Information technology can be a game changer in higher education, as it has been in other sectors. Information technology 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, information technology can create new experiences. But more important, information technology 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 information technology might be, technology does not have impact in isolation—it operates as one element in a complex adaptive system. For example, in order for information technology 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 information technology as a delivery channel for information or services. In other cases, information technology creates unique experiences, whether in learning or student support. Perhaps most important for the future are the examples of IT use enabling alternative models that improve choice, decision making, and student success.

**Convenience**

Information technology is a tool of convenience—information technology can change the game by making it easier for us to do the things we should. For example, mobile devices 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, doing administrative tasks (e.g., registering for classes, paying tuition), and performing 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%), an iPod (62%), a smartphone (55%), a digital camera (55%), and/or a webcam (55%). Communication with technology is convenient. Virtually all students (99%) use e-mail, text messaging (93%), Facebook (90%), and/or instant messaging (81%).

Information technology 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, technology 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**

The impact of information technology 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 information technology—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 information technology can help create.

Experts in service science and service systems are applying the discipline to higher education. 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 to solve important problems.

**The impact of information technology goes beyond convenience—it can change the game through the student’s experience.**

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.

The “college experience” has many facets. Learning and student support illustrate how information technology 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. 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 mobile devices 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). Assessment is another element of the learning experience. Paper-and-pencil tests cannot measure what students really know. Information technology 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 then 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.

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. In the “post-course 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 may be enabled by information technology, include the following:

- **Pro-am:** The apprenticeship model embodies a professional-amateur (“pro-am”) approach to learning—also called “cognitive apprenticeship.” 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.” Emotional engagement (surprise, puzzlement, awe) increases learners’ 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.

- **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—for example, by 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, supplying them with a road map or pathway, and offering the prompts, guides, and hints that can help learners move 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, which allow students to organize learning around themselves (their aspirations, achievements, and reflections) rather than just around courses or the curriculum. Beyond the many examples of how information technology 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 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 help (e.g., for ACT and SAT exams), tools to help students manage college applications, and role-playing modules.

**Collaboration**

Information technology 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. Individuals are empowered with information. Teams can form around any topic or problem. Information technology 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 information technology as a technology to information technology as a facilitator in a process of collaboration, whereby value is created through the interaction of contributors and users. The result is a community product.

Information technology 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 the most challenging problems of both higher education and society. These collaborations are important for higher education because they represent real-world experiences, personal contributions, and opportunities for research.

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 R&D 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 (http://cabig.cancer.gov/about), 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 and connecting the community through sharable, interoperable digital infrastructure and a common set of standards.

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, allowing 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 are 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**

Information technology enables sharing, including the sharing of expensive infrastructures—whether those infrastructures 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 (e.g., digitization, storage) 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 from the 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**

Information technology 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, fundraising, 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 is the best that can happen?

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
Information technology is a game changer by enabling new models through its ability to decouple, disaggregate, and dematerialize.
“customer value proposition,” a “value chain,” and a revenue formula. Possible models for higher education include the following:

- **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.24

Information technology allows institutions to unbundled and rebundled 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 to 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 to provide 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.

**Our greatest challenge will not be information technology but will be our ability to unlearn our experience of higher education.**

**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 logics of discrimination, and ensure continuation of democratic principles.”29 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 information technology can help higher education achieve even more.

A large number of educational practitioners are using information technology to reshape education. The hope is that even more individuals and institutions will do so. Our greatest challenge will not be information technology but will be our ability to unlearn our experience of higher education. Our assumptions, beliefs, and behaviors may be unconscious.30 What kind of higher education enterprise would we create if we treated all beliefs as
hypotheses rather than rigid legacies? 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 information technology and new models. Different models serve different needs. For higher education to achieve its mission, we owe it to ourselves and society to use information technology well and wisely. It can be a game changer.

Notes
3. Ibid.
6. Ibid.
12. Ibid.


30. Ibid.

31. Hamel, “Reinventing Management.”

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