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The Future of Technology and Learning in the University

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Abstract: The future of technology on the university campus has reached a critical juncture. In this paper we propose eight areas in which substantial changes in university education may be at hand: Students, Instructional Design and Pedagogic Techniques, Teachers and the Institutional Setting, New Forms of Content and Exchange, Intellectual Property, Infrastructure, Power and Data, Support, and Security & Backup. It is our determination that *leadership* must play a critical role in the equation, not only to implement technological developments but also to plan adequately for long-term changes. We conclude with eight hypotheses about technology and learning in the University intended to be provocative and to stimulate discussion and analysis.

Introduction

The potential consequences of rapidly evolving technologies of information and communication are finding their way into an increasing number of conversations and decisions in higher education. As the state-of-the-art in education-relevant technology moves well beyond PowerPoint presentations and web-based syllabi, issues involving everything from the development of new buildings to the recruitment of faculty and staff increasingly confront matters of technological change.

We would like to offer here a few observations to stimulate thinking and discussion about how learning may evolve in coming years under the influence of rapidly changing technology. We aim to raise possibilities, some of which may materialize and some not, in order to encourage thoughtful deliberation about change. We believe that technological change poses questions of a deeper nature than simply what technology works best in what classroom situations. The new means of communication and teaching open for evaluation some of the basic assumptions in education regarding the purpose of the classroom and the basic roles of teachers.

We do not claim a crystal ball permitting us to predict the future with great precision; nor do we attempt to anticipate specific technological products likely to be available beyond the very short term. Our expertise comes from several disciplines.

We pose the following question:

What will be the technological context of university teaching and learning fifteen to twenty-five years from now?

As a way of placing this question in historical perspective, recall that ten years ago the commercial World Wide Web did not exist, and twenty years ago personal computers were a rarity. While it is impossible to know what new technologies will emerge in the next decades, it is reasonable to assume that geometric rather than linear technological growth will produce changes greater in magnitude than developments since the introduction of the personal computer and commercialization of the Internet.

We divide our question into eight areas: Students; Instructional Design and Pedagogic Techniques; Teachers and the

Institutional Setting; New Forms of Content and Exchange; Intellectual Property; Infrastructure; Support; and Security and Backup. Following a discussion of these possibilities is a summary in the form of several speculative hypotheses. (We do not consider here matters of curricular content, leaving for another venue discussion of what knowledge and skills would constitute a high-quality university education in the next few decades.)

Area 1: Students

For centuries, being a university student has meant carrying writing instruments to class for the purpose of transcribing words spoken or written by a teacher. This basic model may change in the next fifteen to twenty-five years, as many students carry powerful handheld or laptop electronic devices in addition to or instead of paper notebooks and pens or pencils. These devices may combine audio-visual recording and display with telephony and the typical functions of today's computers, such as word processing. Students will use these devices to capture elements of the classroom experience as well as for other purposes. Instead of transcription by hand, many students may capture the basic content of a lecture electronically, while annotating and modifying notes using their electronic tools as they listen.

Outside of class, students will have access to powerful file-searching and exchange capacities that vastly surpass present term-paper mills selling documents online. Resources available to students may include notes and video of lectures from past courses as well as from other universities, as well as homework assignments, term papers, and exams – all addressable by sophisticated searching techniques. These will likely exist and be exchanged outside the control of universities themselves.

Area 2: Instructional Design and Pedagogic Techniques

The fundamental classroom design has been unchanged for time immemorial: students sit in rows, teachers stand at the front, and a surface upon which the instructor writes is located at the front of the room. Two superficial modifications to this design have been added in recent decades; blackboards have been replaced in many cases with whiteboards, and simple light-projecting display devices have been added. These display devices are either permanently installed in selected classrooms, as in the case of television monitors or projection booths and screens, or they have been purchased in portable form by a central depot, and then delivered to and removed from specific classrooms on an as-needed basis. This has meant that most professors in most classes teach in roughly similar ways in a technological sense.

In the next fifteen to twenty-five years, changes in this model will occur. A substantial number of faculty will use in their classrooms electronic successors to white- or black-boards. These will surpass greatly in sophistication and flexibility current technologies such as PowerPoint, let alone overhead projectors. These technologies will permit real-time, in-class writing and drawing by instructors so that what is written on the "blackboard" appears directly on students' electronic notebooks.

As many new forms of instructional technology become available, greater heterogeneity in teaching methods and styles will emerge. Some faculty will use one highly sophisticated technology, some will use another, and some faculty will use none at all, preferring the old blackboard or overhead. In our view, variation in use of new technologies – including their avoidance altogether by some faculty – is healthy. The best possible educational world is one in which faculty have a wide and varied suite of teaching methods and technologies available to them and are therefore able to use their own judgment in an environment rich in choices. The aim of the university should be to provide the widest possible set of teaching options and infrastructure to faculty who are then able to choose techniques they believe best suited to their courses.

Therefore, classrooms of the future will face new physical infrastructure needs and expanded demands on central instructional support services. Physical infrastructure needs may include:

- moveable furniture and seating,
- multiple display technologies in the room,
- adaptable surfaces for writing/display/recording (currently-available electronic white-boards provide one rudimentary prototype for these new technologies), as well as
- data and power available ubiquitously throughout the room.

Demands on central instructional support services will include:

- the expertise and funding to acquire new technology far more aggressively that at present,
- the ability to distribute and re-configure advanced classroom services in ten-minute passing periods between classes, and
- substantial support and repair staff.

Consider that in many institutions, presently most large classrooms feature only overhead projectors as part of the basic room technology; instructors desiring a computer and data projection, video, or even a wireless microphone, must make special arrangements in advance. An instructor preparing lecture notes in the morning for an afternoon class may be prevented from making a change in medium because of the lack of technological and administrative flexibility.

This kind of system will be severely burdened in a future in which hundreds of faculty employ different technologies from week to week in their classrooms. Fifteen to twenty-five years from now, the basic package of room services will have to be vastly more sophisticated, less dependent upon advance reservations, and more capable of quick changes from one class to the next.

Area 3: Teachers and the Institutional Setting

As an increasing number of faculty in different disciplines begin using information technology for instruction, it is likely that the nature of both the faculty job and the "course" will change (and vary) in ways that are not well supported by the current institutional structure. Currently, a large public research university functions on an institutional model by which a lone instructor teaches a course to students and may be aided by teaching assistants. However, "best practices" are likely to emerge according such alternative paradigms as the following: (1) A well-developed and well-taught course using IT may require a team of instructors from different disciplines (e.g., engineering, art). (2) A well-developed course using IT may require substantial development time in advance of the actual presentation of the course by a collaborative team of instructors and research assistants.

To allow for the growth of such alternative best practices, the institution of the university will need to change in a number of possible ways. For example, there will need to be a robust and financially supportable model of team teaching, of adequately compensating instructors for course development work (e.g., through course relief or stipends), and of more flexible use of TA and RA funds.

Area 4: New Forms of Content and Exchange

At the outset of the 21st Century, a divide exists between the recording and “processing” of words and the recording and processing of visual and audio information. The latter are now almost exclusively the domain of professional firms and organizations, while the former are the province both of individuals and professionals. In other words, nearly everyone now records, modifies, and communicates the written word, while comparatively few people record, modify, or communicate visual and auditory information.

In the next fifteen to twenty-five years, this division of labor will change. Visual and audio information of all kinds will be recorded and distributed in a wide variety of settings and contexts by individuals as well as organizations and professionals. This transmission of audio and visual information may approach in ubiquity the current recording and distribution of written information, and the monopoly now held by businesses and professionals over it will decay. This will be true in universities, as students increasingly record and capture information in ways other than note-taking and writing.

One implication is that what is now labeled “video-conferencing” and consigned for technological reasons to special facilities may occur in many places – wherever, perhaps, access to “the Internet” exists. This may mean that most classrooms and faculty offices will need to take on some of the features of today’s video-conference facilities, with multiple cameras to capture speaker and audience, microphone systems capable of capturing all participants’ voices, and sophisticated lighting, as well as digital signal processing equipment and production controls.

In the future, designated video facilities will themselves become substantially more sophisticated –approaching in capability today’s professional television production studios in demands for lighting, room audio recording, multiple video cameras, editing, and data processing.

Area 5: Intellectual Property

Currently, there is widespread and demoralizing confusion among instructors and students about the nature of "fair use" and other intellectual property or ownership issues in an academic setting. Based on present experience, this confusion is so pervasive that it has one of two equally adverse consequences: it inhibits experimentation and development of course materials or student projects; or it encourages a "don't ask, don't tell" *de facto* policy of copyright transgression. Given the likelihood that the exact application of the Digital Millennium Copyright act for the academy will take a decade or more to sort out in the courts, and given as well the possibility of future amendments to the act, there will be a need in the university for a proactive group (of faculty and administrators) charged with clarifying, interpreting, and adjudicating intellectual property issues.

Area 6: Infrastructure: Power and Data

At the most fundamental and mundane level, technological change implies the need for universal delivery across campus and throughout buildings of two services: power and data-connectivity. Every student and every faculty member in every classroom and every office may well need power and data connectivity, regardless of the specific technological devices in use. In today's terms, this means that it will no longer be sufficient for the university simply to deliver one Internet port and IP address to each room on campus, along with a few power outlets located along the walls.

Current computing services in most organizations are organized in ways that are highly location-dependent and extremely difficult to reconfigure as technology changes. For instance, most buildings feature limited-diameter conduit providing one fixed-location data port in each office. Simply moving the location of that port from one wall to another or to a conference table -- let lone replacing metal wire with optical cable -- is a difficult and expensive task. Future needs will include far more ubiquitous delivery of IT infrastructure but also means for easily making changes at lower cost. Examples might include providing large-diameter empty conduit throughout every room (at least in new buildings), and providing support for wireless distribution of at least some services.

The central challenge in this regard will be to avoid attempting to guess what specific infrastructure might be needed in the future and instead seeking ways to design a general infrastructure than can be changed and adapted as needed at the lowest possible cost. That is, when designing a new building, rather than guessing what specification fiber optic cable will be in use ten years from now, one should create infrastructure that permits any cable to be readily installed and then replaced as needed.

> *An Uncertainty:* If wireless communication continues at its present rate of bandwidth-growth for a substantial period of time, many of the data connectivity needs will be met wirelessly. From the perspective of planning and architecture, this is the most hopeful future. If wireless communication technology does not keep pace with expanding bandwidth needs – especially as video communication becomes more common – it may be necessary to provide a means for supplying ever-changing physical cables throughout classrooms and offices.
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> *Another Uncertainty:* If battery technology improves sufficiently so that laptop computers and handheld electronic devices can operate for an entire day of classes or meetings without recharge, then requirements for the distribution of AC power will be modest. If battery technology does not so improve, then it is conceivable that every seat in every classroom and meeting room will one day need AC power.

Area 7: Support

Technological change will require vastly increased demand for an area that in almost every organization lags behind attention to hardware and software: support services. The increasing sophistication of technology combined with increased reliance on technology may mean that in the area of IT support, staff-to-faculty and staff-to-student ratios will have to increase substantially. IT support staff may in many instances have to train faculty in use of IT-assisted classrooms.

"Facilities" and "IT" are likely to become increasingly intertwined in practice, and so structural changes in administrative practices may be necessary. The current division of labor within IT services may also have to be re-designed. The categories we now use will likely have to evolve in new directions. These new directions will require new kinds of

balance between centralized and decentralized support. Also, the scope of IT support will likely have to expand substantially to include such areas as: handheld-electronics support, classroom production services, wireless networking support, database programming and support, etc. As the level of interconnectivity increases – assume that virtually every electronic device anywhere is "on the Internet" – these various support specialties will have to interact more with one another and be better prepared to provide coordinated response.

Another, related challenge will involve how the diminishing place-dependence of technology blurs some of the lines between "personal equipment" and "campus equipment" and will generally make *place* far less relevant to the capacity to communicate and work.

In many ways, university practices and policies at present assume clear distinctions between technology owned by the university and technology owned by the employee, and between work conducted on campus and activities conducted elsewhere. Site-licenses, support, and even access to library-controlled databases often assumes that technology located on the physical grounds of the campus is university-related or owned, and that located elsewhere is not. The fact that a traveling faculty member may not have access to the full suite of university library resources through the Internet is the most compelling example of this place-dependence built into current policies. Especially as faculty carry increasingly powerful electronic tools with them at home and while traveling, and as these tools (think very sophisticated Palm Pilot/cell phone/video phone/laptop combination) are used for both personal and work-related purposes, new kinds of licensing and support models will be necessary.

Area 8: Security and Backup

Given the increasing complexity and variety of information technology used on campus, the increasing demands made upon such technology for instruction in particular (e.g., middleware and database-driven Web sites that allow instructors and students to edit course sites through the Internet; wireless connections, etc.), and the increasing sophistication and variety of viruses, spam, and other transgressive uses of information technology, it is likely that there will be non-trivial issues of security that the university will need to address to support instruction. For example, instructors will want the security of knowing that only they can use the Web forms that edit their course; instructors will also want to be able to manage who can see what student paper or test result on a site; and students will want confidentiality in some circumstances. This requires not a centralized, lock-down system of security but instead a granular, often locally-adaptable model of security. In addition, the use of online IT for courses increasingly makes instructions a 24/7 event, with the result that any downtime will be problematic. A robust backup plan for instructional resources will thus complement the security that instructors and students need to feel to be comfortable working in an IT environment.

Leadership

As futuristic as many of these possibilities may seem from the present perspective, most have already been implemented at various universities. Many are available through now Internet2 capacities and applications. For the most part, these concepts have been proven feasible technologically, if not pedagogically.

We would stress that the merit of this technological present and future is largely unknown. We expect that a good deal will be learned in the next fifteen to twenty-five years about which kinds of teaching and learning are enhanced by use of various new technologies, which are unaffected, and which might be harmed. The point is that these technologies have begun arriving, and it will be increasingly important to a university's competitiveness and reputation to position itself on the leading edge of developing and learning about information technology and education.

We conclude by summarizing the various possibilities described above in eight hypotheses about technology and learning intended to be provocative and to stimulate discussion and analysis.

Speculative Hypotheses About the Future of Technology at the University

A) Power and data-connectivity are required everywhere on campus where there is a human being; when students sit down in a classroom, they must plug into "the Internet."

B) Students are just as likely to videotape a lecture or capture it digitally by other electronic means as to write down the professor's words with a pen or pencil.

C) Homework, term paper assignments, and lecture notes enter the world of "Napster" and its successors, so that students can type into a sophisticated search engine the text of their assignment and have returned to them a list of relevant papers available for free or at a nominal cost from around the world.

D) Every room on campus is a "video-conference" room.

E) "Extension" or "distance learning" are no longer segregated administratively and physically from regular instruction but instead occur in many regular courses offered on campus.

F) Every time a conference table is moved from one side of a room to another, data and power must be moved to follow it; every five years, cabling between computers must be removed and replaced all across campus.

G) It is routine for two professors using a classroom in adjacent time periods to require entirely different classroom technology on short notice.

H) Faculty require three times more "computer support" than now.