



Making Mathematics Relevant: College Algebra Reform at Trinity College

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Trinity College was founded in 1897 by the Sisters of Notre Dame as a Catholic, four-year, liberal arts college for women. The college offers bachelors degrees in 22 areas. Trinity's faculty includes 60 full-time faculty; 95% of the full-time faculty have earned doctorate or equivalent degrees. The mathematics department has 4 full time mathematics faculty. I joined the faculty in fall 2000.

In 1993 the college adopted the Foundation for Leadership Curriculum (FLC), a broad core curriculum required of all undergraduate students. The goals of the FLC, in the words of the mission statement, are to "prepare women to become the leaders of tomorrow by providing them with a breadth and depth of essential knowledge and skills as well as an understanding of how ways of knowing interconnect and cross the boundaries of traditional academic disciplines." Before its recent revision, the FLC curriculum required all undergraduates to complete at least one mathematics course. At that time, there was a two-track system in place. Students who planned to major in math or science could take Pre-Calculus or Calculus to satisfy their FLC requirement. Students who were not math or science majors could take Math for Liberal Arts Majors to satisfy their FLC requirement.

The college recently shifted its demographic target towards students in its own community, the District of Columbia. As a result, Trinity has become a minority serving college: the Spring 2003 enrollment was approximately 551 full time undergraduate students, 60% of whom are African American or Latin American. Trinity College's focus on helping minority women to succeed in math and science and to increase their mathematical and scientific literacy is consistent with the national focus of the last decade or so. National attention has increasingly focused on the need of colleges and universities to provide better math and science education to all of their undergraduates, especially to women, minorities, future teachers, and non-math and non-science majors.

Many of our students are graduates of the DC public school system and come from disadvantaged socio-economic backgrounds. Many are also first generation college students and are balancing full time jobs and the responsibilities of raising children along with academics. As evidenced by decreasing scores on the freshman mathematics placement exam, many of our students are arriving at college with less preparation than needed to complete their FLC mathematics requirements.

Under the system in place in 1993, those who did not place into one of the FLC courses were required to take College Algebra before they were allowed to take their FLC required course. As such, College Algebra became a de-facto pre-requisite for Math for Liberal Arts Majors as well as for Precalculus. When the mathematics faculty began examining this system, two major problems were discovered. The first problem was that the majority of incoming freshman placed into College Algebra and the D-F-W rate in that course was very high (see Table 1). The second problem was that for non-math and non-science majors, the college algebra material was not necessary for success in the next course, so its relevance as a pre-requisite had to be questioned.

Grade in College Algebra	% of Students
A	23%
B	20%
C	20%
D-F-W	37%

Table 1

The first concern addressed by the department was the high rate of unsuccessful students in College Algebra. In 1999 the mathematics faculty decided to add Intermediate Algebra, which was intended to be a pre-requisite for College Algebra. The placement exam was revised with the goal of giving some extra help to the students who needed it and hopefully increasing the success rate in College Algebra. The introduction of this new course raised two important questions:

1. Will the students be successful in Intermediate Algebra?
2. Will Intermediate Algebra help reduce the D-F-W rate in College Algebra?

In order to try and answer these questions, in fall 2001 we examined the grade spread for both Intermediate Algebra and College Algebra. We were surprised to find that not only were the students performing almost as poorly in Intermediate Algebra as they were in College Algebra, but the D-F-W rate in College Algebra had actually increased since the introduction of Intermediate Algebra (see Table 2).

Grade	Intermediate Algebra	College Algebra After Intermediate Algebra
A	23%	18%
B	22%	21%
C	20%	19%
D-F-W	35%	42%

Table 2

Clearly, the students were not benefiting from all this remediation. In fact, we seemed to be doing an effective job of alienating the students and increasing their math-phobia by making them fail at the same material over and over again. We were not getting any closer to accomplishing our self-stated goal of encouraging women to take an interest in math and science.

Many students come to us with a great deal of anxiety re-

garding mathematics, and our traditional algebra courses are very much like all the courses they have already been unsuccessful with in high school. The fact that they were again unsuccessful at mathematics was for them an unsurprising if disappointing fact. It seemed as though we were pushing those students to pursue majors that required very little mathematics. We needed to look deeper into the problem.

In December 2001, Dr. Sita Ramamurti and I were invited to attend the AMS-MER workshop entitled *Excellence in Undergraduate Mathematics: Mathematics for the 'Rest of Us'* at Arizona State University. I had also attended a College Algebra Reform Workshop at the Joint Meetings in January 2000, run by Dr. Don Small. As a direct result of these meetings, we began to re-evaluate the goals for the mathematics department. We asked ourselves several new and more far-reaching questions, still keeping our original questions in mind:

3. Who is our audience?
4. What skills would be useful for them?
5. Are we doing a good job of encouraging women in mathematics?

To address question 3, we looked at the breakdown of majors at Trinity. Because of the FLC requirement, the mathematics department serves all the students in the Trinity community, but very few of those students are math or science majors who will take the standard calculus sequence (see Table 3). However, many of our students major in the social sciences and will need to take a statistics sequence. This led us to begin questioning the relevance of College Algebra to students who would not go on to take Calculus. Much of the reform work being done on entry-level mathematics courses questions the notion that the mathematics faculty must ensure that students must show proficiency in simple algebra before we can allow them to graduate. With this in mind, we also attempted to answer question 4, what skills will be useful for the non-math and non-science students?

Major	% of students
Business	23%
Human Relations	22%
Communication	15%
Psychology	8%
Political Science	7%
International Studies	5%
Math/Science	5%
Other	15%

Table 3

To determine what skills would be useful for students in these other majors, we decided to ask our colleagues in those fields what skills they would like their students to have. Through an informal questioning process, we determined that the skills we should be focusing on are the ability to read and interpret a graph, the ability to work with real world data, the ability to use mathematics to model data, and the ability to make predictions using the model. We decided to develop a new course based on these ideas. Since many of these same ideas had been discussed in Don Small's workshop, we examined his book, *Contemporary College Algebra*, and decided to adopt this as our textbook.

The course teaches students to analyze and model data through the use of a graphing calculator. The goals of the course are to encourage exploratory learning, to improve communication skills (reading, writing, presenting and listening), to develop a sense of the applicability of mathematics to real world situations, to increase the student's confidence as a problem solver and to allow the students to become comfortable with the graphing calculator. The general outline of a typical problem is that the students are given a collection of data, they create a scatter plot of the data and then try to determine the general shape of the curve formed by the data points. Once they have chosen an appropriate function type, they attempt to fit a curve of that type as closely as possible to the data points using either shifting and scaling techniques, or, later, an appropriate regression program, which is a built-in to the calculator. Once they have an acceptable model, they use it to answer questions about the data. The questions are sometimes posed to the students, and sometimes the students are asked to pose their own questions. The class time is spent working on problems individually and in small groups. Student assessment, in addition to exams, quizzes and homework, is based on class participation and 2 or 3 out of class group projects. The projects culminate in a written report that contains background information, calculations and explanations of calculations.

In addition to creating this new course, we wanted to make sure that the sequence of required courses made sense for each student. We therefore proposed the following change to the old system, which was adopted in Fall 2002. Incoming freshmen take a newly developed placement exam. Math and science students take a different exam than the non-math and non-science students. If a student identifies herself as neither a math nor science student, she will place into a Basic Mathematics course only if the placement exam indicates that she needs to refresh her basic mathematics skills. If she passes the placement exam, she may take either Math for Liberal Arts Majors or our new course, Elementary Mathematical Model-

ing. Math for Liberal Arts Majors is recommended for students whose majors do not require any additional math classes. Elementary Mathematical Modeling is recommended for students whose majors require them to take statistics. Both courses satisfy the mathematics FLC requirement for the student. Math and science students are still required to take the traditional sequence of courses leading up to Calculus, (College Algebra and PreCalculus). Qualified students may place out of College Algebra and/or Precalculus and go directly into Calculus.

We have been using this new system and this new course now for 3 semesters. Given that Trinity is a small school and that class sizes tend to be quite small, the total number of students who have taken Elementary Mathematical Modeling thus far is 86. It is too soon to fully judge the impact of the new FLC requirements, but preliminary results are promising (see Table 4).

Grade	Elementary Mathematical Modeling
A	15%
B	30%
C	29%
D-F-W	26%

Table 4

The 26% D-F-W rate for this new course is still higher than we would like, but the D-F-W rate for College Algebra before we introduced this new course was 45%. Also, it is significant to note that not one student has dropped Elementary Mathematical Modeling in three semesters it has been running. This could be a sign that the students feel more confident with their performance in this course than they felt in the traditional College Algebra course, which had a drop rate of 8%.

Math for Liberal Arts Majors had been a pre-requisite for Introductory Statistics. Now most of the students take Elementary Mathematical Modeling instead. We decided to examine student performance in the Introductory Statistics course to see if the new system has had any impact. The conclusion we reached is that there does not seem to be a significant difference in the grades of students who take Elementary Mathematical Modeling instead of Math for Liberal Arts Majors.

At the end of the Fall semester in 2003 we distributed a survey to the students enrolled in Elementary Mathemati-

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cal Modeling. The goal of the survey was to allow the students to make a self-assessment as to whether the goals of the class were being met. Since the number of respondents to the survey is so small (17), we will have to wait for further data before we can draw any conclusions, but the response to the survey was generally quite positive.

One component of getting students interested in math and science is to get them to feel confident about their abilities in those fields. In order to determine if this new course inspires self-confidence, the first question on the survey is to indicate if you agree or disagree with the statement, *This course has improved my mathematics self-confidence*. The answers to this question are on a scale from 1 - 5, with 1 corresponding to *strongly disagree with the statement* and 5 corresponding to *strongly agree with the statement*. The student response to this question had a mean of 4.2.

One goal of the course is to help the students become better problem solvers. Several statements on the survey address this goal including: *This course has improved my problem solving skills*, and *This course has increased my self-confidence in solving word problems*. These ques-

tions had a mean response of 4.2 and 4.1 respectively.

Another goal is to improve the students' communication skills. We asked them to respond to statements such as: *This course has improved my mathematical writing abilities*, *This course has improved my mathematical reading skills* and *This course has improved my ability to explain my answers to mathematical questions*. Mean responses to these questions were 4.1, 4.1 and 4.0 respectively.

The student response to the new course was not very enthusiastic during the first semester. The format is not what they are used to, and they did not like having to explain their answers or to work exclusively with word problems. According to our survey results, student attitudes toward the course have changed and are currently quite positive.

In the future, we would like to try to develop an objective instrument to assess whether the goals of the class are being met. We would also transform our current “Basic Mathematics” course into something less traditional, and hopefully more relevant and interesting for the students, without sacrificing basic mathematical skills in the process.

The **Mathematicians and Education Reform (MER) Forum** seeks the effective participation of mathematicians in mathematics education reform at the K-12, undergraduate, and graduate levels, and the recognition of the importance of these efforts to the well being of the mathematics community. The MER Forum envisages the pursuit of educational reform through informed discussion of educational issues, thoughtful responses to changing educational conditions, and the dissemination of exemplary programs. The creation and support of a network of mathematicians with a sustained commitment to mathematics education is central to this vision.

www.math.uic.edu/mer