External review
Biology program review
Department of Biology and Chemistry
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Background:
The Department of Biology and Chemistry is undergoing a program review for its biology undergraduate and graduate programs. The department wrote a clear, well-organized, comprehensive self-study, which was provided to me on April 17, 2018. I subsequently visited the campus on April 24, 2018, when I met with faculty, staff, students and administrators.

The previous program review was conducted in 2013. The department appears to have taken this process seriously, as most of the recommendations from the previous review were implemented.

There is nothing in the self-study that I disagree with. Specifically, the section Plan for Change seems realistic and desirable. What follows in this review are additional suggestions/comments, based on the documents that I was provided, the information that I gathered during the site visit, and additional information available of the university's website.

Assessment and curriculum changes:
Assessing biology programs is very problematic because there is currently no professional accreditation available. As a result, it is very difficult to assess what students know and can do, in part because there is no basis for comparison. There are some national standardized tests available (ex. Biology Major Field Test) but the problem with administering such tests is that there is no incentive for the students to do well. As a result, students typically try to answer the test as fast as possible, with as little effort as possible.

The department used a combination of in-house pre- and post-tests, as well as curriculum mapping to evaluate the level of exposure of the students to the leach learning outcome. The in-house test can suffer from the same weakness as the national tests (low student motivation to take the test) while curriculum mapping measures the exposure of the student, but not what they know or can do. It is imperfect, but I do not have a suggestion to improve the quality of the assessment measures. We struggle we the same issues at our institution. Assessment is especially problematic for "skills". How to you measure that students grasp the ethical dilemmas involved in biological research? Having limited assessment of student performance that are objective and reliable, it is very difficult to formulate recommendations for curriculum improvements.

Nevertheless, since the last program review, the department implemented a number of changes aimed at improving the educational experience of the students, for example the addition of a Human Anatomy and Physiology course and the refinement of Capstone course learning outcomes and offerings. Adopting learning outcomes based on the Vision and Change/BioCore documents was an excellent initiative.

"3 Rs"
Nationwide, in all fields, there is growing concern that undergraduates finish their degree with deficient reading, writing and quantitative skills. Especially for upper level courses, it would be desirable to require students to produce substantial written assignments that require independent reading, including some articles from the primary literature. In regards to quantitative skills, the department should consider the possibility of requiring a course in statistics as part of the major. There is very little in biology today that does not require at least a basic understanding of

statistics. In addition, biology courses should continue to have regular, but simple, statistical assignment to re-enforce the concepts throughout the degree.

Capstone experience.
It is very wise to set clear and realistic learning outcomes for the capstone experience as a first step. Unless this is done, it would be very difficult to determine which course should count as a capstone, or if there is an alternative method of meeting the capstone requirement (ex. a common course that all students must take, a senior seminar course, and senior research course etc.). Any capstone experience course should include a substantial writing assignment. By covering many programmatic learning outcomes, the capstone should be a site of programmatic assessment.

Delivery of the content
Improving the education of the students is not limited to changing what if offered. It should also consider how it is offered. There was no mention in the self-study of efforts to increase the use of active learning methods. There is ample evidence that such methods can have a substantial impact on student success. The fact that it was not in the self-study does not mean that such methods are not used by the instructional faculty, it just means that it was not reported.

There is, on the other hand, an obvious effort by the department to promote experiential learning for the students, through internships and in-house research opportunities. Such efforts, in particular the internships, should be supported though release time for the coordinator(s) because they require a substantial time commitment to develop and maintain relationships with organizations that can provide internship opportunities for the students.

A mechanism that could be considered to further enhance experiential learning would be the implementation of a "research course", which would also serve the purpose of providing an additional capstone course. In a research course, a project is broken into multiple components so that each student has a specific hypothesis to test, a question to answer. The "class" time is divided into multiple components:
-Lectures/discussions about the nature of science, how research is done, the ethical considerations that must be considered, etc.
-Hands-on workshops of literature searches, data collections and analysis (including statistics), preparation of graphs and tables, etc.
-Lectures/discussions to provide students with the background information, the context of the project to be done
-Experimental work, collecting data, analyzing data
-Presenting the results as an extensive written report and a public presentation (which could be done at the end of semester departmental reception or at the Fitchburg State University Undergraduate Conference for Research and Creative Practices.

If such as course were to be offered every semester, with 12 students per class, 24 students per year would be exposed to a meaningful research experience (which is one the outcomes of BioCore). It would have the beneficial side effect of helping to keep faculty active and engaged in their field of research, which can be very challenging because of high teaching load and service commitments.

Removing barriers to success/graduation

Overall, retention rates, time to graduation, and graduation rates are good for a science program. The strategy to steer struggling student to other majors, trying to keep them at FSU, is a commendable strategy. Many students have an unrealistic view of what it takes to study biology, and if it is not a good fit for them, then it is in their best interest to be steered to another major as soon as possible.

An issue that appears to be problematic for students is the ability to register in the classes that they need, offered when they need them, when they can take them. There are many possible causes for this problem: the class schedules of too many classes overlap, too few sections or too few choices are offered. Depending on the source of the problem, a number of non-exclusive solutions are possible:

1-Evening classes. Scheduling of undergraduate courses is currently limited to daytime hours (8am-430pm). There is a contractual limitation to offering classes at later hours because faculty cannot be involuntarily assigned to teach courses after 4:30pm. However, there are probably adjuncts who would be thrilled to teach at night, when it does not conflict with their regular daytime job. If it is "voluntary", then my interpretation of the contract is that it these courses would fall under the MSCA day contract, not under the CGE. I could not find information about the ratio of biology course taught by adjuncts, but the number seemed very small. If it is compatible with the collective bargaining agreement, increasing the number of adjuncts who teach introductory courses, at night, would offer alternative scheduling for students, would free up time for full-time faculty to teach electives/capstones, and free the daytime schedule to have more slots available for electives/capstones.

2-Lab sizes. Most labs, including those in introductory courses, are limited to 16 or 18 students per lab. Yet, the lab spaces are large enough to accommodate more students. Increasing lab size provides advantages only if there are at least 5 sections/semester of a given course: 80 students can be served by 4 labs of 20 instead of by 5 labs of 16. Making this change could result in reducing the number of introductory biology (for majors and non-majors) lab sections by at least 2-3 sections/semester. The effect is that it would free up faculty time and time slots.

Doing this would require to purchase additional equipment so that all students in the labs have what they need, but this should pay itself very quickly due to the decrease in manpower required. More importantly, it needs faculty acceptance. There may be a lot of resistance to increasing the caps of labs, but it is very common for universities to have 20 students per lab in the introductory classes.

Increasing lab sizes may give the department leverage in negotiating lower enrollment minima for upper level courses. In other words, a compromise could be reach where the department agrees to increase lab size of 1000 level courses if the administration agrees to allow lower enrollment minima to run upper level courses.

A potential logistical issue with increasing lab sizes is the size of the associated lectures, and of the lecture rooms, which are relatively small (even the largest one has maximum capacity of 80, if I recall correctly). I do not recall what are the typical sizes of the lecture rooms, but if they

cannot accommodate at least 40 students, then increasing lab size to 20 students may be problematic. A possible workaround is to "un-link" lectures and labs. For example: instead of offering three lecture sections of 32 students, each associated with 2 specific lab sections of 16 (serving 96 students total), students could enroll into any of 2 possible lecture sections (capped at 50 each) and select any of 5 lab sections (capped at 20 each). The result is that a total of 100 students could be served, with one fewer lecture and one fewer lab section. The students may have different instructors for lab and lecture, but that is common at other institutions. Un-linking labs and lectures increases scheduling flexibility overall, for instance by allowing adjuncts to teach night labs for courses that have daytime lectures taught by full-time faculty.

3-Increasing the number of introductory courses taught by adjuncts. A general increase in the number of 1000 level courses taught by adjuncts, to the limit of what is allowable by the collective bargaining agreement, may be needed to allow full time faculty to teach electives or capstones. Faculty time will be even more limited than it is now if the new collective bargaining agreements results in compensating labs on a 1-to-1 basis. The hiring of more adjuncts may be inevitable.

4-New full-time, tenure-track faculty position. The hiring of another full-time faculty is well justified, even more so if the new collective bargaining agreement compensates labs 1-to-1. The field of expertise decided previously makes sense: a vertebrate biologist who can teach A&P. A possible refinement of the field would be to search for an ecological/environmental animal physiologist (see below, under resources). Having this new position would help to alleviate the burden of teaching the courses for non-majors, thus freeing time for all full-time faculty (including the new hire) to offer electives/capstone courses.

5-Have a reliable, and regular rotation of electives/capstone courses. It would be highly desirable for the department to have stable, predictable two-year rotation of courses, so that students (and advisors) can have reliable 4-year plans.

6-Offer more 3-credit courses (no lab) as electives. Lab classes are very time consuming for the students. Offering a few more lecture-only courses would ease the problem of student not being able to sign up for classes that they need, when they need them

7- Helping transfer students before they get to FSU. It is very common for transfer student from community colleges to come in with most of their general education requirements completed, but very few science courses completed. This puts them in a position where their schedules have to be very heavy, filled with lab science courses, for the remainder of their degree. Many students from FSU transfer from a nearby community college (Mount Wachusett Community College). The department should continue to work with the college to formulate a pathway that will allow for a smooth transition once the students arrive at FSU. For example, they should be advised to complete their general biology and chemistry sequences while at MWCC, as well as a few math/science courses, so that their schedule is not overloaded with lab science courses once they arrive at FSU

Graduate program:
The MA in Biology lack clear learning outcomes. Solving this issue should be the first priority. There needs to be a consistent and reliable offering rotation of courses; the selection of courses offered must be based on the learning outcomes of the program.
Increasing the reliability of the course offerings could rely on cross-listing the courses for undergraduates (with a clear differentiation about what I expected from both populations). Offering hybrid and online courses may also remove some of the barriers involved in having enough students who take each class to make them run.
There are logistical issues that need to be resolved, including avoiding for the undergraduate to have to pay more if the courses are managed by GCE, and properly compensating faculty for teaching these courses in the evening. Such issues can be solved, and the administration appears to be very supportive of finding solutions.

A fundamental challenge that faces the graduate program is to have enough faculty involved so that a regular and predictable course schedule can be offered. Some of the recommendations mentioned above for the undergraduate program ("Removing barriers to success/graduation") may indirectly help. For instance, increasing lab size and increasing the number of introductory courses taught by adjuncts, will free up faculty time and therefore allow more participation in the graduate program.

Resources
Release time:
Long-term release time should be provided to support both an Internship Coordinator and the Health Science Advisor. Providing internship opportunities for students is a highly effective way to promote experiential learning and is a highly valuable recruiting tool. Coordinating internships require a substantial amount of time, and it is not realistic to expect a faculty member to take on this task without appropriate compensation, every year. Similarly, the role of the Health Science Advisor requires a substantial amount of time and should be appropriately compensated.

Short-term release time should be provided to a full-time faculty to continue to review and revise the graduate program.

Budget:
The operating funds ($104,000 for FY 18) are adequate for a department of this size.
The travel funds ($5,200, or $400/faculty) are too low. This probably limits faculty participation to professional meetings, which can be highly valuable for professional development.
Strategic funds ($5,800 FY18) which are used primarily for equipment purchases, are probably adequate for now because the new building is well equipped. However, as time goes by and the current equipment ages, the department needs to formulate an equipment replacement plan to minimize "surprises".

Physical resources:
The new building is beautiful, well-designed, well equipped, and has enough room to accommodate another full-time faculty. In addition to teaching hall and labs, it has project/research spaces where students can work on research projects with faculty mentors, a

greenhouse and animal care facility. The building is a great asset, and a highly valuable recruitment tool. Many comments from the student surveys reflect this; they love the building.

Support staff: Technical and clerical staff are highly qualified and the number is adequate for a department of this size.

Teaching staff. The department currently has 12 full-time biologists. Given the number of biology majors, an additional faculty position in biology, as planned, is highly warranted. The ratio of majors to full-time faculty (24:1) is high and one must also take into consideration the large number of service courses offered to non-majors (Anatomy and Physiology, Life Sciences) which consume a great deal of faculty time and resources. When the department tried to fill this position last year, it searched for someone to teach Anatomy and Physiology and with expertise in vertebrate biology. This was probably a wise choice, as it was justified by the need to offer more physiology-type courses to biology majors. After evaluating the curriculum map prepared by the department (Appendix M), it appears that the field of expertise could be refined. For example, someone working in the field of ecological or, environmental physiology of animals could, in addition to contribute to the teaching of Anatomy and Physiology, fill a gap in the expertise of the department, and could lead to the offering of new courses that would contribute significantly to covering learning outcomes that came out as weak in the assessment.

Library resources seem adequate for the undergraduate and graduate programs, but it is very difficult to predict how this may change in the coming years. The role of libraries is in flux and rapidly changing. For example, using google scholar to find articles, many of them available as PDFs for free, has completely changed how we use the primary literature.