

NEED FOR THE DESIGN OF A MATH TECHNOLOGY COURSE AT A LIBERAL ARTS COLLEGE

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Introduction

As technology becomes a part of all our daily lives, we realize the need for all our math majors to be exposed to as many of the math software that is currently available. In our calculus, linear algebra, and differential equations classes we currently use Derive to explore the many aspects of mathematical concepts. In our statistics classes we use Excel or SPSS as well TI83 to analyze large sets of data and to study application problems.

The needs and expectations of students in a small liberal arts college are very different from those of students enrolled in larger universities, and yet at the end of their four year program the liberal arts math majors must compete with students from other universities for the same jobs or graduate admissions. The success rate of the math graduates in a small university is a key factor in survival of the mathematics major in these institutions.

It becomes essential to the survival of the mathematics major in small universities to demonstrate that their graduates not only are equipped with theoretical knowledge of undergraduate concepts but also they acquire a deep understanding of technological tools to solve practical problems. At small universities we do not have access the same level of resources as larger institutions, and furthermore, most of our faculty members at small universities are overextended due to excessive committee and service obligations. As a result, in order to survive and stay competitive we must use creativity and innovation in our classrooms and in the design of our curriculum. Creation of a comprehensive math technology course, which may also be used as an exit course for graduating seniors, could add to the attraction of our mathematics program.

Before we focus on the design of a math technology course in a small liberal arts college, we need to get a better understanding of the challenges and the benefits of mathematics programs in small liberal arts colleges. This will help us to decide on the level of material as well as the prerequisites and selection of appropriate topics for the course.

Challenges

●**Limited budget:** Most small liberal arts colleges are private universities that are driven on tuition. As a result, there is often a battle on how budget should be distributed among

various departments and existing programs. It comes as no surprise that mathematics faculty often have to work hard to justify why computer labs deserve an upgrade and why money should be spent on expensive software such as Mathematica.

●**Lack of support from other departments:** Most small liberal arts colleges do not have the facilities and resources to offer courses in hard sciences which are necessary background for engineering programs. On the other hand, majority of these colleges excel in some liberal arts oriented program such as music, theater, law, or criminology, none of which requires extensive background in mathematics. Obviously there is very little hope to get support from these programs to strengthen the mathematics major.

Fortunately liberal arts colleges also offer other programs such as business administration, biology, education, computer system information, and computer science, all of which require some knowledge of mathematics. To what degree the faculty members in charge of the mentioned programs are willing to cooperate with the mathematics department varies and depends on the institution. However, it is rather discouraging to admit that in many small universities, the programs outside mathematics show very little support toward mathematics, and in fact, in an attempt to increase their graduation rate, they often reduce the mathematics requirement for their students.

●**Difficulty recruiting students:** As mentioned earlier, most small liberal arts universities do not offer hard sciences, which is a prerequisite to attract students who are interested in pursuing graduate work in engineering or other applied programs.

●**Limited recourses outside classroom:** Because of limited budget, it is often a challenge to hire knowledgeable full time mathematics tutors who are capable of working with advanced math and statistics software such as Mathematica, Derive, and SPSS. The alternative is to rely on those students who are enrolled in either the mathematics major or minor. This gives some of the dedicated math majors and minors an opportunity to improve their mathematics and communication skills, but unfortunately it is only a temporary solution and in long run there will always be a need for professional tutors who can work weekdays from 8 to 5 and possibly on the weekends.

●**Difficulty hiring qualified adjuncts:** Because of financial restraints, small universities are not able to offer the same salary to the potential adjuncts as the larger universities. Consequently they always struggle to find qualified adjunct instructors who are willing to work for a low salary.

●**Overextension of the full time faculty:** The top priority of any mathematics faculty in a small liberal arts institution is teaching and working with students. It is well known that many educators join small universities because they love to teach and because they have little or no interest in research. Students in small universities are very demanding and require a lot of attention. Faculty members often have to go out of their way to work with students outside the classroom, prepare them for conferences, and provide them with internship opportunities.

The mathematics faculty members in small universities must perform many services outside their teaching duties. The expectations are high. Every faculty member is expected to actively participate in committee work and other duties that at times may even cross over into administration work. In addition, because of the small size of the mathematics department, the mathematics faculty must serve on various hiring committees within the department as well as outside the department, evaluate adjuncts and take care of their needs, prepare academic program review reports for the mathematics department and the administration, update the curriculum guides for all the mathematics courses, and so forth.

●**Difficulty offering variety of math electives:** Due to small size of mathematics departments in small colleges and the obvious overextension of the mathematics faculty, it is always a challenge to offer variety of advanced undergraduate mathematics courses. The mathematics departments must carefully schedule electives and required mathematics courses based on the needs of individual students, and as a result, students are often compelled to choose from a rather smaller selection of electives courses.

●**Small class sizes:** Many of the upper division undergraduate mathematics courses in small liberal arts colleges are under 15 students in size. In fact, it is not unusual to have an upper division math class of fewer than ten students. The benefits of such small classes are rather obvious and they are discussed later in this paper. There are, however, disadvantages to teaching small classes. Above all, if there are two or three students or even just one student with weak background, the entire chemistry of the class could change. The weaker students often tend to slow the pace and in the process they try to convince other students in class to join them. Another disadvantage of small classes lies in the fact that students have very few study partners to exchange ideas with while working on group projects and technology related assignments.

Benefits and Rewards

●**Personal attention/working with students:** The number of students majoring in mathematics programs in a small college is rather small and very manageable, and for that reason, the size of most of the mathematics classes offered to the math majors is very small. As a result, math majors and faculty members will have the opportunity to work closely with one another. If a student finds a faculty member who is knowledgeable in a particular area of mathematics in which he or she is interested, the student should have no problem requesting the faculty member to put time aside to work with him or her. Personal attention is the number one reason many high school graduates and their parents choose smaller and more expensive private colleges over larger universities.

●**Small class sizes:** As a consequence of small classes, professors can focus on individual student needs, weaknesses, and strengths, and spend more time on group projects and other assignments outside the classroom.

●**Bringing faculty closer together:** As mentioned earlier, there are many service duties that will have to be performed within the mathematics department. Considering the small size of the mathematics department in a small university, the mathematics faculty must meet frequently and regularly to accomplish the goals and objectives of the department. Team work becomes a major factor in the success of the department and brings the mathematics faculty closer together, which in turn, improves the moral of the faculty members.

●**Motivation factor:** If you do a research on why mathematics graduates with Master's degree or Ph.D. are attracted to work for smaller universities, you will arrive at the conclusion that they enjoy teaching as well as working in a smaller and friendlier environment. It is a rewarding experience to watch the young enthusiastic mathematics majors work through their four years of education and it is even more rewarding to see them succeed after graduation.

Need for a Math-Technology Course

Thus far we have discussed some of the challenges and rewards that many of the small liberal arts institutions encounter. To what degree these criteria may impact the mathematics programs may depend on other factors such as the size and reputation of the university as well as the other programs offered by the institution.

The one fact that appears to stand out is that when it comes time for high school graduates with strong mathematics background to decide between a small liberal arts college and a large resourceful university, the small college is clearly in disadvantage. The one and perhaps only benefit that may attract the attention of high school graduates and their parents toward a small college is the personal attention that students will receive. Mathematics and science departments in small colleges cannot match large universities resources, flexible schedule, and wide range of course offering.

Our goal is not to compete with larger universities in quantity but in quality. Because of the challenges that were mentioned earlier, creating a mathematics program that is identical to programs in larger universities may not be as effective or even practical. In particular, offering variety of courses at different time blocks is not even a possibility.

Mathematics departments in small universities need to come up with creative ideas to recruit a selected number of hardworking and enthusiastic students into their mathematics programs. Vast majority of undergraduate mathematics students set goals to continue on to graduate school in applied mathematics or engineering, or tend to look for career opportunities in education or actuaries. As a result, it sounds logical for the mathematics departments in small colleges to focus on applied mathematics and technology as well as the qualifications of their mathematics faculty when designing their program. It becomes important to implant innovative ideas that would add character to the program and would differentiate the mathematics program from mathematics programs offered at larger universities. One such idea is to design a comprehensive technology course that contains some of the major topics from calculus sequences, linear algebra, differential equation,

statistics and other mathematics courses in which technology is used to solve applied computational problems.

Course Objectives

The math tech course serves several objectives. Above all, this course concentrates on how to use technology to solve applied and real life problems as well as difficult computational problems that help students deepen their understanding of the concepts behind some of the fundamental theories of mathematics. Knowledge of various technological and statistical software and calculators is a key factor to succeed for all mathematics students whether they wish to continue on to graduate work in applied sciences or elect to join the work force.

Secondly, due to lack of time many of the important concepts in mathematics and in particular in calculus are examined only on the surface. This is especially true in small colleges where students are more demanding and often tend to slow down the pace of the lectures. For instance, important theoretical concepts such as definition of definite integral and numerical integration in calculus are often ignored or are not analyzed thoroughly. Furthermore, not enough time is spent on other applied computational problems such as area and volume problems. The course gives professors a chance to reinforce the concepts that have already been covered in some of the key undergraduate mathematics courses and gives students a second opportunity to learn the concepts in more depth.

Finally, the course is a collection of some of the major applied topics in mathematics that every undergraduate student is expected to master before he or she graduates. The course may ultimately be used as an exit course and as a tool to assess the collective math knowledge and technology skills of the graduating seniors.

The exact list of the topics to be covered in the course will depend on the mathematics program outline plus the qualifications of the mathematics faculty members in charge of the department. The core of the course consists of computational projects from calculus, differential equations, linear algebra, and statistics. In addition, depending on the required courses within the mathematics program, selected topics in computer programming and other elective mathematics courses may be added to the course outline.

Conclusions and Summary

It is not an easy task for mathematics programs in small liberal arts colleges to compete with the mathematics departments in large universities. The challenges are many and the advantages are few. One attempt to tilt the balance toward small colleges is to create a mathematics technology course that focuses on major applied and theoretical concepts from key undergraduate mathematics courses such as calculus, linear algebra, differential equation, and statistics. The course makes the mathematics program more attractive and it prepares students more properly for future opportunities.