Game Changers

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FROM THE EDITOR

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—Diana G. Oblinger

IT as a Game Changer

Diana G. Oblinger

INFORMATION TECHNOLOGY CAN BE A GAME CHANGER in higher education, as it has been in other sectors. IT has brought about much of the economic growth of the past century, accelerating globalization and fostering democracy. Such broad impacts would be impossible if "information technology" were only a set of technologies. As our use of mobile devices, games, and social networks illustrates, IT can create new experiences. But more importantly, IT enables new models. It can disaggregate and decouple products and processes, allowing the creation of new value propositions, value chains, and enterprises. These new models can help higher education serve new groups of students, in greater numbers, and with better learning outcomes.

As important as IT might be, technology does not have impact in isolation—it operates as one element in a complex adaptive system. For example, in order for IT to be a game changer, it requires that we consider learners as well as the experience that the student, faculty, institution, and technology co-create. The system is defined, in part, by faculty workload, courses, credentialing, financial models, and more. To realize changes through information technology, higher education must focus on more than technology.

This chapter explores many ways that information technology can be a game changer. Some are as simple as using IT as a delivery channel for information or services. In other cases, IT creates unique experiences, whether in learning or student support. Perhaps most important for the future are the examples of IT enabling alternative models that improve choice, decision making, and student success.

Convenience

Information technology is a tool of convenience—IT can change the game by making it easier for us to do the things we should. For example, mobiles

allow us to stay in touch anywhere. Mobile applications help us find the fastest route to our destination, the best restaurants, and the least-expensive gasoline. Mobile applications allow students to receive grades, register online, anticipate the arrival of the bus, listen to lectures, collect field data, connect to their tutor, look up resources, and more. Even simple, convenient tools such as e-mail have been transformative for students and faculty, providing better communication, instant assignment submission, and exchanges outside of office hours.

Convenience is the primary value students cite for technology in higher education today. It makes accessing resources, administrative tasks (e.g., registering for classes, paying tuition), and academic work faster and easier. Students believe technology makes them more productive. Students own many different kinds of technology, but their preference is for small, mobile devices. A majority of students own a laptop (87 percent), an iPod (62 percent), a smartphone (55 percent), a digital camera (55 percent), and a webcam (55 percent). Communication with technology is convenient. Virtually all students (99 percent) use e-mail, text messaging (93 percent), Facebook (90 percent), and instant messaging (81 percent).[1]

IT serves as a delivery channel for information of all kinds, increasing convenience, access, and flexibility. Millions of books are available online (e.g., Google Books); lectures come in all formats (e.g., podcasts, YouTube, Khan Academy). Beyond information, IT serves as a convenient delivery channel for academic support programs (e.g., Smarthinking) and online courses (e.g., StraighterLine). Access to colleges or universities, whether to their student services, instruction, or the library, can occur anytime and anywhere. Alternative models for cost and pedagogy are possible when information and processes move online, but convenience alone can change the game.

Improving the College Experience

IT's impact goes beyond convenience—it can change the game through the student's experience. The college or university "experience" is more than the classroom, the course, or the campus. The experience is determined by social, technical, and intellectual interactions involving students, faculty, and staff; the organization; and the infrastructure, including technology. Contrast the student experience—before and after IT—of registration, the "card catalog," or receiving grades. The value is not in the tool, per se, but in the streamlined, more user-friendly experience IT can help create.

Experts in service science and service systems are applying the discipline to higher education.[2] Service science asserts that the customer and the service provider co-create value. Value is not in the product (e.g., a course or a degree) but in the experience created by interaction, such as that occurring

between faculty and students. For example, the real value of a course may lie in the critical thinking a faculty member encourages in a student, the integration of content with real-world experience, and the motivation to continue learning and solve important problems.

Learners' backgrounds and expectations impact their college experience and what they value. Students bring radically different levels of readiness, goals, and needs to higher education. Some value the on-campus experience; others are more focused on employability. A range of educational options are emerging to accommodate this diversity. These models are increasingly predicated on personalization and support systems that allow students to address their challenges and achieve their goals, whether they are well prepared or unprepared for college. For those students who come fully prepared, higher education can find new and innovative ways to add even greater value to their educational experience.[3]

The "college experience" has many facets. Learning and student support illustrate how IT can change their experience.

Learning

A high-quality learning experience changes the game for students. Unfortunately, our existing structures for teaching are not adequate for our current understanding of learning—which is experiential, socially constructed, and interdisciplinary.[4] If learning is assumed to be confined to the classroom or a lecture, valuable opportunities are lost.

Consider a student's traditional class experience being transformed with augmented reality, which uses mobiles and context-aware technologies to allow participants to interact with digital information, videos, visualizations, and simulations embedded in a physical setting (e.g., see http://ecomobile.gse.harvard.edu).[5] Assessment is another element of the learning experience. Paper and pencil tests cannot measure what students really know. IT enables very different assessments through detailed observations of performances. For example, a simulation can present students with a six-legged frog, asking students for a hypothesis, and letting them choose what to do, as well as how. In the process, they illustrate their ability to

- design a scientific investigation;
- use appropriate tools and techniques to gather, analyze, and interpret data;
- develop prescriptions, explanations, predictions, and models using evidence; and
- think critically and logically.[6]

Today, courses may be better thought of as tools to manage time, staff, and resources or as building blocks for the discipline. However, the bounded, self-contained course can no longer be the central unit of analysis of the curriculum because it may no longer be the place where the most significant learning takes place.[7] In the "postcourse era," learning occurs through inquiry and participation, social connections (e.g., blogs, wikis), and reflection.

Features of valuable learning experiences, which may be found inside or outside of courses and enabled by information technology, include:[8]

Pro-am: The apprenticeship model embodies a professional-amateur ("pro-am") approach to learning—also called "cognitive apprenticeship."[9] Learners gain skills and accelerate their development by interacting with others who are more expert. Online communities such as nanoHUB.org (http://nanohub.org) can provide such pro-am opportunities. NanoHUB.org is a collaborative community involving undergraduate and graduate students, faculty, and industry experts. This "pro-am" network shares instruction and simulations, as well as research tools and results.

Hard fun: Learning experiences that are instructionally and intellectually challenging and engaging are "hard fun."[10] Emotional engagement (surprise, puzzlement, awe) increases learner effort and attention, improving learning outcomes. Games are designed to provide "hard fun," as are simulations and other immersive environments.

Real world: Students are motivated by engaging in real-world problems that matter to them. Technology provides new opportunities for "real-world" experiences through simulations, virtual environments, gaming, open-innovation networks, and other approaches. For example, virtual trading rooms allow students to "trade" stocks. Nursing students use mannequins and simulations to practice procedures. Capstone experiences often focus on real-world problems. Such activities have high impact because students discover the relevance of learning through real-world application.[11]

Feed-forward: Along with providing feedback, the learning experience should draw learners into new experiences, engaging them in "wanting to know" and connecting them with how to learn more. Recommendation systems can support "feed-forward" mechanisms, e.g., suggesting the next course or experience.

Structured autonomy: Students can drive their own learning, but not without structure or support. Assistance can be provided by motivating students, providing them with a road map or pathway, and by providing the prompts, guides, and hints that can help learners past obstacles. Carnegie Mellon University's Open Learning Initiative (OLI) provides these types of guides and supports for learners (see Chapter 15). Online communities—formal and informal—can provide support, as well.

Support Services

Information technology can change the college or university experience through its impact on support services. The "experience" of the library is no longer a card catalog (even one online)—it is about portals, learning commons, and integrated support. The "experience" of advising is not limited to course selection—it is a reflective and integrative experience involving e-portfolios, allowing students to organize learning around themselves (aspirations, achievements, and reflections), rather than just around courses or the curriculum.[12] Beyond the many examples of how IT changes student support, the way it shifts models is also important. Three examples illustrate some options.

Peer-to-peer: Academic support can be distributed throughout the community—a peer-to-peer approach—rather than being provided by an "expert." For example, OpenStudy (http://www.openstudy.com) allows students to help each other rather than relying on a faculty member. OpenStudy is a social-learning network where students can give and receive help. Assistance may be in the form of a live chat, a response posted online, or through a drawing board where users help each other solve problems. Grockit (https://grockit.com/) is another example of an online social-studying network, with participants in 170 countries. Few institutions can provide expert help 24/7 within traditional structures. A shift to a peer-to-peer model provides new opportunities.

External service provider: Services are provided by organizations outside of higher education. For example, Parchment (http://www.parchment.com) allows users to request, store, and send educational credentials. Beyond sending transcripts to prospective institutions, students can use their transcript to compare their credentials with what colleges require, receiving recommendations about where to apply. Parchment also allows students to estimate their chances of being admitted to a specific institution and to compare themselves with other applicants.

Informed choice: Other services link education and careers, helping students make better-informed choices. Career Cruising (http://public.careercruising.com/us/en) encourages students to think about their future career goals and the studies required to achieve those goals. For younger ages, an educational game helps students learn more about careers, life planning, and social skills. Other related services are provided as well, such as test preparation (e.g., for ACT and SAT exams), tools to help students manage college applications, and role-playing modules.

Collaboration

IT can change the game through its catalytic role in collaboration. With the Internet, everything and everyone is connected. It provides an architecture for participation and collaboration.[13] Individuals are empowered with information. Teams can form around any topic or problem. IT has created a participatory culture.

Wikipedia is a well-known example of participation and collaboration. The technology provides an infrastructure that allows individuals to contribute what they know to a collective work that becomes better through sharing and use. Individual contributions are not limited by training, title, or employer. Wikipedia illustrates the subtle shift in emphasis from IT as a technology to its value in facilitating a process of collaboration whereby value is created through the interaction of contributors and users.[14] The result is a community product.

IT and collaboration form the basis for crowdsourcing, such as when innovation and problem solving come from the global community, not just an internal R&D unit. At a scale never before possible, collaboration is being harnessed to solve some of higher education and society's most challenging problems. These collaborations are important for higher education because they represent real-world experiences, personal contributions, and opportunities for research, as well.

For example, Innovation Exchange (http://www.innovationexchange.com) allows community members to respond to challenges sponsored by Global 5000 companies and not-for-profit organizations (e.g., minimizing the water used for cleaning and sanitizing, making multilayered packaging more recyclable). The web-based community expands the sponsors' innovation capacity beyond their internal research and development teams. Innovation Exchange uses a pay-for-performance model (e.g., prizes of $50,000). TopCoder (http://www.topcoder.com) brings together a competitive software development community with over 250,000 coders from 200 countries. The individual or individuals who develop the best code receive a prize.

Whether called open innovation, innovation intermediaries, or crowdsourcing, innovation is "outsourced" to the community, tapping into individual expertise, passion, and competitiveness. Because the work is not sourced "in-house," the model, costs, and reach all shift.

Colleges and universities engage in a variety of research and instructional collaborations. For example, a large cancer-research collaboration, caBIG, brings together a virtual network of data, individuals, and organizations to focus on cancer research. The community has redefined how research is conducted by adapting or building its own tools, connecting the community through

sharable, interoperable digital infrastructure and a common set of standards (http://cabig.cancer.gov/about/).

Citizen science is another manifestation of collaboration. Cornell University, for example, hosts a citizen-science site on ornithology (http://www.birds.cornell.edu). More than 200,000 people gather data, which allows scientists to determine how birds are affected by habitat loss, pollution, disease, and so forth, resulting in scientific papers (more than sixty since 1997), as well as management guidelines and advocacy material. Participation by "citizen scientists" (e.g., 1,000,000 bird observations reported to eBird on average each month; 15,000 people count birds at their feeders for Project FeederWatch) allows the researchers to extend their reach well beyond the university team.

Collaboration is tapped through a variety of formats, including games. Foldit (http://fold.it/portal) is a computer game enabling users to contribute to research about protein folding. Proteins influence many diseases (e.g., HIV/ AIDS, cancer, Alzheimer's); they can also be part of the cure. Protein structure determines how the protein works and how to target it with drugs. Protein folding is complex; current research methods are expensive even with supercomputers. Foldit takes advantage of humans' puzzle-solving intuitions—people play competitively to fold the proteins. Players also can design proteins to help prevent or treat important diseases. Foldit papers have been accepted in scientific journals such as *Nature Biotechnology*, *Nature*, and the *Proceedings of the National Academy of Sciences*.

Shared Infrastructure

IT enables sharing, including the sharing of expensive infrastructures—whether those are information, technology, or people. Because digital resources can be shared and are independent of time and location, it is increasingly possible for resources to be shared among institutions—aggregating supply/demand or use/curation. For example, digital copies of books can be used by multiple parties, even simultaneously. Rather than each institution digitizing copies of the same books, colleges and universities can choose which institution digitizes which volumes and which institution stores the original print version. Such collaborations can reduce costs (digitization, storage, etc.) and stretch resources.

For example, the libraries at Columbia University and Cornell University collaborate on digitizing and sharing library collections in a project named 2CUL (the moniker, pronounced "too cool," is derived the from libraries' acronyms). Although the broader 2CUL initiative encompasses many areas of

shared library services, such as collection development, cataloging, and staff expertise, a key focus of the project is developing the technology infrastructure that enables the partners to improve book and digital-document delivery and e-resource management, as well as provide a shared long-term archive of digital materials. Columbia and Cornell believe this shared service will transform the way their library systems provide content and services to their constituencies, realizing that they can achieve more together than they can alone.

HathiTrust provides another example of shared infrastructure. HathiTrust is a large-scale repository of digital materials owned by a collective of over sixty research libraries in the United States and one in Europe. HathiTrust operates on a model of shared governance and financing, collecting, preserving, and making digital materials accessible. Also, HathiTrust is developing discovery and computational tools that enable researchers to search and analyze digital content, including formats other than books and journals. As of late 2011, the trust's repository contains almost 10 million digital volumes, 27 percent of which are public domain titles.

Other types of infrastructure can be shared as well, such as networks, processing capability, and data storage. For example, TeraGrid was a grid computing infrastructure (high-performance computing resources, databases, tools, and experimental facilities) combining the resources of eleven institutions. Learning tools can also be shared. For example, iLabs is a collection of online laboratories that can be accessed through the Internet, allowing students to conduct lab experiments anywhere and at any time. Open-courseware collections could be considered a shared infrastructure. For example, the Saylor Foundation's Saylor.org is an open-access online-learning platform that provides self-paced college-level courseware to the public free of charge.

Informed Decision Making

IT can change the game by enabling better decisions. Colleges and universities strive to improve their decision making, often turning to analytics. Analytics can include trend analysis, regression analysis, forecasting, simulation, prediction, data visualization, and optimization. Analytics can be used to spot trends or make choices. In business, for example, analytics is used to monitor credit cards for fraud, predict product needs, monitor "reputation" on social networks, and optimize workloads.

Higher education uses analytics to inform decisions about admissions, fund raising, learning, student retention, and operational efficiency. In an era

of "big data," analytics is more than reporting. There are more data than ever, and the speed of processing allows questions to be asked:

- What happened?
- How often and where?
- What exactly is the problem?
- What actions are needed?
- Why is this happening?
- What if these trends continue?
- What will happen next?
- What's the best that can happen?[15]

Higher education's adoption of analytics is growing in response to demands for accountability and the need for greater efficiency and continuous improvement.

Analytics can track and predict student performance, providing alerts to students when their patterns indicate they are at risk of poor performance. In other cases, faculty or advisors are alerted to potential problems, allowing them to intervene and provide specific types of assistance to students.

Purdue University's Course Signals project uses data from course management systems and other data sources. Algorithms are used to highlight patterns associated with poor performance. Alerts (e.g., e-mails) can be sent to students or faculty flagging those who might be at risk. With Course Signals, grades improved consistently at both the course and departmental level. Students in courses using Course Signals received more Bs and Cs, with fewer Ds and Fs, than those in sections that did not use the tool. For example, in a large undergraduate biology course, there was a 12 percent improvement in B and C grades, with a 14 percent reduction in D and F grades. While withdrawals remained about the same, there was a 14 percent increase in early withdrawals (those done early enough to avoid affecting the student's GPA).[16] In some courses, As and Bs increased as much as 28 percent.[17]

The University of Maryland, Baltimore County, uses analytics so that students can compare their progress with that of their peers through a self-service feedback tool, Check My Activity (CMA). CMA uses data from the university's course management system, allowing students to compare their online course activity against an anonymous group of peers who earned the same, a higher, or a lower grade for any assignment. Peer comparisons improve students' awareness and understanding of the link between their behaviors and performance as they monitor their course progress.[18]

Analytics can provide feedback to faculty and course designers, allowing

them to make targeted improvements to course material. Carnegie Mellon's Open Learning Initiative (OLI) uses analytics to gather feedback at multiple levels for continuous improvement, as well as for research. While students are working through the course, data are collected to provide insight to students, faculty, course designers, and learning scientists. In a study of the OLI statistics course, students learned a full semester's worth of material in half the time and performed as well as or better than students using traditional instruction over a full semester. Retention of material was not significantly different when OLI and traditional students were tested more than a semester later.[19] In tests of OLI at community colleges, students learned 33 percent more material in the OLI sections.[20] (See Chapter 15.)

Making good choices about a program of study may be as important as knowing how well a course is progressing. Choosing the best course, sequence of courses, and program of study is a game changer for students and institutions. *Ambient intelligence* is a term used to describe services that personalize recommendations for users, such as recommendations one might receive on Amazon. Ambient intelligence is dependent on information technology to collect fine-grained information about users, compare it with information from millions of others, and return tailored recommendations that are adaptive (e.g., change in response to users), personalized, and anticipatory. Ambient intelligence powers sites such as eHarmony, Netflix, and others.

Many students have difficulty knowing what courses to take—courses that will apply toward their degree as well as courses that suit their learning style or schedule. Applications that compare a student with others who have similar goals and preferences can suggest courses or degree options for students. With hundreds or even thousands of options, students (and advisors) may find the alternatives too overwhelming to make the best-informed choice.

Applications such as SHERPA (Service-Oriented Higher Education Recommendation Personalization Assistant), developed by Saddleback College in Orange County, California, remember students' preferences and make recommendations for courses, scheduling, and open sections. Such recommendation engines can help both students and advisors who are challenged to know all the available and appropriate options—especially if students have work schedules or other personal circumstances to accommodate.[21]

Austin Peay State University's course recommendation system, Degree Compass, provides personal recommendations to students for courses that best suit their program of study and their talents. The recommendations are not based on what students will "like" the most, but on the courses that apply to the students' program of study, course sequencing, and where they are likely to achieve the best outcomes. The system provides information to advisors

and department chairs to help them target interventions and adjust course availability, as well. Students benefit through reduced time to graduation. Future enhancements may help students select majors. (See Case Study 3.)

Other recommendation engines are being developed to help guide students through transfer and degree completion, such as the University of Hawaii's STAR program. (See Case Study 7.) The cost and time savings could be significant. One national estimate of the redundant costs to students, institutions (e.g., financial aid), and government (e.g., delayed tax revenue) for students who take too many credits (through inefficient transfer or excess credits) is $30 billion per year. The annual costs for credits that do not help a student move toward a degree are estimated to exceed $7 billion.[22]

Unbundling and Rebundling

Beyond its value as technology, IT is a game changer by enabling new models through its ability to decouple, disaggregate, and dematerialize.[23] Clayton Christensen's theory of "disruptive innovation" highlights IT as the catalyst of new models that may be a result of splitting, substituting, augmenting, excluding, and/or inverting. Such models not only use technology but are based on different business models.

A business model is an organization's blueprint for creating, delivering, and capturing value. All models involve a "customer value proposition," a "value chain," and a revenue formula. Possible models for higher education include:[24]

- Open business models—these models use external as well as internal ideas and resources. For example, an "outside in" model uses external ideas and resources to support the institution (e.g., open educational resources used in courses).

- Unbundled models—in these models, providers of specific products (e.g., student recruitment services or infrastructure services) are integrated into an institution's structure.

- Facilitated network models—these bring together a mixture of products and services from multiple organizations to improve a service.

Information technology allows institutions to unbundle and rebundle many activities that were previously bound to a physical location (e.g., the campus) or assumed to be the role of a single individual (e.g., a faculty member). This ability to mix-and-match in new ways makes it possible for institutions to change traditional models. Institutions such as BYU-Idaho are choosing to not replicate all the elements of a traditional college or university model. In

the case of BYU-Idaho, the academic calendar, faculty rewards, intercollegiate athletics, and instructional models are different.[25] They have documented improvements in the quality of the student experience, lowered the relative cost of education, and served more students.[26]

Western Governors University is a well-known institution that has selectively unbundled and rebundled traditional university functions. For example, WGU has separated traditional faculty roles, unbundling curriculum development from course delivery. Faculty identify the best courses but do not write the courses themselves. Mentoring is provided at the course level as well as through the student's program of study; mentors do not develop the curriculum. Credit hours as the unit of measurement have been displaced by competency exams (see Chapter 9). Similarly, the University of Phoenix distributes faculty roles differently from traditional institutions, centralizing course development, for example (see Chapter 10).

Peer 2 Peer University (P2PU) is an open-education project that uses peer learning rather than instructor-led learning, unbundling and rebundling a number of traditional elements. P2PU uses volunteer-facilitated courses, informal study groups, and one-on-one mentorship and community support. Anyone can decide to run a course or create a study group. Open educational resources and online social learning provide the learning experience. P2PU does not certify learning or offer degrees.

Experiments on the certification of learning are being conducted through programs such as Mozilla Badges (see Case Study 6) and OER university (http://wikieducator.org/OER_university/Home). These models decouple learning and certification. OER university, for example, is not intended to be a formal teaching institution. Rather, it is designed as a partnership with accredited institutions that provides credit for open educational resources–based learning.

Although more common in business and industry, many organizations contract for their online services through others (e.g., Target's online site is powered by Amazon). Higher education institutions contract for services with hundreds of firms. Institutions such as the University of Southern California (USC) have outsourced online program development (e.g., to 2tor for the USC Master of Teaching program; see Chapter 17). Other providers, such as Altius Education, provide online program-development services to institutions such as Tiffin University.[27]

The number of organizations providing disaggregated services has grown significantly in the last several years. Smarthinking provides course support. Khan Academy and YouTube provide videos and online lectures. Groups such as GoingOn provide platforms for academic and social engagement through

online communities and Facebook-like exchanges. Courses are provided through such avenues as the OpenCourseWare (OCW) initiative, a large-scale, web-based publication of MIT course materials. These organizations make it easier for higher education to assemble the most appropriate mixture of products and services, offered by multiple organizations. These services help institutions achieve greater economies of scale—and economies of scope, by offering the wide array of programs and services desired by students.[28] Colleges and universities can selectively assemble the elements that best serve their needs.

Conclusion

We ask a great deal of higher education: "to prepare leaders, train employees, provide the creative base for scientific and artistic discovery, transmit past culture, create new knowledge, redress the legacies of discrimination, and ensure continuation of democratic principles." No matter how much higher education has achieved, we have greater expectations—for our students, our institutions, and our society. In an age reshaped by technology, we have great expectations that IT can help higher education achieve even more.

A large number of educational practitioners are using IT to reshape education. The hope is that even more individuals and institutions will do so. Our greatest challenge will not be IT but our ability to *un*learn our experience of higher education. Our assumptions, beliefs, and behaviors may be unconscious.[29] What kind of higher education enterprise would we create if we treated all beliefs as hypotheses rather than rigid legacies?[30] Information technology can be a game changer in the complex adaptive system that is higher education. Consider the technologies that have changed the game and changed our models—the Internet, e-mail, Facebook, Twitter, instant messaging, Wikipedia, and more.

Higher education must move beyond the fear of what we have to lose with IT and new models. Different models serve different needs. For higher education to achieve its mission, we owe it to ourselves and society to use IT well and wisely. It can be a game changer.

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