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HIGHER EDUCATION IN THE DIGITAL AGE: A U.S. PERSPECTIVE ON WHY ACCURATE PREDICTIONS MAY BE DIFFICULT

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ABSTRACT
This paper analyzes some of the ways in which Information and Communication Technologies (ICTs) are being employed as possible solutions to the triad of pressures facing US research universities: (a) holding down costs, (b) providing access to an increasingly diverse demographic, and (c) maintaining quality. It presents the preliminary results of a large research project investigating the economic and pedagogical impacts of technology enhancements in a large lecture course at the University of California, Berkeley. Findings from this study, as well as a review of activities taking place through out the US, show that student expectations and backgrounds, the pace of technological change, financing ICTs, demands of public stakeholders, and the emergence of new competitive markets are among the multiple pressures that US research universities must face as they plan for the future.

INTRODUCTION

Rhetoric suggests that Information and Communication Technologies (ICTs) will be an important solution to the triad of pressures facing colleges and universities: (a) holding down costs, (b) providing access to an increasingly diverse demographic, and (c) maintaining quality. It is in this environment that university leaders are faced with making decisions about internal and external on-line learning markets, but with no clear models to reference. Not only are answers to questions of educational efficacy, revenue streams, and nature of potential markets elusive, but the creation of high quality on-line offerings is expensive, and requires huge capital investments.

Any academic can verify that ICTs have provided powerful new tools to forge global research networks in higher education and industry. These same tools, combined with the international hunger for technical and professional education, provide opportunities for traditional and nontraditional higher education providers throughout the world to provide anytime, anywhere education across international boundaries, and possibly make money doing it. It is in this hyper-charged atmosphere of competition that university leaders are being asked to consider whether their own institutions will remain the sole or even primary producers and providers of specialized knowledge. Who among us has not heard the pundits that have suggested that ICTs represent thenext high growth internet industry and provide a possible breach of the former monopoly held by traditional higher education providers (Drucker, 2000; Moe & Blodgett 2000)?

HOW MANY US SCENARIOS CAN WE ENVISION FOR 2005?

Collis and Moonen (2001) have provided four thoughtful scenarios for predicting strategic pathways that higher education institutions might choose with respect to their use of ICTs in developing international strategies. Our work at the Higher Education in the Digital Age Project[1] at UC Berkeley suggests that predictions about the future consequences of ICTs for higher education are complicated by both the diversity and rapidly changing character of institutions, student populations, and the technologies themselves. Such diversity and speed of change suggests that predicting the emergence of one, or even a few, US or regional “scenarios” for flexible learning may be impossible.

For example, the US system of higher education is most accurately described as diversified. The range of institutions includes public and private research university systems, private liberal arts colleges, trade schools, community colleges, “corporate” universities, proprietary schools such as the University of Phoenix and DeVry, as well as other types. Each of these types has specific missions and student bodies. Diversity is enhanced by the fact that we have no federal ministry of education, and higher education is regulated by the states (Eaton, 2001). Further complicating such predictive exercises is the fact that there can be an immense amount of diversity of functions and student bodies within single institutions. This may be particularly true of the public research universities, or multiversities (Kerr, 2001) whose missions include undergraduate and graduate education, high quality research, and public outreach and service. It is these systems, particularly the University of California ten-campus system, that will be the focus of this paper.

Trow (1997) points out that the University of California system (and other public research university systems) encompasses elite, mass, and universal forms of education within each campus: elite forms are predominantly represented by the graduate student experience, mass forms by the traditional early undergraduate experience, and universal forms are provided by UC Extension, our continuing education/adult learning arm. The range of applications of ICTs to the teaching and learning enterprise at these institutions reflects their multiple missions and audiences. For example, our extension divisions, long in the business of adult continuing and distance education, have been active in developing programs for on-line, off-site learners, including international audiences.[2] Our professional schools of business, engineering, and law are actively involved in professional education activities for adult learners, and many are or will be developing international on-line programs for professionals overseas. Technology enhancements to traditional courses for residential undergraduate students take many forms. They run the gamut from simple course home pages, to sophisticated on-line interactive text-books, to streaming indexed lectures. Most of these enhancements to traditional courses have been fueled by individual faculty effort and enthusiasm – not by centralized strategic planning pathways that envision scaling on-site enhancements for new markets of off-site students. The “cottage industry” nature of these on-site activities are therefore somewhat idiosyncratic as to their representation by discipline and their explicit pedagogical goals.

The possibility of coordinating and integrating these oft-times parallel activities into a more cohesive strategic endeavor is becoming more urgent for public research universities as they are faced with new pressures from within and without, and are being asked to do much more with less. For example, in the United States, public and private colleges and universities nationwide expect to enroll more than two million new full-time students by 2010, a phenomenon referred to as Tidal Wave II (CPEC, 2000). The University of California (UC) ten-campus system faces an increased enrollment of almost 63,000 full-time students – a 43 percent increase. The University of California, Berkeley (UC Berkeley) campus is being

[1] Many of the ideas in this paper are the result of my on-going discussions with colleagues in the Higher Education in the Digital Age Project at the Center for Studies in Higher Education. Our work is partially supported by the William and Flora Hewlett Foundation and the A.W. Mellon Foundation. For a description of our program and associate scholars see http://ishi.lib.berkeley.edu:80/cshe/projects/university/
[2] See for example UC Berkeley Extension’s on-line course offerings at http://learn.berkeley.edu/

asked to explore how to absorb an additional 4,000 students by 2010. This represents an annual growth rate of 1.1 percent over the next ten years (UC News and Communications, 2000). Possible solutions for handling this increased student body include offering classes during the summer, expanding regular enrollments during fall and spring semesters, and making use of technology to expand on- and off-campus learning opportunities.

The anticipated influx of new students over the next decade has prompted UC Berkeley, which enrolls more than 31,000 undergraduate and graduate students, to explore options for serving more students, more cost effectively, without significantly increasing teaching and support staff in large lecture courses. Consequently, there are a number of large-scale experiments taking place within the campus and between campuses.

DIGITAL CHEM 1A: A CASE STUDY

One such experiment in the College of Chemistry at UC Berkeley has provided those of us at the Center for Studies in Higher Education with an opportunity to do an in-depth study of different social and economic aspects of technology innovations on the UCB campus. Specifically, we undertook a quasi-experimental two-year analysis of the use of technology enhancements in the teaching of Chemistry 1A.[3] Before summarizing the nature of the analysis and our first year findings, a brief description of the scope of the course is necessary.

Chemistry 1A is the largest, most visible course at UC Berkeley – nearly 2,000 students, or one half of the freshman class, enroll in Chemistry 1A each year, and approximately 100 teaching and support staff are required to teach and manage the course. In addition to the large number of students and staff involved, the course is a gateway to more advanced study in many disciplines. The College of Chemistry is exploring a number of possible strategies for accommodating more students, which include:

- reducing the number of faculty teaching during the fall and spring semesters in order to have faculty available to teach in the summer session;
- possibly reducing the number of lectures offered and reducing demand on lecture hall seats;
- reducing time spent in labs by 25% to increase the use of lab rooms from two times per day to three times per day.

To achieve these goals, individuals in the College have developed a course, called *Digital Chemistry 1A*,[4] that includes:

- deployment of on-line quizzes and pre-laboratory assignments;
- conversion of the lecture chalkboard content to PowerPoint slides; and,
- broadcast of video lectures, with synchronized and indexed slides, over the Internet for on-demand replay (Figure 1).

In the fall semester, two faculty members oversee the course and perform lectures. They are supported by approximately 45-50 Graduate Student Instructors (GSIs) who teach lab sections. An additional eight support staff also play an active role in implementing Chemistry 1A by assisting with lecture demonstrations, scheduling lab sections, preparing laboratory rooms for student experiments, and other miscellaneous tasks.

[3] This work is funded by a grant from the A.W. Mellon Foundation's Cost Effective Uses of Technology in Teaching (CEUTT) program initiative, and depends on the contributions of many, including Professors I. Michael Heyman, Lawrence Rowe, Alex Pines, Dr. Mark Kubinec, Dean Gary Matkin, Dr. Flora McMartin, Shannon Lawrence, Jonathan Henke, Marytza Gawlik, among others.
[4] The Digital Chem1A website is at http://www.cchem.berkeley.edu/~chem1a/digitalchem1a/

Chemistry 1A lectures are scheduled at one of the largest lecture halls at UC Berkeley. Three identical one-hour lectures are scheduled at 9:00 a.m., 11:00 a.m., and 1:00 p.m. One of two faculty members gives each lecture assisted by a demonstration expert. Traditionally, Chemistry 1A lectures included the use of eight chalkboards and a fully equipped laboratory bench (for live demonstrations). A recent development has been the conversion of chalkboard content to PowerPoint slides, and projection of video and other graphics on overhead screens during the lecture for easier viewing of the lecturer and demonstrations by students in the back of the lecture hall. In fall 2000, 45 labs sections were scheduled in four-hour blocks for Chemistry 1A.

Analyzing Costs and Pedagogical Impact

Our study is interested in a series of interrelated questions:

- Are the technology enhancements effective pedagogical tools?
- Do the technology enhancements have the potential to be cost effective?
- How might off-site audiences use the products of this on-campus experiment?

In fall 2000, all students had access to identical course content, though two types of lab sections were offered: *digital lab sections* and *analog lab sections*. The content and requirements for each type of section was identical; the only difference between the two groups was the medium used by students to accomplish certain tasks. All students and GSIs were randomly assigned to either a digital or analog lab section as part of the course design. Lab formats were randomly selected after students were enrolled and GSIs section assignments were made. Students and GSIs could not opt in or out of section type.

As part of this study, we collected quantitative and qualitative data on faculty and staff teaching and preparation activities through questionnaires, interviews, and observations of lab sections. Data on student performance and attitudes about the on-line material were collected through surveys, focus groups, and grades. To evaluate the cost effectiveness (Levin & McEwan, 2001), we focused on time spent by teaching assistants, staff, and faculty in preparation, grading, and administrative tasks between digital and analog sections. A primary goal of the first year study was to compare overall course costs for two formats of instruction in Chem 1A: digital lab sections and analog lab sections. We employed a modified version of activity-based costing (Erhmann & Milam, 1999) to determine the total costs associated with the analog and digital sections.

We also examined the impact of the technology enhancements on some aspects of student learning. To date we have examined four aspects of pedagogical effectiveness: (a) student learning outcomes as measured by grades, (b) the course completion and retention rates, (c) student attitudes regarding the course, and (d) a carry-forward experiment. We also collected data on student background and on-line user statistics.

PRELIMINARY FINDINGS

Our first year of study provides some intriguing preliminary data on both the costs and utility of the current technology enhancements in Chem1A at UC Berkeley. A discussion of our preliminary analysis follows:

- Our observations and cost figures suggest that GSI time could be reallocated from tasks such as out-of-class grading and in-class administration to more time in teaching and interacting with students. Based on our observations, labs could be shortened by from four hours to three. The second-year study will test this hypothesis by reducing lab time to three hours for lab sections. If this proves practical, chemistry could add approximately 20 lab sections per week and accommodate approximately 600 students without acquiring new space for labs.

- The lead faculty for Digital Chemistry 1A estimated an average savings of 12 hours per week because of technology enhancements. Savings were primarily due to the substitution of PowerPoint slides for creating chalkboards. The cost savings are considerable, and will be captured each year with only minor revisions in subsequent years.

- Data indicate that most students in Chem 1A use the on-line lectures primarily as study aids, and the majority (>80%) would not substitute remote viewing for attending lecture. Our preliminary analysis of use of other on-line video lecture archives at UC Berkeley (Rowe et. al., 2001) suggests that some students have a tendency to opt out of attending some or all of the lectures, thus freeing up seats in the lecture hall. The degree to which students opt out may be heavily influenced by time of day (e.g., early morning) and the style of lecture delivery. It was clear from our study that Chemistry 1A contrasts sharply with these findings. Excellent lectures presented by dynamic teaching staff appear to be a big draw for students.

- The availability of the archived lectures has the potential to allow a larger number of students to be enrolled in the course, without increasing faculty time lecturing. Reduction in the number of lectures given each day from three to one or two, and by requiring some students to attend lectures virtually, could realize significant saving in faculty time. Because the same lecture is given three times per day, staff and facilities costs could be saved if a proportion of students either opted out of attending lectures, or a lottery system was devised so students were required to view a certain number of lectures per semester on-line.

Student Performance and Attitudes

We have found no significant difference in grades or retention between analog or digital groups. Given that large lecture courses have a reputation among educators as being poor learning environments (The Boyer Commission on Educating Undergraduates in the Research University, 1999), we were interested to find that usage statistics and survey comments indicate that students were very engaged with the on-line materials. We suspect that the positive reception of Chemistry 1A technology enhancements is related to a number of factors:

- The enhancements were minimally disruptive to the teaching style and pedagogy of the teaching staff;
- The enhancements increased convenience for students and faculty;
- The enhancements were “generic” enough that students could use them flexibly and on their own terms (e.g., reviewing lectures on-line for exam study, repetition of difficult sections by non-native English speakers, taking quizzes multiple times);
- The overall quality of this large lecture course is exceptionally high. The faculty in charge are dedicated to providing the best experience possible for students, and are constantly integrating feedback into course improvements.

Scalability and Faculty Adoption

There is certainly the possibility that several faculty, or even faculty on other UC campuses, might be able to share on-line materials developed for Digital Chemistry 1A. Hypothetically, the availability of on-line material to every Chemistry 1A instructor may (a) eliminate the need for ‘reinventing’ the course by each instructor and thus allow time-savings in preparing, organizing, and updating the course materials, and (b) free the instructor to creatively use the lecture time as a more student-interactive experience. In reality, the sharing of teaching materials among faculty in a research university environment may be complicated by multiple factors such as faculty idiosyncrasies and the continuity of underlying support structures for technology enhancements. Interviews with other faculty members who taught subsequent semesters of Chemistry 1A suggest that the successful wholesale adoption of technology enhancements from one semester to the next cannot be assumed.

We suspect that any scaling benefits will come either (a) when newly hired faculty, who might be more adroit with new technologies, enter the department, (b) the course can be “modular” so that faculty can select materials that fit their learning goals, should their learning goals differ from the developers’ intentions and/or (c) if the materials can be made available to off-site student audiences. It is unclear if this latter assumption is realistic. Scenarios that might emerge could include the creators of the course working with a private publisher to make the materials commercially available as an electronic textbook.

Alternatively, the UC Extension arm might adapt the course materials developed for Digital Chem 1A for off-site student populations, including students in high schools and other colleges and universities. Other possibilities include the campus licensing the electronic version of the course to some other on-line education provider.

DISCUSSION

Since the advent of the Arpanet, colleges and universities have been at the forefront of creating and experimenting with ICTs in their normal work of research and teaching. Most institutions enhance many of their traditional course offerings and/or provide some courses entirely on-line, which means students and faculty can exercise more choice about the modalities they use for teaching and leaning. A number of findings from our work with the Digital Chem 1A experiments, and other on-going activities throughout UC, suggest that accurately predicting the future will depend on how universities respond to a variety of variables: students, technology, public expectations and needs, costs and sustainability, and new competitive markets.

Response to Student Expectations and Backgrounds

An important unknown for future planning is that we simply do not understand enough about the students of the future, who will have been weaned on peer-to-peer file swapping, Google searches, and wireless instant messaging. What expectations will these students have about their learning environments and the nature of scholarship? How will institutions respond to cohorts of students who may have non-traditional concepts of time and space in scholarship?

We do know that many students have new ideas about the nature of coursework. They appear not to use the library in traditional ways, and they cull many more resources from the web (Carlson, 2001). We know from the UC Berkeley Digital Chem 1A experiment and reports from other campuses, that, given choices about how they take a course, many students will choose an on-line video lecture component as either a back-up for or a substitute for attending lectures. Many students also appreciate the opportunity to do lab preparatory work and quizzing on-line. It is clear that the positive response to the technological enhancements in Digital Chem 1A was because they increased convenience for students and faculty, and were “generic” enough that students could use them flexibly and on their own terms.

Moreover, we do not know how many students will eschew traditional liberal arts curricula for the immediate economic benefits that can be derived from management and technology education. It is probably safe to assume that as new on-line education providers proliferate and consolidate, the range of educational choices available to students will increase, and many mature students will forsake a traditional four year residential college experience for certification and part-time degree programs. For example, Cliff Adelman’s work suggests that a huge cohort of international students is forsaking traditional higher education institutions and instead enrolling in IT certification programs. *“ A new class of postsecondary providers has come on the scene: boundary-breaking and border-crossing every step of the way to scramble institutional and governmental assumptions about the future. In our frenetic fascination with the likes of the University of Phoenix and virtual degree delivery, we have been looking for challenges in the wrong direction.”* (Adelman, 2000).

Response to Changing Technologies

Institutions are continually asked to make choices about on-line education development and delivery. The explosion of the Internet and associated technologies in the latter half of the 1990s, has made combining production and delivery technologies with interactive communication technologies the rule rather than the exception. ICTs encompass many modalities, and are underpinned by a plethora of new hardware and software that can be combined in an almost infinite number of ways. N-way video streaming, digital library and museum database management, simulations, teleconferencing, telephony, and wireless communications are just some of the modalities at the disposal of higher education institutions. Each modality has particular characteristics that contribute to its relative strength or weakness as an effective tool for tried-and-true teaching/learning methods, which include a mix of lectures, small seminars, laboratories, field work, library research, one-on-one tutoring, and so on. The options available for combining particular pedagogical goals with specific technologies creates an environment that can differ as much within institutions as it does among them.

Finally, university planners must consider that questions remain concerning whether high quality interactions between student and teacher, and among students, the *sine qua non* of a quality educational experience, can be replicated, or even approached, in on-line environments (Phipps & Merisotis, 1999). If one spends any time around computer scientists at a research university, however, one realizes that indeed Internet2 (http://www.internet2.edu/) and the myriad applications it can support (tele-immersion, haptic feedback to name two examples), have the potential to provide ubiquitous high-quality on-line interactions among individuals in the not too distant future. The nature of the technologies themselves may also allow entirely novel modes of teaching and learning that we have not yet imagined. And as the technologies and their use evolve in unexpected ways, simpler scaling of traditional teaching to new off-site audiences cannot be discounted.

Responses to Containing Costs and Fostering Sustainability

The degree to which ICTs are cost effective is problematic, and is currently under study by a number of institutions and individual researchers.[5] Most agree that the integration of ICTs into extant or new institutions is expensive, especially if institutions want to be on the leading edge of ICT development and quality. The development and deployment of high quality on-line distance courses, such as those offered by the UK Open University, are expensive and require large numbers of students to break even (Curran, 2001). There is some evidence, however, that the strategic use of on-line resources in large lower division lecture classes at traditional institutions may result in some savings and redistribution of teaching staff time (Twigg, 1999; Massey and Zemsky, 1995). The high costs of educational technology infrastructure (internet accounts for students, staff and faculty, wiring classrooms, dorms, and offices, technical support staff), the rapid change in the technologies themselves, and the relative dearth of institutional strategies for financing campus technology (Green & Jenkens, 1998), suggest that cost-savings, if they are to be realized, may be in the future.

Clearly the current high costs of ICTs in education cannot be entirely financed by most institutions' available internal operating budgets. Therefore experimentation with new financing arrangements is taking place (Goldstein, 2000; Matkin, 2001). These new forms of financing may entail creating investment partnerships with private industries (especially those in media and high technology), dependence on federal and private grants, regional or functional consortia, imposition of student technology fees, and/or venture capital funding. The Digital Chem 1A experiment suggests that sustaining such activities requires certain assumptions about how teaching staff, including faculty, work. University planners will need to reconcile the divergent and sometimes competing philosophies of an institution's core teaching role and new roles that require devising cost-effective educational delivery schemes for new markets.

Response to Public Stakeholders

Public universities in the US are under immense pressure to satisfy the needs of multiple stakeholders and make concrete contributions to the public good. This can be achieved through various means including economic development activities that derive from research as well as direct outreach to local communities. An emerging issue in the US, particularly in states with large immigrant populations such as California, is how to prepare under-served high school students for productive college careers. Many hopes are being pinned on ICTs to address this particular need. The areas with most promise include the provision of "advanced placement" courses to urban and rural high schools, or the enhancement of community college curricula to increase the rate of transfer from these two-year "open door " colleges into the research university milieu of the University of California. At the University of California, a number of experiments are underway to address this need. Making Digital Chem 1A and other undergraduate courses available to secondary and community college students is one possibility being explored. Another is the forging of unique technology partnerships among community colleges, the California State University (CSU) system and UC campuses as embodied in the development of the new UC campus at Merced in the central valley of the state. Of course there are possibilities that these activities could scale to non-California or even non-US populations. Initiatives such as the MIT OpenCouseware project (http://web.mit.edu/ocw/), which are exploring new ways of making some of the educational assets of

[5] See for example the CEUTT projects at the A.W. Mellon Foundation website http://ceutt.org

"branded" US research universities available free to the public offer tantalizing possibilities for extending the reach of US higher education. Contrary to speculation, however, the posting of on-line course materials such as syllabi and lecture notes will probably not provide a substitute for the "full service" delivery of an entire course on-line by a renowned university professor.

Response to New Competitive Markets

The emergence in the last few years of a diverse array of on-line education models has been phenomenal (Cunningham et al., 2000; Dirr, 2001; Eaton, 2001; OECD, 2001a). They include for-profit ventures (Fathom.com, NYU Online, University of Phoenix On-line, Onlinelearning.net), equity stakes in external companies (U Chicago, Columbia, UNext.com), university consortia (Universitas 21, Western Governors University, University Alliance for On-line Learning), licensing agreements (Pearson, McGraw Hill), and the MIT OpenCourseWare initiative. Most of the for-profit ventures appear to be responses to the perception of burgeoning global markets for "just-in-time" education, and many are either owned or in partnership with "branded" research universities. At first glance, many of these ventures appear well positioned to go after the potentially lucrative "low hanging fruit" of business management studies, IT training, and other professional and corporate training curricula both in the US and abroad. The reality of profit potential for many of these ventures, however, has been elusive (Wilson, 2001).

The array of models, and their evolving business strategies, suggests that many research universities with investment capital have responded quickly to perceived threats and opportunities, without much hard data to rely on.[6] For example, despite the huge investments in these ventures it is not known: (a) how large or lucrative the emerging global markets for on-line education will be, (b) whether the traditional higher education sector can dominate the market, or (c) how efforts to enhance traditional university curricula might scale to these new audiences.

What might the US landscape look like in 2005? That will depend on which institutions one is examining. Choices that make sense for a well-focused proprietary such as the University of Phoenix may be entirely different from choices that are realistic for a community college or a small residential four-year institution. Different still will be the choices made by large multiversities, whose missions encompass undergraduate and graduate education, research, and continuing education. These institutions, and their private counterparts, appear to be taking a "hedge your bets" strategy. Multiple activities are being pursued and juggled, each tailored to specific opportunities and constituencies. As one of the largest exporters of education services (OECD, 2001b; Wende, 2001), it probably safe to predict that many segments of the US higher education sector will maintain an active role in international education. The US research university international market orientation is primarily on the periphery, via their continuing education arms, professional schools, or the new spin-offs geared towards non-traditional students. There are experiments, however, such as the MIT-Singapore initiative and the Stanford Wallenberg Global Learning Centers, that are taking place at the core of institutions as well.

CONCLUSIONS

We can safely predict that there will always be a market for residential higher education in the US and the unique socialization and networking roles it serves, both at public and private universities. It is also clear that markets for new ways of accessing higher education are emerging. It may be that small private institutions will be primarily interested in investing in technologies that enhance their regular offerings; perhaps secondarily (if at all) getting into the distance on-line learning business. Larger public research universities may see the on-line market as an important new source of students and funds, and will thus capitalize heavily in new ventures to be at the forefront of the predicted boom in global on-line education. Some predict (Collis, 2001; Hilsberg, 2001) that the most threatened institutions in the US are those whose primary mission has been the provision of undergraduate curricula to undergraduates.

[6] Longitudinal case studies of some of these ventures have been developed by S. Lawrence and D. Harley, and can be found http://ishi.lib.berkeley.edu/cshe/projects/university/ebusiness/

The structure and function of existing and emerging models will be determined by an equally diverse array of internal and external pressures: differential institutional missions, student demographics, varying perceptions of new markets and competitors, the exigencies of financing technology-mediated learning, and the attendant controversies that accompany a university entering the marketplace. The latter issues include intellectual property, faculty time and incentives, conflicts of interest, and preservation of quality. Successful models will provide a flexible mixed or hybrid mode that allows for varying proportions of on-line and face-to-face teaching and learning methods. Furthermore, the successful models that emerge for an institution will be the result of careful planning, and reflect a synthetic approach that includes wise use of the existing technologies and is customized to the subject matter, to student needs and schedules, to faculty culture, and the institution's mission, goals, and budgets.

University planners are in need of data and analyses of past and current activities related to the development, implementation, and financing of ICTs in higher education. One of our jobs at the Center for Studies in Higher Education is to try to make sense of this world through research projects and the creation of a network of administrators, technology implementers, and higher education scholars to discuss on-going developments. As my colleague Martin Trow has succinctly stated it, the shifting nature of the technologies, student audiences, external pressures, and institutional strategies suggests that imagination may be an important tool not only for those whose task is strategic planning, but also for those scholars whose goal is analyzing and describing this emerging landscape.

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Figure 1: Berkeley Lecture Browser view of webcast Digital Chemistry 1A Lecture
Users can watch the video lecture with synchronized slides. They can look at slides before or after the current slide, reposition the video and slide to the one selected in the slide index or returned by the keyword search command.