IS TECHNOLOGY A FRIEND OR FOE OF LEARNING?[1]

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In almost every teaching workshop we give, someone asks if the rise of instructional technology and distance learning signals the end of higher education as we know it. As it happens, we believe it does, but we regard this as good news, not bad. Consider the following two scenarios.

Scenario 1

Sharon boots up her computer, connects to her heat and mass transfer course web site, checks out the assignment schedule, sighs heavily, and gets to work. In the next hour and a quarter, she

- quickly reviews last week's multimedia tutorial that presents material on convective heat transfer, asks questions and poses problems, and provides feedback on her responses and corrections if she misses;

- watches a video of her instructor lecturing on the same topic, advancing rapidly to his discussion of a particular homework problem that gave her a lot of trouble;

- begins working through this week's tutorial, which deals with a shell-and-tube heat exchanger preheating the feed stream to a distillation column, and clicks on a hot link in the process description that takes her to supplementary material on heat exchangers, including a cutaway schematic, photos of commercial exchangers and tube bundle assemblies, and outlines of exchanger operating principles and design procedures;

- returns to the tutorial and builds the steady-state energy balance and heat transfer equations, branching to a linked database to retrieve needed physical properties of the process fluids;

- uses linked numerical analysis software to solve the equations, size the exchanger, and generate plots of shell-side and tube-side temperatures vs. axial position along the tubes;

- brings up a heat exchanger simulation and first predicts and then explores the effects of system parameter changes on exchanger performance;

- closes the tutorial, checks her e-mail and finds a message from her instructor clearing up a point of confusion she had e-mailed him about late the previous night, sends a message to the other members of her class project group reminding them of their scheduled chat room conference at 7:30 that night, and logs off.

[1]*Chem. Engr. Education, 34*(4), 326-327 (Fall 2000).

Scenario 2

Fred goes to his 8 a.m. heat and mass transfer class, drops his homework on the front desk, takes his seat, yawns, and wonders if he'll be able to stay awake until 9:15. Professor Maxwell greets the class and asks the students if they have any questions. One of them asks about a homework problem and she goes through the solution on the board. She then draws a block diagram of a heat exchanger and writes the energy balance and heat transfer equations. When she finishes writing the last equation she asks the class how they would determine the film coefficients in the expression for the overall heat transfer coefficient. Fred vaguely recalls something about correlations from the last lecture but doesn't feel inclined to say anything. When no one volunteers a response the professor reminds the class about the correlations and writes the equation for one of them on the board, and then completes the calculations. She asks again if any of the students have questions, and they don't. She then notes that different correlations must be used for laminar flow, and she writes an expression for one of them. While she is writing Fred glances at his watch, sees that it is 9:13, and closes his notebook. The instant she finishes he wakes his neighbor and heads for the door with the rest of the class.

These scenarios raise a question currently being pondered throughout the academic world. If Sharon and Fred are roughly equivalent in intelligence and knowledge of the course prerequisites, which of them will learn more—the one taught in the live classroom or the one taught with technology? There's no way to know for sure, of course—how much a student learns in a course depends on many things—but technology is the way to bet in this example. The rich mixture of visual and verbal information, self-tests of knowledge and conceptual understanding, practice in problem-solving methods, and immediate individual feedback provided by the technology in Scenario 1 are far more likely to promote deep learning than the passive environment of the traditional lecture class...and the fact that Sharon lives 750 miles away from her instructor's campus and has never seen him in person doesn't change the likelihood that she will learn more and at a deeper level than Fred.

This speculation is not baseless: studies comparing technology-based and traditional course offerings are beginning to appear with regularity, and technology is looking better all the time.[2] Universities that specialize in distance education are learning how to use multimedia courseware and the Internet effectively and the quality of their offerings is gaining increasing recognition.[3] When students in the near future have a choice between (a) attending passive lectures at fixed locations and times in a campus-based curriculum and (b) completing interactive multimedia tutorials at any convenient place and time in a distance-based curriculum, guess which alternative more of them will begin to choose.

This is not to say that technology is a panacea. Passive instructional technology—e.g., simply pointing a video camera at a conventional lecture or using the Web only to display text and pictures—does not promote much learning, no matter how dynamic the lecturer or how colorful the graphic images. Moreover, even at its best technology will never be able to do some things that first-rate teachers do routinely, such as advising, encouraging, motivating, and serving

[2]M. Kadiyala and B.L. Crynes, "A Review of Literature on Effectiveness of Use of Information Technology in Education," *J. Engr. Education, 89*(2), 177–189 (2000); D.R. Wallace and P. Mutooni, "A Comparative Evaluation of World Wide Web-Based and Classroom Teaching, *J. Engr. Education, 86*(3), 211–219 (1997).
[3] T.K. Grose, "Distance Education the UK Way," *ASEE Prism,* November 1999, pp. 26–29.

as role models for students, helping them develop the communication and interpersonal skills they will need to succeed in their careers, and getting them to teach and learn from one another. Most successful people can think back to at least one gifted teacher who changed their lives by doing one or more of these things; it is unlikely that anyone will ever be able to do the same for a software package.

Here, then, is what our crystal ball says about the future of higher education. An increasing share of undergraduate degrees will be earned in well-designed distance-based programs at conventional universities and institutions without walls like the British Open University,[2] and an increasing number of people will bypass college altogether and seek competency-based certification in fields like information technology.[4] Some highly ranked research universities will still teach traditionally and continue to attract undergraduates by virtue of their prestige, serving primarily as training grounds for graduate schools. Many of the much greater number of less prestigious universities will try to keep doing business as usual, but having to compete for a shrinking pool of undergraduates will force them to either change their practices or close their doors. And a growing number of universities will systematically incorporate interactive multimedia-based instructional software in their live classroom-based courses, making sure that the courses are taught by professors who serve as true mentors to their students and not just transmitters of information. These universities will continue to thrive—and they will provide the best college education anyone can get.

[4]C. Adelman, "A Parallel Universe: Certification in the Information Technology Guild," *Change, 32*(3), 20–29 (2000).