Evolving Technologies

A View to Tomorrow

By Molly Tamarkin, Shelley Rodrigo, and the 2011 EDUCAUSE Evolving Technologies Committee

This year’s EDUCAUSE Review article by the EDUCAUSE Evolving Technologies Committee focuses on two specific evolving technologies: alternative IT sourcing and mobility. These technologies are having a significant effect on higher education institutions, both as administrative organizations and as centers for learning and research. The article reflects many discussions among members of the committee. However, individual committee members worked on specific sections: Brian Stewart, “Inputs to Our Future”; David Bantz, Dee Childs, Steve Landry, and Fran LoPresti, “Alternative IT Sourcing”; Tanya Joosten, Shelley Rodrigo, and Jennifer Sparrow, “Mobility.”
Inputs to Our Future

Information technology plays a unique role in higher education, providing a responsive learning environment to facilitate the development and distribution of knowledge while also enhancing the operational effectiveness of academic institutions. To rephrase the service “iron triangle” of quality, time, and cost, technology can make learning deeper, faster, and cheaper—though not necessarily all three simultaneously and not without significant disruption to existing norms and practices. Already we have seen a shift from knowledge acquisition and retention to collaboration and development become a desired outcome: in the digitally networked community, knowledge unshared is knowledge unknown. It is no longer sufficient for learners to know what; they must also know why and how. Knowledge is not an end but a means, and the need of professionals to keep abreast of new ideas has become de rigueur for an ever-expanding range of careers. To paraphrase an economics precept, “We are all professionals now.”

Information technology—through its speed, accuracy, scalability, traceability, comparability, measurability, connectivity, and interoperability—provides an environment that is highly conducive to the formation, sharing, and recording of ideas. It allows us to collaborate in real time, in new ways, and in combination with resources that raise understanding to new levels. What are the drivers underlying this age of technological empowerment? Table 1 shows the current trends that are driving the change and creating the conditions for the adoption of technology.

Two of the most critical technologies that are maturing and evolving in robust, scalable ways for colleges and universities are alternative IT sourcing and mobile computing. Though certainly not new, these technologies have become important touchstones of IT services and operations at institutions of widely varying sizes and missions. One indicator of the growing significance of a technology is when institutional leaders (beyond the CIO) speak of it not only as a technology that supports efficiency and convenience but also as a strategy to further a key institutional mission or goal. This is certainly true of alternative IT sourcing and mobility.

Alternative IT Sourcing

Alternative sourcing for information and computing services is not new to higher education. Examples of campus services that are frequently outsourced include the campus bookstore, facilities maintenance, and food service. Although a few campuses have fully outsourced their IT operations, the tight linkage between information technology and academic operations in key areas such as student records, classroom technologies, instruction, and research has kept the IT organization at most campuses a part of the institution’s operations.

Recent advances in hardware, software, and networking have created more opportunities to explore alternative sourcing for IT services, however. According to the 2010 Campus Computing Project, 75 percent of all private colleges and universities have or are creating a strategic plan for cloud computing; across all higher education institutions, this figure is 55 percent.¹ Evolving technologies such as cloud computing and Software-as-a-Service (SaaS) promise to increase institutional flexibility and reduce operating costs, thus providing attractive alternatives to traditional IT services.

Timothy Chester, CIO at Pepperdine University, uses SunGard Higher Education’s managed help-desk services for his campus and reports that user satisfaction with IT services has increased while lowering operational costs.² In the 2009 Campus Computing Project survey, Kenneth Green found that nearly half of responding campuses outsourced their campus e-mail systems, with Google and Microsoft the leading providers for a trend that was a novelty just a few years ago.³ Many campuses are using collaborative tools such as Google Docs as a supplement to or replacement for their

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Table 1. Trends Affecting Technology Adoption

<table>
<thead>
<tr>
<th>REVENUE GENERATION</th>
<th>COST REDUCTION</th>
<th>ACADEMIC IMPACT</th>
<th>STUDENT CENTRICITY</th>
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<tbody>
<tr>
<td>Decreased public support</td>
<td>Elimination of resource duplication</td>
<td>Improving outcomes</td>
<td>Individualized program and course delivery</td>
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<tr>
<td>Increased entrepreneurialism</td>
<td>Emphasis on organizational efficiency</td>
<td>Ensuring curriculum relevancy</td>
<td>Cross-institutional flexibility</td>
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<tr>
<td>Increased market competition</td>
<td>Greater attention to scale economies</td>
<td>Pedagogical innovation</td>
<td>Greater attention to value for cost</td>
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traditional learning management systems (LMSs), and these LMSs themselves are increasingly being offered as hosted services. Blackboard offers managed hosting for its system, rSmart (among others) hosts Sakai, and Moodle has similar hosting options, with MoodleRooms being one such option. Cloud-based infrastructure services such as Amazon's EC2 (Elastic Cloud Computing) are replacing local servers, freeing up space in data centers and reducing local utility costs. At Seton Hall University, for example, traditional academic departmental servers are being moved to Amazon's EC2 to reduce cost and improve security and reliability while maintaining a large degree of departamental control. Even campus ERP systems are moving toward alternative sourcing: several consortia host SunGard's Banner ERP system for participating campuses, such as ITEC. Although these new IT sourcing alternatives enable campuses to rapidly extend or replace current campus-based services, a number of issues need to be watched carefully as IT services move from campus to alternative sources. How will the institution ensure that the data is secure, that the institution has the necessary control over and access to data that might reside off campus? How will it manage user accounts and access? How will it allow other systems to integrate with other systems, either on campus or off? How will the institution manage e-discovery or access users’ data in an

There are also multiple services offered in the cloud:

- **Software as a Service (SaaS)**: The consumer accesses the provider’s applications running on a cloud infrastructure.
- **Platform as a Service (PaaS)**: The consumer can deploy, onto the cloud infrastructure, applications that it created (or acquired) using programming languages and tools supported by the provider.
- **Infrastructure as a Service (IaaS)**: The consumer can access processing, storage, networks, and other fundamental computing resources and can deploy and run arbitrary software, which can include operating systems and applications, via the provider.

The Issues to Watch

Although these new IT sourcing alternatives enable campuses to rapidly extend or replace current campus-based services, a number of issues need to be watched carefully as IT services move from campus to alternative sources. How will the institution ensure that the data is secure, that the institution has the necessary control over and access to data that might reside off campus? How will it manage user accounts and access? How will it allow other systems to integrate with other systems, either on campus or off? How will the institution manage e-discovery or access users’ data in an

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**2011 EDUCAUSE Evolving Technologies Committee**

Rochelle Rodrigo, **Committee Co-Chair**
Residential Faculty
Mesa Community College

Molly Tamarkin, **Committee Co-Chair**
Associate University Librarian for Information Technology
Duke University

David A. Bantz
Manager OIT Identity and Access Management Services
University of Alaska

Melody Childs
Deputy CIO and Executive Director of HPC and User Support
Louisiana State University

Stephen diFilipo
Vice President and Chief Information Officer
Cecil College

Tanya Joosten
Associate Director, Learning Technology Center
University of Wisconsin-Milwaukee

Stephen G. Landry
Chief Information Officer
Seton Hall University

Frances LoPresti
Director, Enterprise Technical Infrastructure
University of Maryland

Robert H. McDonald
Associate Dean for Library Technologies and Digital Libraries
Indiana University

Jennifer Sparrow
Director of Emerging Technologies and New Ventures
Virginia Tech

Brian Stewart
Vice President for Information Technology and Chief Information Officer
Athabasca University

D. Teddy Diggs, **Staff Liaison**
Publisher/Editor, EDUCAUSE Review EDUCAUSE

Catherine W. Yang, **Staff Liaison**
Senior Director
EDUCAUSE
emergency? How can risk be managed when there is a lack of transparency? What contract elements will provide the most protection to the institution?

**Security**
Alternative sourcing—even to another part of the central IT organization or to a regional data center—represents a fundamental shift in lifecycle management of information technologies (planning, adoption, support, refresh). As such, it is understandable that IT managers and executives, unsure of the terrain, may be dubious of handing over responsibility for critical IT functions and roles to providers outside their organizational boundaries and control. Ownership of data is a particularly complex issue for higher education, with state and federal legislation and regulations.

When evaluating a cloud provider's security practices, institutional leaders can take comfort in the number of security taxonomies already in place. Information about the ten domains of IT security, as well as a resource guide for information security, is available from the International Information Systems Security Certification Consortium (ISC)² website (http://www.isc2.org). In addition, EDUCAUSE and the National Association of College and University Attorneys (NACUA) have collaborated in developing resources for assessing and contracting for security provisions when implementing cloud computing.⁵

**Identity Management**
Cloud-based services can manage identities and user authentication/authorization as part of the service, requiring the institution or users to maintain a digital identity with the service provider. For some service providers, this is the default mode of operation, and a component of deployment is the provisioning of identifiers and credentials for each user. These service-based identities may or may not be synchronized with identities at the home institution; regardless, ongoing maintenance is required, as well as an appreciation for the risks and benefits of cloud-based identity management.
**Portability**

The cloud-service space is relatively immature with significant volatility, making vendor lock-in a higher risk than onsite services. A business-continuity plan must be prepared in case a vendor or service is suddenly unavailable. Such a plan should provide for a way to continue operations as well as a way to obtain institutional data. Institutions should be cautious about a proprietary application programming interface (API) for utilizing the cloud service, since this may limit the institution's ability to change providers easily. A number of efforts—such as the Deltacloud project (http://incubator.apache.org/deltacloud/) and the Open Cloud Consortium project (http://opencloudconsortium.org/)—can provide a common API so that institutions can move from provider to provider as well as use multiple providers.

**E-Discovery**

E-Discovery refers to the need to hold or freeze electronic information for possible discovery in legal proceedings. When electronic data (e-mail, database entries, data files) is on-premise and controlled by a central organization, relevant information is typically identified and then held in a frozen state, often by making a copy. Most organizations use a set of tools to enable the discovery and copying process.

When electronic data is in the cloud, however, this process may be difficult to conduct unless a contract specifies data and log ownership and access. Internal investigations of illegal or inappropriate activity, as well as legal or administrative electronic discovery requests, are time-consuming endeavors in the best situations. Responding to a discovery request can be challenging when the data are physically off-site and the architecture of the vendor system may require additional provider negotiation if these needs are not anticipated in the contract. Steve McDonald, general counsel of the Rhode Island School of Design, states: “It is important to understand—ahead of time—the architecture...
of the vendor’s system, how and in what format it keeps your data, and what tools are available to you to access your data so that you will be ready for any e-discovery needs that may arise.”

**Risk Assessment and Transparency**

As with any service, risk assessment should be part of the planning process to ensure that the contractual aspects of the service incorporate appropriate institutional protections. In general, a deep risk assessment of cloud services is difficult due to the lack of operational transparency and the inability to audit the provider’s security practices via tools such as a penetration test. Services that are difficult to audit include back-up procedures, data destruction, and systems and personnel monitoring. Some measure of risk can be determined, as seen in the University of Florida’s guide for SaaS assessment. Still, in the last decade, SaaS providers have shifted from either owning their own infrastructure or employing a co-location strategy to relying on alternative sourcing service providers for platforms and infrastructure. This supply chain makes accountability challenging for institutions.

**Contracts**

In J.R.R. Tolkien’s “Lord of the Rings” mythology, the sinister “One Ring that binds them all”—forged to dominate living beings and their domains—was impervious to damage. Though an IT outsourcing contract (or service level agreement, if sourcing locally) need not be sinister, it should be the One Ring that binds together all of the service delivery, performance, reliability, change management, access control, security, and support elements of an institution’s cloud environment. The contract should also affirm an institution’s ownership rights to the stored data and, if appropriate, intellectual rights to software code. Although many contracts also provide for financial sanctions in the event of a service outage, such sanctions may prove cold comfort in the wake of a prolonged outage, data loss, or loss of confidence in the service. Sanctions should therefore be seen as primarily a deterrent, and the institution should instead focus on both a contractual method and a well-considered internal exit strategy should the need arise to discontinue the service. The good news is that many state and federal governmental entities and peer institutions may already have contracts with alternative source and cloud providers. Before a college or university attempts to write its own contract from scratch, it should check with other institutions and state agencies. For example, at least five states (New York, Oregon, Colorado, Iowa, and Maryland) have contracted with Google for the use of some of Google’s applications. In addition, an EDUCAUSE wiki lists example contract clauses.

**Summary**

Although these service offerings are still evolving, alternative IT sourcing can offer an institution the flexibility and agility it needs to meet changing expectations.

**Mobility**

The pervasiveness of mobile devices today allows for just-in-time/anyplace access to a body of knowledge, encourages participation and collaboration, and facilitates the gathering of information to a degree never before realized. Smart phones, tablets, slates, and other mobile devices have given users instant access to information, an ability to capture creative thoughts as they happen, and a personal publishing and content-creation platform that can multiply individual knowledge through the collective intelligence of a personal learning network and beyond. In other words, mobile technologies are what we are using to make connections on a day-to-day basis:

- 5.1 billion people have mobile phone subscriptions, while only 4.2 billion people have toothbrushes.
- At colleges and universities, 63 percent of students have smart phones.
- In the United States, 59 percent of adults access the Internet wirelessly, with 65 percent of 18–29-year-olds accessing the Internet with a mobile device.
- In addition to Internet access, 95 percent of 18–29-year-olds use their mobile phones to send and receive text messages.
- In 2010, 40 percent of adults went online wirelessly with a mobile phone, compared with 32 percent in 2009.
- 95 percent of 18–34-year-olds have a mobile phone.
- 70 percent of 18–34-year-olds own a laptop.

In addition to being wireless communication devices, these mobile technologies can enhance learning. Mobile devices can increase the availability of access, particularly among lower-income, lower-education households. In a 2010 Pew Internet & American Life Project, Aaron Smith noted that in these households, primary access to
the Internet via a mobile phone is more prevalent than in higher-income, higher-education households. These findings should promote strong mobility strategies in higher education.

**Importance of Mobility: What Does Mobility Enable?**

Mobility allows us to increase our access, efficiency, and effectiveness in meeting process needs in the areas of higher education teaching and learning, research, and business services. Mobility facilitates the ability to retrieve, gather, and share information despite distance in space and time. It not only provides students access to course content and information but also offers opportunities for dialogue and collaboration in order to meet higher-order learning needs. Faculty can overcome the challenges of the face-to-face classroom and static learning technologies by using mobile technologies to create more informed classes, facilitate an instant exchange of ideas and gathering of feedback, use new methods of student assessment through digital media, and provide experiential learning opportunities.

In addition, whereas traditional research methodologies can be extremely time-consuming, mobility facilitates the gathering of quantitative and qualitative data. Surveys can be administered via mobile devices (web-based and app-based) to collect data and responses from the identified sample. Qualitative data is not only more easily gathered but also more easily analyzed. Interviews and focus groups are captured with audio-and video-recording systems on mobile devices. Further, these devices can transcribe this rich media (audio data) into textual data that can then be coded and analyzed.

Finally, the most prominent move toward mobile devices on campus may be in administrative uses. Many staff are moving to mobile devices (e.g., tablets) to increase their ability and efficiency in performing work-related tasks such as checking e-mail, developing and sharing information, and instantly accessing information. These devices also make it easier to share and collaborate in face-to-face meetings and to decrease paper consumption. Campus units are able to more easily provide timely information and access to services. Students can review the schedule of classes, register for classes,
review their financial information, pay tuition, view their Class schedule, schedule an appointment with an advisor, get updates on student groups to which they belong, e-mail their instructors, and access the LMS to check grades.

Mobile devices can transform campus processes across the institution and across diverse audiences—from parents and prospective students to alumni and administrators. Mobility has the potential to enhance the student experience from first contact with the institution to graduation and beyond while also creating a more productive workplace for faculty and staff.

Evolving Mobile Technologies
Mobile technologies have been around since the widespread availability of books and ink and paper. The printing press allowed for learning to occur whenever there was a book and a reader. As these technologies continue to evolve, the areas of teaching and learning, research, and administration have an opportunity to evolve as well, to transcend physical and temporal boundaries to increase efficiency and, potentially, effectiveness.

With more than fifty different types of tablets introduced at the Consumer Electronics Show (CES), this format is one of the most significant evolving mobile technologies of 2011, as emphasized by the iPad 2 and the Motorola Xoom, which was chosen as Best of Show at the 2011 CES. Tablets offer wireless capabilities, a light weight and small form factor, and easy-to-use applications. Dual cameras on tablets allow users both to capture images and videos and to edit those rich media. Further, videoconferencing allows for increased collaboration among students, researchers, teachers, and staff. In addition, continuous development of applications for the Apple and Android markets is making tablets more attractive for day-to-day use. Yet even though tablets are gaining quickly in popularity, there is little diffusion among students on campuses at this time, giving administrators, instructional technologists, teachers, and student-support staff time to identify the campus processes that can be best facilitated with tablets.

The lack of Adobe Flash support is currently a primary challenge with certain tablets. For example, Apple has made it clear that it will support only HTML5, whereas Motorola does support Flash. Many campuses have spent tremendous human resources in training and design to produce content (e.g., voice-over lectures) in a Flash-based format because it is easier to view in a browser and does not require downloading a video. This raises the question as to what format is best for developing higher education content for distribution to students and the community.

Implementation: Readiness, Challenges, and Best Practices
Institutions pursuing mobile initiatives need to consider the capacity of their campus infrastructure and the accessibility of their content and services. Although most students have laptops, many still do not have mobile app-based phones or tablets (e.g., Android and Apple). This parallels what we see in the social use of mobile devices. According to Robin Wauters: “Smartphone apps are still in vogue, and most mobile app stores continue to grow by leaps and bounds. Yet consumers spend more time engaging with the mobile Web on their smartphones.” Further, although many students have data plans, these plans may allow for texting and e-mail but may not have sufficient capacity for extensive browsing. Consequently, it would be wise to explore practices that exploit the technologies that students already have in their hands. Researching and evaluating the mobile technologies being used by students, faculty, and staff on a given campus is essential to targeting mobile initiatives based on evidence rather than speculation.

Through such research and evaluation, faculty and staff can ascertain students’ abilities to access applications through mobile devices. Only then can an appropriate array of mobile web-based learning activities be integrated into classrooms. These activities can include web-based access to course content as well as student response systems and input-gathering mechanisms. Students can access course content via their mobile browsers from the course management system or other web-based repositories. Further, students can participate, contribute, and provide feedback through their mobile browsers using web-based clickers, online polling systems, and Twitter backchannel. However, data access requires more than a mobile device; it also requires network availability within the IT infrastructure.

In pursuing campus mobile initiatives, institutions need to consider several factors regarding their infrastructure capacity. As Josh Keller notes: “The hype has outpaced the reality, to judge from the experiences of Stanford and other colleges. Getting iPads and iPhones in the hands of college students is the easy part; rebuilding campus infrastructure to support mobile devices is expensive.” One of the first infrastructure
components to consider is access to the Internet through the campus wireless system. Mobile devices will require access to the Internet to facilitate the use of mobile browsing and mobile applications. Although some students may have a data plan through a wireless service provider, many may require access to the Internet and data through the campus wireless system. Campus wireless systems should be easy to access, have persistent sign-on, and have the bandwidth and capacity to serve mobile users.

The following scenario illustrates the potential challenge. A lecture hall of 200 students is required to participate in a learning activity designed to increase engagement and interactivity, such as a feedback or backchannel comment (e.g., web clickers, Twitter backchannel). Most lecture halls currently have capacity for only a limited number of wireless access points, which typically do not match the room capacity. Further, the bandwidth of the data for the room may not be appropriate for the activity in which these 200 students will participate. If a faculty member requires 200 students to utilize a mobile device for a learning activity, there may not be adequate wireless access points or data capabilities for every student to participate.

Sufficient power is another key infrastructure consideration. As initial mobile pilot projects have indicated, active use of mobile devices during a class drains power; students thus leave the class with dead phones, lowering their satisfaction with mobile learning initiatives. Many classrooms do not have an adequate power infrastructure. There may be a few outlets scattered on the side walls, leading to power availability tied to seating arrangements. Not only are additional power outlets essential, but additional breakers are also needed to manage the additional outlets. Outfitting rooms with the appropriate power infrastructure can be costly; an alternative is “power-up stations” located outside of classrooms in common areas. These recharging stations are a cost-effective way to provide a needed resource for students and for mobile initiatives on campus. However, their placement across a campus needs to be strategic to provide greater access to power resources in areas where students normally congregate. In addition, some companies are now exploring wireless power charging capabilities, which will greatly improve the ability to implement campus mobile initiatives in the future.

When considering “mobile-friendliness,” institutions must understand how their content and services can best be developed for mobile browsers and devices. As students move beyond social uses of mobile devices, they will expect to use their mobile devices to access institutional content and services. Campus information needs to be developed for a portable medium; campus websites need to be accessible from mobile browsers; and campus services need to be delivered on mobile devices. However, mobile application development may not be the best development approach. Some colleges and universities—such as the University of California–San Diego, one of the first mobile application users—are deserting applications to focus on mobile web development of campus information.

But before considering how to develop mobile resources, institutions should first determine who is going to develop them. Many campuses are training staff in developing mobile applications, while others are hiring new staff to meet the need. Still other campuses are outsourcing the work to a third party. Initial applications typically focus on campus business services, an important step in strategic planning for a mobile future. The question that does not have a clear answer at most colleges and universities is, Who will develop pedagogically driven mobile apps to improve teaching and learning in the classroom? Publishers, vendors, staff, faculty?

The development of classroom applications that will improve teaching and learning requires a unique combination of technical capacity and pedagogical vision. It is a ripe era for interdisciplinary collaborations in order to identify pedagogical needs that can be met with mobile learning, to highlight effective pedagogies for mobile learning, to develop mobile applications that can facilitate improved learning outcomes, and to research the effectiveness of mobile processes on teaching and learning.

**Summary**

Although the mobile devices themselves are changing rapidly, it is clear that colleges and universities can start making an institutional commitment to support these devices through changes to the campus infrastructure as well as pedagogical activities in the classroom.

**Call to Action**

Neither technology—alternative IT sourcing and mobility—can evolve without leadership, which itself is evolving.
Much of the future of technology in higher education will thus be determined less by the technologies themselves and more by the leaders guiding the strategic use of these technologies. Leaders of postsecondary institutions face an environment very different from that of their predecessors only a generation ago. Entering freshman classes are no longer composed predominantly of high school graduates eager to attend a post-secondary institution as an extension of their school life and a ticket to their economic future. Higher education learner cohorts have become more demographically heterogeneous, with more complex expectations, abilities, requirements, learning preferences, and socioeconomic circumstances than learners in previous generations. Today, the “traditional” student arrives with learning modalities distinctly different from those of the students who arrived prior to the post-PC era. As a result, the singular mode of knowledge delivery can no longer claim to meet the learning requirements of this evolving demographic. We are moving into a multimodal milieu in which the creation and dissemination of knowledge will require a variety of bandwidths, both literally and figuratively, to allow disparate communities to fully engage.

Information technology has a critical enabling role to play. To meet the responsibilities of this role, technology leaders must participate in strategy creation as well as operational delivery within higher education institutions. The question is not whether the IT organization should play a bigger role, but how and with whom. If higher education is to fulfill its social, political, economic, and educational mandates, it will need to incorporate technology to a far greater extent than it has to date. A peripheral adoption of enhanced learning technologies will no longer suffice. The future of higher education—the view to tomorrow—is irrevocably integrated and intertwined with evolving technologies such as alternative IT sourcing and mobility.

Notes
5. See <http://www.educause.edu/wiki/Cloud%20Fimplementation>.
13. Ibid., p. 5.
16. Ibid.
18. See, for example, the Mobile Computing Program at Seton Hall University: <http://www.shu.edu/offices/technology/about-mobile-computing.cfm>.

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Molly Tamarkin (tamarkin@duke.edu) is Associate University Librarian for Information Technology at Duke University and Co-Chair of the 2011 EDUCAUSE Evolving Technologies Committee. Shelley Rodrigo (shelley.rodrigo@gmail.com) is Residential Faculty at Mesa Community College and Co-Chair of the 2011 EDUCAUSE Evolving Technologies Committee.