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Sweeping predictions are often riveting, but most change processes play out in nuanced and incremental ways. While change in higher education expedited by technology is a safe bet for the future, it is equally certain that technology adoption will proceed unevenly across the higher education landscape and be driven by a wide range of factors. Shifting demographic, market, political, and other forces will require many colleges and universities to redefine their institutional cultures and missions. At the same time, socioeconomic realities and security-related disruptions will constrain the transformational potential of information technology. Some factors will limit the extent of innovative technology adoption while others will spur the transformation of teaching and learning. This article examines potential instructional technology adoption in U.S. higher education in the context of these factors and predicts some consequent changes in institutional practice.

Institutions at a Crossroads

Perhaps no factor has had greater impact on technology adoption within postsecondary institutions than the culture that defines those institutions. Higher education is known for its conservative response to change, and a number of scholars have written about the slow rate at which institutions embrace innovation (Miles 1964; Getz, Siegfried, and Anderson 1994). Yet many aspects of higher education have undergone fundamental shifts in the last ten years that have been driven by advances in information technology. Technological developments have set in motion significant changes in the way information is created, accessed, vetted, and disseminated. At the same time, technology's impact on student learning has been far from revolutionary. Distance education has certainly helped make learning opportunities accessible to an increasing number of traditional and nontraditional students, but many programs appear to have simply bolted on technology to enable traditional pedagogies (Twigg 2000; Zemsky and Massey 2004). The implementation of transformational innovations in residential educational settings has been limited to isolated pockets.

The organizational culture of traditional higher education institutions is still defined largely by the role of the faculty. The proclivity of the average faculty member to invest in new pedagogies is undermined by two characteristics of traditional academic culture: the dearth of incentives to promote innovation in teaching excellence and the isolation in which most pedagogical decisions are made. In fact, faculty members have almost absolute autonomy over decisions regarding instructional quality within the classroom, leading one observer to refer to higher education as “one of the last centers of craft-based production” (Taylor 1998, ¶3). That model will remain sustainable at some, but not all, traditional institutions. Those driven by external forces to make the most pronounced changes will find their success closely linked to their ability to sustain job satisfaction among their faculty members.

The current management and marketing of distance and residential education programs offers an interesting case study on the potential effects of broader trends on institutional culture. Some institutions are establishing a clear delineation between the two, limiting their distance education offerings in order to maintain the exclusivity of their residential brands. Private and prestigious public institutions, which are most likely to pursue this strategy, occupy a somewhat paradoxical position with regard to instructional innovation. On one hand, they are well positioned financially and can attract creative faculty members. On the other hand, their faculty members have fewer incentives to reinvent the traditional classroom experience. As a result, their investments in innovation tend to take the form of high-profile exemplars that rarely impact student learning at the institutional level. Other institutions, especially two-year institutions and for-profit providers, see the

burgeoning adult education market as their future (Allen and Seaman 2007; Tierney and Hentschke 2007). Their academic programs will depend heavily on technology to address the needs of nontraditional students. Finally, some traditional institutions are pursuing a combined strategy that blurs the lines between distance and residential education. Innovative pedagogy at these institutions will be driven in part by shifting student expectations about what it means to attend college as undergraduate education begins to transcend the physical boundaries of college campuses (Duderstadt and Womack 2003).

Online and hybrid courses will increasingly represent the vanguard of innovative and effective pedagogy adoption in higher education. As the practice of using interdisciplinary teams that combine the strengths of subject matter experts, instructional designers, and others to produce online courses becomes the norm (Paulson 2002; Williams 2003), institutions emphasizing innovative course delivery will usher in a new generation of high-quality online learning experiences. Currently, institutional initiatives to extend the undergraduate experience beyond the confines of the campus adopt the approach of popular programs like Study Abroad, programs which offer limited options and constitute a relatively small portion of the typical four-year experience. However, when students are no longer dependent on proximity to campus for instruction, more may opt to pursue postsecondary education through extended field work, nonacademic service opportunities, or emerging constructs like adventure learning (Doering 2007). In an increasingly global economy, students will also have more options for integrating traditional corporate apprenticeships that offer both rich undergraduate experiences and seamless transitions into productive working careers (Boud and Solomon 2001). For a small but growing percentage of students, time spent on campus will become a supplemental part of the collegiate experience.

Of course, the promise of the customized collegiate experience will not be realized without overcoming administrative and cultural barriers to coordinating alternative postsecondary experiences (Lederman 2007). It will likely be another ten years before advances in online learning and a widely accepted framework for assembling custom curricula across institutions converge.

Shifting Demographic Winds

One of the most important developments on higher education's supply side will be the decreasing pool of tenured full-time faculty members. While the number of faculty positions is expected to increase by nearly 25% through 2016, the majority of those positions will be filled with nontenured faculty members or contingent faculty, many of whom will have part-time appointments (U.S. Department of Labor 2006). These trends are likely to continue through 2030 as growth in the overall U.S. workforce is expected to slow considerably (Hough 2003).

The tighter labor market will present both challenges and opportunities for postsecondary educators. Elite institutions will have less trouble attracting full-time faculty members, and large research institutions will also see their ranks of contingent faculty members grow, especially when graduate students are included in the count of part-time instructors (Monks 2007). Competition for qualified contingent faculty members will become fierce among traditional and for-profit institutions, especially those agressively pursuing online and other innovative instructional models.

Residential institutions of all sizes that need to sustain even moderate growth will struggle to scale less-efficient instructional models. Those institutions will be under increasing pressure to optimize the use of their limited faculty resources. Introductory courses, for example, will increasingly blend faculty contact hours and comprehensive online learning packages developed by courseware publishers. Campus leaders at institutions struggling to transform the traditional faculty culture may find contingent faculty members to be more willing participants in early reform efforts than young tenure-track faculty members who are busy pursuing tenure or senior faculty members who have significant investments in their own teaching strategies and materials.

While the number of full-time faculty members is declining, the overall demand for higher education services is expected to increase, with anticipated enrollment increases of 15% to 20% through 2015 (Hussar 2005). Moreover, the typical student profile has changed over the last thirty years as more students enroll part time and later in life while holding down full-time jobs and supporting families. By some definitions, nearly three-quarters of all undergraduates are now nontraditional students (U.S. Department of Education 2002). This trend will support the expansion of online and hybrid programs as the benefits of online learning for students who are not well served by traditional residential models are already well documented (Howell, Williams, and Lindsay 2003, "Student Enrollment Trends").

Strategic directions of higher education institutions will also reflect regional disparities in population trends. For example, in states where population growth is driving up demand for higher education services, technology adoption will be required to allow both distance and residential courses to scale up. Institutions that serve states and regions with declining populations will be driven to similar instructional models for different reasons. Those that survive will adopt blended residential models in order to reduce costs, using the savings to retool their business models. Some will look to tap the distance-education market by building niche degree programs. Within the next 15 years, some university systems serving decreasing regional populations will have consolidated their offerings, discontinuing some academic programs or closing some physical campuses altogether.

Foreign-born students are already a significant portion of the anticipated swell in U.S. postsecondary enrollment through 2015, and international students may constitute a second wave in subsequent years. Global demand for international education is expected to increase by nearly 70% between 2003 and 2025 with English-speaking countries serving nearly half of those new students (IDP Education Party Ltd. 2003). With its large number of online providers and overall reputation for higher education, the United States is well positioned in the global e-learning market (van der Wende 2002), but even brand-name providers will have to improve their content and delivery models to compete successfully.

Learning Outside the Classroom

Oblinger and Oblinger (2005) review much of the recent literature regarding the learning expectations of an incoming generation of students that takes technology for granted. Although the notion that all students arriving on college campuses are technology savvy is misleading (Kaminski, Seel, and Cullen 2003), technology has an important presence in the lives of most students. To date, most instructors and students have been willing to view course-related innovation and technology use in student life as separate domains even in situations where the disconnects are glaring. This compartmentalization will be increasingly difficult to sustain, especially at institutions moving toward innovative educational models. The learner-centric models of the future will feature less-structured, instructor-driven learning and will assign more importance to informal resources that have previously been viewed as supplemental to the lecture and the course textbook.

Similarly, the idea of campus-based learning communities will continue to cede ground to distributed immersive models in which a larger percentage of students' time-on-task is spent engaged in participatory knowledge creation across networks of dispersed learners and learning communities (Foreman 2007; New Media Consortium 2008). The most engaging content will be online and will build on trends in virtual worlds (Exhibit 1), gaming (Exhibit 2), and personal feedback (Exhibit 3) (van Dam, Becker, and Simpson 2005). Today's Web feed protocols (Exhibit 4) are forerunners of a comprehensive data network that will provide learners with a continuous and personalized stream of information and perspectives.

Many of today's campus-based supplemental instruction services will be replaced by third-party services such as human and artificial intelligence-mediated tutoring (Massey University 2007). The most compelling value will be offered by providers who can bring together disciplinary content, informal learning communities, and educational services to create custom learning experiences for matriculated students and independent

learners. Within 15 years, automated agents will be able to assemble learning sequences on both broad and narrow disciplinary topics, selecting from a wide range of open and proprietary learning materials and methods and handling the transactions necessary to put them together. Those designed in light of educational research data will deliver learning experiences with stronger pedagogical foundations than the strategies employed in many college classrooms today. Given trends in market share concentration within the media industry (Klinenberg 2007), it appears that media conglomerates may be in the best position to offer premium services within the next 10 years. However, the importance of commercial publishers in the higher education market will diminish as the open-content movement evolves (Liang 2007).

Increasingly, the challenge for many instructors and librarians will not be finding relevant course-related materials but identifying and steering students toward appropriate external resources and learning communities to complement their approaches to content. By 2030, the role of faculty members at institutions that adopt the most divergent models will have transcended Barr and Tagg's (1995) notion of a learner-centered paradigm where the primary function of the instructor is to guide student discovery and knowledge creation. By this time, the role of faculty at many institutions will emphasize higher-order assessment such as comprehensive evaluations.

Access to a Moving Target

The notion of the digital divide focuses attention on access to the infrastructure and, increasingly, the skill sets necessary to use technology effectively. Over the next 10 years, disparities in access to technology will persist despite efforts to remedy them just as similar disparities have persisted in arenas such as housing, health care, and access to quality K-20 education. Uneven student access to technologies will continue to have implications for overall technology adoption. With both fairness and market entry in mind, educators will remain reluctant to integrate technology-enabled learning strategies unless they can ensure access to the relevant technologies. The ability of institutions to subsidize the cost of ensuring equal access for their students will vary. Most institutions will have to strike a careful balance between staying innovative enough to compete and raising the technological bar too high for their target markets (Zastrosky 2007).

Higher education will benefit from the continuing miniaturization, service integration, and commoditization of external computing devices, handheld or otherwise. These devices will be ubiquitous on college campuses, but the proliferation of devices in the consumer electronics market will make it increasingly difficult for institutions to drive adoption standards. Institutions will spend less on subsidizing personal computing solutions and more on third-party information services and emerging models for disciplinary content and learner interaction.

The device-centric technology paradigm will continue to dominate until 2035 or 2040 when products made possible by the convergence of biomedical advances and nanotechnology will enter the consumer marketplace. Several prognosticators predict that technology will be more directly integrated with brain functions and key sensory organs (eye and ear implants, haptic enhancements); genetic manipulation techniques will also offer opportunities for the convergence of biology and technology (Daanen and Facer 2007; Kurzweil 2005).

Regardless of what technologies emerge over the next 25 years, students from higher socioeconomic levels will ultimately realize the most educational benefits from their use. As the students of today do, these students of the future will have the earliest access to leading-edge educational products.

Data-Driven Learning Options

The relationship between technology adoption and instructional assessment will become increasingly symbiotic to the benefit of both. During the next 10 years, instructional assessment initiatives will continue to

be driven by concerns about the rising cost of higher education and the need for online education programs to differentiate themselves in an increasingly competitive market. The ability of the accreditation industry to keep up with evolving online educational products will be especially important during this period (Reeves 2003).

Meanwhile, technology will facilitate advances in assessment design, data collection, and data analysis. More instruments will be available to help students map their learning preferences and strengths to relevant courses of study. Educators will take a much more sophisticated approach to identifying and correcting student misconceptions, abandoning the "empty vessel" approach to learning that assumes that student exposure to course subject matter begins the first day of class. By 2030, cradle-to-grave assessment strategies will be a standard part of the K-16 educational experience. The primary drivers of this development will be student and parental demand for more personalized learning opportunities and the efficiencies available to postsecondary institutions that do a better job preparing incoming students. Initiatives such as the American Diploma Project have begun building the framework for an achievement data system that spans the historic divide between high schools and colleges (Achieve, Inc. 2008).

Adjusting to Disruptions

While numerous factors suggest that technology adoption in higher education will accelerate in the coming years, technological development will also be subject to unanticipated disruptions that may have the effect of slowing local or regional efforts to transform instructional models.

The U.S. economy has experienced 14 recessions since 1920, 3 of them severe (Moore 2002). Since 1979, downturns in state investments in higher education have closely correlated with national recessions, and that lost ground has not been made up nationally. Additional recessions are likely to occur over the next 25 years, temporarily undermining technological advances and further widening access disparities. State budgets for higher education will continue to be crowded by healthcare costs and other critical services. Instructional innovation funds at public institutions are likely to be among the first budget lines impacted.

Furthermore, in recent years, security has replaced instructional integration as the number one concern of chief information officers at institutions of higher education (Foster 2005). While most experts downplay the likelihood of cyberattacks crippling critical communication infrastructures or systems (Bocij 2006; Cohen 2003), the increasing sophistication and organization of hackers suggests that smaller-scale attacks will continue to be a concern. Education institutions and others straddling a finer line between security and mission are particularly vulnerable to malicious intent. Attacks may come in the form of higher-order computer viruses or compromised third-party systems on which higher education institutions are increasingly dependent. A number of institutions will likely be the victims of a major exposure of personal data.

A series of serious attacks or one involving a symbolic target will lead some educational institutions to reassess their dependencies on some technology-enabled solutions. Those with significant investments in online learning will be hardest hit and will be forced to consider long-term contingencies.

Conclusion

A higher education future characterized by disparate technology-adoption patterns promises a diverse group of stakeholders. Twenty-five years from now, some of today's higher education institutions will look remarkably unchanged while others will be almost unrecognizable. Technology adoption during this period of transition will not be universally smooth, equitable, predictable, or even pedagogically sound. Nonetheless, global society will benefit in the long run from the development of an unprecedented variety of learning services and providers.

Of all the variables likely to impact technology-adoption decisions in higher education over the next 25 years, perhaps none is more important than the decisions that traditional institutions are making right now about their future roles and missions. A head start will not ensure success in an increasingly competitive environment, but those engaged in the hard work of integrating continuous innovation into established institutional cultures will be in a stronger position to reach new students and provide new learning experiences.

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