

REVIEW OF THE B.S. IN CHEMISTRY

Classification of Instructional Program (CIP) Code: 40.0501
Chemistry, General

OVERVIEW

The B.S. in Chemistry program at Illinois State University is housed in the Department of Chemistry within the College of Arts and Sciences. The department also offers a minor in chemistry, a B.S. in Biochemistry, a M.S. in Chemistry, and two master's level chemistry education degree programs, the Master of Chemistry Education (M.C.E.) and the Master of Science in Chemistry Education (M.S.C.E.).

The Department of Chemistry is consistently among the top producers nationally of undergraduate chemistry graduates with a degree certified by the American Chemical Society. Students in the B.S. in Chemistry program choose between a general chemistry plan of study and a chemistry teacher education sequence. The general chemistry plan prepares students for entry-level positions such as laboratory coordinator, research assistant, product testing or analysis, technical sales, or service representative and for graduate study in chemistry and related fields. The majority of students completing the general chemistry plan of study subsequently work in the private sector. The chemistry teacher education sequence prepares students for initial teacher licensure in Illinois with an endorsement to teach chemistry at the secondary level. The chemistry teacher education sequence is affiliated with the teacher education unit at Illinois State University.

Enrollment by Plan of Study, Fall Census Day, 2009-2016

B.S. in Chemistry, Illinois State University

First Majors Only

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|-----------------------------|------|------|------|------|------|------|------|------|
| Plan of study: | | | | | | | | |
| Chemistry | 100 | 92 | 80 | 92 | 95 | 93 | 103 | 85 |
| Chemistry Teacher Education | 44 | 56 | 42 | 28 | 31 | 27 | 27 | 30 |
| Total | 144 | 148 | 122 | 120 | 126 | 120 | 130 | 115 |

Degrees Conferred by Plan of Study, Graduating Fiscal Year, 2010-2016

B.S. in Chemistry, Illinois State University

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|-----------------------------|------|------|------|------|------|------|------|
| Plan of study: | | | | | | | |
| Chemistry | 19 | 19 | 16 | 16 | 17 | NA | 15 |
| Chemistry Teacher Education | 0 | 12 | 7 | 4 | 4 | NA | 2 |
| Total | 19 | 31 | 23 | 20 | 21 | 25 | 17 |

EXECUTIVE SUMMARY PROGRAM REVIEW SELF-STUDY REPORT

Self-study process. Numerous faculty and staff members of the Department of Chemistry, either individually or as members of department committees, were involved in the multiple-year program review self-study process. The Undergraduate Programs Committee and the Department Council reviewed the program curriculum and the student learning outcomes assessment plan for the program in light of feedback from the American Chemical Society, which accredits the program, and from the Assessment Advisory Council, a campus-wide committee that support units with their assessment efforts. The Facilities Committee, the liaison between the department and the library, and the academic advisor were consulted for input on appropriate sections of the self-study report. Students provided input for the study through interviews conducted by the department chairperson at the time of their graduation. Alumni provided input by completing a survey administered by University Assessment Services. The department

chairperson wrote the self-study report, drawing on information gathered throughout the review process and on input and feedback provided by both the current and immediate past associate chairpersons.

Program curriculum. Students in the B.S. in Chemistry program take a broad spectrum of courses that leads to a degree certified by the American Chemical Society. For new incoming students, requirements for admission to the program are those of the University. Students transferring into the program after having completed 45 or more credit hours must meet several additional requirements, including a grade of C or better in Calculus I, General Chemistry I, and General Chemistry II. To graduate from the program, students are required to take at least 45 credit hours of chemistry, eight credit hours of calculus, and eight credit hours of physics. A grade of C or better in all chemistry courses is required to qualify for American Chemical Society certification.

Program or academic unit faculty. The Department of Chemistry consists of 20 full-time tenure track faculty members (as of fall 2016). Three are currently in administrative roles: the department chairperson, the Associate Vice President for Research and Graduate Studies, and the director of the Center for Mathematics, Science, and Technology. All tenure track faculty members are full members of the graduate faculty at the University or have applied for that designation. All tenure track faculty members (including the three administrators) teach and mentor students in the program. Tenure track faculty members teach all laboratories and lecture courses taken by program majors. Non-tenure track faculty members participate in general chemistry and organic chemistry laboratory instruction.

Program goals and quality indices. Faculty has adopted five student learning outcomes for the B.S. in Chemistry program: 1) students will have a strong understanding of the fundamental basis of the science of chemistry through mastering key concepts in at least four of the specific areas of physical chemistry, organic chemistry, inorganic chemistry, analytical chemistry, and biochemistry and with advanced work in one of the areas through independent investigation (research); one of the areas may be chemical education; 2) students will develop information and communication skills (oral, written, and computer) needed to be a professional chemist, to be successful in doctoral study in the discipline, or to enter a program leading to a degree in medicine or a related field; 3) students will develop problem-formulating and problem-solving skills relevant to the field of chemistry; 4) students will develop safe and effective laboratory techniques including those for chemical handling and use of chemical instrumentation; and 5) students will learn how to translate their knowledge of chemistry into practice.

Student learning outcomes assessment plan and process. Assessment data are collected each semester from course instructors, from graduating students through exit interviews, and from the stockroom manager. Data are compiled by the department chairperson and are discussed with the Department Council. Following those discussions, assessment results are shared with the Undergraduate Programs Committee. The report of assessment results is also made available to all faculty members. Any party to the assessment process may initiate revision of the assessment plan. The plan revision process begins with consideration by the Undergraduate Programs Committee. There is a desire in the department to more closely align assessment strategies for the undergraduate chemistry program with current goals and with assessment standards of the program accreditor.

Specialized accreditation. The B.S. in Chemistry program is accredited by the American Chemical Society (ACS) through its Committee on Professional Training. ACS considers the B.S. in Chemistry an “approved program” qualified to offer “certified degrees” in chemistry. In 2013 the Department of Chemistry submitted a request to ACS for continued accreditation of the program. The request was approved by ACS in December 2015. The department is scheduled to submit its next request for reaccreditation in 2019. The chemistry teacher education sequence has been approved by the State Educator Preparation and Licensure Board of the Illinois State Board of Education. The sequence is part of the teacher education unit at the University accredited by the National Council for Accreditation of Teacher Education (NCATE). The teacher education unit was last accredited by NCATE in 2012. The next accreditation review, to be conducted by the Council for the Accreditation of Educator Preparation (CAEP) as successor to NCATE, is scheduled for 2019.

Responses to recommendations resulting from the previous program review. The 2008-2009 review of the B.S. in Chemistry program by the Academic Planning Committee resulted in five recommendations. First, the Academic Planning Committee asked the department to continue refining the assessment plan for the program and to incorporate assessment of student advising in the plan. Questions related to advising have since been added to the exit interviews of graduating students. Initial efforts to develop an exit survey to be administered after each advising

session were abandoned with a change in department leadership and with the hiring of a (temporary) full-time professional advisor. Instead, informal interviews of students selected through random sampling have been conducted by the department chairperson. These efforts could be institutionalized going forward. Second, the Academic Planning Committee asked the department to continue its support for cooperative education, which combines classroom- and laboratory-based learning with practical work experience. Employers (often program alumni) continue to contact the department about cooperative education opportunities, but few students have taken advantage of the opportunities. Thus, the challenge to the department has shifted from finding employers willing to participate in cooperative education to encouraging students to participate in them. One approach considered by the department is adopting an internship requirement for the program, which a cooperative education arrangement could satisfy. However, the number of cooperative education opportunities is still not high enough to accommodate all students who likely would seek a cooperative education arrangement to meet an internship requirement. Third, the Academic Planning Committee asked the department to continue recruiting efforts with high schools and community colleges to diversify the student body. Efforts continue in this area. They include stronger co-advising partnerships with area community colleges and joint summer research efforts with the City Colleges of Chicago (made possible by National Science Foundation funding). Thus far these efforts have resulted in greater diversity among students in the department during summer terms but not to increased applications from City Colleges of Chicago graduates seeking to continue their education at Illinois State. Fourth, the Academic Planning Committee asked the department to continue to look nationally to identify benchmark and aspirational programs. As one of 688 chemistry programs certified by the American Chemical Society (ACS), the B.S. in Chemistry program at Illinois State has many peers around the nation. The program is commonly among the top 30 schools with respect to the number of ACS-certified degrees conferred, when such statistics are made available. Fifth, the Academic Planning Committee recommended that the department adapt the curriculum of the B.S. in Chemistry program to new ACS accreditation standards. Through a major curriculum review and revision, the department has done so. Since then, however, more changes to accreditation guidelines have been made by ACS. The department will need to review the program curriculum against those additional changes in due course.

Changes in the academic discipline, field, societal need, and program demand. Since the 2008-2009 program review, demand for chemists has declined nationally, especially for newly-graduated chemists, and unemployment among chemists is now higher than it has been in many years. The number of entry level positions available to new chemistry program graduates has declined as more experienced candidates fill those positions. This situation is unlikely to change with the continued consolidation of large multinational corporations. Chemistry program graduates now rarely work for a single company for their entire career; rather they typically begin in a temporary or work-for-hire arrangement, move into more permanent positions, and often move from one company to another. Employers (and the American Chemical Society) now expect graduates to have computer literacy, safety, ethics, oral and written communication, and information literacy skills in addition to traditional laboratory skills.

Major findings of this program review self-study. Based on this extensive program review, faculty of the B.S. in Chemistry program finds the program to be in good standing. A large majority of students enrolling in the program graduate from it and report high levels of satisfaction with it. However, improvements are still in order. The student learning outcomes assessment plan should be updated to better and more clearly align with American Chemical Society (ACS) accreditation standards and with strategic plans adopted by the Department of Chemistry, College of Arts and Sciences, and the University. Before that can occur, however, the department needs to update (perhaps overhaul) its strategic plan to align with strategic plans of the college and University. Attention to the curriculum to maintain alignment with ACS standards and to remain current with changes in the discipline is an ongoing challenge. Some concerns were raised during this program review regarding adequate, intentional, and systematic coverage in the curriculum of computer literacy, safety, ethics, oral and written communication, and information literacy skills. These concerns merit further scrutiny by the faculty, as do questions regarding the balance between foundational and advanced topics courses, coverage of macromolecular/polymers, and adequacy of laboratory time.

Initiatives and plans for the next program review cycle. The primary initiatives for the B.S. in Chemistry program during the next program review cycle are development of a new strategic plan for the Department of Chemistry and revision of the student learning outcomes assessment plan for the program. Other matters identified through this program review that might be further considered through the strategic planning process include support by the department of the General Education program at the University; study abroad opportunities; student support mechanisms; facilities, equipment, and computing infrastructure; and general chemistry offerings. With a new department chairperson having recently been hired and with many years having passed since the previous strategic

plan for the department was adopted, undertaking a comprehensive strategic planning process seems the most prudent first action following this program review.

PROGRAM REVIEW OUTCOME AND RECOMMENDATIONS FROM THE ACADEMIC PLANNING COMMITTEE

Review Outcome. The Academic Planning Committee, as a result of this review process, finds the B.S. in Chemistry program to be in Good Standing.

The Academic Planning Committee thanks the program for a thoughtful and critical self-study report.

The committee congratulates faculty for continued recognition of the B.S. in Chemistry program by the American Chemical Society (ACS) as an “approved program” that may offer “certified degrees” in chemistry. The committee also recognizes the program for graduating more chemistry teacher education students than any other Illinois university with an ACS-approved program. The committee encourages the department to work toward continued approval by ACS of the chemistry teacher education sequence by investigating options for recognition by ACS of the student teaching component of the sequence.

The committee recognizes the program for the quality of its students, as demonstrated by rising average ACT scores that are consistently higher than the university average and by participation of chemistry students in the University Honors program at rates double or triple the rate across all undergraduate programs at the University.

The committee commends faculty members for the individualized attention and support they provide students. Since the last program review faculty has revised the curriculum to allow students greater flexibility in meeting program requirements. Curricular changes include new or expanded courses, changes to the timing of course offerings, and elimination of some prerequisites. Despite a challenging fiscal environment, the department has maintained and upgraded equipment vital to the curriculum through careful budgeting and grant procurement. The program has committed to quality student advising by retaining a full-time advisor who has instituted a holistic approach to advising through application of student development theory. Faculty members continue to promote collaborative faculty-student research involving frequent one-on-one mentorship of students and communication by students of research findings through presentations, posters, and papers; in some years faculty members have provided students opportunities to assist them with research in other countries through multiple-week research trips. The program has worked closely with Milner Library faculty to select resources most appropriate to the curriculum and to student and faculty research. Program and library faculty have also collaborated to teach information literacy skills students need to succeed in the discipline.

The committee commends the program for its service to the university community through the General Education courses the program offers and through courses that meet requirements of other academic programs. The committee recognizes contributions by chemistry faculty and students to area schools, museums, organizations, and community initiatives such as the Children’s Discovery Museum, State Farm Millennium Girls Project, Army National Guard Civil Support, and Chemistry Olympiad. The committee also recognizes efforts by the department to engage corporate partners in curricular and co-curricular activities.

The self-study report identifies revision of the student learning outcomes assessment plan for the program as a primary initiative for the next program review cycle. The report indicates the need to better align learning outcomes and data collection with standards and reporting requirements of ACS. To prepare for the 2019 ACS review but also to inform program changes during the next review cycle and beyond, the committee asks program faculty to revise the assessment plan and to implement the revised plan by collecting and analyzing data, utilizing findings to inform programmatic decisions, and documenting decisions made and the rationale for them. The committee asks the department to submit the revised assessment plan to the Office of the Provost by May 15, 2018, and to submit a report to the Office of the Provost regarding implementation of the plan by October 1, 2020. The committee recommends that faculty consider feedback provided by the Assessment Advisory Council and assistance available from University Assessment Services staff as it revises the assessment plan for the program. The committee encourages faculty to develop a plan that can be sustained by the department given its faculty and staff resources. To that end, every student learning outcome need not be assessed every year nor is it necessary to evaluate the work of

every student. Staggering assessment of learning outcomes across multiple years and sampling student work are appropriate strategies.

Recommendations. The Academic Planning Committee makes the following recommendations to be addressed within the next regularly scheduled review cycle. In the next program review self-study, tentatively due October 1, 2024, the committee asks the program to describe actions taken and results achieved for each recommendation.

- The self-study report articulates the need for a new strategic plan to guide the department and its programs through the next program review cycle and beyond. The report notes that, with the department chairperson position now filled and with more than 12 years having passed since the previous strategic plan was adopted, undertaking a strategic planning effort is a prudent first action following program review. The committee concurs. The committee views the strategic planning process as an opportunity for faculty to address issues that have emerged through the program review process, including, but certainly not limited to, student retention, recruiting students who self-identify with racial or ethnic groups traditionally underrepresented among undergraduate chemistry students at Illinois State, and maintaining access to library resources needed to support the curriculum and faculty research.
- The self-study report identifies student retention in the sciences as a constant struggle at universities across the United States. For the B.S. in Chemistry program at Illinois State, the fall-to-fall retention rate for external transfer students has been as much as 7.5 percentage points lower than the average across all undergraduate programs at the University during the most recent five years for which data are available. In three of those five years, the fall-to-fall retention rate for first-time-in-college students was lower than the university-wide rate, by as much as 7.2 percentage points. The committee encourages faculty to further analyze retention rates and to develop strategies to stabilize and increase them. Strategies could be included in the new strategic plan for the department or in a student retention plan associated with but separate from the strategic plan. To help analyze student retention, faculty might consider establishing an ongoing process for obtaining and documenting input from students leaving the program before graduation. Retention strategies to consider include providing additional help for students struggling to succeed in gateway courses and designing co-curricular activities and alumni events to positively impact retention. Faculty might also consider additional ways to prepare students for new and emerging types of jobs for which program graduates will compete.
- The self-study report states that attracting students from racial and ethnic groups traditionally underrepresented in chemical sciences and in the undergraduate chemistry program at Illinois State continues to be a challenge. The report also articulates concern about retention of students from traditionally underrepresented groups, noting that the department currently does not have a plan for addressing the concern. The committee recommends that the program develop and implement a plan to recruit for student diversity and to retain students from traditionally underrepresented populations once they enroll. Essential to retention efforts are strategies for maintaining an inclusive environment in the program and department. The plan could be a component of the new strategic plan for the department or could be associated with but separate from that plan.
- The self-study report notes the challenges faced by program and library faculty to maintain access to journals and databases most needed for teaching and research in the department. Subscription prices continue to rise while funding for those subscriptions has been stable at best, necessitating difficult resource choices. The committee is concerned about this situation, including its potential impact on ACS approval of the B.S. in Chemistry program. The committee recognizes the difficulties of addressing this concern and the reality that other disciplines at the University are facing similar challenges with regard to library resources. Nonetheless, the committee encourages program and library faculty to maintain a prioritized list of journals and databases needed to support student learning and research and to maintain ACS approval, for use in the event that additional budget reductions are necessary or additional funds for library resources become available. The committee further encourages program and library faculty to continue investigating alternative library resource funding strategies and resource delivery options, including, but not limited to, enhancing resource sharing across universities in the state, expanding per-use subscription services such as *Get It Now*, incorporating funding for library resources in research grant proposals, and seeking contributions to library funds by external entities (e.g., corporate funding).

- It is likely that chemistry departments at some other universities have been similarly challenged to retain students, recruit for student diversity, or maintain an adequate level of research resources. It is also likely that some of those departments have implemented strategies intended to address one or more of those challenges. The committee recommends that faculty identify those other departments and study the strategies they have deployed for their applicability to the chemistry program at Illinois State. A logical first step in identifying those departments is to consult the list of programs faculty has already identified through the program review self-study process as aspirational programs. If programs heretofore identified as aspirational programs do not provide faculty sufficient guidance with these challenges, faculty might identify additional aspirational programs.
- The self-study report describes extensive efforts by the department to document and communicate with program alumni through faculty outreach and use of social media. To help further develop alumni relations, the committee recommends that the department investigate establishing an alumni advisory board. Such a board could provide input regarding curriculum design and student learning outcomes assessment, help students establish networks in the discipline and compete for jobs, guide the program and department with solicitation of external funding to support equipment and library resource purchases, and assist the department with student recruitment and retention efforts. With the Department of Chemistry having celebrated its 50th anniversary throughout 2016, interest among alumni in establishing an alumni board may be particularly high at this time.
- The self-study report notes inconsistencies between descriptions of the chemistry minor in the undergraduate catalog and the student information system. The committee concurs with the recommendation in the self-study report that faculty reevaluate requirements of the minor. The committee asks the department to ensure consistency in the description of the minor across the catalog, student information system, and student advisement and recruitment materials such as the department website.
- The committee recommends that, in support of its student recruitment and public outreach efforts, the Department of Chemistry continue to make publicly available information regarding research interests of each faculty member in the department and opportunities for faculty-student research collaborations. The Faculty/Staff and Research sections of the department website effectively communicate this information in a manner comprehensible to upper division undergraduate students, graduate students, and academicians but not necessarily to prospective undergraduate students or the general public. The committee recommends that the department consider providing this information in a manner accessible to the latter populations as well.
- Beyond the work requested by the committee to revise the student learning outcomes assessment plan for the program, the committee urges the program to continue to utilize information collected through student learning outcomes assessments over the next eight years to make program improvements and to document how that has been done.