PERSPECTIVES

The Biology Major Capstone Experience: Measurements of Accountability

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Abstract: Loras College senior biology and biology research majors are required to take a comprehensive exam, give an oral presentation, write this talk into their thesis and participate in an exit interview with a non-biology faculty member before they graduate. Details of these capstone experiences will be discussed further. Other capstone experiences that might be included were discussed such as a hands-on lab skill assessment test, a 1-2 year research experience, and making an e-portfolio to include a resume and class artifacts. Suggestions for other items to consider in a senior capstone experience are included.

Key Words: capstone experience, biology major requirements,

INTRODUCTION

College and university biology faculty and graduating senior biology majors need ways to show that the educational experiences they have participated in together in the previous 3.5 years have resulted in measureable increases in scientific knowledge, writing, speaking, techniques or skills and critical thinking. College faculty need to generate artifacts that confirm their accountability. Learning outcomes that were presented early in the careers of college students need to be measured during the senior year for their level of accomplishment. Many of the recommendations of Bio 2010 (NRC, 2003) can be addressed by finishing an undergraduate experience in biology with a comprehensive senior capstone experience. The purpose of this article is to give some examples of activities of some capstone experiences so that more colleges and universities can incorporate some of them into their program outcomes, be more accountable for their teaching and use the results to improve their curriculum.

COMPONENTS OF AN "IDEAL" CAPSTONE EXPERIENCE

Overall, the "ideal" biology major senior capstone experience would contain the following components to measure essential aspects of their four years of training:

- A comprehensive exam that measures their recall knowledge.
- A 30 minute oral presentation on a recent biological hot topic and be able to show that they are an expert on this topic by answering questions well and confidently from their peers, faculty or the public.
- A 1-2 year research experience where their results are publishable and they have mastered several basic scientific research skills.
- A written thesis in the format of a scientific journal article that is ready to be sent in for publication.
- A skills/techniques assessment test where they work hands-on in front of a peer or faculty member to show their competence level in 1-5 above.

AN EXAMPLE AT LORAS COLLEGE

Seniors in biology at Loras College choose between a biology major and a biology research major. The biology major requires 34 credits of courses with accompanying support courses in Math, Chemistry and Physics. These students in their junior year in consultation with a biology faculty advisor pick a topic of personal interest. They construct a learning plan for this topic that includes a bibliography, a proposed timeline of study and culminates in a 30 minute oral presentation on this topic to their peers and faculty in senior seminar in their last spring semester. Essentially they train themselves to be an expert on this topic and present a written thesis in review paper format. In the past 5 years about 75% of graduating majors have chosen this option.

Biology research majors also take the same 34 credits and supporting courses but also get one more credit for doing their own research project that is supervised by a biology faculty member. They consult with a biology faculty member early in their junior year to construct a research proposal plan and timeline for the next 3 semesters. This work culminates in a 30 minute oral presentation of their

research results to their peers and biology faculty in their last spring semester. Essentially they train themselves to be an expert on their specific topic of research and present a written thesis as close to publishable journal format as possible.

Both majors are required to take an on-line, 57-question, comprehensive exam in November of their senior year. This exam was written by Loras biology faculty and consists of 6 subdivisions of the biology curriculum: Physiology, Molecular, Evolution, Ecology, Plant/Animal Biology and Genetics. The format of this exam is passage-based, like the MCAT, where a series of multiple choice questions follow each passage which has pertinent information, data, figures or background to answer the questions. Results of this exam are used for year-to-year comparisons of student performance and also to check on the information recall or retention of information in each biology subdivision. Students often ask, "Is this something I have to study for?" or "what happens if I fail?" Our response is, "No studying is necessary and all we ask is to give it your honest best shot." It seems to have been a consistent tool to gauge the knowledge recall levels of our students.

Both majors are required to participate in a 30 minute exit interview session with a non-biology faculty or staff person. This session uses about 10 minutes for written responses to 8-10 questions and then about 15-20 minutes for an oral discussion of their answers to share them with the group. Many times they speak out when they hear comments or suggestions from other students that are similar to theirs. This session has resulted in valuable feedback about our curriculum, its course sequence, experiences that they would have liked more of or that were missing, advising effectiveness, etc.

The biology faculty at Loras have also discussed a required lab skills/techniques assessment session for all seniors. This is still in the discussion stage. This session would include 5-6 learning outcomes that we think are important for all biology majors to be able to demonstrate competently before they graduate. We envision them coming into a lab and working at 3-4 stations for 30 minutes per station to show a faculty member the following skills: 1) troubleshoot PCR or an electrophoresis set up; 2) design an appropriate sampling procedure for a given experiment; 3) Read and explain a selected piece of primary literature in which they have some previous background; 4) pipette correctly producing serial dilutions; 5) analyze a set of data using appropriate statistics; and 6) be constructively critical of results in 1-5 for other fellow students. Having all these stations set up and ready for students to come in and work with them is problematic but different versions of this are in discussion here.

OTHER EXAMPLES OF CAPSTONE COMPONENTS

Other components of a senior capstone experience could also be included or inserted to replace the recommended sections shown above. Building a resume and writing a cover letter with the feedback of biology faculty or campus career center experts would be valuable for any graduating senior. Making an e-portfolio with examples of writing, experimental data and results, field classes, posters, summaries of class discussions, pictures of service projects or notes from shadowing experiences could be inserted in the e-portfolio. Videotaping 3-4 senior oral presentations from one year can be shown to next year's class to show good or not-so-good examples of presenting a talk. Organizing a group service project to help the campus or local community might build camaraderie of senior majors. Going away on an overnight retreat for 1 or 2 weekends with faculty and students could be used to discuss environmental issues and/or increase the conservation connection or land ethic of each senior. Conducting a senior panel of majors for all underclassmen, declared majors or not, would allow them to talk about their biology experiences and answer questions from the younger students. Asking for a written reflection about how several subdivisions of biology interconnect might be a valuable experience for seniors. Asking them how information and lab work in Molecular Biology, Ecology and Evolution interconnect might be challenging but rewarding for not only students but faculty too. Giving students a chance to communicate and discuss controversial or hot topic issues in biology with campus or local community members is an excellent method for checking on the knowledge and application ability of graduating seniors. Topics like stem cell research, evolution in schools, the Gulf oil spill, or genetically modified organisms are examples of good discussion topics.

Other skills or techniques that could be measured or incorporated into a capstone experience to test level of competency include basic microscopy, diversity and taxonomy examples, or writing about their conservation or land ethic development over their four years. Another idea is to bring back a biology major who recently graduated in the last 2-3 years, have them be the guest of honor at the first senior seminar, have them talk about where they are now and their recommendations for current students about life after undergraduate college.

A few specific examples cited here show a variety of capstone experiences as well as discussion of why each of the components has been chosen.

Truman State University shows a variety of capstone experiences in different disciplines including biology (Truman, 2003). The Department of Biological Sciences at the University of Cincinnati has a good description of their capstone program including options for research, teaching, field trips and courses (U of Cincinnati, 2008).

Many ideas have been mentioned here for possible inclusion in a biology major capstone experience. It remains the prerogative of the biology faculty at each institution to pick the activities that will help them assess their students' learning and teaching most effectively. These suggestions also help biology faculty make measurements of learning outcomes so they can be more accountable for their time and money spent in the educational process.

ARTICLE NOTE

This article was written after the author led a roundtable discussion with faculty and students at the 2010 annual meeting of the Association of College and University Biology Educators (ACUBE) at Lourdes College in Sylvania, OH October 8, 2010.

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