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ABSTRACT

Research findings on computer use in college courses are reviewed. Faculty who have utilized computers in their courses report that computers increase student engagement, add realism to instruction, promote skill mastery and understanding of basic principles, augment laboratory experiences, and encourage inferential thinking. Five case-study excerpts show how computer use impacts student learning. Faculty report that computer usage requires a heavy, ongoing investment of their time in finding or developing software, training students, adapting curriculum, and modifying lectures or exercises. It is concluded that computer-based learning motivates faculty and students alike, differs from traditional lecture and discussion classes in several ways, requires leadership, and is costly, but has great rewards. Nine further readings are listed. (JDD)

IMPROVING COLLEGE TEACHING AND LEARNING

The Computer Revolution in Teaching

In colleges across America a revolution is under way that challenges the basic form of learning and instruction. The instrument of this revolution is the computer. Can computer-based learning help students? At what cost? It is too early to answer these questions definitively, but NCRIPTAL research on the early adopters of technology points to likely answers.

Computers are now being used on many types of campuses in disciplines as different as physics, political science, English composition, and music. On any one campus the number of faculty who offer computer-based activities in their teaching is small—less than ten percent on most campuses—but these early adopters report that computers provide their students with learning opportunities that go beyond what is possible with traditional readings, lectures, discussion groups, and lab sessions.

What motivates these pioneers to adopt this technology in the face of the seemingly insurmountable barriers of time and money? Why don't they devote their energy to "more scholarly" activities? The answer lies in their recognition of what computers make possible for their students' learning experiences.

In NCRIPTAL studies of computer use in higher education, faculty report that computers increase student engagement, add realism to instruction, promote skill mastery and understanding of basic principles, augment laboratory experiences, and encourage inferential thinking. The following five case-study excerpts show how this happens.

Increasing Student Engagement. Not surprisingly, today's students are fascinated by tasks done on computers. This fascination has benefited writing students who use word processors. A professor who teaches remedial writing observes that word processors make students want to re-examine their writing and revise it. "For one thing, what they produce looks good—it's in a 'classy' form."

As superficial as it may seem, this willingness to shape a paper motivates students to revise it. Teachers of writing have long advocated revision as a means to improvement, but they report it is difficult to implement this approach with traditional paper and pencil. Noted one instructor: "Working at the computer, the student finds that the paper can be changed and moved around. A lot of things can happen to that paper before it's printed, so the student begins to value more his or her ability to play with that text, which is precisely what I think contemporary teachers of writing want to effect."

Adding Realism to Instruction. One of the best ways to learn a foreign language is to experience it in natural settings. To do this, a professor of Hebrew developed a tutorial program to teach

beginning students. A videodisc version of a popular Israeli television series helps students master the subtleties of oral language. At various points, the computer stops the show and tests the student's comprehension. If the answer is wrong, the program reviews the relevant scene with the text of key words overlaid on the television screen. Students can ask for definitions of unknown words.

For more advanced applications, such as literary analysis, another tutorial guides students through the individual words and phrases of a work. The professor now reports they are better prepared to discuss the meaning of the work when they come to class.

Promoting Mastery and Understanding. In large introductory courses, students vary greatly in their backgrounds. Inevitably, many are not prepared for college-level courses. This is a particular problem for many minority students. A professor who teaches introductory biology in a 500-student lecture course developed a computer-based study center to compensate for students' deficiencies. He wrote a set of simple tutorials to test their ability to apply basic concepts in the course to higher-level problems. Since wrong answers represent common misconceptions, students who select those answers see an explanation for the error. The professor reports that students who used the optional program twice a week improved their test scores dramatically—from twenty-three points below the old class average to only one point below a new and higher class average.

This same professor developed several animated tutorials to help students understand such dynamic processes as protein synthesis—processes that were difficult for some students in his heterogeneous class. When students have difficulty understanding a complicated concept in lecture, he encourages them to use the appropriate tutorial until they understand it.

Reconceptualizing the Laboratory. Simulations are being used extensively in the natural sciences to compress time and to allow students to experiment freely. This can change the goal of science courses from mastering facts to developing an understanding of processes. A simulation in astronomy, for instance, allows one professor to illustrate the motions of the stars and planets over a period of time that goes well beyond what students could observe in a semester. One student in this class noted, "It really helps to see what the planets are doing, and the moon in the different phases. Since you'd have to wait all month to see what the moon is doing, it's neat to see it happening right before your eyes."

In chemistry, the computer is having a major impact on the wet lab—a staple of introductory chemistry. The wet lab is not eliminated but rather supplemented in important ways. One professor explained, "The time involved in doing the experiment is so long that you cannot afford to have students fail. The classroom period is just so long. That makes it difficult for students to design experiments themselves." With simulations, he reports, students have time to learn more by designing their own experiments, running them, and re-running them if the original design fails.

Simulations are playing the same role in other natural science courses, such as botany and physics, as well as in such social sciences as psychology and anthropology.

Promoting Inferential Thinking. In both the physical and social sciences, computer tools, such as statistical programs, give students the experience of manipulating large quantities of data and drawing their own inferences. An ecology professor noted that the essence of his course is learning about the interrelationships of many factors—light, temperature, moisture, and environmental gradients—and how these affect the stability of a land mass. Before computer-based statistical programs came along, most lab time was spent collecting and analyzing data; this left little time to interpret the findings. Now, he notes, "The computer allows us to decrease the amount of time that we would spend number crunching, and it gives us that time to use in more profitable ways. We can do more sophisticated kinds of experiments, we can collect more data, we even analyze the data in more sophisticated kinds of ways, and it doesn't take as long."

The Price of New Learning

These early adopters of technology find the computer encourages learning experiences that are difficult or impossible with traditional campus teaching. But at what cost? Early adopters report the benefits of computers require a heavy, ongoing investment of their time: They must find (or develop) the appropriate software; students must be trained to use it; the curriculum must be adapted; and long-established lectures or exercises must be modified. Most important, faculty views of what is important for students to learn (and therefore for faculty to teach) will change. Faculty find themselves less authority figures and more guides helping students become learners, not repositories of the facts and generalizations of others.

Lessons From Early Adopters

Systematic research has not caught up with the computer revolution, but early adopters of com-

puter-based learning provide useful insights about its character and value:

1. Computer-based learning motivates faculty and students alike, creating involved learners.

2. Computer-based learning environments differ from traditional lecture and discussion classes in several ways:

   a. Effective faculty become less purveyors of knowledge than guides to learning.

   b. Tutorials free instructors to help students gain deeper understanding.

   c. Computer simulations and tools elicit divergent, not convergent, responses from students. Students and faculty become fellow learners.

   d. The curriculum may be affected by a need to redefine what students should learn.

3. Computer-based learning is costly in both obvious and hidden ways:

   a. Initial outlays may be $3500 per "station" for hardware, software, and facilities; $1000 per year for maintenance and training.

   b. Effective computer-based learning requires campus training. Faculty and students alike need training in the operation of computers and the use of generic software tools. Faculty also need training in the selection and effective use of educational software.

   c. Computer-based learning requires great investments of faculty time, even when software is bought "off the shelf."

   d. Computer-based learning often requires special classroom environments so all students in a course can use computer-based activities with the instructor present.

4. The rewards for an institution can be great; they include a renewed investment by faculty as they hone their skills as teachers, and motivated, more knowledgeable students who are better able to assume leadership in the coming century.

5. Transformation of the campus requires leadership: from department heads and central administration, to allocate resources equitably, and from individual faculty members, who develop teaching-learning models for their disciplines.

—Jerome Johnston

Further Readings on This Topic

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This **Accent** is based on the research of Jerome Johnston and Robert B. Kozma and the staff of NCRIPTAL's research program on Learning, Teaching, and Technology.

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