MATHEMATICS

NeXTSTEP brings calculus to life with *Mathematica*

University of Missouri, Columbia

These days, Professor Elias Saab's Calculus II class at the University of Missouri, Columbia, seems more like a think tank for experienced mathematicians than a lower-division college course. During a recent class, 25 students learned about Fourier Analysis, used series expansion techniques to solve differential equations, and solved a system of 24 simultaneous equationsÐproblems typically reserved for their upper-division classmates.

When Saab pops into the computer lab, most evenings he ®nds a group of his Calc II students hovered around NeXT computers interpreting the results of their homework problems. ªStudents are actually discussing calculus theory with one another,º says Saab. ªThanks to the computer, undergraduate students are talking to one another about mathematics, and they have a greater understanding of what calculus is all about.º

To concentrate more heavily on calculus theory and less on technique, Saab decided last year to teach Calculus II as a NeXT computer-based course. Saab replaced his traditional textbook with Calculus&*Mathematica*, an innovative curriculum developed at the University of Illinois. Students now solve all homework problems and submit all assignments to Saab via e-mail, something he never thought he'd be doing.

Saab says he opted to teach on NeXT machines for several reasons: ªThe biggest plus is that the NeXT machine comes equipped with *Mathematica* at no extra cost. The speed of the machine is also an important factor. Other platforms, running at the speed of NeXT, would have been much more expensive and would have lacked a good user interface for students. NeXT is an easy machine to learn because of its user interface; students grasp it quickly.º

Saab adds that because NeXT machines can easily compute solutions for a variety of calculus problems, his students can dedicate more time to learning about calculus concepts than students enrolled in traditional mathematics courses. ªIt is no longer necessary for me to go into lengthy detail about the technique of integration because the computer can compute such problems faster and more accurately than students can by hand. Instead, we have time to emphasize the theory.º

Saab also spends a good deal of class time focusing on practicalÐalbeit complicatedÐapplications of calculus theory. ªThere is a lot more opportunity for students to solve interesting problems that pertain to real-life situations. I wanted to get away from textbook examples, most of which are dead examples. Examples on the computer are alive. One can change them over and over to develop an in®nite number or examples. Students now solve problems with 100 unknowns. They can't do that using the tables in a textbook, but they can do it with a NeXT machine running *Mathematica*.º

Saab says the computer-based course is initially ªmore workº for the students, but that their effort is paying off. To test current students' knowledge against former students, Saab gave one pencil-and-paper test during the semester. In past semesters, students earned an average score of 65 percent on the test while this class averaged 80 percent.

The winter of 1992, Nakhle Asmar, an assistant professor of mathematics at Missouri, also tried *Mathematica* and NeXT machines in his Applied Analysis course. Although his students still solved problems with pencil and paper, he held several computer-lab sessions during which he solved partial differential equations, for example, using *Mathematica* on a NeXT machine.

ªI was skeptical at ®rst about using computers to teach the class,º Asmar says. ªThat's why I didn't have the students use *Mathematica* to solve equations. But in the end, I was amazed at what *Mathematica* could do in terms of graphing and how quickly equations could be solved. Consequently, I've decided to incorporate NeXT computers and *Mathematica* into the class next fall.º

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