Articulation of Student Learning Goals and Objectives

The Department of Mathematics and Statistics teaches more than 12,000 students per year, more than any other department on campus and more than the College of Engineering, the School of Education, the School of Nursing, or the School of Public Health and Health Sciences. We offer nearly 200 sections of General Education courses, more than twice any other department on campus. Thus, although we have nearly 400 majors, much of our teaching is to students in other disciplines mathematics and statistics are, of course, fundamental to a very wide range of majors. Even our upper-level and graduate courses have substantial enrollments from other departments across the campus. Only a few of our courses, however, can be characterized completely as service courses that would not be taken by students majoring in our department. Thus, almost all of our courses are taken by Mathematics and Statistics majors, but these students are only a fraction of the enrollment in those courses. In this section, we discuss learning goals and objectives in terms of the major, but the discussion applies quite generally to the courses we offer.

Mathematics and Statistics is a broad major, covering pure mathematics, applied mathematics, and statistics. Students select from seven separate concentrations: Applied Mathematics; General Mathematics; an Individually Designed Concentration; Mathematical Computing; Pure Mathematics; Statistics; and Teaching. For instance, the Applied Mathematics Concentration is intended to prepare the student for a career in government or industry, the Pure Mathematics Concentration is intended to prepare the student for graduate study in mathematics, and the Mathematical Computing Concentration is intended to prepare the student for careers that require both knowledge of advanced mathematics and extensive knowledge of computer programming. Although all majors must master a core body of knowledge covered in Math 131, 132, 233, 235, 300, and 370, each student must also complete a concentration.

The goals and objectives of the concentrations are, of course, different. Each concentration requires several advanced (400 or higher) courses in Mathematics and Statistics, but allows the students a variety of choices to fulfill the requirements. For instance, the Pure Mathematics concentration requires:

1. Algebra: Math 411 or Math 511
2. Complex Variables: Math 421
3. Advanced multivariate calculus: Math 523
4. At least one of the following courses: Math 412, Math 512, Math 563
5. At least one applied mathematics course either chosen from the follow- ing list or another course with sufficient applied mathematical content approved by the Chief Undergraduate Advisor: Math 331, Math 456, Math 532, Math 534, Math 551, Math 552, Stat 516
6. At least two additional courses numbered 400 or higher. With the approval of the Chief Undergraduate Advisor, these may be appropriate courses outside the department.

Some of these choices represent different depths of treatment of related material. For instance, Math 511 is an honors version of Math 411, Introduction to Abstract Algebra I, covering somewhat more material and going into greater depth. In other cases, the alternatives cover very different material. Math 456, for example, is a course in mathematical modeling, the construction of mathematical representations of problems from other domains, while Math 551 is a course in numerical analysis, the use of computers to approximate solutions to mathematical problems for which exact solutions cannot be obtained, or at least cannot be obtained practically. So one student who completes the Pure Mathematics concentration will learn about models of the spread of AIDS and another will learn about the numerical problems involved in approximating the solution of systems of partial differential equations on a computer. Even without counting courses from
outside the department, a student has in principle at least several hundred distinct ways to complete the Pure Mathematics concentration. The other concentrations allow similar numbers of choices. It is thus not feasible for us to list in one place very detailed learning goals and objectives for all the ways a student could complete the major. We do give higher-level goals and objectives. For example, our web page for the undergraduate program says

“The goal of the mathematics program at the University of Massachusetts has three aspects. First the students learn basic material such as linear algebra, differential equations, and statistics needed to successfully attack a wide range of problems. Second, they learn to think with rigor. Lastly they learn to approach apparently unsolvable problems by studying simpler problems, doing experiments and bringing together different concepts.”

And the web page giving the the departmental major requirements says

“The requirements for a mathematics degree provide the student with maximum flexibility in designing an overall course of study to meet his or her scientific, educational and career goals. The beginning courses emphasize computational skills, problem solving, and the understanding of basic concepts. As students progress, they must solve problems that are less and less routine and more abstract or intricate. Some upper-level courses emphasize proofs and the understanding of abstract structures, while others emphasize advanced computational methods or the formulation and analysis of mathematical or statistical models of reality. A number of the courses involve the use of computers in a fundamental manner in the development of the material covered.”

We provide detailed syllabi for all courses. In addition to the usual material about exams and grading, these indicate the kind of problems students will be expected to solve, at the very least by indicating the sections of the textbook from which students should be able to do the problems. The Undergraduate Program Director (UPD) and the and Chief Undergraduate Advisor (CUA) review these syllabi and discuss them with the course instructors. The syllabi are distributed to all students at the beginning of the semester (either on paper or on the web). These represent specific behavioral learning objectives, saying that students should be able to do particular kinds of problems.

Collection of Evidence

Most of the detailed learning objectives are in the form of students should be able to do problems like these examples. All of our undergraduate courses involve homework and exams. (In the junior-year writing course and perhaps one or two others, exams may be replaced by papers or presentations.) So we have available detailed information about how well students could meet the detailed learning objectives.

We collect some information about post-graduation plans but do not use other detailed indirect measures. We also confer regularly with the departments that require or recommend our courses. For example, the UPD meets regularly with representatives of the College of Engineering to discuss the content and effectiveness of the courses taken by large numbers of Engineering students. Review and Interpretation of Evidence The Undergrad Affairs Committee (UAC) reviews grades, exam scores, student and faculty comments, etc., from our courses. When problems are identified, the UAC, UPD, and CUA take action. For example, the UPD may convene committees to review the curriculum, the structure of particular courses, the use of online material and homework in particular courses, etc. These committees examine information about topics covered, the exam questions and grades, homework assignments and grades, as well as teaching methods, etc.

Use of Results

Specific changes are implemented based on the evidence. For example, about four years ago, evidence suggested that students in the calculus sequence for mathematics, physical science, and engineering majors were not making fully effective use of discussion sections and instructors office hours. This became particularly apparent through analysis of data from surveys that the College of Engineering conducts of its students at the end of the freshman year. After considerable discussion with the College of Engineering and the collection of further data, we opened a new help center for students in those classes in 2008. The center is staffed by the instructors and TAs from Mathematics 131 and 132; each instructor and TA spends part of
his or her regular office hours in the center and two senior TAs have work in the center as their primary teaching responsibility. The center is open for several hours a day and has been utilized quite heavily by students. The data indicated that exam scores in these courses, which have been increasing since we began using an on-line homework system in 2007, had a significant jump after the institution of the Help Center. Student feedback was also very positive.