Mathematics in the Life Sciences: Developing a Best Practice

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ABSTRACT

Studies suggest that compared to other undergraduates, students majoring in science, technology, math, and engineering (STEM), experience an unwelcoming, and sometimes hostile, classroom environment (Daempfle, 2003; Seymour & Hewitt, 1997). As a result, students in these majors often lose interest in their field of study. This research suggests that the academic major of a student may influence her or his decision to persist. Beckett (2006) supported these earlier findings about choice of major and persistence. In Beckett's single-institution study, students who majored in STEM disciplines were less likely to graduate than students in other disciplines or fields. Given existing scholarship about persistence and graduation of STEM majors, initiatives such as the Mathematics in the Life Sciences (MLS) program at the University of Missouri are critical not only to student success but to the future of STEM. This paper provides an overview of the MLS program and suggestions for best practices based on program evaluation efforts with MLS students and faculty.

Keywords: STEM-Increase K-20 Interest and College Enrollment, Best Practices, Hands-on Learning

OVERVIEW OF THE MLS PROGRAM

The National Science Foundation (NSF) funded MLS program has two main goals. The first is to recruit mathematically talented undergraduates into science, technology, engineering, and mathematics disciplines. The second major goal is to integrate mathematics more thoroughly into the introductory STEM curriculum, especially in the life sciences. By making use of two previously established programs, the Freshman Interest Groups (FIGs) and the Life Science Undergraduate Research Opportunity Program (LS-UROP), the MLS program creates an engaging learning community for approximately 20 undergraduate students annually. This learning community consists of the students: (a) living together in the same residence hall; (b) participating in a FIG proseminar; (c) taking a co-enrolled set of courses their first semester with a curriculum developed specifically for the MLS program, focused on integrating mathematics and life sciences; and (d) participating in faculty-mentored research projects during the summer following their first year in the program. These elements are intended to challenge and support the student scholars and to improve retention in the interdisciplinary areas within STEM disciplines. Funding from NSF also allows us to provide students with need-based financial aid, which in some cases, has made all the difference in a student's ability to attend the university.

Laufgraben and Shapiro (2004) defined learning communities as having the following characteristics: (a) small groups of faculty and students, (b) integration of curricular components, and (c) opportunities for students to "establish academic and social support networks" (p. 3). While the FIG program helps officially establish a learning community for our students, the MLS program also seeks to reach beyond the approximately 20 undergraduate students admitted each year. Our goal is to create a learning community that spans the University of Missouri as well as surrounding K-12 school systems. While the MLS

students are participating in the learning community through hands-on learning of a mathematically-integrated curriculum and faculty-mentored research, the faculty leaders are participating through development of curriculum and of their own interdisciplinarity through interactions with faculty from other disciplines as part of the MLS program. Indeed, many of our faculty leaders have always had a passion for interdisciplinarity. This is represented in the following quote from an interview with one of our faculty leaders regarding the benefits of interdisciplinary learning, "…I just kind of think you can't separate the idea of trying to expand our knowledge. Just satisfying a healthy curiosity about the world. Some of it may go somewhere and some of it may not but probably the fact that we're asking questions is at least as important as the answers we're getting. That atmosphere has to be encouraged."

Although we are only in our second year of the program, it is already apparent that the MLS program is encouraging just such an environment for our students and faculty. For example, our second-year students are able to identify connections between mathematics and the life sciences and recognize the influence of the MLS program on their abilities to identify these connections, particularly through hands-on learning in labs and other research-related experiences. One student quote in particular highlights this finding, "The connections between the two are everywhere. Mathematics and life sciences go hand in hand and the possibilities for research on this fascinating relationship are seemingly endless." Furthermore, another student had this to say, "The MLS program opened my mind to a world of research and knowledge that I had no idea existed prior to being involved in the program. It was an eye-opening experience to say the least."

SUGGESTIONS FOR BEST PRACTICES

As mathematics continues to become increasingly integral to all STEM disciplines, particularly in the life sciences, we hope the MLS program will serve as a model for developing a STEM learning community that increases K-20 interest and college enrollments. As with the MLS program, other colleges and universities are encouraged to develop programs that focus on: (a) integrating mathematics more thoroughly into the introductory STEM curriculum; and (b) attracting, retaining, and graduating mathematically-talented students who may not otherwise have chosen STEM majors. These learning communities should avoid being narrowly defined by the direct participants but should hope to expand to include all STEM-interested individuals at the university and in the surrounding K-12 environment.

The MLS program has participated in several K-12 outreach activities thus far including: (a) speaking at state conferences aimed at math and science teachers, (b) inviting teachers and students to join us at science events held on campus, and (c) visiting area schools in order to reach mathematically-talented students from underrepresented populations. Much of our success in this area has been the result of cultivating academic and social networks at both the faculty- and student-levels with campus offices such as Admissions, Residential Life, and Financial Aid, as well as partnerships with principals and teachers in the K-12 arena. The involvement of individuals with a knowledge of higher education and student affairs in the MLS program has provided a great deal of support in the areas of marketing, recruitment, developing partnerships, and socialization of students and faculty. As such, faculty interested in establishing similar programs should consider what other offices on campus can bring to the table, particularly those in student affairs areas.

Previous research has found that retention of STEM majors is a concern throughout higher education in the United States (e.g., Beckett, 2006; Daempfle, 2003; Seymour & Hewitt, 1997). Furthermore, studies on persistence have highlighted the importance of

examining the effects of ethnicity, gender, and socioeconomic class (e.g., Astin, 1997; Paulsen & St. John, 2002). We strongly believe that programs such as ours will not only be successful in attracting mathematically-talented students who might otherwise choose non-STEM majors, but also in encouraging and supporting students to successfully complete STEM degrees.

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