Chapter 13
Education, Technology and Simple Innovation

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Abstract This chapter explores the current context of higher education, identifying six patterns which impact decision-making and either enable, inhibit or require innovation. Technological developments likely to have an impact on higher education are reviewed, and a model of innovation is introduced. It is suggested that, while some developments are occurring which are of interest, there are "pockets of innovation" everywhere in higher education—these are, in the big picture, not disruptive and not leading to major change in how higher education is funded, organized, managed and deployed. In short, technology is not producing the "transformation" or "revolution" in higher education which some had envisaged, at least not yet.

Keywords Demographics • Technology • Complexity • Innovation • Internationalization • Competitiveness • Risk • Transformation

13.1 Introduction

Educational technologies have been presented as a transformative force for schools, colleges and universities. Whether we are looking at the teaching of mathematics for K-12 students, access to higher education for traditionally disadvantaged groups or the transformation of universities or colleges as operating institutions, technology is seen to be "the answer". Take this example from Social Ventures Australia (2013) in an influential blog:

> For a world in a perpetual state of transformation, technology is shattering old certainties and erasing aged dogmas. It's redefining our professional systems and our personal networks. It's altering how we approach problems and is expanding the realm of what's possible. We now occupy a world that is connected on multiple dimensions and at a deeper level — a global system of systems. The same transformation is occurring in our classrooms. Gone are the days of the teacher barking orders to 30 students from a black board. In its place are carefully planned and easily adaptable lesson strategies to maximize student engagement. Technology is facilitating this shift.

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Or this from Friedman (2013) describing the "revolution" (*sic*) in higher education in the *New York Times*:

> I can see a day soon where you'll create your own college degree by taking the best online courses from the best professors from around the world — some computing from Stanford, some entrepreneurship from Wharton, some ethics from Brandeis, some literature from Edinburgh — paying only the nominal fee for the certificates of completion. It will change teaching, learning and the pathway to employment. "There is a new world unfolding," said Reif [President of MIT], "and everyone will have to adapt".

Yet a great majority of our schools, colleges and universities are not transformed or shifting to radical new approaches to teaching and learning because of technology. While blended learning is extensive, it is so precisely because it maintains the power relationships between learners and instructors: technology is helping to maintain traditional roles rather than transform them. The "revolution" envisaged by so many in 2013 is not producing the transformative behaviour or significantly improved results many expected and were confidently forecasting.

Indeed, there are signs that the educational technology revolution is faltering, at least in higher education. California's move to create an online university appears to have fizzled (Hechinger Report, 2015); many largely online universities like the University of Phoenix (USA), Athabasca University (Canada) and the Open University (UK) are struggling financially; and some private networks of colleges, such as Corinthian (also owners of WyoTech), have closed. Even Pearson Corporation, which is seeking to shift from being the world's largest publisher to being the world's learning company, is struggling (Reingold, 2015). The annual review of online learning developments in higher education in the USA published each year since 2009 shows that enrolment growth in online courses is slowing, though it still outpaces enrolment growth for more traditional programmes (Allen & Seaman, 2014).

While many primary, middle and secondary schools have embraced technology as part of their strategy to personalize and facilitate learning, there are growing cautions about the use of such technology in schools. There is a desire to leverage technology to enable choice, flexibility and individualization. Yet this desire is not matched by experience or by evidence. The advocates and vendors for technology in schools fail to fully recognize that high-quality learning environments are deeply relational, humanistic, creative, socially constructed, active and inquiry oriented (McRae, 2013).

So what is the transformative role of technology in education, and what kinds of innovation are leading to significantly improved learning outcomes for learners? What kind of changes can we expect to see which derive from developments in technology?

In this contribution Canada is used as a case study of innovation, change and development in education with a strong focus on higher education. In part, this is because Canada is an advanced nation with a high performance education system as measured by PISA and other indicators and is widely regarded for its technology developments, being the place where Desire2Learn and Blackboard were developed, the home of several major technology hubs and a place where significant investments have been made in online learning infrastructure.

13.2 Some Context

Before we explore innovation and the likely future for higher education, we need to understand the context. There are six contextual issues which need to be understood if we are to explore likely developments in colleges and universities in the developed world. In this observation the focus is Canada, but the same issues are applied elsewhere. These are:

13.2.1 Demography

Canada's demography is changing significantly. While the population will grow through to 2063, it will do so largely through immigration—Canada's birth rate is low (except amongst First Nations communities, which show the strongest birth rates, and recent immigrants). By 2030, three in ten Canadians will be from a visible minority. The most significant trend is the ageing of Canada's population. By 2030, one in four Canadians will be aged 65 or older, and the senior population will represent 22 % of all Canadians (this group currently represents 15 %). What is more, seniors will live longer as the life expectancy of Canadians continues to improve. This in turn will have major implications for the Canadian workforce. By 2030, there will be fewer people in the workforce. Not so long ago, there were almost five people of working age for every retiree, by 2030, there will be closer to two and the workforce will be expected to fund and support increased costs of health care, social services and education.

Such an analysis could also be provided for a great many countries, especially in the mature developed economies of Europe, Russia and parts of Asia. While global population will grow to some nine billion by 2050, this masks declining populations within regions of the developed world.

13.2.2 Structural Complexity

With the pursuit of massification of higher education since the mid-1960s, there has been a growing expectation that more and more individuals will attend college and universities and that educational attainment will continuously rise. Indeed, some provinces have committed to this as a strategic intention. In 2016 there are significantly more universities and colleges than there were in 1995. Canada now has 98 public universities and over 130 public colleges. Similar developments have occurred in most developed economies.

This has led to a complex system which has some barriers to learner mobility:

- Weak within and interprovincial or interstate transfer credit systems
- Weak systems for prior learning assessment

- Lack of portability for certain credentials (especially trades and certain professions), reflecting trade barriers and certification differences between provinces and states
- Weak but improving systems for the fast and efficient recognition of foreign credentials

The key issue for governments is whether, given expectation of a lower revenue base from taxation linked to demographic change, they can afford such a complex and comprehensive system. Put another way, just what portion of funding for the complex system which has evolved since the 1960s will be paid for by government and what portion by students and potential employers? It is already the case that several colleges and universities in Canada, the USA, the UK and elsewhere face technical bankruptcy.

13.2.3 Changing Student Expectations

As students pay more of the costs of their own education, they demand more in terms of quality, relevance and engagement. More specifically, students are seeking high-quality courses and programmes which are work relevant (but not solely focused on employment competencies) and engaging. They are much more critical of the quality of their education than many of their predecessors. As governments reduce their per capita expenditure on higher education (following the trend they have pursued for the last 20 years), these expectations will increase.

Students are looking for access to quality programmes, delivered with flexible options supported by coaches, guides and mentors who can personalize learning and leverage the knowledge and skills the learner brings to their studies. Many more are now looking at university and college courses, suggesting that the boundaries between such institutions will shift. By 2030 more joint or seamless programmes will be in place. They are also looking at shorter programmes with much more acceptance of credit transfer, work-based learning credit and prior learning assessment which is efficient and not cumbersome. The emergence of so-called micro-credit (e.g. badges), short courses, accelerated degrees and joint college/university integrated programmes are all responses to this need.

13.2.4 Costs and Competitiveness

As has been mentioned, several universities and colleges are facing financial challenges due to declining revenues from the government, changed market conditions and shifts in student demand. Others are looking at mergers, and there are likely, between now and 2030, to be significant structural changes in our systems of higher education throughout the developed world.

More significantly, a combination of global competitive forces in higher education and cost issues is forcing many institutions to rethink their curriculum focus

and strategic intentions—they are seeking differentiation. They are also looking initially at significantly increasing the international student population in their institutions (who pay higher fees), at employer- or government-sponsored programmes, shorter programmes (e.g. micro-credentials, badges), collaborative programmes and other initiatives, all of which are intended to either sustain or grow registrations and retention while increasing revenue. Governments are actively encouraging these developments. At the same time, institutions are looking at cost reduction through reimagining their labour costs and reducing the range and breadth of activity—using differentiated programming to create competitive advantage.

The challenge here is that these developments increase the competitive nature of the market for students and staff and represent significant shifts in the way in which colleges and universities undertake their work. Union agreements, especially faculty agreements, are not designed for such shifts or nimbleness. Some institutions are now "stuck" between an old paradigm and a new one and do not seem to be able to build the bridges needed to make this shift.

13.2.5 Internationalization

Some programmes in some institutions now have 30% or more of their students who are international students. More programmes include international study components, and more students are completing part of their programmes in countries other than those in which they are registered as programme students. More learners are coming to Canada, for example, with part of a programme completed in another country and more courses have international components and links to international research, applied research or organizations. Higher education is increasingly an international business.

The growth of a mobile international student body will continue, though it will become an increasingly competitive market as more institutions seek to capture these students. A variety of estimates suggests that, by 2030, some three million individuals will be seeking to study internationally—an increase of one million from 2015. At this time, the USA, the UK and Australia are preferred destinations, especially for postgraduate study. Indeed, the UK has become increasingly dependent on international students to fund its complex system and requires some 100,000 or more *new* international students each year to sustain the system. Recruitment depends very much on immigration rules, costs, relevance, security and quality of student life.

13.2.6 Technological Developments

Since 2000 there have been many changes in the technological landscape. Handheld devices now surpass desktop computers in terms of ownership and use. Growing access to broadband across the developed world (but still not universal) has changed

access to knowledge, information, services and support. The emergence of online learning has transformed access to learning for great many students and has changed the dynamics of higher education. It is now the case that (app.) 1.5 million online courses for credit are being taken by Canadian higher education students each year[1]—7.5 million in the USA (Allen & Seaman, 2014).

By 2030 there will be further changes. These seven patterns seem the most likely:

1. Machine learning and artificial intelligence will increasingly be used to enable adaptive learning. Advances in artificial intelligence and machine learning are occurring rapidly, as can be seen in the growth of predictive systems, robotics and new analytics products. As these developments continue, "smart" devices (we already have smart thermostats, fridges, televisions) will become ubiquitous. Such smart systems will be embedded in the devices we use for learning and will begin to identify patterns of behaviour and activity which require either remediation or accelerated learning. Such adaptive systems will become more and more personalized over time, as individual patterns of activity and behaviour shape the use of content, assessment and interactions. Learning management systems designed simply as delivery mechanisms for content will be replaced by an adaptive system in which interaction drives content.
2. Handheld, mobile and integrated devices will continue to develop and become the de facto tools for learning, communication and peer networking. Handheld and mobile devices are already in the possession of close to four billion persons. New, faster devices which are also lighter and cheaper will increase adoption and use of handheld and mobile devices, which will also carry more functionality and will have intelligent "apps" to support learning. The recently launched Osmo add-on for iPad enables the iPad to support a range of games for learning in three dimensions. We can expect more third-party "add-ons" and apps which will extend the utility of such devices. We can also expect these devices to strengthen their ability to connect to social networks.
3. Predictive analytics will grow in significance in terms of student retention and learner support. Big data analytics are already in use in student recruitment centres, aiming to identify likely candidates from pools of enquirers. Such data sets are also being used to predict, from assessment data, students who are most likely to drop out or temporary withdraw, based on their patterns of attendance, assignment submission and assignment performance. These data are used to spur active intervention with a view to increasing retention and completion. But this is the top of the iceberg. We are likely to see much more use of data and analytics aimed at ensuring mastery of knowledge and skills and effective learning. Such predictive analytics will significantly improve the more they are used since the aggregated data on which they depend will be continuously enriched.
4. Interconnectivity of devices and systems will be a significant feature of the "Internet of Things" and activities. Homeowners can manage their furnaces from

[1] This is a "best guess" based on available information. Unfortunately, there are no systematic approaches to data collection across Canada which permits an accurate statement.

the other side of the world, check who is arriving at their door while in flight and make deposits with cheques at their bank without leaving home. Connectivity and integration are the buzzwords driving the Internet of Things. Look at developments in health care. Blood pressure can be monitored continuously by means of the Apple Watch and other devices; exercise trackers are embedded into smart phones; diabetes monitoring is now possible with third-party add-ons to a smart phone; and soon, we are advised, simple blood tests for a range of conditions will be possible through add-on devices for tablets and smart phones. Imagine these developments for learning—new developments in the field of study are flagged instantly, on-the-fly testing for competencies and skills, instant connection to global expert presentations on topics studied in a course, and real-time viewing of skills in action for apprentices.

5. Gamification and virtual reality will enable significant advances in teaching a range of subjects, especially laboratory-based subjects. Simulations already exist in chemistry, physics, biology, engineering and other sciences. What is likely to occur is the significant advances in gamification and simulation and the development of easier to use, faster and more innovative "creation engines", making the development of simulations and games easy for those without significant experience. Some of these already exist, but others are in development. We can expect some of the resultant simulators and games to be available as open education resources (OER), but many will also be proprietary. It is also likely that many of these games and simulations will be designed to test skills and competencies, so that apprentice electricians, for example, can be tested on their abilities largely through simulators. Some of these developments will make use of virtual reality environments, also now quickly emerging.
6. Translation engines will continuously improve and become embedded in a great many applications. Buckminster Fuller created the "Knowledge Doubling Curve"; he noticed that until 1900, human knowledge doubled approximately every century. According to IBM, the build out of the "Internet of Things" will lead to the doubling of knowledge every 12 h. To make sense of this growing knowledge "mine", translation is required. The faster we are able to translate from one language to another—say, from English to Mandarin or Cantonese and vice versa—then the more we can make use of this knowledge for learning, development and change. Translation engines have been with us since the early 1980s, but are becoming progressively better and more useful, with wearable simultaneous devices becoming available in 2016. Given the extent of learner mobility and the growth of the international student body, these developments may make learning easier for many students.
7. Collaborative technologies and social media—enabling rapid connectivity between learners, instructors and global experts—enable knowledge sharing for all forms of learning. During the last five years, mainly as a result of the growth of social networking, products dedicated to collaboration and supporting the growth of communities of interest and practice have appeared. Some of these are focused on project management and business, but many are being used for educational networking, resource sharing, collaboration and learning. All of the major

learning management systems have "collaboratories" either designed in or available as "add-ons". Some specialist software—e.g. Ning, Core Community, Basecamp—have emerged as leaders in this space. Such systems provide for rapid and easy sharing of documents, videos, games and simulations, ideas as well as supporting collaborative groups and focused conversations. Given the power of peer-to-peer learning and learning networks, these developments are likely to accelerate.

While in the past, the barrier to accelerated adoption of such technologies has been the willingness of faculty members to utilize them, student behaviour and the other trends and patterns listed here will lead to more and more colleges and universities adopting these technologies not simply for competitive advantage but also for survival.

13.2.7 Global Competitiveness

All of these trends and patterns lead to one conclusion: it will get more difficult over time to recruit and retain, retain students as the market for these students becomes increasingly competitive and value sensitive. What is more, governments will assess institutional performance by their ability to sustain themselves while offering less financial support per capita: expectations will grow, while resources available to meet these expectations shift from government to more varied sources of revenue.

What is more, the competition which institutions face is not just local, regional or national: it is global. The University of Toronto, for example, is competing with all of those institutions listed amongst the top 100 in the world, not just for students but also for staff. There is a global war for talent.

This new level of learner choice requires a reimagination of what courses, programmes, credit and learning looks like. Offering the same programme in 2030 in the same way as it is being offered in 2016 is likely not to be a successful strategy. New business models, programme designs, pedagogy, uses for technology and new forms of assessment and credit granting will be found so as to enable colleges and universities to be sustainable.

13.3 Innovation and Its Challenges

Denning and Dunham (2010) suggest a simple model of innovation as a process. It involves a number of discrete phases which may run in parallel, in or out of sequence or all simultaneously. The key point here is that innovation requires a number of different processes and that, as an overall process, it is messy. The discrete phases they suggest are shown in Table 13.1.

Table 13.1 The stages of innovation following Denning and Dunham (2010)

The eight innovation processes			
The work of invention	1	Sensing	Sensing that there is an opportunity to undertake things differently—looking and seeing what others are doing, engaging with others in different parts of the world, taking a note of developments in other sectors (e.g. health, nonprofits, business) … Sensing also that there is a need to do something differently … that "we could do better". *Developing the sense of knowing*
	2	Envisioning	Being able to share a compelling story about doing things differently—"selling" a vision, opportunity and showing "how" it works for you with passion. *Showing the courage of conviction*
The work of adoption	3	Offering	Making the offer to work to change an outcome by using the process/work shared in the envisioning process. *Showing the courage of the offer*
	4	Adopting	Overcoming resistance to change by doing what you said you would do with the new process/work and continually improving what you do to produce improved outcomes. *Showing resilience*
	5	Sustaining	Gaining commitment to keep doing the "new" work and securing the support of one or more first follower. *Showing determination*
Creating the environment for next practice	6	Executing	Making the "new" way of working routine and effective, such that it produces reliable and consistent improvement in outcomes. *Demonstrating professional effectiveness*
	7	Leading	Being proactive in mobilizing others within the organization (and elsewhere) to adopt the emerging practice and supporting them when their commitment falters or when they need additional support. *Showing professional leadership and building scale*
	8	Embedding	Establish the "new" practice as the norm for both each organization and educational systems and embodying the spirit of "we can change". *Showing that change can work, get to scale and stick*

The key with innovation in education is that it leads to change practices, improved educational outcomes and learner engagement and is both replicable and scalable. When we apply these requirements, little in higher education has changed, at least for the majority of learners and faculty. While we can all point to examples of truly innovative developments in a great many institutions, none of these have fully transformed these institutions "beyond recognition". We are still building physical classrooms largely as we did in the 1950s (though now they are "wired"), and we still use very similar admission and assessment systems as we did in the 1980s. If we were to estimate the scale of transformation using the Rogers adoption curve, higher education would be strongly classified as at the "early adopter" stage in most countries, with some institutions showing significant structural and operational innovations (Rogers, 1983).

In higher education, innovations based on technology are challenging activities. There are few people or financial resources to encourage and enable experimentation, and when these are available, they are usually channelled and directed. While this does lead to pockets of innovation, a collection of pockets does not make for an effective integrated system.

Often, innovations at one level of the system are constrained by continuation of old methods or working at another. For example, shifting to 365 points of admission for student registrations in courses (as has occurred in the Kentucky Community Technical College System) is inhibited by the insistence that all institutions use the same student information system; the way in which colleges and universities are funded by some variation of the Carnegie unit inhibits flexibility, especially with course length and credit weights; quality assurance regimes, based largely on an outdated notion of quality, inhibit genuine curriculum innovation; traditions of student assessment and the way in which these assessments are linked to credit inhibit innovation around micro-credential (sometimes called nano-certification) and badges.

The most significant inhibitor to innovation is the lack of investment in the professional development of those who teach in higher education. There is still no requirement for these individuals to have qualifications in pedagogy, instructional design or effective use of technology for learning. Nor has there been significant investment in supporting professional development aimed at overhauling antiquated methods of learner assessment, both in terms of assessment for learning and the assessment of learning.

Despite these challenges, remarkable things are happening. For example, the Commonwealth of Learning's (COL) use of text messaging, local radio, community networks and other supports for farmer education and cooperatives in India, Africa, Asia and other parts of the Commonwealth has produced remarkable transformations of farming practice, farm profitability and farmer livelihoods. This work is also replicable and scalable and has used all of the processes outlined by Denning and Dunham (2010). COL's work in support of the Virtual University of the Small States of the Commonwealth (VUSSC) and the Transnational Qualifications Framework (TQF) which enables learner mobility across 31 countries are significant achievements (Kanwar, 2015).

We can also point to interesting developments in a great many institutions, not least those which change the use of time and place, permit learners greater flexibility in terms of both what and how they learn (Contact North, 2013; Downes, 2015) and to creative developments related to assessment (Hill & Barber, 2014) and the uses of big data (Daniel, 2015). While these are important and hold the potential to be transformative, the contextual forces described above act as inhibitors to the potential leveraging of these related developments for significant change. Not only is innovation inhibited, it is frustrated by the inflated expectations sold by vendors, the plateau of productivity forced by a variety of forces which often results in a trough of disillusionment experienced by faculty and administrators (Fenn & Raskino, 2008). In terms of the innovation model introduced above, the final two stages—the work of adoption and readying for next practice—falter against the organizational "rules" developed to prevent higher education from transforming itself (Mills & Murgatroyd, 1991). Technology is a necessary but insufficient driver of innovation.

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