The chemistry department 2017 assessment report highlights relevant material submitted to the American Chemical Society Committee on Professional Training for our 6 Year Periodic Review. An extensive report was filed to the ACS-CPT for review of the department’s undergraduate programs. The periodic report serves as a basis for external review of all aspects of the chemistry department including curricula, instrumentation, staffing, support, workload, salary, infrastructure, assessment, diversity, and future directions. In addition to an extensive report, over 120 documents were uploaded for review and feedback.

Curriculum

The revised ACS-CPT curriculum sets guidelines for student certification. Major and cognate course requirements were submitted for ACS certified major programs and supported with uploaded documents of catalog copy of major grids and course descriptions for all department programs and courses. Syllabi and copies of all exams were submitted for review, as were lists of laboratory experiments for all required laboratory courses that included reagents and instrumentation used for each experiment. The revised curricula require introductory, foundational, and advanced courses in each of the sub-disciplines of chemistry (analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, and physical chemistry) and a minimum number of laboratory hours. The report details how each requirement is met. Examples of student theses representing various sub-disciplines were submitted for review, as was the department rubric used for research/thesis/oral defense assessment.

The report and supporting materials will be evaluated by the ACS-CPT and provide the department with an external assessment of the quality of its programs, including depth and breadth of lecture and laboratory course offerings.

Student Skills

a. Problem solving, communication, teamwork

Professional skills in problem solving are developed by working out problems in courses and recitations, as well as examination questions where students provide calculations and explanations for their answers. Teamwork skills are developed during laboratory courses with students working in pairs and pooling class data to observe reactivity patterns and reach conclusions based on pooled data. Ethics is emphasized in lectures and laboratory courses; including accurate documentation and presentation of data and using accepted citation guidelines. Communication skills are developed in upper level courses with required student
presentations. The research courses culminate in a written thesis and a defense evaluated by a faculty committee and assessed via a rubric.

b. Effective retrieval and use of chemical literature

In advanced courses, students are required to give formal presentations or write papers requiring searches of the chemical literature. They formulate a search strategy under the supervision of course faculty. The undergraduate research course represents a significant portion of student experience with information retrieval. Mentors guide their students through literature searches that provide background for their research and theses. This is an ongoing process throughout the student's research, culminating in a written thesis and oral defense.

c. Safety in lab

Safety begins in the first introductory laboratory. Instructional laboratory courses begin with a safety overview of the location of safety equipment, MSDS access, safety rules, and the signing of a safety agreement. Laboratories begin with a discussion that includes safety considerations and a collection of student pre-labs that include calculations and relevant safety points. Laboratory coats and goggles are worn. The Chemical Hygiene Officer checks research and instructional laboratories for safety compliance. Research students sign a safety acknowledgement form that includes safety regulations, a description of the research project with a list of chemicals, and copies of approvals of appropriate university oversight committees.

d. How Student Skills are Assessed

Problem solving is assessed in course examinations for individual students and in overall course/program assessment with embedded questions targeted toward specific student learning outcomes. Rubrics are used for the research thesis/defense, as well as in a number of advanced courses requiring student presentations. Laboratory grading rubrics include sections on safety and ethics (data collection, citations, etc.). A copy of the rubric used for the capstone experience for chemistry and biochemistry/research track majors was submitted to the ACS-CPT for review.

*The ACS-CPT will evaluate how the department meets the recommended student skills outcomes and provide the department with an external assessment of these outcomes.*

Assessment

The department is very active in collecting assessment data and evaluating the results of the data to guide program improvement. Each program has multiple Program Learning Outcomes goals. Both individual course assessment and overall program assessment are conducted on an ongoing basis. Assessment methods include embedded examination questions, grading rubrics
for learning, communication skills, and laboratory performance, and collection of results from standardized ACS exams. Capstone experiences are evaluated with rubrics. Students in programs leading to certification are required to conduct undergraduate research culminating in a written thesis and oral defense. A faculty committee evaluates the research/thesis/defense of each student using a rubric. A faculty member coordinates collection of all assessment rubrics.

In 2014, the department began a detailed assessment of the introductory chemistry laboratories. Multiple student learning outcomes for each of the 21 sections were evaluated. The project was coordinated by the faculty supervisor who developed the rubric and guided the graduate teaching assistants in the evaluation process. The data was pooled and a report distributed to the department. The results served as the basis for a conversation on how to improve student learning and resulted in improvements to our program.

Following collection of assessment data, a proposed plan of action for goals falling short of the target is developed. In subsequent years, the effect of the changes is assessed. Data is collected and evaluated within the department and then submitted to the University.

Examples of Use of Assessment to Improve Learning

The two most significant examples are 1) introduction of recitation sections for the introductory chemistry courses and 2) a proposed curriculum change whereby the analytical chemistry laboratory (Instrumental Analysis) will be taken after completion of the lecture course. These are programmatic changes. In addition, each course is assessed individually and examples of faculty improvements based on the data include modifying lectures to include more problem solving/board work, providing more detailed instructions and feedback for laboratory reports, and putting more emphasis on topics where student performance was below the target.

Recitations were introduced following a detailed assessment of all 21 sections of freshmen introductory lab courses. Most student learning outcomes were met. The majority of goals falling short of the target were classified as "quantitative" skills. Additionally, faculty observed students struggling more with math skills and problem solving in the lecture courses. The recitation sections meet one hour per week with smaller course caps than the lecture courses, and focus on problem-solving and question/answer sessions. Students are given a weekly quiz on current class material.

One of the capstone courses spends a period at the end of the semester discussing the program. Students are asked what is working well, as well as for suggestions on program improvement. A repeated comment over several years was a suggestion that experiments using a particular instrument in Instrumental Analysis follow discussion of that instrument in the lecture. This was not always possible given the number of students needing to use each instrument during the semester and the high utilization of the laboratory space for other instructional laboratory courses, as well as research. The proposed solution is that the lecture will be taken in the Fall and the laboratory in the following Spring.

The ACS-CPT will evaluate how the department meets the assessment requirements and provide the department with an external assessment of department assessment practices.

Recent Developments and Future Directions
In 2016, the department began a comprehensive review of our curriculum, beginning with the chemistry major and biochemistry major leading to ACS certification. We proposed and discussed several modifications of requirements and sequencing of courses, taking into consideration the 2015 ACS-CPT guidelines, as well as the results of our program assessment. A consensus was reached on the chemistry major curriculum and we are in the midst of conversations on the biochemistry curriculum. A highlight of the new chemistry major is that all chemistry major graduates will meet the requirements for ACS certification and we are considering a similar proposal for the biochemistry research track. The new program for the chemistry major requires students to take a foundation and advanced course in each of the five subdisciplines, in addition to elective courses. The requirement for research leading to a written thesis and oral defense is retained. As noted in the assessment discussion, the sequencing of the instrumental analysis lecture and laboratory (analytical) has been modified. In addition, the Instrumental Analysis laboratory course now has a capstone project requiring the students to work on an independent project in pairs. The requirement for a third semester of organic chemistry has been replaced by an elective to allow students more flexibility to pursue individual interests. The department requested a polymer chemist and will introduce a polymer chemistry course, and possibly a degree track, if approved. The proposal for the chemistry major revisions was submitted to university curriculum review committees and approved for implementation in Fall 2018. We anticipate a proposal for biochemistry major revisions will be submitted next Fall. We will then consider any changes to the degrees not leading to ACS certification.

An additional curriculum change is that qualified undergraduate students will be allowed to enroll in graduate chemistry courses as electives. This will expand opportunities for students to pursue more in-depth courses to align with their interests and future goals. This policy required consultation with the University Administration. Guidelines have been established that will work well for the chemistry programs.

Within the past five years, we have hired several faculty members for replacement positions. This year, we requested two tenure track positions. The first is for a polymer/materials chemist to complement the department and support the new ACS curricular requirements. The second is for a biochemist to support the increasing need for biochemistry due to increases in the number of biochemistry and BCMB majors, as well as support for non-department programs with large numbers of pre-professional students. The additional faculty members will reduce reliance on nonpermanent faculty, as well as bring the number of contact hours of several current faculty members in line with ACS-CPT recommendations.

The department moved into the new Loyola Integrated Science Center. In addition to dedicated instructional and research laboratories, there are numerous community spaces for student/student and student/faculty interactions. Faculty offices are in suites with five faculty sharing similar research interests. The suites are in close proximity to the research laboratories. The research laboratory suites have student write-up areas, often with computer stations.

The department has decided to look into expanding internships opportunities for students. One faculty member volunteered to coordinate the effort. He has contacts in industry and will look into expanding opportunities, as well as increasing student awareness. This year, an alumnus visited campus and gave a presentation discussing internship opportunities for students. In addition, we developed a relationship with a supervisor from a local chemical company looking to hire graduates, as well as offer internships. We plan to expand these contacts in the future.

Once we complete our curriculum review, we will resume discussions on new programs. At this point, we began discussions of medicinal chemistry since we have three synthetic organic chemists, two of whom have worked in the pharmaceutical industry. In addition, we have two biochemists, an analytical chemist with bioanalytical interests, and an inorganic chemist conducting research in bioinorganic chemistry. If we are able to hire a polymer/materials chemist, we plan to look into the feasibility of a polymer chemistry program.
The ACS-CPT will review the plan for future directions and provide the department with external input on the proposed directions.