Assessment of Mathematics-Intensive Programs

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Many readers of this volume are mathematicians who do mathematics simply for the sake of the mathematics, just as some people who run enjoy running for the sake of running. But some people run not as an end in itself, but as a means to some other end. Some run to get into shape for another sport, to lose or maintain weight, or for a variety of other reasons. Similarly, mathematics departments offer courses for students who enroll not to learn mathematics as an end, but to acquire the mathematical knowledge and technical skills prerequisite for success in other disciplines. It is far easier to assess how well a person runs than it is to assess how well a mathematics program promotes effective student learning of desired mathematical knowledge and skills. Fortunately, some of our colleagues at institutions across the country have taken up the challenge of assessment in their mathematics-intensive programs.

Mathematics-intensive programs are an area ripe for assessment. Loosely defined, mathematics-intensive programs include the various service courses that mathematicians teach to future engineers, medical specialists, architects, economists, and other professionals, including those courses that serve both mathematics majors as well as students majoring in other disciplines. Since accreditation agencies and university administrators generally focus assessment either on the major or on general education, there has not been as much pressure on mathematics departments to assess mathematics-intensive programs.

Of course, there are specific exceptions to that general statement. For many years, mathematics departments at institutions with engineering schools have had to assess their programs in accordance with the standards established by the Accreditation Board for Engineering and Technology (ABET). Accrediting agencies, and there are many such organizations recognized by the Council for Higher Education Accreditation,[1] are increasingly focusing their evaluations on "learning outcomes" (student work) that are evaluated as evidence that students have learned what departments report they are teaching. The focus of this new type of assessment is not on what mathematics courses students have taken or on what content they have studied, but on what mathematics students demonstrate they can do. Barbara Moskal at the Colorado School of Mines describes an example of a mathematics department with a well-documented, outcomes-based assessment program at an engineering school (p. 149).

Like departments at engineering schools, mathematics departments at institutions with accredited teacher prepara-

[1] www.chea.org/Directories/index.asp

tion programs must conduct outcomes-oriented assessment as directed by state education departments and by accrediting agencies such as the National Council for Accreditation of Teacher Education (NCATE). Assessment of mathematical programs that support teacher preparation is addressed elsewhere in this volume, in particular in case studies from Monmouth University (p. 125) and the University of Texas, Brownsville (p. 133).

It is important that mathematics departments take note of and react appropriately to this shift in focus to outcomes-based assessment required by NCATE, ABET, and other professional, state, and regional accrediting agencies. This change in the accreditation process poses a potential threat to mathematics departments that do not keep pace. For example, ABET now requires that students "demonstrate proficiency" in completing mathematical tasks as opposed to just taking mathematics courses. Unless mathematics departments are proactive and conduct assessments of student proficiency in required outcomes, engineering departments could take on the responsibility of teaching and assessing the mathematical content of their programs.

Commonalities

In reviewing case studies in this volume that describe the assessment of mathematics-intensive programs, some commonalities are noticeable. One subtle theme that arises repeatedly is the need to account for the culture of the institution in which the assessment is taking place. Failing to account for the cultural environment can reduce the effectiveness of assessment efforts. Thomas Rishel's report from Qatar (p. 113), for example, illustrates how assessment both revealed and adjusted to cultural issues due not only to nationality differences, but also to the educational background of the students and the perceived need to develop a mathematics program appropriate for the future profession of the students. Assessment can be conducted more readily in an environment in which it is accepted as part of the culture of the institution, as it is at West Point (p. 103), or in relatively cohesive departments such as Keene State College (pp. 157), than it can in departments that are fragmented or not supportive of program assessment.

Computer technology is part of the culture at many institutions, and the use of technology in learning mathematics or in assessing the learning of mathematics is another common theme. Some mathematics departments have the additional service responsibility of introducing students to the use of technology and software such as spreadsheets, computer algebra systems, and/or graphing calculators to solve mathematical problems. Those skills and tools will be used in subsequent courses in other disciplines. To facilitate the use of mathematical skills in courses where they are needed, the new CUPM Curriculum Guide (CUPM, 2004) strongly recommends collaboration between mathematics departments and partner disciplines, including collaborations that ensure the appropriate use of technology across disciplines. This is a significant part of the assessment program at West Point (p. 103) and at Virginia Tech (p. 109).

In the 21st century, computer technology will not only be used for solving mathematical problems but also for the delivery, management, and assessment of mathematics instruction. Course management systems such as Blackboard and WebCT are becoming increasingly sophisticated in their capability to organize, deliver, manage, and assess mathematics courses conducted in the classroom, on-line, or a combination of both. The collaborative use of those tools between disciplinary partners can facilitate the collection and analysis of assessment data. The cost-effectiveness of on-line mathematics instruction which provides, arguably, the equivalent level of mathematical learning is discussed in Virginia Tech's case study (p. 109), a continuation of the assessment described originally by Olin and Scruggs (1999). Electronic portfolios maintained by students are part of the West Point case study, but more sophisticated web-based electronic portfolios are commercially available, and are in use on my campus (Keene State College) by other disciplines.

Using technology effectively is just one example of the important lessons to be learned from the experiences of those who have done assessment in mathematics-intensive programs. The larger critical need is for communication with other disciplines throughout the assessment process. Our colleagues in mathematics' partner disciplines are significantly affected by the learning that occurs in our courses, and it is important that we inform them of, and include them in, our assessment agenda.

Team teaching can be that kind of inclusive interdisciplinary activity, and assessment of such an effort is described in an earlier case study from Jacksonville University (Repsher & Borg, 1999). Conducting the assessment in the courses of other disciplines, as has been done at North Dakota State University (p. 93) can provide "a detailed picture of those quantitative skills needed for upper-division course work in other departments and an assessment of the quantitative capabilities of emerging juniors outside the context of specific mathematics courses." Other activities that promote meaningful communication in interdisciplinary collaboration are addressed in earlier case studies from Oakland University (Chipman, 1999) and the University of Wisconsin at Madison (Martin & Bauman, 1999).

In the latter study, Bill Martin implies that an activity to facilitate interdisciplinary connections is for a member of the mathematics department to participate as a member of the college or university assessment committee. My service on just such a committee helped me make interdisciplinary connections at my college and has ensured the mathematics department is doing assessment work consistent with the work of other departments on campus.

If there is a final theme to address, it is that assessment is a marathon, not a sprint. In the past, accreditation visits and program reviews were periodic events that prompted some last-minute data gathering to support oftentimes vague claims of departmental effectiveness. Motivated by the pressure from institution administrators and accrediting agencies, the experience of many departments is that continuous assessment of specific goals and objectives is becoming part of the department culture, part of the way that departments routinely go about the business of helping students learn mathematics. This is as true in mathematics-intensive programs as it is in the other programs for which mathematics departments are responsible.

References

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