# Teaching and Learning

**1. How will teaching and learning be different in the twenty-first century because of information technology?**

*Alfred Bork, Professor Emeritus of Information and Computer Science, and Physics, University of California, Irvine:* Teaching, in the sense of someone conducting a class of twenty or more students, either locally or at a distance, will mostly vanish at all levels of learning. Learning will be a much more individualized and interactive process; computer-based learning material will adapt to the needs and pace of each individual student, through distance learning for large numbers of students.

*Diane Balestri, Director, Computing and Information Services, Vassar College:* Learning will become more conveniently accessible for many. More important, students will routinely use sophisticated digital tools for hands-on, collaborative learning and research; they will examine and manipulate their own selections from vast stores of multimedia materials to generate new knowledge and to create new inventions and works of art. Good teaching will mean bending these new tools and resources to the purposes of learning in the disciplines while (as always) providing patient and personal support to students.

*Carl Berger, Director and Academic Liaison, Professor of Science and Technology Education, University of Michigan, Ann Arbor:* Prediction is tricky, but from what is just now emerging, we can predict that the use of instructional management systems and the interchange of teaching and learning modules will allow for more sharing, for an interchange of individualized teaching and learning that will extend far beyond classrooms. Instructors will easily design and produce instruction and will involve students in active learning, guiding them as they construct knowledge.

*Jacqueline Hess, Director, National Technology Demonstration Lab, Academy for Educational Development:* One of educators' most frequently voiced complaints is that they feel isolated—from peers, mentors, resources, and just-in-time support. Information technology offers an end to that isolation, for all who have access and wish to use it. Access to colleagues, experts, and rich libraries of educational material will be available through any number of online vehicles.

*Carol A. Twigg, Executive Director, Center for Academic Transformation:* Information technology's attributes of disaggregation, disintermediation, diffusion, and differentiation will come into play. The features of teaching and learning will be split apart and reassembled. New self-service models will disintermediate knowledge acquisition by substituting software intelligence for human intervention. The more the new learning models are used, the more value they will acquire. Lastly, the "pieces" of teaching and learning will be used for numerous purposes in the currently disparate worlds of K-12, higher education, and training.

*Rika Yoshii, Associate Professor of Computer Science, California State University, San Marcos:* There will be more individualized interactive learning—students will be given interactive "intelligent tutors" so that they can learn at their own pace, wherever they are, with their own automated "tutor." This "tutor" will also accompany them during "distance learning," which will have become not broadcast lectures but interactive multimedia exchanges with humans, making high-quality learning more accessible.

**2. What is the greatest barrier to the transformation of teaching and learning?**

*Bork:* The greatest barrier is the almost complete absence of the type of tutorial learning materials I have described above. We need first to conduct some extensive experiments with such materials, developing them and conducting large, professional evaluations. On this basis we can proceed to the large-scale development of learning sequences.

*Balestri:* The only real barrier will be the limit of human imagination brought to bear on the ways in which information technologies can benefit teaching and learning. The training of elementary and high school teachers needs to be completely rethought in light of these new tools and sources for learning, for instance, as does the nature of librarianship for the management of digital resources.

*Berger:* The greatest barrier is that teaching and learning using technology will be simply a linear transform of our current teaching and learning. We're just finding out that students can learn differently with technology and that we can teach in ways that are impossible without technology. It's as if we have just discovered that the "book" with its table of contents allows us to access elements out of sequence, something impossible to do with the verbal "lecture."

*Hess:* Our reliance, in this century, on secondary and tertiary materials, on "pre-chewed" synopses, is keeping us from fully benefiting from the promise offered by new technologies to provide multiple voices and primary source materials. The technology offers a path toward simulation-based, contextual learning, but we don't yet know how to walk down the path.

*Twigg:* The greatest barrier is the lack of standards for professional practice. Unlike most other professionals, college faculty can practice without a license. The Ph.D. may indicate a professor's research competence, but it does not attest to knowledge about how students learn. College teachers pay almost no attention to the existing research about how students learn. Imagine if medical doctors practiced medicine based solely on their individual perceptions about how to cure sick people. We need standards of professional accountability for college teaching.

*Yoshii:* There seems to be a lack of serious motivation and budget to develop high-quality computer-based materials that can provide more quality interactions than classroom teaching. Most developers seem to settle for obtaining some advantages (e.g., self-paced; fast distribution of materials) by giving up other aspects of quality learning such as those obtained through one-on-one tutoring.

**3. How should campuses prepare for the teaching and learning changes that we can expect over the next ten years?**

*Bork:* Begin to think in terms of large-scale distance learning, U.S. versions of the UK's Open University, using highly interactive, tutorial computer-based courses, in all subject areas. But there is no sign now that this is happening; current views of distance learning in the United States are very weak.

*Balestri:* Consider information technology to be a strategic resource, and fund it appropriately now. Build and retain a strong central IT staff while distributing skill in the use of IT widely across the campus. Build an infrastructure (networks, classrooms, library resources) that is flexible enough to grow and to adjust quickly to technical change. Encourage faculty to work collaboratively and across disciplines in developing instructional uses for IT. Plan for ubiquitous student access to all the resources needed for learning.

*Berger:* Many campuses are spending millions of dollars to revamp the administrative infrastructure based on Y2K, legacy systems, and the demand for easily usable information. Given the nature of the changes in teaching and learning, we shall easily spend *twice* as much to revamp and update our teaching and learning infrastructure and the users' interface to that infrastructure. This investment is already starting on many campuses, through "CourseTools" and dynamic learning Web pages for students.

*Hess:* Professional development, professional development, and more professional development. This needs to cover everything from instructional design principles for online educators to time management (which differs significantly in the distributed learning world), intellectual property rights in the digital world, and ways of teaching students how to evaluate and balance media-rich learning materials. On more logistical fronts, there are libraries to digitize and dorm rooms to wire.

*Twigg:* Some campuses will experience almost no changes because they are convinced that their current academic practices are fundamentally sound. They will use technology as a supplement to their existing practices and will require minimal preparation. Other campuses will recognize that IT offers the opportunity to transform academic practices by improving access, enhancing quality, and controlling costs. Such campuses will need visionary leadership, a willingness to take risks, substantial resource commitments, and an understanding of the required operational tasks.

*Yoshii:* We can start thinking now of the new requirements for developing and employing the high-quality learning materials explained in my answer to Question 1: the required budget, the evolution in faculty roles and reward systems, the adaptations in required facilities and staff, and the evolution of the grading system.

**4. What advice would you give to faculty today with regard to improving student learning?**

*Bork:* Do not develop Web sites as is currently being done! Begin to think about how to make learning much more interactive. Become involved in developing highly interactive tutorial units.

*Balestri:* I would not presume to give advice to faculty on this subject. My staff at Vassar are available to provide support and partnership to faculty as they seek to develop their teaching, and I encourage faculty to take advantage of our

help. I also encourage faculty to make a compelling case with their deans and financial officers for the technology resources (both equipment and staff) that they need to carry out their teaching and research.

*Berger:* Demand the tools and the training, and the *time,* to try new techniques (t⁴nt?). Our recent survey of 1,500 faculty members informed us that these are the biggest obstacles. Our faculty also told us that they *want* to learn and try new techniques; indeed, the small number already using these new techniques reported that they use the new tools daily and that the techniques have changed the way they approach teaching and learning!

*Hess:* Focus more on context and less on formula. Make sure the context is international. Encourage collaborative, not isolationist, learning. Many students leave the university still not knowing how to ask the right question. There is still too much emphasis on content memorization. Although I believe that third-graders need to know their times tables without the use of a calculator, university students and lifelong learners need to know how to access, evaluate, and utilize information efficiently. Here, technology presents both the challenge and the tools.

*Twigg:* Shift from a "push" teaching strategy, which treats all students the same, to a "pull" strategy, which recognizes differences in learning styles and interests: move students from passive listening and note-taking to active learning; offer self-paced, interactive materials; find ways to teach abstract concepts interactively and visually; provide greater hands-on experience with data analysis; provide more individualized assistance when students need it; structure collaboration among students; and enable 24 x 7 access to online learning resources.

*Yoshii:* Think of ways to make learning individualized and interactive with the goal of assessment to aid each student's learning. The more information one can collect from a student as he or she learns, the more we can tailor the instruction to meet the student's needs. The computer-based materials teachers use need to embody such quality assessment and individualization.

**5. Will individual faculty members retain full responsibility for the curriculum in the future?**

*Bork:* As suggested in my first answer, and by Peter Drucker, it is unlikely that "individual faculty members" will exist in the future. Some will be involved in the design of the new courses.

*Balestri:* At liberal arts colleges such as Vassar, I am sure that they will. Here, as elsewhere, the responsibility for the curriculum is in fact collegial and collaborative (residing in departments and curriculum committees, not simply in the hands of individuals). The widespread use of expensive digital tools and resources will reinforce the need for campus-wide planning and even for cooperation with other institutions in order to maximize the benefits of a particular technology in the curriculum while containing costs.

*Berger:* Yes, but with an important provision. Faculty members are and will be the persons responsible for curriculum, modules, lessons, and even particular sessions. But as they come to rely on the full collaboration (not just support) of nonfaculty designers, evaluators, and researchers in the creation and development of instruction and learning, they will share in the responsibilities and the rewards. The hidden question is whether or not the institution will *own* the curriculum.

*Hess:* To the extent that this question implies that faculty members may lose control to an institution-wide, template-driven approach, I would say no, they will retain individual responsibility. But to the extent that we are moving toward fully distributed learning, with teaching resources, both human and material, distributed throughout the world, faculty members will have to learn to work collaboratively on discrete curricula.

*Twigg:* College faculty members do not have full responsibility today. Society's expectations of what students need to know, textbook publishers, software producers, and professional societies are among the many shareholders of the curriculum. In the past, these shareholders influenced individual faculty members. In the future, new forms of higher education may bypass the faculty member and offer services directly to the student. However that future plays out, college professors will not be the soul source for the curriculum.

*Yoshii:* As mentioned in my answer to Question 3, faculty roles will change when classroom instruction cedes to self-paced materials and distance learning. Instead of each teacher being responsible for his or her own materials, the same materials will be used for each course no matter who "teaches" it. However, teachers need to be fully involved in the design of such materials by supplying their pedagogical expertise.