Fitchburg State University Chemistry Program

External Review

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The Department of Biology & Chemistry is in the process of reviewing its chemistry undergraduate program. The department wrote a comprehensive, insightful self-study report, and I received it on March 5. On May 1, I met with the Provost/Dean, Librarians, and Students. On May 8, I met with the Faculty/Chair and the Provost/Dean.

The previous program review was conducted in 2022. The department appears to have taken this process seriously, as many of the recommendations from the previous review were implemented. The chemistry program is completing an additional review at this time to align their program review cycle with that of the biology program.

Based on the data presented in the written documents provided to me and what I observed on campus, the self-study accurately identified many key strengths of the department as well as highlighting some opportunities to enhance the program. In the review below, I offer additional comments and recommendations based on the self-study, documents that I received during the site visit, notes made during my meetings during my site visit, and additional information from the website.

Program Strengths

It was clear to me from the self-study document and everyone who I spoke to on campus that this program benefits greatly from its highly engaged, accomplished and thoughtful faculty. The faculty clearly form strong connections with their students and advisees and work hard to help them succeed during their college years and beyond. Students enrolled in the initial teaching licensure program, which is a high credit bearing program, expressed their gratitude that the faculty rearranged the department course schedule to ensure they can graduate on time. This highlighted the care and dedication with which the faculty approach their advising work. Several students noted their enthusiasm about performing undergraduate research with faculty, noting that they loved the opportunity to do hands-on labwork and create something new on their own. They said they learned about their research opportunity when the faculty mentor discussed it during one of their classes. Students typically find it engaging when modern research topics are infused into chemistry courses across the curriculum, and this also provides an opportunity for the instructor to link what an expert is doing in their research lab to the concepts/theories being discussed in class.

The grant-writing and instrumentation skills of the faculty benefit the department in many ways. The recent NSF-funded S-STEM grant is expected to benefit the department in myriad ways, especially in terms of recruitment and retention of students with unmet financial need. The department owns a good collection of instruments relative to its number of majors, including equipment that it has recently purchased using external funds from their recent Mass Life Sciences grant. Incorporation of hands-on experimentation using these instruments in the

department's analytical chemistry class no doubt enhances the practical laboratory skills that students develop in the program as either majors or minors, yet typically requires in-house maintenance of the instrument. It is therefore valuable that the department's analytical chemist developed significant knowledge and skills working in the instrumentation industry before joining the faculty. The time, effort, and skills required to complete this kind of service for the department should not be underestimated. Students, indeed, said they viewed the in-person lab components of their courses as vital to helping them understand the material, and in many cases, it was their favorite aspect of their courses. To support hands-on learning of this kind, it is very important that the department continue to employ a dedicated technician after the current technician retires. The suggestion to have a transition period wherein a new technician is hired and employed concurrently to learn from the technician who is retiring seems like a good idea.

Thoughtful efforts have been made to effectively assess the impacts of the program on student outcomes including disciplinary knowledge, lab skills, safety, and communication skills. These outcomes are highly valued by the American Chemical Society. It is particularly commendable that they have used a rubric to evaluate student presentations, and that the rubric has been revised based on self-evaluation.

Current Challenges

The faculty view student recruitment as the key challenge facing their program and providing support to allow students to succeed and be retained is also viewed as critical to the future success of the program. These issues of decreasing student recruitment, retention, and enrollment are college-wide, and in fact industry-wide, concerns. One enduring challenge is that many students arrive at college without the math skills necessary to succeed in their STEM courses. This mirrors trends seen in STEM programs across the country and is a difficult challenge to address. Overall, the chemistry program has been thoughtfully designed to help students develop the requisite knowledge and skills necessary to successfully complete their STEM major during the introductory chemistry sequence. While some current practices seem likely to help such students succeed and be retained in their major, I am concerned that some others could negatively impact retention.

Requiring students to obtain a threshold score on their math placement exam and offering extra practice with basic math skills at the beginning of the General Chemistry 1 course are common practices that seem likely to promote student success and timely degree completion. Policies such as the requirement that students earn at least a C- in each introductory course before proceeding to take the next course in the sequence, and only allowing a student to attempt each course twice before suggesting they switch majors, seem likely to ensure that students who do successfully complete the introductory sequence are more likely to possess such math skills and complete the major in a timely manner. However, they are also of some concern given the department's desire to increase student retention. Separating marginally performing students from their peers that began the major at the same time (their cohort) removes a key source of peer support. This can be especially discouraging and alienating for students from underrepresented groups. Re-taking courses can increase the number of years required to complete the degree, which is particularly burdensome for students with unmet financial needs. While it is important to acknowledge that many students arrive at college with weaker math skills than is optimal, outsize focus on evaluating and ameliorating this perceived deficit is not likely to be inspiring for students. I therefore also encourage the faculty to also consider a strengths-based approach to promoting student success, thinking about what strategies have worked or could work to increase the intrinsic interest of the students in the discipline and cause them to strive for increased skill development and higher achievement.

Notable department efforts to retain students in the introductory sequence include the embedded tutors program and offering exam “post-mortem” assignments to students. During my visit, students shared that many faculty provide “exam recovery” opportunities-in other words, extra credit assignments to help them earn points back while learning from their mistakes. This approach is common in the industry and appropriate. In person, the faculty clarified that they do allow students to attempt a course more than twice if extenuating circumstances (i.e. personal, family, medical or mental health issue) prevented them from succeeding. While students clearly perceived the embedded tutoring program as valuable (both as the tutor and the tutee), the program is sometimes difficult for students to access since the tutoring hours take place in a different building at scattered times when their peers may be scheduled to take other classes or work off-campus.

Recommendations

To address the recruitment and retention issues currently facing the program, I recommend the following:

1) Expand/refine and advertise distinctive aspects of chemistry program. When asked what makes program distinctive, the faculty said small classes, caring involved faculty etc. which is very common at small-medium schools. When advertising the program to prospective students, I recommend focusing on what makes the department unique. For example:

    a. One unique (and highly advantageous for students!) selling point for the College is that students can apply for the LECOM Early Acceptance Program to Medical and Dental School. I suggest explicitly building pre-medicine themes into courses offered across the curriculum (in this department and others). Infusing additional topics of special interest to students who would consider minoring in chemistry/biochemistry into the curriculum may also help with student recruitment.
    b. Leverage the thoughtful work the department has performed assessing student learning outcomes. Evidence of practice skill acquisition during the program is likely to appeal to prospective students. You might consider expanding your assessment of laboratory skills to include some kind of direct lab skills assessment (as opposed to quiz questions), or offering some kind of micro credential, certificate or LinkedIn badge program that students can earn to further illustrate how the program adapts to meet student interests/needs.
    c. Related to this, you might consider building an explicit pipeline from your program to a local graduate program geared towards building industry connections. For example, you could set up an agreement for your students to receive priority or guaranteed admission to a 4+1 style program spanning both institutions (and its associated industry opportunities) if they achieve specific admission criteria (i.e. GPA threshold).
    d. It is obvious there are talented grant writers in the department, and that other faculty have also been very active pursuing grants. I recommend leveraging the faculty skills & enthusiasm in this area, as well as the strong ties (i.e. articulation agreements) the institution has to local community colleges, to pursue a Noyce grant, which would help attract students to the initial teaching licensure program.

2) Connect students with the department and existing students prior to admission
    a. Consider holding scientific outreach / teaching demonstration events at local high schools and community colleges. Notably, to do this well would require a significant time input on behalf of the faculty involved, and therefore resources committed by the institution in terms of consumables and faculty time (alternate professional responsibility time). You might consider involving students in these efforts (For example, enrolling them in a 1-credit course focused on developing their teamwork / communication / presentation skills). This could be leveraged in current/future grant work.
    b. Consider offering research experiences to students before they matriculate. Faculty shared that much like at my institution, it is challenging to provide summer research experiences without financial support for both faculty and students. One way to potentially build community for transfer students would be to encourage prospective students from local community colleges to participate in a 1-credit research course at Fitchburg State shadowing one or more upper division research students while they are still enrolled in community college (similar to an early college program). This would help them get to know the campus and the chemistry faculty/community. This could potentially help recruitment in two ways: direct recruitment of the students engaging in the undergraduate research experience, and indirect recruitment of other students at the community college while also making them feel more comfortable and connected once they arrive.

3) Provide additional wrap-around supports for students who struggle in introductory courses.
    a. Rather than providing embedded tutoring sessions in a different building (or perhaps in addition to this), consider offering tutoring sessions in the foyer on the 3rd floor where students can easily access other classmates doing homework and the tutors in between classes. Expanding the tutoring hours to include some evening times when athletes can attend could also improve access to the program.
    b. Consider restructuring the introductory program sequence in such a way that students can complete more math courses before taking General Chemistry 2 (i.e. 1-2-1 model), or offering a summer boot camp course to help students who struggled with the math-intensive aspects of General Chemistry 1 to help them stay on track to graduate with their cohort.
    c. Review the grading scheme applied in introductory courses to evaluate if summative assessments (i.e. exams) have an outsized impact on students' final course grades. Consider allotting more points to formative assessment, as this can help retain students from underrepresented groups.

4) Increase opportunities for majors to attend class and study together, amplifying their cohesion as a cohort and thereby promoting positive non-cognitive outcomes for students. Provide additional community space for students enrolled in the program.
    a. Arrange the schedule of first year majors so that they take at minimum their general chemistry courses but ideally several of their courses together to increase cohort effect.
    b. Consider providing a commuter lounge (containing a couch, fridge, microwave, table, chairs, safe space to store belongings) to help the 60% of students who live off-campus to connect with another and build community.

c. Redesigning the 3 floor alcove as a study space (containing round tables, chairs, whiteboards, functional water bottle filling station) could help promote casual contact among the busy students and faculty. If the space is available, you may find that majors and/or chemistry club members spend time between classes eating, socializing, and studying which will promote social cohesion and resilience.

Please do not hesitate to contact me if you have any questions, or would like additional insights about other aspects of the program not focused on above.

Sincerely,

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