Computers in the Classroom: How Information Technology Can Improve Conservation Education

> Ultimately, the qualities of education that we care most about are not technological; they are matters of educational philosophy and practice. . . . [I]n thinking about education, we ought not to be preoccupied with computers at all, and if the transition is successful, we will not be.
>
> Starr (1996)

Introduction

Technological advances over the last 20 years have provided us with tools and techniques that are essential to the way we practice and communicate conservation biology today. Through the innovative use of new technological tools, including information technology, whole new lines of investigation have opened. For example, geographic information systems, in concert with remote-sensing technology, allow us to track habitat and landscape changes across space and time. Tools to analyze DNA in populations of plants and animals have changed the way we manage endangered species. Modern supercomputing tools allow construction of sophisticated models for ecological forecasting or predictions of the influences of global change. And we can communicate new questions, results, proposals, and manuscripts to colleagues down the hall or across oceans in seconds via electronic mail. Clearly, our professional cultures and lives are rich with tools and have been profoundly affected by these technologies. But has this technological revolution transformed our courses and classrooms as well?

Early on, computer technology was viewed as a way to increase students' access to instruction and instructors and to provide economies of scale for traditional modes of instruction. The vision, or at least the hope, was that computer hardware and software would make teaching and learning "better" and more "effective." Has this potential been reached? Especially over the last dozen years, local and federal governments and private organizations have made tremendous investments in bringing computers and technology into the classroom at all levels of the educational enterprise. Yet Cuban (2001) argues that the promise of technology in the classroom has not been reached given the quantity of technological resources placed in classrooms in the United States and that information technology has been oversold and underused. The conclusion about being oversold is rooted in the myth that if access to computers and technology were increased (e.g., an Internet connection in every classroom), faculty would eagerly adopt these technologies to transform instruction and learning.

But what about underuse of the resource? It is not caused by technophobia (Cuban 2001), given the extent to which these technologies are used outside the classroom in the everyday work and lives of faculty. A hasty (and certainly not systematic) perusal of conservation biology course syllabi on the World Wide Web leads me to conclude that information technology is now being used by many faculty and departments for administrative support tasks related to educating students (i.e., listing syllabi, course schedules, assignments, and other information on a Web site for student access outside of class). Such course-management uses are unlikely to help students actually understand and master the scientific concepts we are teaching (National Research Council 2002). Information technology is underused because many of us have not had the time or opportunities for professional development to explore how to utilize technology to better connect our teaching with learning.

The Instructional Environment

> The process of using technology to improve learning is never solely a technical matter, concerned only with the properties of educational hardware and software. Like a text book or any other cultural object, technology resources for education . . . function in a social environment, mediated by learning conversations with peers and teachers.
>
> National Research Council (2000)

Computer-based technologies can be powerful pedagogical tools (in addition to being rich sources of information) and can turn the passive recipient of information into an active participant in the learning (National Research Council 2000). But just as technological tools in our research are of limited value if we have not identified a question before using them (e.g., Feinsinger 2001), they are of little instructional value if we have not clarified our goals for student learning before bringing them into the classroom. In the pedagogy lies the power of the teaching tool (Dede 2000). Effective use of information technology requires faculty to make decisions about the

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goals of the course that relate to the content, what students should know and be able to do at the end of the course, and how the learning environment will be organized to provide students with the best opportunity to meet the course goals. Interestingly, providing opportunities to interact with course material through the use of computers and information technology tends to change the course from a competitive endeavor to one that is more collaborative (Starr 1996), student-centered, and focused on the cognitive development of the student. But lest we run amok in so-called technological fundamentalism (Orr 1994, 1996), we need to ensure that we minimize the extent to which technology might be used by us and our students in ways that limit learning. Using technology poorly can lead to student backlash when we spend more time deciding which animation features of PowerPoint to use to jazz up a presentation than focusing on what we actually have to say, or when we resort to simply delivering more information faster.

Based on my own experiences and those of my colleagues with information technology in the classroom, and some reported in the literature (e.g., National Research Council 2000, 2002), I briefly describe four applications for integrating information technology into conservation biology instruction (though there are many additional applications): lecture delivery, the learning environment and engagement of student participation, creation of learning communities, and assessment of student learning.

Engaging Lectures

It is possible to make a lecture more engaging and entertaining by using the presentation tools available to us with computers and associated software. Computer-enhanced presentation tools allow faculty to incorporate multiple ways of representing information. Complementing Power Point text slides with three-dimensional color graphics, digitally recorded sounds, and full-motion video engages more students and offers the potential to extend students' attention spans.

The Learning Environment and Engagement of Student Participation

Information technologies are especially powerful for integrating representational thinking and problem representation, thus creating new ways to represent data to aid interpretation. The ready availability of Web-based tools to display complex data can be used to develop environmental decision-making problems. Moreover, integrating information technology into instruction can provide students with more experiences in how knowledge is discovered, created, shared, and shaped in their fields (Batson & Bass 1996).

We have always used real-world ecological issues in conservation biology courses. But now it is possible to explore them in ways that make the experience more authentic. Rather than talking about loss of habitat, students can use the tools themselves, tools that require them to think about how to represent the problem. Data sets, maps, and other images are now readily available on the World Wide Web. Students can access these data to delve into conservation case studies (and explore, as part of their assignment, the role of information technology in conservation biology research). "Digital field trips," in the lecture or the lab, enable students in real time to enter into events at a distance and participate in scientific experiments (Starr 1996) and bring students closer to the primary sources of data and knowledge in our fields. Many excellent resources and software programs are available to engage students in the field of conservation biology. For example, *Teaching Issues and Experiments in Ecology (TIEE)* is an internet-based, peer-reviewed, and classroom- and field-tested collection of teaching materials to facilitate inquiry-based experiments in laboratory courses which uses active-learning methods and current controversial issues for lecture classes (www.ecoed.net/tiee). Materials on topics such as anthropogenic changes to nitrogen dynamics and destruction of coral reefs and seagrasses are both scientifically sound and pedagogically innovative, and they integrate new teaching information technologies such as the Internet. Likewise, BioQUEST (www.bioquest.org) provides technological tools (many of which are appropriate for conservation biology and ecology courses) in the form of simulations and databases to construct learning environments that engage students in the activities of practicing scientists.

Learning Communities for Students

I regularly use the Web to host course-related discussion sites. Students can pose questions to me and the teaching assistants, but they also use these sites to interact with one another. They have used the discussion sites to share data, collaborate on assignments, and argue the fine points of take-home exam questions the night before they are due. Experience to date has demonstrated that the ability to interact asynchronously when their schedules allow frees students to reflect on what they have learned in class and to contribute to creative dialog at all hours. Web discussion sites make the reasoning of students more visible to faculty and themselves (National Research Council 2000) and provide opportunities for students to reflect on their understanding relative to that of their peers.

In conjunction with discussion groups, I require students to post data from their laboratory investigations on the course Web site for peer review and discussion and for sharing their data so students can test hypotheses. As an example, a teaching colleague, Paul Spruell, and I wanted our students to learn an important lesson about collaboration and evaluating their data in a context larger than that of their own lab group. Students ran PCR analyses and gels on samples of microsatellite DNA of threatened bull trout. Then, using a handheld digital camera, each lab group took photos of their gels and developed hypotheses about the extent of population segregation in fish from different tributaries. By the end of the day, all photos from all groups and lab sections were posted on the course Web site. As an assignment, students compared their preliminary hypotheses with new analyses based on all the data available from all lab sections. Later, on the course discussion site, an interesting dialog ensued as these introductory biology students debated questions that conservation biologists often are confronted with, such as how much data is enough, how reliable are the data from other people, and, in comparison with a bigger data set, how reliable were the data they had contributed? This type of experience and dialog would have been difficult to create for students without computers and information technology. In structuring learning opportunities for our students, the Web can be both a digital library and a digital laboratory (Starr 1996).

Real-Time Assessment of Student Learning and Understanding

One of the perpetually vexing questions that goes through my mind every time I teach is "I wonder if these students really understand what we have just spent an hour exploring." Especially in large lecture courses, it is difficult to accurately assess the extent to which students have mastered a topic or whether they still have lingering misconceptions. Recently we began experimenting with "personal response systems" (PRS). This tool provides especially helpful information I can use to make decisions about whether or not to move on to a new topic. Knowing that students can have strongly held misconceptions about certain topics (e.g., expression of rare deleterious alleles in small populations versus large ones; interactions of carbon dioxide sources and sinks in the global carbon budget), I project a question or two that requires students to choose between the correct answer and incorrect responses reflecting different misconceptions. Students use a hand-held transmitter to respond to the question and rate their level of confidence in their answer. All answers and confidence levels are instantly compiled, graphed, and then projected onto a screen to stimulate class discussion. At this point, students look at the response data from the class (often the most frequently chosen answer is an incorrect one) and discuss the plausibility of each answer in small groups. Then they use the transmitters to answer the question again. What is interesting and revealing is that during the course of the classroom discussion, the students' confidence levels tend to increase as they debate the answers in their small groups and as misconceptions are addressed during these break-out discussions. After one or two break-out discussions, more than 90% of the students tend to choose the correct answer and with high confidence. The value of technology in this case is that I gain information that helps me pace the course and students have time to discuss and reflect on the material and check their understanding against that of their peers. The instructional challenge of this technology is finding a balance between exposure to content and providing enough time for in-class discussion and student interaction. But what is the point of moving on through the course if foundational material has not been mastered? This application of technology makes us confront that question in real time, when we can still make timely instructional decisions (versus after a midterm exam when both faculty and students may have fewer options for remediation).

Bridging the Information Technology Divide

What will it take to make better use of information technology in science instruction? Faculty members need access to equipment, training, and incentives if they are to more fully embrace these tools (National Research Council 1996). First, if it is not already available on our campuses, we need access to computer hardware and software and Internet connections in our classrooms and offices.

Second, we need opportunities for professional development so we can learn both how to use the tool and how to teach effectively with the tool. Annual meetings of professional societies are ideal for workshops and short courses on integrating information technology into science instruction. Not only can faculty learn new pedagogical strategies for incorporating technology into instruction, they can share ideas related to instructional materials they have developed.

Third, it is risky to move away from a safe (if tired) lecture and to depend on tools that have a tendency to crash at the worst possible moment. We need to collaborate with one another in our teaching, as well as in our research, to judge the success of a new instructional approach and to be able to link the new teaching strategy to student learning and understanding. Working with colleagues, we can treat our teaching as classroom research and isolate the teaching strategies in the moment they are used to focus on their specific effect in the classroom.

Fourth, we need time. Changing teaching takes time: most faculty members realize that more time will be spent on student-centered courses than lecture-based ones. Exploring new technologies and how to use them effectively takes more time than making minor fixes on old lectures from year to year. Moreover, bringing information technology into the classroom is not a one-shot deal but a continuing investment in incorporating evolving technologies. The implication is that we will have to spend more time on our teaching. Choosing the content to cover is the easy part. Figuring out how to use instructional tools to help students understand and master the content in the field is the time-demanding challenge.

Rewarding the Scholarship of Teaching

> At the heart of the current debate, the single concern around which all others pivot, is the issue of faculty time. What's really being called into question is the reward system, and the key issue is this: what activities of the professoriate are most highly prized?
> Boyer (1990)

Many of us would like to incorporate instructional technology more effectively into our courses. Whether or not faculty members are willing to devote their time to these endeavors depends on the reward system—the degree to which teaching and educational scholarship are valued in retention and promotion decisions. Despite what administrators might say, the general system of rewards on campuses values the scholarship of research more than the scholarship of and excellence in teaching (and this is evident at 4-year colleges without graduate programs and "research-rich" institutions). Promotion and tenure decisions are heavily weighted toward the production and quality of research (and the extramural funds generated); consequently, the reward system pushes faculty toward research and away from teaching (Boyer 1990).

Lest we forget, however, the rewards system starts with us: faculty members weigh in early in the evaluation of our peers for tenure and promotion. It is time we start learning how to do a better job of evaluating and rewarding the scholarship of teaching. And in this regard there is an interesting footnote related to instructional technology. According to Batson and Bass (1996), the increased use of the Web may help bridge the gap between traditional scholarship and teaching. They argue that just as information technologies are making the process of knowledge creation more public, they are also making our teaching more public. As we post more of our course materials on the web, our teaching is more public and therefore more open to peer review. Moreover, these new technologies also are providing new venues for publication and professional collaboration (e.g., creating and publishing materials with TIEE, BioQUEST). Batson and Bass (1996) further argue that the uses of these new formats for peer-reviewed dissemination do not fall neatly into the traditional boundaries we have wrapped around teaching and research; fundamentally, they may represent a new "borderland" between the two. Further discussion and exploration must determine how information technology can be used to close the gap between traditionally defined scholarship and the scholarship of teaching in ways that influence the rewards system in the future and thus the extent to which we are willing and able to allocate more time to teaching.

Conclusion

Now, more than ever, we are realizing that instructional technology can have a transforming influence on the way we teach by more effectively supporting collaboration and creation and mastery of knowledge (Dede 2000). This process takes an enormous amount of time. We need more good examples of instructional uses of these technologies and indices of their impact on learning. Strengthening the connection between teaching and learning with information technology means more than simply going from using neatly typed overhead transparencies to PowerPoint slides or having students look for information on the World Wide Web instead of working in the library. Rather, as educators we need to discover for ourselves new ways to use technology to reach our goals in the classroom. This means reorganizing our teaching to focus on student learning opportunities afforded by these rapidly evolving technologies.

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