Research & Occasional Paper Series: CSHE.8.02

CSHE Center for Studies in Higher Education

UNIVERSITY OF CALIFORNIA, BERKELEY
http://ishi.lib.berkeley.edu/cshe/

INVESTING IN EDUCATIONAL TECHNOLOGIES: THE CHALLENGE OF RECONCILING INSTITUTIONAL STRATEGIES, FACULTY GOALS, AND STUDENT EXPECTATIONS [*]

March 2002

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ABSTRACT

The Higher Education in the Digital Age Project (HEDA) is concerned with the policy implications of information and communication technologies (ICTs) for higher education. This paper specifically analyzes some of the ways in which 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 a brief review of activities taking place throughout the US, and discusses some of the pressures that US research universities must face as they plan for the future. Challenges include the financing of ICTs, the pace of technological change, academic culture, student expectations and backgrounds, demands of public stakeholders, and the emergence of new competitive markets. This paper arose out of discussions we have held under the umbrella of the HEDA Project. Those discussions, which included a meeting in October 2001, are referenced throughout.

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

[*] *A version of this paper was published as* Planning for an Uncertain Future: A U.S. Perspective on Why Accurate Predictions About ICTs May Be Difficult. (2002*) Journal of Studies in International Education*, Vol. 6, No 2, Sage Publications.

elusive, but the creation of high quality on-line offerings is expensive, and requires huge capital investments.

Our work at the Higher Education in the Digital Age Project[1] at UC Berkeley confirms 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 suggest that predicting the emergence of one, or even a few, US models for flexible learning may be impossible. Many of the ideas in this paper are the result of my ongoing discussions with colleagues in the Higher Education in the Digital Age Project at the Center for Studies in Higher Education, including the meeting in October 2001. Transcripts from that meeting are referenced throughout.

Diversity of Institutions, Systems, and Approaches

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, unlike many other countries, have no federal ministry of education, and higher education is regulated by the states (Eaton, 2001). Predictive exercises are further complicated by 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.

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. 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 textbooks, 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 therefore makes them 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 (UC News and Communications, 2000).

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. 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. Consequently, there are a number of large-scale experiments taking place within the campus and between campuses that are directly testing the feasibility of the latter strategy.

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 have undertaken a quasi-experimental two-year analysis of the use of technology enhancements in the teaching of Chemistry 1A.3 A summary of our findings (Harley *et al*. 2002) from the two-year analysis can be found at http://ishi.lib.berkeley.edu/cshe/projects/university/chem1a/summary.html

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. 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.

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?

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.

Potential Cost Savings

- Our observations and cost figures suggest that faculty and GSI (Graduate Student Instructor) time could be reallocated from tasks such as lecture preparation, responding to routine student questions, out-of-class grading, and in-class administration to more time teaching and interacting with students.

- 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, however, that some students in other courses have a tendency to opt out of attending some or all of the lectures, thus freeing up seats in the lecture hall.
- 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. 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 if a lottery system were devised so students were required to view a certain number of lectures per semester on-line.

Student Performance and Attitudes

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 in the positive reception of the Chemistry 1A course and its technology enhancements, which we suggest 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, New Audiences, 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. 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) if 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.

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 that 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 and other research universities, suggest that the future landscape will depend on how institutions respond to a variety of variables: costs and sustainability, technology, students, public expectations and needs, and the realities versus perceptions of new competitive markets.

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 robust institutional strategies for financing campus technology (Green & Jenkens, 1998) suggest that cost-savings, if they are to be realized, may be in the future.

Goldstein (2000) makes clear that the current high costs of ICTs in education cannot be entirely financed by most institutions' available internal operating budgets. Therefore we are seeing experimentation with a wide variety of new financing arrangements. 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 (Goldstein, 2001; Matkin, 2001a). Kalil (2001) suggests that activities with high social rates of return and low private rates of return will be in need of large scale federal investment. The Digital Promise Project (www.digitalpromise.org), which has forwarded the idea of a Digital Investment Opportunity Trust, is dedicated to this ambitious goal.

Whatever the arrangement(s) an institution chooses, the Digital Chem 1A experiment suggests that sustaining such activities with the work of core faculty at research universities requires making certain assumptions about how teaching staff, especially faculty, work. Peter Lyman (2001) makes the case that the role of faculty, especially with respect to their intellectual property, is a core consideration when discussing viable markets and the diffusion of innovation in courseware. 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.

Changing Technologies and Their Effectiveness in Academic Environments

Institutions are continually asked to make expensive choices about on-line education development and delivery strategies (see, for example, Rowe, 2001). The explosion of the Internet and associated technologies in the latter half of the 1990's 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 standard modalities at the disposal of higher education institutions. Each modality in fact has particular characteristics that contribute to its relative strength or weakness as an effective tool for tried-and-true teaching/learning methods. Contrary to the rhetoric of the constructivist "student-centered" movement, these successful methods usually include a varied 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 create powerful opportunities for amplifying teaching and learning effectiveness. The array of options also creates environments that can differ as much within disciplines, and institutions, as it does among them.

University planners, however, must consider that significant 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 and 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.

Student Expectations and Backgrounds

Future planning is confounded by the fact 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? For example, Sally Johnstone (2001) has pointed out the importance of "swirling," a phenomenon where students mix teaching and learning modes by combining traditional courses with on-line courses, sometimes from different institutions.

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 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 the enhancements increased convenience for students and faculty, and they 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. Students enrolled in traditional programs also might supplement their education with courses from non-traditional providers. 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 (Adelman, 2000).

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 (e.g., Stark, 2001). 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 for scaling these activities to non-California or even non-US populations.

Initiatives such as the MIT OpenCourseware project (Abelson and Kumar, 2001; http://web.mit.edu/ocw/), which are exploring new ways of making some of the educational assets of "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 (Matkin, 2001).

Response to New Competitive Markets

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 to 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 who have suggested that ICTs represent the next high-growth internet industry and provide a possible breach of the former monopoly held by traditional higher education providers (Drucker, 2000; Moe & Blodgett, 2000)?

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.[6] Most of the for-profit ventures appear to be responses to a perception that global markets for "just-in-time" education are burgeoning, and many are either owned by or partners with "branded" research universities.

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. As one of the largest exporters of education services (Larson, 2001; OECD, 2001b), many segments of the US higher education sector maintain an active role in global, as well as domestic, education markets. The reality of profit potential for many of these ventures, however, has been elusive (Wilson, 2001). 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 U.S. higher education sector can dominate the market, or (c) how efforts to enhance traditional university curricula might scale to these new audiences. Some (Collis, 2001; Hilsberg, 2001) predict that the most threatened institutions in the US are those whose primary mission has been the provision of undergraduate curricula to undergraduates.

What might the US landscape look like in the future? 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. Geiger (2001) argues that the boundaries between universities, and community colleges, and distance education, and e-learning, are being contested, and that universities are in fact competing with themselves. The result is that these institutions appear to be "hedging their bets," pursuing and juggling multiple strategies each tailored to specific opportunities and constituencies.

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 onlysecondarily (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 in order to be at the forefront of the predicted boom in global on-line education.

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 makes wise

use of existing technologies and is customized to the subject matter, to student needs and schedules, to faculty culture, and to 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. One of the most pressing problems we have identified is that we are observing a "fast running experiment," which lacks the traditional data sets and methodologies that social science researchers need for analysis (Geiger 2001). As Martin Trow (2001) 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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NOTES

1. Our work is supported by the William and Flora Hewlett Foundation and the Andrew 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/.
3. This work was 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/.
5. See for example the CEUTT projects at the A.W. Mellon Foundation website: http://ceutt.org.
6. Longitudinal case studies of some of these ventures have been developed by S. Lawrence and D. Harley, and can be found at http://ishi.lib.berkeley.edu/cshe/projects/university/ebusiness/.