



# MATHEMATICS THROUGHOUT THE CURRICULUM

## PROJECT NEWSLETTER

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## Revitalizing mathematics:

### *MTC shows students how useful math can be*

In 1994, the National Science Foundation issued a call to revitalize undergraduate education. Reacting to what it saw as a gap between the level of students' mathematical skills and the level needed to function successfully in a technology-driven workplace, NSF set out to increase students' ability to understand and use mathematical sciences.

Two math professors at Indiana University answered that call. Daniel Maki of Indiana University Bloomington and Bart Ng of IU-Purdue University at Indianapolis developed the MATHEMATICS THROUGHOUT THE CURRICULUM (MTC) project, which spans all eight IU campuses. Instructors from fields such as art, biology, business and criminology pair up with math instructors to create courses that demonstrate how mathematical tools can lead to real-world solutions.

"The biggest obstacle for most students is their inability to see that mathematics is connected to their everyday lives," Maki says.

Math presented a worrisome obstacle for Deidre Davis, a business student at IU South Bend. Davis struggled through two weeks of a required math course before abandoning it.

"I was entirely lost and went to see a

counselor," Davis says. "She told me about a new course called *Mathematics in Action* and said it was being taught in a different way."

Team-taught by business Professor Paul Kochanowski and math Professor Morteza Shafii-Mousavi, the MTC course *Mathematics in Action* emphasized the relevance of mathematics. The two professors delved into new concepts by using examples like employee scheduling and investment analysis, as well as assigning teams of students to work on problems from local businesses.

"It was fun," Davis says. "It wasn't just a bunch of numbers. We could see how it applied."

Davis not only completed the course and earned an "A," but she also decided to take another statistics course the following semester. Building on concepts she learned in *Mathematics in Action*, she received her second "A" in a field she once dreaded.

Hoping to increase the number of students who experience such success, MTC co-directors Maki and Ng are



*Students gather information for a math project at the Otis Elevator Company.*

working with more than 80 faculty members to change the way mathematics is taught at IU. Over the next four years, they plan to introduce 30-35 new courses, which will be team-taught and emphasize hands-on projects.

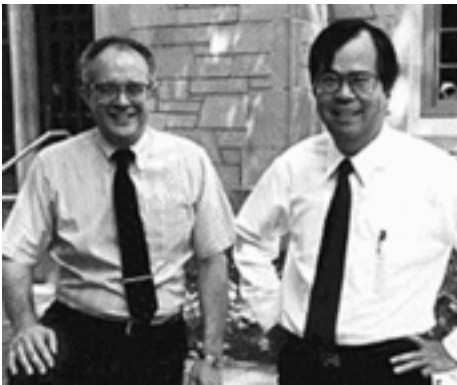
"This is a win-win situation for faculty and students," Ng says. "By integrating math with other subjects, the students learn the techniques when they need them, and faculty can gear the courses to a specific area."

NSF was searching for projects that

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## FROM THE DIRECTORS



*IU math Professors Daniel Maki and Bart Ng*

It's been almost a year since we received funding from the IU Strategic Directions Initiative and a major grant from the National Science Foundation for the MATHEMATICS THROUGHOUT THE CURRICULUM project. We are pleased with the project's development to date and with the new batch of courses that began this fall.

We are encouraged not only by the faculty's response to the initiative, but also by the students' response to the courses that have been taught. Many students are coming away with a new appreciation for mathematics and a better understanding of its applications. We're on the right track.

This summer we met with instructors of the initial MTC courses to discuss how to effectively evaluate the courses and create materials to disseminate to other schools — two topics of special concern to NSF. Ultimately, NSF wants the courses to be replicated in colleges and universities throughout the country. Our task is to determine how undergraduate mathematics can be improved throughout the IU system so we can promote nationwide change.

In addition to developing new courses, we are collaborating with other institutions in the NSF initiative. All together, seven schools, or groups of schools, are attempting to invigorate undergraduate mathematics, and each project is following a different route. (See National Scene - page 5.) Within the IU system, we are uniting mathematics with such fields as art, biology, business, criminal justice and nursing so that students can explore concepts that are directly related to their field of study.

In our first issue of the newsletter, we feature a course in criminal justice taught at IU Bloomington. In our next issue, we'll highlight a business and math course at IU South Bend and an art and mathematics course at IUPUI.

This project is an exciting endeavor for us, and we'd like to thank all the faculty who have been helping us, especially our co-principal investigator, Richard Patterson.

We welcome people to contact us for more information or with suggestions for new courses. Please see the back page for information on our mailing address, phone number, web address and e-mail addresses. We look forward to your comments.

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# Revitalizing math (continued from page 1)

would serve as national models for effectively integrating mathematics with other disciplines. Convinced that the MTC project — which had already received \$300,000 from the IU Strategic Directions Initiative — would serve as such a model, NSF awarded the project with a \$2.8 million grant in late 1996.

As with most elaborate plans, the MTC project arose from simpler origins. In 1980, Maki spent a year at the Claremont Colleges in southern California directing student teams in a math and engineering clinic. Students worked on math-related problems from local industries and turned abstract equations into tangible solutions. At the end of the program, they presented their findings to industrial representatives at a day-long event.

Maki discovered that “the interaction between students and real-life experiences cannot be duplicated in the classroom,” he says.

A few years later, Maki introduced a similar approach at IU. When the College of Arts and Sciences teamed up with the Business School in 1989 to form the Liberal Arts in Management Program (LAMP), Maki joined with business Professor Wayne Winston to create a new course. In *Analytical Problem Solving*, students applied mathematical tools to projects from local businesses and government agencies.

“Students are not going to be interested unless they can see practical applications,” Winston says.

So Maki and Winston got their attention. The professors lined up industry and government projects for students to work on in teams of four. They taught students mathematical and statistical tools and then turned them loose on the projects. One team had to determine how many tellers the IU Credit Union should use on a given day and time. Multiple

regression provided the answer.

Another group conducted a quality control project for the Otis Elevator Company. They measured the probability of meeting product specifications for elevator rails and completed a process capability study.

For students who were predominantly uninterested in mathematics, it was a refreshing approach. “They didn’t realize what math could do in the world,” Winston says.

Since many workplaces rely on Excel software to perform statistical programming, Maki and Winston taught students how to use Excel spreadsheets to perform statistical calculations.

“We put more emphasis on using technology to carry out the techniques we are teaching,” Maki says. “If we teach you about linear regression in one class, the next session we’ll go to the lab and plot regressions using the computer and a real data set.”

This hands-on, interdisciplinary approach was just what NSF had in mind when it set out to improve undergraduate mathematics. According to Maki, the LAMP course was a model for the MTC proposal and was critical to the project’s selection from a pool of 200 applications.

“We had experience in what NSF was asking people to do — teaching interdisciplinary courses to students who were not traditional math students,” Maki says.

Not only did the project directors have the type of model NSF was looking for, but they also had the support to go with it. “We had cooperation from a lot of faculty, deans, departments, chancellors and administration members,” Ng says.

Along with developing strong institutional ties, the MTC project has been working on implementation strategies. A significant part of the process involves



*Maki and Winston discuss math concepts with students in Analytical Problem Solving.*

getting people on board to teach the courses and negotiating between departments, faculty and deans about the details. What they learn about course implementation from working within the different IU campuses will be a valuable lesson, says Ng.

“We literally have a cross-section of institutions here at IU, from the pastoral setting of the residential Bloomington campus to the urban atmosphere of IUPUI,” Ng says. “The comprehensive nature of the IU system is very attractive as a test bed for NSF. The results we produce will be applicable to schools across the country.”

And that is a critical element of NSF’s ultimate goal. IU is one of seven institutions involved in the NSF initiative. The agency is interested in developing courses that can be replicated in academic institutions across the country. “Our biggest task is not just producing good courses,” Maki says, “but disseminating what we’ve learned and producing good materials.”

Since each institution has different ideas and approaches to the NSF initiative, the MTC project will share its successes with the six other schools to advance the overarching goal — to systematically improve undergraduate education in the nation’s colleges and universities.

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# Professors teach the stats on crime



*IU math Professor Steen Andersson and criminal justice Professor William Selke*

When IU Bloomington senior Nicole Mauck signed up for *Techniques of Data Analysis* (P291), an alternative statistics course for criminal justice majors, she didn't know what to expect. "I heard horror stories about regular stats classes," Mauck says.

Her fears were quickly laid to rest. "The professors made the course fun," she says. "I don't think I missed a class, and that's pretty good for me."

Mauck's discovery underscores the philosophy behind the MATHEMATICS THROUGHOUT THE CURRICULUM project: Math needs to be put in context. Students are more comfortable and interested in learning math when it relates to their field of study. In P291, the criminal justice department put this principle into practice.

Criminal justice Professor William Selke and mathematics Professor Steen Andersson team-taught the course to 23 students at IU Bloomington in the spring of 1997. The class substituted for a required course and introduced mathematical concepts such as probability theory, distribution models and regression analysis.

The course differed from traditional classes in three ways. The first difference was the increased emphasis on class projects. "Student assignments were based on problems using real criminological data," Selke says. "Sticking with data that comes from your field — that generates interest from students."

The second difference was the extensive use of computers in the course. Students spent half the time in lectures and the other half in the computer lab. They used Excel software exclusively in

the lab instead of the more traditional SAS or SPSS programs. Selke found Excel spreadsheets more helpful than other programs because "students weren't tempted to try to do more statistical analysis than they could understand on their own," he says.

The third difference was the student-to-instructor ratio. The class had only 23 students with two instructors, compared with a typical class of 60 students with only one professor. A recurring problem in math courses, Selke says, is that "some students are left behind in the dust." In their course, Selke and Andersson had the time to ensure that students grasped the material.

Students weren't the only ones who learned from the course. Both Selke and Andersson gained new insights into their respective fields. "I learned a great deal," Selke says. "I gained a broader perspective about statistics than just the nuts and bolts."

Andersson says that the emphasis on computers changed his mind about using technology in the classroom. "Some higher level math classes would be very adaptable to computers," he says. "In some of the classes, computers should be used all the time."

This fall, Selke will assume all teaching responsibilities, while Andersson will act as course advisor. In addition to creating new project data sets, Selke also wants to work on the lecture notes, which Andersson wrote for the course. Most textbooks in the social sciences use examples that are too general, Selke says, so they decided to create their own textbook for P291.

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## NSF Meetings

Directors of the seven projects met at Villanova University in June to present updates and share ideas. NSF representatives ran a workshop on developing evaluation techniques to ensure that courses are appropriately reviewed and revised. In addition to conducting student and faculty attitude surveys, project participants agreed to establish student learning objectives that would be tested at the end of the course. The group will meet next summer at West Point.

In July, several directors presented project reports at the Society for Industrial and Applied Mathematics' (SIAM) 45<sup>th</sup> Anniversary and Annual Meeting held at Stanford University.

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## Professors

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"The main mistake with statistical textbooks is that they focus too much on (formula) derivations," Andersson says. "They should focus on concepts and statistical thinking."

One problem the professors encountered, however, was "getting the lecture notes at the right level," Selke says. "The first several sets of lecture notes were, I think, beyond the level of the students."

Despite the inevitable challenges of teaching a new course, the student evaluations were encouraging. Most of the students found the course interesting and useful to their field of study. A few said it was the first math course they had ever enjoyed.

Nicole Mauck recommends the class to fellow students. "The course was better than regular classes," she says, "because it was interesting and more hands-on."

NSF has awarded grants to seven projects across the country, including IU, to revitalize undergraduate mathematics. Below is a summary of the other six projects:

### **Mathematics and Its Applications in Engineering & Science**

**Rensselaer Polytechnic Institute** with 5 collaborating schools

RPI is developing an expandable library of hypertext modules that link mathematics with its applications in engineering and science and that will be available via the Web to all instructors.

### **Mathematics Across the Curriculum**

**Dartmouth**

Dartmouth's main goal is to integrate math with such areas as architecture, art, biology, computer science, engineering, geology, literature, medicine, music and philosophy.

### **Middle Atlantic Consortium for Mathematics Throughout the Curriculum**

**University of Pennsylvania** with 5 collaborating schools

This project aims to show students how mathematical concepts can be used to solve problems they'll face in their careers. It includes the creation of multi-media applications modules and the development of multi-level interdisciplinary courses.

### **Multimedia Mathematics: Across the Curriculum and Across the Nation**

**University of Nebraska-Lincoln; Oklahoma State University** with 4 collaborating schools

The Multimedia consortium focuses mainly on mathematics, biology, chemistry, engineering and physics. It will introduce technology-based services and materials that explore innovative methods of presenting mathematics and science.

### **Project Intermath**

**U.S. Military Academy** with 7 collaborating schools

Project Intermath is designed to promote change in the teaching of undergraduate mathematics through two strategies: developing an Inter-disciplinary Lively Application Projects (tool for measuring student growth across several dimensions); and integrating the curriculum.

### **Long Island Consortium for Interconnected Learning in Quantitative Disciplines**

**State University of New York-Stony Brook** with 9 collaborating schools

The Long Island Consortium is taking a comprehensive approach that focuses on changing modes of instruction and learning, making connections between mathematics and other quantitative disciplines, and the use of educational technology.

## For more information about MTC

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## PROJECT UPDATE

### Seven new MTC courses were taught during 1996-97:

- ✦ Art and mathematics
- ✦ Criminal justice and statistics
- ✦ Economics and game theory
- ✦ Economics and statistics
- ✦ First-year biology and mathematics
- ✦ Mathematics for industry
- ✦ Physics and mathematics

### Nine additional courses will be taught during 1997-98:

- ✦ Chemistry and mathematics
- ✦ Finance and mathematics
- ✦ History and mathematics
- ✦ Intermediate biology
- ✦ Linguistics
- ✦ Mathematics for liberal arts
- ✦ Mathematics for social sciences
- ✦ Nursing and mathematics
- ✦ Speech and hearing

**Additional courses will be  
developed during 1997-98.**

### MTC Advisory Board:

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