



Constellations Near

By Charles Kerns

for mining

1. New Technologies in Teaching and Learning

As a learning activity designer, I explore how new technologies are likely to change specific teaching and learning problems and practices. For this article, I shall examine, in detail, one instructional practice: the lecture. It is important to look at the possibilities for change in the lecture because this mode of teaching is still the dominant practice in higher education. I do not mean to suggest that the traditional lecture will disappear, but that new models for oral presentations by instructors are appearing and are following normal innovation-adoption patterns.

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The lecture has already been affected by technology, of course. During the past twenty-five years, the lecture was extended into distributed learning through analog video recordings. Given the opportunity, many students choose to view videos rather than attend lectures, even when doing so involves inconvenient visits to an audio-video center. Once recorded lectures are made available, it is difficult to constrain use only to certain students. Some students register for online courses while living on campus, simply to gain access to the recordings. In addition, faculty want to make lecture recordings available to all students, local or distant, for makeup and review.

Many technologies—including streaming video, widespread high-bandwidth networks, recording whiteboards and rooms, automated indexing of audio and video, IP-based videoconferencing, and new types of computer-supported collaborative learning (CSCL) tools—can affect how lectures will be “given.” With tools to digitize, index, summarize, link, and annotate video, we can create and distribute streaming-video recordings of lectures, including the slides and whiteboards that were presented. Handouts, alternative illustrations, animations, references, problem sets, and assessments can be indexed and tied to points in the audio-video recording. These clusters of resources and activities can be used as independent modules or learning objects, in some cases replacing the event of the lecture. Indexed recordings allow students to access specific moments in the lecture. Once the lecture recording has nonlinear access, students will move from sequential viewing (as must be done in the face-to-face lecture) to a combination of sequential (with and without pausing) and search-and-review viewings.

Another change is that online, lecture-based learning objects will be used with communication tools for discussion and annotation. New systems allow moments in the video to be annotated with students’ questions, novice and expert explanations, drawings, and other representations of the content. Excerpts from lectures can be pasted into students’ Web page projects and papers to elaborate on

the original content. The students’ works can then be linked back to the original learning object. Eventually, the recorded lecture can lose its centrality in the learning object. The lecture thus evolves from a single event to a mediated, “chunked” learning object to a dynamic set of resources. It evolves from a performance to an annotated recording of the performance to a new type of dynamic text.

Because of these possibilities, it is difficult to predict exactly how learning objects that contain lectures will be used by students. We do know that students do not like most lectures—students often feel isolated, distant, and passive in the large lecture halls. They have trouble dealing with the continuous flow of information. With online lecture modules, students are able to decide when to “go” to a lecture, with whom to go, where to see it, and what to do while viewing it. With shared, network access, lectures can become distributed, informal group events (as homework has become for high school students with telephones and chat rooms). In both local and distributed informal study groups, students will dissect, review, and question the information in the lecture. Research has shown that for learning, facilitated group viewings of recorded lectures, both co-located and distributed, have been as effective as or more effective than simply attending lectures.¹

Faculty, administrators, and academic technologists should support collaborative viewing. Planners and designers should be aware that students’ study of lecture learning objects will lead to new types of behaviors determined by temporal constraints, learning styles, social supports, and other variables. Faculty need to monitor these new practices to identify those that are effective in helping students gain deep understanding. Academic computing groups should provide logistical and technical support for interaction, not simply distribute digital video recordings, in order to encourage the evolving collaborative learning practices.

The face-to-face lecture event, in which people physically meet, is an impetus to informal interactions: asking questions of instructors and friends in the hallway before class, carrying out dis-

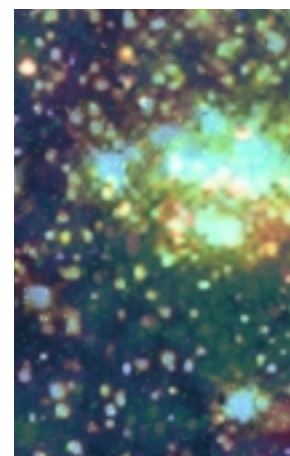
cussions with other students, and developing trust and supportive friendships that start with the camaraderie resulting from facing common challenges. If students study from lecture-based learning objects, they will still need these informal interactions. CSCL tools that support casual discussion, trust building, and awareness are currently being researched. Collaborative activities will likely become part of the lecture-viewing practice. Buddy lists and other methods of maintaining awareness in informal groups have already become popular on some campuses and in some distributed learning environments.

As in most mediated learning interactions, the instructor will lose some level of control over students’ behavior when lecture-based learning objects are used. Attending face-to-face lectures several times weekly provides external discipline for the student. When students can schedule their viewing and discussions of an online lecture, they will need more support in planning their time—and in developing meta-learning skills.

Finally, what happens to faculty as the lecture changes from being an event to being part of a learning object? Many faculty like to give lectures. Others are driven by the economic necessities of large classes. Many feel that the presentation of a long, sustained, oral argument is an important form of academic discourse. Lectures often form the skeletons of future books. In any case, faculty have become experts in organizing and preparing the content of lectures. They have gone through an apprenticeship in lecturing. They create lectures with little outside assistance. They consider the lecture their own independent activity. When lectures are part of a complex, online learning object, instructors must rely on technicians, producers, and, often, instructional designers, programmers, and other support staff. Learning objects that include lectures can force the faculty into new relationships. Some faculty may create lectures as they always did and leave the production to others; some may become producers; some may act only as content consultants in production groups.

How will faculty integrate learning objects into their teaching? Rather than providing basic coverage of facts (which

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learning objects can provide), will lecture periods consist of more complex discussions and arguments? Will they be periods of remediation based on monitoring student interactions with learning objects? Will more guest lectures delivered over IP-based videoconferencing offer different viewpoints? Will there be fewer, but intellectually more stimulating, lectures? Or will faculty simply be assigned more students per course?

Other instructional practices—seminars, laboratories, tutorials, problem-based instruction, peer tutoring—can be analyzed similarly to the lecture. These analyses need to look for constellations of interlocking, mutually supportive technologies that affect practice by providing rich interactions, access, effective learning, and efficiency.

2. Return on Investment

Faculty must adopt the new technologies in order for their teaching to remain relevant to current activities in research, government, the arts, and business. Faculty must integrate digital tools—digital libraries, symbolic manipulation programs, design tools, and new communication systems—into teaching. These are the tools of researchers, scientists, writers, engineers, businesspeople, and doctors—those whom the faculty prepare in academia. The return on investment to academia is participation and, hopefully, leadership in the new complex of learning institutions being formed in industry and the for-profit education sector.

These digital tools are built for ex-

perts. They are complex and assume the user has domain knowledge. They provide little structure for learners. An integrated framework for the special needs of students must be constructed around these tools. Higher education cannot rely solely on research and business to provide this type of environment but must take the lead in developing and evaluating integrated learning environments.

In some cases, colleges and universities have started this transition, very gradually, by replacing the paper syllabus, reading list, and handouts with Web-based course-support tools. But faculty must understand that the technology they now have available is a preliminary framework that will be expanded. Projects such as the Open Knowledge Initiative (<http://mit.edu/oki/>) are creating an extensible, modular framework to facilitate tool integration.

As we develop online environments, we must attend to current research in learning. Educational researchers have found that the simple transmission of information does not lead to deep understanding. Active engagement by learners is crucial for them to construct knowledge that can be applied and transferred, not just recited. These research findings must be incorporated into the development and design of course-support systems.

3. Mobility and Wireless

The adoption of wireless devices can be discussed from several points of view: the nomadic student, the mobile user, and the facilities designer.

The Nomadic Student

Students are like independent consultants who have three or four very demanding clients but no office.² Because students need continuous access to information and want to communicate with other roaming students as they move from location to location, they would likely benefit the most from wireless devices. After all, faculty and staff have offices.

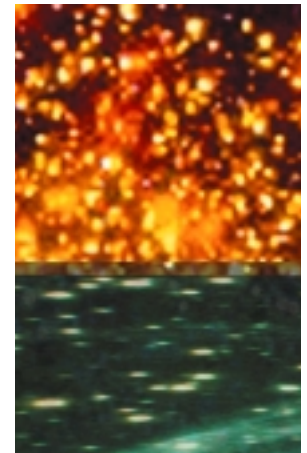
It was argued several years ago that students would adopt laptops for similar reasons. But because there was no connectivity in most facilities, students generally went to networked computer labs or used their own desktop computers. There they checked e-mail, looked up information, and did assignments. They did not carry laptops.

Once students can connect from any location, I expect different behaviors. Wireless connectivity supported by easy-to-use authentication protocols should bring about a revolution on campuses. This could be the “small device revolution,” rather than the expected “laptop revolution,” because many students will have moved directly to smaller devices.

The Mobile User

I have a wireless laptop and also a dependency problem. I always take my laptop computer with me. I type during meetings even if it bothers others. I look up facts on the fly when I am having discussions. My calendar is always available. In fact, I no longer need an office. My office has become a storage area for my

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favorite chair and other items. I want wireless connectivity everywhere.

The Facilities Designer

Facilities must allow students, especially those working in groups (both face-to-face and distributed), to interact with each other and with their computing devices. Individual students will browse information, send messages to others, and take notes on small devices. Even though the furniture is not designed for this type of use, students make adjustments. They lie on the floor. They curl up in corners. They find ways to work. Designers can observe students' behavior and make changes that will support individuals using wireless devices.

Missing, however, is the basic infrastructure for group activities in which students communicate with interconnected devices. New protocols must allow users to easily share documents across devices, display multiple individuals' windows on public screens in meeting rooms, transfer and annotate each other's information, and print and scan anywhere. At present, the nuts and bolts for group activities are not in place. This situation could frustrate students, leading to a retreat back to current systems.

In large-group, seminar, and project activities, social protocols are followed for attending the activity, taking turns, and conducting side discussions. Wireless devices are a disruptive technology. When I work on my laptop at a meeting, my action is usually interpreted as my not paying attention to the central activity. If I establish online side conversations or critiques of the dominant activity, the meeting starts

to fall apart. In the creation of the technical infrastructure, social protocols for the utilization of continuously connected devices will evolve. When is it OK to use the devices? All of the time? Facilities designers and planners need to be aware of changes in common courtesies and practices and need to provide for them.

4. The "Information Grid"

The information grid is now (and should be) an interaction grid. Yet commercial information businesses want a constrained, controlled distribution channel. Information providers are creating sticky portals, trying to hold the user in a tightly constrained information world. Much of the previous electromagnetic infrastructure—the radios and televisions—became a distribution system. Early in the last century, Berthold Brecht pointed out that every receiver could be a transmitter. We now have the similar situation with the general-purpose computer. Whereas the economies of constrained bandwidth and analog systems made it difficult to realize Brecht's idea with the radio, the promise of cyberspace is to support complex interactions in which all users have voice and access. Commercial constraints can work against this promise.

Academia, on the other hand, works for open exchange. Academia has a special role in cyberspace as the champion of learning and knowledge-building. Although knowledge industries will work with higher education in some of these efforts, these enterprises have proprietary constraints and obligations that disallow many interactions. Academia must champion fair use, access, and the contin-

ued development of an environment of interaction, discourse, critique, and deep learning, not just an environment for one-way distribution of information, for commercial or political purposes. Academia has led the way in developing pedagogical methods (inquiry-based learning, collaborative knowledge-building, problem-based learning) and online learning interaction tools (in systems such as CoVis <<http://www.covis.nwu.edu/>> and CSILE <<http://csile.oise.utoronto.ca/>>).

5. Leveraging Technology for Teaching

My first advice for leveraging technology for teaching is to focus on coordinating the planning of computing environments, both the technical and the organizational/human support infrastructure. Planning must be coordinated among the users (faculty and students) and the different groups that carry out support functions on campus. There are many required functions that must be executed to have successful technology deployment leading to better teaching and learning. Unfortunately, if only one function is absent, then technology programs often fail. Also, if one function is developed without coordination with others, then it is often wasted—it cannot grow or be fully used. Critical functions in pervasive computing environments include faculty development, TA training, server support, networking, help desks, courseware development, digital libraries, software evaluation, acquisition and dissemination, computer lab maintenance, support for networked classrooms with

projectors, and personal storage and backup systems. Planning must include all of these areas.

On most campuses, these functions are carried out in different administrative units: the registrar, housing, networking, centers for teaching and learning, libraries, bookstores, academic departments, academic computing centers, IT centers, AV support, and others. Often, the current organizational structure is the result of ad hoc solutions to last decade's problems. The need for local decision-making in planning and managing microcomputer use led to multiple computing groups. It is difficult for these groups to create common Web environments, to coordinate planning, and to develop critical, shared services for enhanced computing environments. A central authority, often the President's Office, must lead the coordination of planning when a major enhancement is undertaken.

My second advice for leveraging technology when planning new computing environments is to listen not only to early

adopters but also to the average faculty member. Listen to those who realize that enhancing the computing environment is needed but who do not know where to start. They are often scared by the time, effort, and knowledge that the early adopters needed to create innovations such as hand-built, online courses or personal digital libraries. Strategic planners must take into account the time that faculty really have available to participate in making use of the new computing environments. They should look well beyond those with whom they can easily talk about computers.

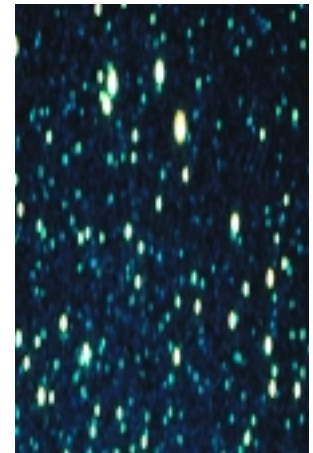
Finally, planning and implementing pervasive computing environments should not be a top-down project carried out by technologists. It must be a negotiation among the computing and networking experts, human interface designers, pedagogy experts, faculty, administration, and students. Faculty know their content area, they know what problems students have in their disciplines, and they know their time constraints. Students know how they like to learn, where

and when they will study and do projects, and what programs and activities interest them. Administrators know what resources are available. Technical experts know what possibilities exist for new types of interactions. It is only when these groups exchange ideas that the new environments can be fully realized.

6. The Digital Divide

I would like to start by examining some implications of the "digital divide" concept. This idea elevates digital access to preeminence in a complex web of inequities. It replaces divisions based on education or health care or hunger with a division based on access to digital resources. One reason for this emphasis is that the Web was viewed as a panacea, as a solution to the inequities. On the Web, it has been argued, all can have a voice, all can learn, all can sell their services in an open market, and in a consumer economy, all can find the best price for anything. But a second look after the dot-com bubble burst makes us reconsider this premise. In the euphoria, many forgot

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that unencumbered digital access can happen only with motivated, educated, knowledgeable people. The Web cannot offer salvation to those who are not prepared to use it. We cannot isolate the digital dimension from the causal factors in a network of differences. They are interlinked and interdependent. Causal factors must be addressed to effect change. The Web alone will not help the mass of the disenfranchised, isolated, or poor.

Furthermore, the term *digital divide* simplifies the issues of access into an issue of things—products that store, move, or manipulate bits. For many, this focus points toward a solution based on cheaper boxes and cheaper networks. Since Moore's law implies that things can get cheaper, the solution must be some hardware just around the corner. Many equity solutions thus focus on the product: networked schools, recycled computers, even computers for schools in exchange for purchases in grocery stores. But those of us who have acted as change agents supporting technology transfer know that "digital success" requires more than equipment: it requires training, knowledge about possibilities, an attitude of exploration, support services when systems fail, reading and writing skills, and time for learning and discovery. In academia, we have seen that time is a critical adoption factor for instructors, even those who understand that learning to use their computers will help them in the long run. They are busy; they don't have the time. The low-paid worker needing two jobs to earn enough money has even less time.

What if we limit the problem to schools? We still see the same issue. Teachers need knowledge and skills. Helping teachers acquire this knowledge and these skills and providing teachers with the time to change their teaching cost much more than providing product. Teachers need to learn to teach with computers. Working in K–12 schools, I found that teachers often locked their computers in the closet or simply gave time on the computers to students as rewards for good work. They did not teach with computers. Teachers found it difficult to integrate computers into their ongoing classroom activities. Computer labs and prepackaged software did not solve the problem because these often transformed an inviting, creative tool into a drill-and-practice exercise in typing or some other repetitive skill. Teachers need time to learn how to integrate computer activities into their lesson plans, to learn new ways to teach, and to learn how to use the technical skills of their students. Teachers in overcrowded schools—with too many students, with little release time, with students who have language problems and learning disabilities—have little time to acquire these teaching skills. They need special programs, such as those developed in the Apple Classrooms of Tomorrow projects (<http://www.apple.com/education/k12/leadership/acot/library.html>).

In addition, administrators are only beginning to understand the fiscal implications of computers. Before computers, capital equipment meant buildings and desks, which lasted for fifty-plus years.

Textbooks lasted ten years or more, and classroom maintenance meant spending twenty-five dollars per year on chalk and erasers. Administrators now have capital equipment that needs to be replaced every three to five years and that requires continuous maintenance and faculty training. Wealthy schools can raise the money; poorer school districts cannot.

I have not talked yet about students. They are the best equipped to handle change. But they need to learn new skills within a larger context than peer culture. They need high-quality, well-prepared teachers, good facilities, and, yes, digital access in order for them to move to valued uses of technology.

We must address the need for digital access, but it is part of a complex web of inequities resulting from unequal school funding, teacher workload and pay issues, and training and support problems. We cannot look to the Web for a quick fix. The digital divide is only an indicator of societal inequalities—and not a primary indicator, at that. *e*

Notes

1. See J. F. Gibbons, W. R. Kincheloe, and K. S. Down, "Tutored Videotape Instruction: A New Use of Electronics Media in Education," *Science* (1977), 1139–46, and John Dutra, James F. Gibbons, Robert L. Pannoni, Michael J. Sipusic, Randall B. Smith, and William R. Sutherland, "Virtual Collaborative Learning: A Comparison between Face-to-Face Tutored Video Instruction (TVI) and Distributed Tutored Video Instruction (DTV), Sun Microsystems Research, technical report TR-99-72, January 1999, <http://research.sun.com/technical-reports/1999/smlr_tr-99-72.pdf> (accessed February 21, 2002).
2. Professor Larry Leifer made this observation in his analyses of student needs at Stanford's Learning Lab.