamentals and applications of current chemical and scientific theories.
2. Students will be able to employ critical thinking and the scientific method to design and implement experiments and to interpret data / results.
3. Students will be able to use modern instrumentation and classical laboratory techniques, to design experiments, and to properly document their work in laboratory notebooks and in reports
4. Students will be able to identify and solve chemical problems and explore new areas of research.

5. Students can communicate information to their peers and to non-chemists

b. *Please identify* ***which of your student learning outcome(s) were assessed this past academic year.*** *(One or more of the outcomes and corresponding assessment plans could come from your department's CORE Course Blueprint(s).*

All of the above were assessed during the 2017 – 2018 academic year.

Specifics: Outcome 1 was assessed in the spring semester in CHY 115 and CHY 253 – students in these classes take 3 exams during the semester and the American Chemical Societies (ACS) standardized comprehensive final exam in the appropriate topic. The ACS exams are cumulative and test student knowledge gained over the entire academic year (113 and 115, and 251 and 253). Students in CHY 113 are provided a pre / post survey to gauge their perceptions and misconceptions about basic theory and concepts.

Outcome 2 was assessed weekly, both fall and spring (CHY 116, 252, 254, 233, 374, and 378), by evaluating notes recorded in student's laboratory notebooks and pre-laboratory quizzes. Student's formal full laboratory reports are graded regularly in these courses.

Outcome 5 was assessed during the spring semester in CHY 464 and 470. Students regularly retrieve scientific articles from peer-reviewed journals, secondary journals, and trade journals. Students communicate the findings in these articles to their peers in formal presentations and informal group discussions. Students in CHY 254 (spring) must design an experiment based on their findings from the chemical literature. Using the article as a resource, students design their own natural product extraction experiment. Students learn to navigate several electronic literature retrieval databases, read scientific literature, and adapt published experimental information to their specific experiment. Student's ability to interpret the literature and to successively design an experiment is evaluated.

c. *Do you have a* ***matrix or curriculum map*** *showing when your student learning outcomes are assessed and in which courses?* ***Yes****/No*

i. *If yes, do you have this map published on your website? Please indicate url or attach a copy of the curriculum map.*
See attached

Step 2: Assessment Methods Selected and Implemented

a. *Identify which direct measures (other than course grades), that were used to determine whether students achieved the stated learning outcomes for the degree.*

Weekly quizzes, exams, pre- and post lab assignments. Presentations, discussions, and written reports

b. *Briefly describe when you implemented the assessment activity, and if a scoring rubric was used to evaluate the expected level of student achievement. (This information may be shown on your curriculum map).*

Outcome 1 was evaluated 3-4 times a semester in CHY 251, 253, 233, 371, 461 and 463

Outcome 2 was evaluated weekly fall and spring semester.

Outcome 5 was evaluated at the end of the spring semester in the capstone course. Students present the results of their semester long research project.

Step 3: Using the Assessment results to Improve Student Learning

a. *Briefly describe your unit's process of reviewing the program assessment results (i.e. annual process by faculty committee, etc).* **Discuss at department meetings**

b. *What specific changes have been or will be made to improve student learning, as a result of using the program assessment results?* **Capstone courses were adapted to include more group discussion of current trends in science and more opportunities for students to present information to their peers.**

c. *Date of most recent program review/self-study*? **Spring 2015**

E..Course Assessment Activities: *Is your program able to report any assessment-related activities at the Course-Level... (i.e. created grading rubrics to use in required courses, examined student progress in entry-level courses, developed a new course, etc)? Please briefly explain any assessment projects.*

F. Community Engagement Activities in your departmental curriculum:

a. Does your department have a student learning outcome that is related to any community engagement activities? If so, please state the outcome.

1. Able to communicate the results of their work to chemists and non-chemists

2. Find gainful employment in industry or government, be accepted at graduate or professional schools, or find employment in school systems as instructors or administrators.

3. Can work safely in the laboratory and can convey all pertinent safety information to peers. Understand the proper use of laboratory PPE.

b. Please indicate if any of the community engagement activities listed below are included in your program's curriculum, by noting which activities are required or optional for students in your major.

Community Engagement Activity	*Required/Optional*	
Student Research (related to a community-based problem)	R	O
Student-Faculty Community Research Project	R	O
Internship, or a Field Experience	R	O
Independent Study (community-related project)	R	O
Capstone Course (community-related project)	R	O
Service-Learning (course-based)	R	O
Study Abroad, or an International Program	R	O
Interdisciplinary Collaborative Project (community related)	R	O
Student Leadership Activities (related to a team project)	R	O
Students/Faculty Community Leadership (advisory boards, committees, conference presentations)	R	O
Other activities:		

c. Please list any courses (i.e. EDU 400) that have a community engagement activity in your program.

Entry-level courses: _113 and 114_______ Mid-level courses:__CHY 233_______ Upper-level courses: _CHY 385, 464, and 470__

There are a number of topics that recur throughout the chemistry curriculum. The following tables are intended to help you see the connections this topics bring to the courses we offer. A short explanation of each topic follows the tables.

CHY Lecture Courses

topic\course	**113**	**115**	**233**	**251**	**253**	**345**	**351**	**371**	**373**	**377**	**421**	**461**	**463**
Acid/Base	⊕	⊕	⊕	⊕	⊕	⊕					⊕	⊕	⊕
Bonding	⊕			⊕	⊕	⊕		⊕		⊕	⊕	⊕	⊕
Computation						⊕	⊕	⊕		⊕	⊕	⊕	⊕
Equilibrium	⊕	⊕	⊕	⊕	⊕			⊕	⊕		⊕	⊕	⊕
Kinetics		⊕	⊕	⊕	⊕	⊕		⊕	⊕		⊕	⊕	⊕
Redox	⊕	⊕	⊕	⊕	⊕					⊕		⊕	⊕
Separations	⊕	⊕	⊕				⊕			⊕		⊕	⊕
Spectroscopy	⊕	⊕	⊕	⊕	⊕		⊕	⊕		⊕	⊕	⊕	⊕
Synthesis			⊕	⊕	⊕	⊕	⊕			⊕		⊕	⊕
Thermodynamics	⊕	⊕	⊕					⊕	⊕		⊕	⊕	⊕

CHY Laboratory Courses

topic\course	**114**	**116**	**252**	**254**	**374**	**378**	**422**	**462**	**464**	**470***
Acid/Base	⊕	⊕	⊕	⊕	⊕		⊕	⊕		⊕
Bonding	⊕		⊕	⊕				⊕		⊕
Computation	⊕		⊕	⊕			⊕	⊕		⊕
Equilibrium	⊕	⊕			⊕	⊕				⊕
Kinetics		⊕	⊕	⊕	⊕			⊕		⊕
Redox	⊕	⊕			⊕	⊕		⊕		⊕
Separations	⊕	⊕	⊕	⊕		⊕	⊕	⊕	⊕	⊕
Spectroscopy	⊕	⊕	⊕	⊕		⊕	⊕	⊕		⊕
Synthesis	⊕	⊕	⊕	⊕			⊕	⊕	⊕	⊕
Thermodynamics					⊕					⊕

*CHY 470 topics will vary depending on student interest.

Acid Base

Acids are proton donors or electron acceptors. Bases are proton acceptors or electron donors. The relative amounts of acids and bases in a solution determine the pH of the solution. Measurement and control of pH is part of processes ranging from farming (soil pH affects plant health) to environmental science (many air pollutants make rain acidic) to medicine (normal blood pH is 7.4, and even slight deviations, acidosis or alkalosis, can be harmful). Students in the USM Chemistry programs study acid-base equilibria, buffers (pH stabilizers), and tools for pH measurement.

Bonding

Bonding refers to the way that atoms join with each other to form molecules (for example, hydrogen and oxygen joining to form water), and the way that molecules bind to each other to produce more complex structures (such as antibodies and antigens joining during the immune response to disease). The strength of bonding varies from very weak interactions between molecules (the attraction of water molecules for cellulose, which gives a paper towel its absorbancy) to strong atomic attachments (bonds among carbon atoms in diamond). Chemists must understand bonding to be able to design molecules with desired properties, such as coatings that resist water, and drugs that prevent antibodies from attacking our own cells, as in diseases like diabetes and lupus.

Computation

Computational methods can be simple, like plotting how the volume of a gas changes with changing temperatures, and then fitting a line through the data points. The equation of that line is an example of Charles's Law. Or computational methods can be extremely complex, taking hours of computer time. For example, a biochemist may computationally model the active site of an enzyme to try to determine the shape of a molecule that could deactivate the enzyme. A medicine to kill a parasite might be developed this way. In many courses within the USM chemistry curriculum, students (and faculty) learn to use modern computer programs for chemical computation.

Equilibrium

Many chemical reactions do not go to completion, but instead reach equilibrium. In this state, a mixture of reactants and products persists because forward and reverse reactions occur at the same rate. Chemists must understand equilibria in order to find conditions that push reactions toward completion, giving high yields of desired products. As an example, the understanding of equilibrium was crucial to the discovery of a process for producing ammonia for fertilizers (and weapons) from nitrogen in the atmosphere.

Kinetics

Kinetics is the study of the rates of chemical reactions. By determining the factors (concentrations of reactants, temperature, pH, catalysts) that affect the rate of a reaction, chemists gain insight into precisely what bonds are breaking and forming as one molecule is transformed into another. With this information to guide them, chemists can design conditions or catalysts that will promote desired reactions and suppress undesired ones. The catalytic converter in your car promotes more complete combustion of exhaust gases, giving a cleaner exhaust. Biological catalysts, better known as enzymes, provide starting points for the engineering of more powerful and specific industrial catalysts. USM Chemistry students study kinetics in a wide variety of contexts, from simply timing color-change reactions to monitoring reaction rates by spectroscopy.

Redox

In redox reactions, electrons are transferred from one chemical species (atom, molecule, or ion) to another. A species is oxidized when it loses electrons, and is reduced when it gains electrons. These two processes are always paired; that is, if an atom or molecule is oxidized, then another atom or molecule must be reduced. Many important chemical reactions are redox reactions. The corrosion of metal surfaces, the use of batteries, chrome plating, the burning of fossil fuels, respiration, and photosynthesis are all examples of processes that include redox reactions. With such a wide range of uses in the natural world, redox reactions are heavily studied by chemists.

Separations

Separations are techniques, such as chromatography, that allow chemists to isolate pure compounds from mixtures. In the laboratory, separations are used to remove impurities after steps in chemical synthesis. Separation of individual compounds from complicated fossil fuel mixtures provides numerous household products. "Natural products" are compounds that have been isolated from materials found in nature, and they are of interest because they sometimes exhibit therapeutic properties. For example, long before analgesics were routinely synthesized, it was known that willow bark soothes minor aches and pains. After the active ingredient, salicylic acid, was separated from inert ingredients and identified, the study of it and related compounds led to the discovery of aspirin. Most modern laboratories are equipped with sophisticated instruments for separating and identifying compounds. Students enrolled in USM's chemistry curriculum routinely gain hands-on exposure to separations tools.

Spectroscopy

A wine critic commenting favorably on the color of a 2001 Cabernet Sauvignon is performing a crude spectroscopic analysis of the wine, because its color results from the light-absorbing properties of the wine's many individual components. Modern instruments refine and extend spectroscopy to cover the interaction of a wide range of electromagnetic radiation (of which visible light is only a small portion) with matter. As radiation is absorbed, scattered, or emitted from matter, it provides a fingerprint of the energy levels available to the sample. This information can be used to identify an unknown, to investigate the structure of a molecule, to provide an image of your brain (magnetic resonance imaging, MRI, is an application of NMR spectroscopy), or even to determine the composition of stars many thousands of light years distant. It is impossible to imagine modern science without spectroscopy.

Synthesis

Almost every part of our daily lives depends on, at some level, a compound that a scientist designed and synthesized. Research chemists often have to balance intellectual, creative, and economic considerations in order to design new molecules and the methods to make them. The uses of synthetic compounds are almost endless, including pharmaceuticals that thwart disease, diagnostic compounds that probe cancerous tissue, catalysts that yield ever more efficient combustion products, flavors and food additives, cosmetics and fragrances, and thin films that coat surfaces to produce miniature superconductors. Several research projects in the USM Chemistry Department include synthesis, and students participate in these projects with faculty or as part of the laboratory curriculum.

Thermodynamics

The energy of the universe is constant. The entropy of the universe always increases. Building on these principles, thermodynamics (from the Greek "heat" and "power") explores such diverse phenomena as phase changes (Does diamond spontaneously become graphite under normal conditions?), colligative properties (Is the osmotic pressure generated across a tree root sufficient to drive sap to the top of the tree?), heating and refrigeration, chemical equilibria, and electrochemistry. With the introduction of statistical methods to chemistry, thermodynamics bridges the molecular and macroscopic realms by relating bulk properties of matter to the populations of molecular energy states.