Numerical Methods - A Real-World Application on Open Courses

"Build it, and they will come." Autar Kaw, professor of mechanical engineering has not built a baseball diamond in his cornfield. Instead, he has plowed under the dried cornstalks of a traditional advanced mathematics course and created an open source Internet-based Numerical Methods class that receives hundreds of thousands of visits a year. The site is the model for the Computational Methods classes at the University of South Florida. It is also a comprehensive reference base for anyone looking for mathematical models used in situations where approximations are needed.

The Holistic Numerical Methods Institute (http://numericalmethods.eng.usf.edu) uses every tool for teaching that the Internet provides, including downloadable textbooks, You Tube videos, worksheets, primers, class syllabi, PowerPoint presentations, online assessment, and even a blog. The user can select from among seven engineering major tracks (chemical, civil, computer, electrical, industrial, mechanical and general). Examples are provided in the math packages Maple, MathCAD, MATHEMATICA and MATLAB.

Professor Kaw is the author of four textbooks on numerical methods, matrix algebra, composite materials, and programming. But in 1990, he saw the future of education, and sent a proposal to National Science Foundation where he planned to send floppy disks to universities with textbook chapters and simulations on numerical methods without regard to copyright or payment. In 2000, the Massachusetts Institute of Technology (MIT) pioneered the concept of Open Courseware (OCW) on the Internet. Understanding that the Internet was the obvious vehicle for his concepts, he applied for and has received four National Science Foundation grants to create an open course on numerical methods based on the offerings at USF. Florida A&M, Old Dominion University, Arizona State University and the Milwaukee School of Engineering are also contributors to the website and use various modifications of the USF course in their engineering departments.

The course is not just a set of formulae arranged in a linear style. "The course uses real-world applications to teach engineering problems," explains Kaw. "Classes like algebra and calculus teach you problems that have exact solutions. But life is not like that in the real world you solve most problems approximately. That is what this course does. It solves a problem which can be modeled by mathematical models."

Since going live in 2001, the site has been awarded the ASME Curriculum Innovation Award (2004) and the ASEE DELOS Best Paper Award (2006). The site also publishes information on its own internal assessments of itself led by Ali Yalcin, PhD, associate professor in industrial and and management systems engineering. People who have contributed to the site are listed under the People link, giving credit to everyone from full professors to undergraduates and what each person contributed to the project.

To truly appreciate the originality and the incredible amount of work that has gone into it, you simply have to visit. The home page is an easy-to-read grid of modular topics that are laid out in order of how

a typical Numerical Methods course would be, but the user can jump around, or as Prof. Kaw suggests, "Just try using it a la carte." There is a thorough explanation of the site for first-time visitors. Both a Google site search and a Resources page for advanced searching is available. Even if you have trouble with multiplication tables, you can search in the Anecdotes on, say, the History of Interpolation and find out that Charles Babbage, the grandfather of modern computing, tried inventing a system that would choose winning horse race numbers in an effort to raise a bit of extra money for his difference engine. And if that proves too entertaining, you can always bring yourself back to reality with the Multiple-Choice Tests option.

This Holistic Numerical Methods website is not just a free, online classroom or a great reference if you have mislaid your MATLAB program for discrete functions. It is a concrete example of Prof. Kaw's philosophy that education has drastically changed in the last decade. Lots of folks in academia talk about the revolution in education, but there are not a lot of real-world applications of that philosophy. But this site is one of them. "This is a hybrid mode of education," explains Kaw. "A few years ago I saw a big disconnect between what we are teaching in class and what students are seeing out there. I very much like to keep in touch with my students, and I would ask them how many things you learned in class are you using." He laughs and continues, "Some say none! So I would ask what they do see out there in the real world." He tucked these examples away and now many of them are incorporated into the website, easily and freely available for anyone to use. "Another reason for the site is openness," he continues. "Isn't that the whole idea of higher education anyway? It is so easy now with the Internet. Just put it out there!"

Prof. Kaw is especially proud of the overwhelmingly positive response to the Numerical Methods site. Literally one million page views were recorded in the last year. There were more than half-million views of the audiovisual lectures on YouTube (http://www.youtube.com/numericalmethodsguy). His separate blog, The Numerical Methods Guy (http://autarkaw.wordpress.com) is also popular and the entries are motivated by questions that students ask him in class. One of the blog responses puts it simply: "I wish I had a teacher like you."

New topics for the Numerical Methods site are scheduled for summer 2011, including Optimization and Partial Differential Equations. Educators interested in customizing the site will find contact information under the FAQ section. Statistical analysis of the course and its success is discussed in the Publications link on the site. A recent proposal written to National Science Foundation seeks to adapt and assess the courseware at additional institutions including Alabama A&M University, Prairie View A&M University, Florida International University, University of Nevada-Reno, University of Texas-Tyler, Louisiana Tech University and University of South Carolina (USC).