Some Thoughts on the Delivery of Interdisciplinary Calculus

Lida K. Barrett
United States Military Academy

Four areas of fundamental concern involved in the delivery of an interdisciplinary calculus course are content, curriculum, appropriate administrative framework, and consideration of faculty time and the required departmental budget. The first aspect--content--is perhaps the one that does and should receive the most consideration. However, without attention to the other three factors, efforts made and results achieved cannot be sustained. The four factors are intertwined. The fourth--consideration of faculty time and departmental budget--is, in certain aspects, a part of the third, but is important enough that it deserves separate consideration.

Content

The best-planned course with excellent materials and the most willing teacher can succeed only if the teacher, the student and the instructional methods are based on the interdisciplinary nature of the course. Faculty and students have preconceived ideas about what will be taught in a mathematics course and how important it is, often based on their own experience. The material of another discipline can be seen, perhaps unintentionally, as window dressing. In student parlance, interdisciplinary material is "stuff" that won't be on the next test. In faculty parlance, it includes facts or concepts that need to be understood only enough to get the mathematics correct, perhaps only enough to identify an application of a particular mathematical concept. Needed on the part of faculty is thorough knowledge of the mathematics AND the physics/engineering involved. Are the connections real and meaningful? Or are they just another way to construct a "word problem?" Genuine interdisciplinary work requires that material be presented in the context of both/all disciplines. Further, as the course progresses, if at all possible, there should be increased sophistication in the content, concepts, and methods in both/all disciplines. The material should be more than a collection of problems. Student understanding should be developed with projects, written assignments and, on occasion, with presentations by the instructor and/or faculty from the other discipline that tie together for the student material that has been taught in ways that the student cannot tie together for herself . (There are appropriate places for lectures.)

Curriculum

Any interdisciplinary course, particularly in the first two years, should be placed in the context of the overall curriculum. Is the course for Physics and Engineering majors and therefore can and should be linked to courses in these disciplines? Is it a course to be taken by the Life Scientist or the Liberal Arts major? Is it a course for all comers regardless of their major field of future study? In the fifties, Mathematics majors, almost without exception, were expected to take physics courses or even to minor in physics. That is not the case today. In the seventies at the University of Tennessee in the presence of a course specifically for Life Science students, the "standard calculus" was comprised of only about fifty percent engineers and physics students. At large comprehensive

institutions there can be separate courses for natural science, business, or other groups of students. At smaller institutions, this is probably not desired or possible.

Mathematics and physics (and for that matter also engineering) are disciplines that a well-educated liberal arts or other major should know. Further, the nature of interdisciplinary learning and a multidisciplinary approach to activities in today's complex world should be fostered early in all students. The mathematics faculty, the faculty of the other disciplines involved in the course, and the faculty from disciplines not directly a part of the material should all understand what constitutes the course content and how it is related to the overall curricula and to their discipline.

A course specifically for students in engineering, physics and related majors (computer science) can and should be carefully tailored to link to courses in these departments. The linkage should be noted in the course work of the other departments. If the primary interdisciplinary nature of the mathematics course is from these disciplines, even if the course is not limited to these students, the faculty of the associated disciplines should know what material is being taught and should build appropriate ties to the material in their courses. Students should be told they will see the material in courses in the other discipline, and faculty in the other discipline should have clearly expressed expectations of the students that they know the material from the interdisciplinary courses. (Students learn and retain what is clearly expected and should not be allowed to get away with, "We never saw that before.")

A Bureaucratic Support Structure

Serious consideration must be given to the setting in which interdisciplinary action takes place. Sometimes good courses develop because two or three faculty are interest in the development and work well together. As their interest, departmental duties or time-demands change, the course or courses either disappear or lose something of their quality. The identification of a course with specific individuals is hard to avoid at the outset. Transition to a more permanent role for the course requires good available text material, a suitable cadre of instructors ready, willing and able to teach the course, and commitment from the department and academic leadership that the course is a standard part of the curriculum, not just a passing fancy. These things require that the course developer(s) be willing to give up or to share their "baby." It also requires that the person[s] with whom the "buck stops" takes responsibility to "spread the baby" around. The relevant departments and curricula people need to see the course as "permanent", that is, on the same basis as other "standard" courses. Interdisciplinary courses will be here to stay when sufficient care is given to these factors.

Time and Budget Commitment

The interdisciplinary nature of the development and delivery of interdisciplinary courses requires faculty and administrative time, budget items and a clear assignment of responsibility for the maintenance of the course in more than one department. These issues must be addressed in the planning and budgeting of time and money in the departments involved. Course development takes time. Learning material in some depth from another discipline takes time. Understanding student background in mathematics and in the other disciplines takes time. The time involved may be non trivial. Ongoing activities involve maintaining departmental coordination with another discipline, coordinating course presentations, team teaching on occasion for one or two periods or

for a semester, staying abreast of changes, and training other faculty to take part. These are all activities that require more time and have less direct support than keeping up with standard course changes within mathematics. In the case of changes within mathematics courses, activity within the department, at professional meetings, and in professional journal[s] is more readily available. At the present time, interdisciplinary work by its very nature requires more time commitment of the faculty and of the department's assignments than a straight mathematics course. The fact that the academic world in general, as well as the scientific world, is becoming more interdisciplinary should mean that committing resources, both faculty time and departmental funding, will become more of the usual thing. Right now, special attention must be paid to make this happen.

Conclusion

James Gleick in his book Chaos notes, "Few laymen realized how tightly compartmentalized the scientific community had become, a battleship with bulkheads sealed against leaks." He goes on to note that Lorenz's discovery of chaos in atmospheric science would have been of interest to others in different fields -- mathematics, physics, astronomy and biology. The publication of his results in an atmospheric science journal meant that this did not happen. Scientist[s] do not have time to read each others' journals. Individuals were seeking something like his discovery in these other fields and in some cases discovered it for themselves.

The context within which most faculty are trained is a disciplinary context. Asking a faculty member to think more broadly, to teach more broadly, is a departure from the majority of his/her own study and research. It requires a different way of looking at teaching and learning. As the fields of mathematics become more linked and as interdisciplinary research projects and results become more prevalent, mathematics course[s] and their delivery should also. Moving to interdisciplinary thinking and courses is a challenge and a necessity in the evolution to de-compartmentalized learning--which is a GOOD thing.