Teaching Calculus and Pre-Calculus with Graphic Visualization

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There has been tremendous progress and advancement in computer hardware and software in recent years. The development of 486 and 586 personal computer systems is revolutionary for personal computer users. Many sophisticated software products are available for almost every field of the sciences, engineering and the social sciences. Many projects which used to depend on the mainframe computer systems can now be performed on personal computers or workstations.

Recently Marilyn Geewax's column in the Atlanta Journal-Constitution stated: "A new study by the White House's Council of Economic Advisors shows that over the past two years, more than two-thirds of all the full-time jobs created were high-paying, rewarding workers with more than the current median wage of $480 a week." The article also pointed out that "the study is being touted as evidence the U.S. economy is healthy because it keeps producing high-paying jobs. But unless our educational system is preparing enough people to take those jobs, we're headed for trouble."

As educators, we must give our students every possible advantage to face the demands of the high technology job market. I always remember that one of the national goals of education is the pursuit of world class mathematics in the next century. I feel that this is the historic task of my generation of teachers. This is the commitment and promise we must make for our next generation and future.

The student population at Kennesaw State University can be roughly divided into two groups: recent high school graduates and older students who have been out of high school for a number of years. Students from the first group are young and energetic. They have grown up in this high technology era. They are eager to study new technologies and expect to work in the high technology market. Students from the second group are relatively mature and experienced people. Many of them are professionals. They may come to Kennesaw State to improve their professional level or to seek a second profession. Some of them used to work, or still work, in low skilled jobs. Obviously, they come to our college to get a modern education so that they can turn their job prospects around. After graduation, they expect to work in high-skilled jobs. They ask us to teach them in the most effective way. This is the demand from the community to us.

The technological environment on the campus of Kennesaw State University is better than ever before. There are many computer experts in both software and computer hardware among our faculty members. I also realize that many of our students are professional computer technicians and users. Our computer laboratories provide faculty members and students excellent facilities and services. The Center for Excellence in Teaching and Learning and the Faculty Professional Development Committee and many other administrative offices offer all possible support to faculty members in developing their professions to meet the new challenges and in helping students to use technology in their studies and research.

The mathematics textbooks we use are well established and have been tested for many years. Generally speaking, they are very good, traditional and suitable for our students. On the other hand, I realize that some of them have not reflected the rapid change and development of computer technology. Some of them do include and use new technology in their contents. However, implementing this new technology in the classroom is a big challenge for our teachers. Obviously most of us did not study this new technology when we were students. The facility which we have and which we can afford will never be able to completely catch up to the rapid changes of high technology.

Last year I initiated the idea of using professional software to teach pre-calculus and calculus with graphic visualization. I really appreciate and enjoy The Rule of Three for teaching mathematics: analytically, geometrically and numerically. I believe that, at least

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for now, we should use chalk for teaching mathematics analytically in the classroom. However computers and professional mathematics software can significantly help us to teach mathematics geometrically and numerically. They can cut tedious, time consuming and repetitive steps between mathematical principles and results. Geometric figures, human beings—even well trained artists and mathematicians—have difficulty drawing geometric graphs on the blackboard accurately. Don't even talk about making three dimensional graphs move around on the board. We should take advantage of high technology and use computers extensively in our classrooms to make our teaching more effective. We should teach students to use computers creatively and positively. We must teach students more than just how to punch keys of calculators and computers or follow software menus. Otherwise, the ability of students will never be beyond the ceiling of existing technology. I believe this is one of the reasons that our institutions of higher learning are very different from job training centers.

I chose a powerful mathematics software, Matlab (matrix laboratory), to design my project. Matlab is a technical computing environment for high-performance numerical computation and visualization. Matlab features a family of application-specific solutions.

A software package that utilizes computer notebooks has been developed. The package consists of two major parts:

1. A software package of computer notebooks shows the general view and properties of elementary functions such as polynomial, rational, exponential, logarithmic, trigonometric and inverse trigonometric functions. It will illustrate the domains, ranges, asymptotes, periods and other important properties of elementary functions so that students are able to review, compare and visualize them in a more intuitive way.
2. Computer graphics programs are used to show the applications of these elementary functions in the natural sciences and engineering. These computer notebooks demonstrate many examples of application of these functions in mathematics, physics, computer science, optics, wave propagation, electrical engineering and music. They provide good supplemental materials for mathematics teaching at the university and college level. These materials will give undergraduate students motivation and inspiration to study mathematics.

The distinguishing feature of this project is the graphic visualization of some abstract concepts. The presenter can use the package to demonstrate how it can animate mathematics and make teaching intuitive and efficient. The audience will see how computer technology affects our classroom teaching.

If our students learn Matlab here at our campus then they can use its toolboxes in their future professions (almost all science and engineering fields, finance and others.) This will help students to succeed in the job market driven by high technology and to pursue their professional development in graduate schools of the future.

Anybody who is interested in my software package should contact me for details. •

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dent exclaimed, "You mean you still have to take courses?" "Have to" was answered by "get to" and questions about "Who paid for the trip" and even "How do you use it" ensued. Spring also brought another opportunity to teach a more developed Western history course. Students now produce video clip presentations exploring movie images of Native Americans, the Overland Trail experience, and mining in the West, complete with analysis of whether the images match Turner or the new Western historians and why.

But the saga was not over. Just recently as I listened to a speaker in "The Year of the Olympics" series describe the Nazi orchestration of the 1936 Olympics my mind once again returned to the lecture in "Representations of the West" and Gramsky's theory of hegemonic control through the use of public events. From Wild West Shows to World Fairs, from the Atlanta History exhibit on African Americans at the Cotton States Exhibition to the Olympics, my experiences in New Mexico and Wyoming keep renewing a new and more scholarly interest in western and non-western areas of history alike.

So where did I go on my Faculty Development grant funded vacation, and who has accompanied me? From Santa Fe and Cody I have gone to the KSC classroom, to a NEH Summer Institute, to a Cobb County Faculty Development Day, to the Atlanta History Center, to a Cobb County high school classroom, and via Library 470, to the 1936 Olympics. Who has gone with me? KSC students in and out of the classroom. Cobb County teachers. Cobb County students. And perhaps most enriching of all, my mind and its growth. Thank you CETL for my 1994 "summer vacation." I hope I never stop traveling on the learning experience you provided me. (P.S., next stop Topeka, Kansas—unless I'm surprised again.). •