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How Online Learning Affects Productivity, Cost and Quality in Higher Education: An Environmental Scan and Review of the Literature

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Summary

This paper reviews the use of online learning in higher education in Canada and internationally. The paper focuses on the following questions:

- What are the cost implications of a shift to online learning? Specifically, does a greater use of online instruction save institutions or systems money and, if so, under what circumstances?
- What do we know about the relationship between online learning and important variables that are often considered when discussing the "quality" of an institution or of a system?

The methodology combines a review of published literature and an environmental scan of recent developments, recognizing the rapidly evolving nature of the subject matter.

The evidence reviewed suggests that, for a range of students and learning outcomes, fully online instruction produces learning that is on par with face-to-face instruction. The students most likely to benefit are those who are academically well prepared and highly motivated to learn independently. Students who are not well prepared to learn at the postsecondary level or do not devote the necessary time to learning are less likely to benefit from online learning and may in fact do better in a face-to-face setting.

The former group – well-prepared and motivated students – is large enough that the provincial government, as the entity with overall responsibility for higher education, should have an interest in making sure they have online learning opportunities available to them. These opportunities should serve students' learning needs, and – if carried out at large scale – should produce cost efficiencies for higher education institutions, the student or both. However, there is no evidence that all of the learning outcomes expected of postsecondary students in Ontario can be achieved solely by online learning.

The authors suggest that the government might set a target that, within three years, a specified list of high-demand university and college programs that are primarily or entirely online will be available to Ontario students. In addition, the government might set a target that, within three years, a specified list of high-demand courses will be available online and will be accepted for credit at all Ontario universities and colleges that offer a program in that discipline. The financial benefits of online instruction depend on achieving economies of scale. A set of high-quality degree programs that qualify the student for admission to any Ontario graduate school, and a set of high-quality courses that are accepted for credit by every Ontario institution, will be preferable to a multiplicity of courses and programs that operate on a small scale.

Emerging developments in online learning hold further promise to improve quality and productivity. By working with other institutions in Ontario and elsewhere, Ontario colleges and universities can leverage and help shape emerging developments in online learning. Coordination will be required to ensure that economies of scale are achieved in an environment of rapid technological change. Ontario colleges and universities should be encouraged to work with peer institutions to ensure that engagement with advances in online learning fully supports the province's strategic goals for quality and access in a time of constrained funding.

These suggested actions will stretch Ontario's policy and regulatory infrastructure. An effective government strategy will begin by adapting existing regulatory infrastructure to remove unnecessary barriers to high-quality online education.

Hybrid courses that blend online learning with face-to-face instruction should also be encouraged where they improve learning outcomes. Hybrid courses fit well within the government's existing regulatory structure and so present fewer policy challenges.

The purpose of adopting online learning should be to free up resources that can be redeployed to preserve and sustain what we value most in higher education, such as mentoring and coaching that enable learners to develop new ways of knowing, doing and being.

A near-universal system of higher education, operating in an economy that produces limited increases in government revenue and in students' family incomes, needs to find areas where productivity can be improved. Students, educators and institutions need to take full advantage of emerging advances in online learning in order to protect the forms of learning that are most valuable in higher education.

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Introduction

Purpose of this paper

This paper provides a literature review and an environmental scan on the use of online learning in higher education, in Canada and internationally. The paper focuses on the following questions:

- What are the cost implications of a shift to online learning? Specifically, does a greater use of online instruction save institutions or systems money and, if so, under what circumstances?
- What do we know about the relationship between online learning and important variables that are often considered when discussing the "quality" of an institution or of a system?

Based on our research, we make some observations about the policy implications for the Ontario government and for Ontario universities and colleges.

Definition: Online learning

The term "online learning" is commonly used to cover a wide range of teaching practices that may in fact differ greatly in terms of learning outcomes, cost and student access. In general, online learning is a course of instruction that is carried out over the internet. Hybrid learning is a course of instruction that is carried out partly on the internet and partly in a face-to-face setting such as a classroom.

Most of the literature we reviewed does not adopt a quantitative definition to distinguish between online learning and hybrid learning. Allen and Seamen (2010, p. 4) have proposed a typology in which online learning is defined as a course where 80% or more of the content is delivered online, hybrid learning is defined as a course where 30% to 79% of content is delivered online, and web-facilitated learning is defined as a course where 1% to 29% of content is delivered online.

In some cases a different definition was adopted in order to reflect local administrative practices. For example, Jaggars and Wu (2010) used a database in which online courses were defined as those where at least 95% of the content was taught asynchronously.

Methodology

Our research program involved two elements: a literature review and an environmental scan.

The literature review focuses on evidence-based research about the effects of online learning on quality, cost and productivity (as opposed to theoretical literature or opinion pieces). We looked for relevant evidence from the international professional and scholarly literature related to one or more of:

- Reliable data concerning the quality of the resulting learning experiences and outcomes, on a wide range of quality aspects including demographics (e.g., access and attainment), learning outcomes (both subject-matter-specific and across-the-curriculum) and stakeholder acceptance (e.g., as apprehended by students, educators and employers).
- Clear explanation of the cost implications for both one-time development and continuing operation and evolution. Costs include direct costs, both one-time and ongoing, and indirect costs in terms of program duration, professional development and executive attention.

- Insights into the required changes in instructional and administrative processes, professional role and academic planning. We saw this element as especially critical in determining requirements for achieving long-term, scalable productivity enhancements.

Given the vastness of the scholarly literature, we have looked especially for meta-analyses which compare traditional versus online education at a system, course or activity level. We have made only secondary use of studies and reports from individual instances or instructors where institutionalization and sustained use have not been addressed.

There are a number of emerging developments which appear to hold promise for enhancing productivity but are too recent to provide the reliable evidence required for inclusion in the literature review. We conducted an environmental scan to identify the important international developments for the Ontario context. We summarize what is currently known from these developments about impacts on cost and quality, what projections have been made regarding potential productivity enhancements, and how these developments can be monitored to aid in understanding their possible future value and impacts.

While the field of online education changes rapidly, our research incorporates information available up to May 2013.

Part 1: Review of published literature

Part 1 contains published articles in peer-reviewed journals and scholarly research reports from non-governmental organizations and similar sources.

Section 1: Educational quality

Effect on student learning: meta-analyses

U.S. Department of Education meta-analysis

The largest meta-analysis of the effect of online learning on students' education was carried out by the United States Department of Education (USED)(2010).

USED identified more than one thousand studies on online learning published from 1996 to June 2008. The large majority did not meet the basic requirements of the meta-analysis, which were that the study:

> (a) contrasted an online to a face-to-face condition, (b) measured student learning outcomes, (c) used a rigorous research design, and (d) provided adequate information to calculate an effect size [i.e., the difference in learning outcomes between online learning and face-to-face learning].

As a result of this screening, 50 independent effects were identified that could be subjected to meta-analysis, of which 43 applied to adult learners (postsecondary or continuing education).

The meta-analysis found that, on average, students in online learning conditions performed at a level that was statistically equivalent to those receiving face-to-face instruction. In most studies the online and face-to-face learning conditions differed in a number of ways, including students' time-on-task, so the comparison does not relate solely to the use of the online medium.

USED also found that students in hybrid learning conditions performed modestly better than those receiving face-to-face instruction. These blended conditions often included additional learning time and instructional elements not received by students in control conditions. Again there were differences in students' time-on-task, curriculum materials and other factors not related to the (partial) use of online instruction.

The benefits of online instruction were larger for studies in which the online instruction was collaborative or instructor-directed than in those studies where online learners worked independently (self-directed learning). There was no statistically significant difference between face-to-face learning and online learning in cases where the online learning was entirely independent.

The effectiveness of online learning approaches was quite broad across different content and learner types. Online learning appeared to be an effective option for both undergraduates and for graduate students and professionals in a wide range of academic and professional studies.

Studies in which USED's analysts judged the curriculum and instruction to be identical or almost identical in online and face-to-face conditions "had smaller effects than those studies where the two conditions varied in terms of multiple aspects of instruction." Instruction could differ, for example, in terms of the way activities were organized (such as group work in one condition and independent work in another) or in the inclusion of instructional resources (such as a simulation or instructor lectures) in one condition but not the other. "The meta-analysis findings do not support simply

putting an existing course online, but they do support redesigning instruction to incorporate additional learning opportunities online" (USED, 2010, pp. 4-5).

Updates by Bowen and Lack

William G. Bowen and Kelly A. Lack have conducted further reviews of thirty studies published after the cut-off for the USED report, up to early 2013, and three other studies that were missed by USED (Bowen & Lack, May 2012; Bowen & Lack, October 2012; Lack, March 2013).

They find "little, if any, evidence to suggest that online or hybrid learning, on average, is more or less effective than face-to-face learning." "[M]ost of the studies have mixed results: on some of the measures, students in the online or blended format did better, but on others they did worse, relative to students in the face-to-face format – or else on some measures the online – or blended-format students did significantly better or worse than the students in the face-to-face format, but on other measures there was no significant difference between the two groups" (Lack, 2013, pp. 10-11).

Challenges underlying these meta-analyses

These meta-analyses highlight some of the challenges in summarizing the research on online learning.

- There is no standard definition of online learning, as we noted in the introduction.
- There is a relative shortage of experimental studies. Double-blind studies (in which neither the participants nor the researchers know which participants belong to the control group, as opposed to the test group) do not exist. Students know whether they are engaged in online learning or not, as do faculty. Some studies are done on a before-and-after basis, so the students taking the online course may differ from those who took the face-to-face course in the past. In many cases the researchers are also the faculty who teach the course, introducing potential bias.
- Many studies have few or no controls for student differences. If students voluntarily choose whether to study online or face-to-face, controls are needed to adjust for potential differences in the ability of the two groups.
- Most studies do not control for differences in instructors, and some do not control for differences in learning materials (such as differences in content between a textbook and an online text).
- Educational outcomes are not measured consistently. Studies may look at homework assignment scores, project grades, exam scores, final course grades, completion rates or other measures of learning.
- Studies may measure learning outcomes without adjusting for dropout rates. For example, a study may find that Group A had better learning outcomes than Group B, but this may be because many learners in Group A dropped out and so are not counted in the learning results.
- Studies may look at educational settings and missions that are not representative of the full range of education (or of the part of the education system of interest to a particular reader). We saw that 43 of the USED learning outcomes are from postsecondary education and continuing education, while seven are from K-12 education. Only seven studies in the USED analysis involved undergraduate or graduate students enrolled in semester-long online courses; the remainder were shorter courses, continuing education courses, or the like (Jaggars & Bailey, 2010).
- The technologies are rapidly evolving. Scholarly publications often study learning that took place several years prior to the date of publication. Their findings are subject to potential criticism that newer technologies would show better results.

- The meta-analyses are vulnerable to a "file drawer" problem, i.e., the tendency of researchers not to seek to publish results that are negative or inconclusive (Rosenthal, 1979).

Recent attempts at rigorous experimental studies

The shortage of rigorous experimental studies in the USED meta-analysis has led to new attempts at such studies.

The most comprehensive such study was conducted by William G. Bowen, Matthew M. Chingos, Kelly A. Lack and Thomas I. Nygren (2012), who arranged for the same introductory statistics course to be taught to 605 students in six different public universities in the US. In each instance, a "control" group was enrolled in a traditional classroom-based course; then, a "treatment" group took a hybrid course using a prototype machine-guided mode of instruction developed at Carnegie Mellon University in concert with one face-to-face meeting each week. Students were assigned to these two groups by means of a randomization methodology.

They found "no statistically significant differences in learning outcomes between students in the traditional – and hybrid-format sections. Hybrid-format students did perform slightly better than traditional-format students on three outcomes, achieving pass rates that were about three percentage points higher, CAOS [Comprehensive Assessment of Outcomes in a First Statistics course] scores about one percentage point higher, and final exam scores two percentage points higher – but none of these differences passes traditional tests of statistical significance" (pp. 18-19).

> In sum, our results indicate that hybrid-format students took about one-quarter less time to achieve essentially the same learning outcomes as traditional-format students. (p. 23)

Bowen et al. summarize the current reality and the potential of machine-based learning that adapts to students' responses as follows:

> To the best of our knowledge, there is no compelling evidence that online learning systems available today – not even highly interactive systems, of which there are very few – can in fact deliver improved educational outcomes across the board, at scale, on campuses other than the one where the system was born, and on a sustainable basis. This is not to deny, however, that these systems have great potential…There is every reason to expect these systems to improve over time, perhaps dramatically, and thus it is not foolish to believe that learning outcomes will also improve… (p. 11)
>
> It is also entirely possible that by (potentially) saving significant amounts of resources, such systems can lead to more, not less, opportunity for students to benefit from exposure to modes of instruction such as directed study – if scarce faculty time can be beneficially redeployed. But none of this will be easy. (p. 17)

In a smaller study, David N. Figlio, Mark Rush and Lu Yin (2010) conducted a randomized study of students in a microeconomics course and compared the learning outcomes for students who attended the live lectures and students who watched videos of the lectures online. They found no significant differences in outcomes.

Non-traditional students

Non-traditional students may be of special interest because of claims that online learning will increase access for students who have work or family commitments that make it difficult for them to take face-to-face courses. The National Center for Education Statistics (2002) defines a non-

traditional student as one who has any of the following seven risk factors: (1) part-time attendance, (2) full-time employment, (3) delayed postsecondary enrolment, (4) financial independence, (5) having dependents, (6) being a single parent and (7) not possessing a high school diploma.

Studies by Samantha Smith Jaggars, Di Xu et al.

Samantha Smith Jaggars, Di Xu and their co-authors have published a series of studies challenging the applicability of the USED findings to non-traditional students. Their research shows that non-traditional students in the United States perform less well than traditional students in online learning. They argue that non-traditional students require additional supports, without which online learning is likely to lead to increased inequity in educational outcomes. Poor online performance rates in community colleges are due partly to the characteristics of students who choose to enrol in those courses, and also to challenges related to the online format – including technical difficulties, a sense of isolation, a relative lack of structure and a general lack of support.

According to Jaggars, "[m]eta-analyses comparing academic outcomes between online and face-to-face courses have typically indicated that there is no overall difference between the two formats but that there is large variation in effects, with some online courses having much better outcomes than face-to-face courses and other online courses having much worse outcomes (e.g., Bernard et al., 2004; Zhao, Lei, Yan, Lai and, Tan, 2005)" (Jaggars, 2011, p. 1). In her own meta-analysis of 36 studies, Jaggars found ten studies that compared online and face-to-face learning while controlling for student characteristics. Four studies found no significant difference in withdrawal rates, and six studies found higher withdrawal rates for online students. All six of the latter focused on community college students. "Taking the broad view across studies, however, most showed either positive effects or no effects for online learning. Yet given the methodological weaknesses of the studies, it is difficult to interpret these results. Relatively poor controls raise the question of whether results were driven in part by student self-selection, and the fact that few studies examined withdrawal raises the question of whether results are driven in part by differential attrition. Moreover, almost all the studies were conducted with university or graduate-level students, which makes unclear their relevance to low-income or underprepared students" (Jaggars, 2011, p. 16).

In a study of the cohort of students who entered the Virginia Community College System in 2004, Jaggers and Xu (September 2010) found that, after adjusting for the fact that online students who chose online courses tended to be better-prepared academically, "students taking at least one online course were slightly but significantly less likely to persist. The model-based predicted probabilities of retention from fall 2004 to spring 2005 were 69% for online students and 74% for face-to-face students; from spring 2005 to fall 2005, they were 67% for online students and 70% for face-to-face students. These results support the notion that, after controlling for the stronger academic preparation of online students, online coursework is negatively related to next-semester persistence" (p. 16). "College-ready students had completion rates 13 to 15 points lower in online education courses, and developmental students had completion rates 11 to 13 points lower in online education courses" (p. 11). Online learning was defined to include courses where at least 95% of the content was taught asynchronously; hybrid courses were therefore excluded.

A parallel study by Xu and Jaggars (March 2011) of students who entered the State of Washington Community and Technical Colleges in 2004 found that "the overall hybrid completion rates were almost the same as the face-to-face completion rates", but "online course completion rates were 8 percentage points lower than face-to-face completion rates." "[C]ourse completion rates were slightly lower for developmental students (i.e., those who had ever enrolled in a remedial course). However, the 2 percentage point difference in completion rates between college-ready and developmental students was negligible in comparison to the 8 percentage point difference in completion between online and face-to-face courses. The decrement in performance for online courses was fairly consistent between college-ready and developmental students; both groups had completion rates 7 to 8 points lower in online courses" (p. 10).

The Washington State study found that completion rates in online courses improve in upper years. This may be because students have gained more experience in online learning, or because those who did poorly switch to a face-to-face format (p. 14).

After controlling for student characteristics, the Washington State study found that "students taking at least one online course were significantly more likely to drop out. The model-based predicted probabilities of dropout from fall 2004 were 34% for online students and 26% for face-to-face students; from the first year, they were 20% for online students and 17% for face-to-face students" (p. 15).

Among students who took at least one online course, "students who took a higher proportion of credits online were significantly less likely to attain an award or transfer to a four-year college: At the 25th percentile (8% of credits taken online), these students had an estimated 54% probability of award or transfer; at the 75th percentile (33% of credits taken online), the probability of award/transfer was reduced to 50%" (pp. 15-16).

A follow-up study of the 2008 cohort found course completion patterns similar to those for the 2004 cohort: "there was a wide gap between the completion rate of face-to-face courses (89%) and online courses (83%); in contrast, the completion rates of hybrid courses (88%) seemed no different from those of face-to-face courses" (p. 18).

Unlike the Virginia study, the Washington study looked at hybrid courses. "Overall, the findings of the current study do not provide strong evidence regarding the effectiveness of hybrid courses [compared with face-to-face courses]: observed patterns of outcomes for hybrid courses were sometimes positive and sometimes negative, were always weak, and were never statistically significant. In contrast, the evidence regarding online courses was fairly clear. We found that students who participated in online courses had lower success rates on a variety of outcomes, even after controlling for a rich array of student characteristics, including prior academic performance and concurrent hours of employment. This pattern of results is quite similar to that observed across Virginia community colleges (Jaggars and Xu, 2010; Xu and Jaggars, 2010), indicating that student difficulties with online courses in community colleges are not confined to one state" (p. 19).

Xu and Jaggars found that these performance gaps existed even though Washington introduced several key supports for online learning in 1998, including:

- Student online readiness assessment: The system's online readiness quiz provides specific feedback to students in terms of whether they are likely to be as successful in an online course as in a face-to-face course.
- Course management system tutorial: In the week prior to the start of an online course, students are encouraged to take a free online tutorial on how to use the system's online course management system.
- Online support services: Most colleges in the system provide round-the-clock online technical support for students, and all colleges offer round-the-clock online reference librarian support.
- Faculty development support: Most online faculty are required to take training that is focused on the use of the online course management system. Also available to interested faculty are additional courses that focus on effective online pedagogies, advanced technological tools, and other topics (Xu & Jaggars, 2011, pp. 2-3).

The authors suggest that support for faculty developing online courses needs to be deepened and better resourced. They also suggest that Washington State needs to require certain students to take advantage of the tutorials and other supports provided for them, whose usage are now mostly

voluntary. (The *Learning Analytics* section of Part 2 discusses emerging developments in identifying students in need of various early support interventions based on their online activities.)

Xu and Jaggars (2013) have also found small but statistically significant differences in student performance based on demographic characteristics. They examined 500,000 courses taken by nearly 40,000 students in Washington State's community and technical colleges, comparing each student's performance in online and face-to-face courses (adjusted for academic year and subject matter).

Across the full population, they found that students in online courses were less likely to complete and were likely to receive lower grades. "Students' average persistence rate across courses was 94.12 percent, with a noticeable gap between online courses (91.19 percent) and face-to-face courses (94.45 percent). For courses in which students persisted through to the end of the term (N = 469,287), the average grade was 2.95 (on a 4.0-point scale), also with a gap between online courses (2.77) and face-to-face courses (2.98)" (p. 14).

They also found that in online courses, "some struggled more than others to adapt: males, younger students, Black students, and students with lower grade point averages. In particular, students struggled in subject areas such as English and social science, which was due in part to negative peer effects in these online courses" (p. i). For example, a white student was 4.3 percentage points less like to complete an online course than a face-to-face course, while a black student was 5.4 percentage points less likely to do so. A white student scored 0.275 points lower on an online course than a face-to-face course (on a 4.0 grade scale), while an African-American student scored 0.394 points lower (Table 4, p. 16).

The study also found that older students adapted more readily to online learning than did younger students; in other words, the decrement from face-to-face to online was smaller for older students than younger ones.

Xi and Jaggars explain the lower marks in certain subjects in two ways. "First, different types of students tend to cluster systematically into different academic subject areas. While some areas attract students with a strong ability to adapt to online coursework, others attract students who do not adapt well. Second, regardless of a particular student's own adaptability to the online environment, her performance in an online course may suffer if her classmates adapt poorly. English and social science were two academic subjects that seemed to attract a high proportion of less-adaptable students, thereby introducing negative peer effects" (p. 24).

Critique of this work

One of the virtues of the body of work by Jaggars and Wu and their co-authors is that it makes use of large sample sizes, and so they are able to locate statistically significant differences that smaller research projects may have missed. We should nevertheless observe that many of their findings point to performance differences between online and face-to-face learning that, while statistically significant, are fairly small.

Jaggars and Wu do not cast doubt on the potential value of online learning in any of their papers. Their concern is that online education may add to educational disadvantages of students who already tend to perform less well than their peers in face-to-face learning. They discourage the idea that online learning can provide easy access to higher education for students who have heavy non-academic responsibilities. Their policy recommendations point to the need for additional supports (in some cases mandatory supports) for students who are not academically well prepared and for faculty who design online courses. These recommendations have implications for costs.

Jaggars and Wu's research program does not specifically address the effects of online learning on students with disabilities. We found one study, by Gary Long, Carol Marchetti and Richard Fasse (2011), which found positive effects of online learning on students with hearing disabilities. They found that "students enrolled in online courses, especially those designed with high levels of online interaction, receive higher grades and report greater learning than students in comparable [face-to-face] courses. In addition, online courses appear to provide deaf and hard-of-hearing students with special benefits in terms of academic achievement through online discussion. Overall, the studies illuminate how the quantity of interaction in online discussions relates to important success factors. Students in online courses with more interaction outperformed students in online courses with less interaction" (p. 1).

Online assessment of student performance

The assessment of students through online technologies is pertinent for the following reasons.

- Faculty spend significant time evaluating students' performance. To the extent that online evaluation reduces faculty time, there may be significant savings that can be reinvested in other learning activities.
- Regular student evaluation with prompt feedback may contribute to student learning. To the extent that online evaluation makes possible an economical form of evaluation and feedback, student learning may be enhanced.

The first reason is pertinent to both summative assessment (the final assessment of a student's achievement) and formative evaluation (assessment as a tool to promote further learning). The second relates to formative assessment only.

Literature reviews by Gikandi et al. and Gilbert et al.

We found two recent reviews of the literature on online assessment, one by Joyce Wangui Gikandi, Donna Morrow and Niki E. Davis (2011) and the other by Lester Gilbert, Denise Whitelock and Veronica Gale (2011).

Both reviews note the shortage of empirical work in this area.

- Gikandi et al. found 91 relevant articles in the period 2000-2010, of which 18 were empirical studies that focused on formative assessment in online or hybrid contexts in higher education. These 18 studies covered a limited range of disciplines (half were in teacher education) and most were case studies rather than experiments with a face-to-face control group.
- Gilbert et al. received 124 recommendations from the higher education community for evidence-based literature, of which 15 were deemed to be peer-reviewed generalizable studies which provided effect size estimates and included some form of control group (including before-and-after studies).

There is no overlap between the 18 empirical studies that are the focus of the paper by Gikandi et al. and the 15 empirical studies identified by Gilbert et al. Only three articles appear in the bibliographies of both of these literature reviews.[1] Gikandi et al. have a narrower scope: they look solely at formative evaluation and they confine themselves to studies of higher education. Gilbert et al. look at both summative and formative evaluation and, while they address their work to practitioners in higher education, they include many papers deemed relevant from the K-12 system and professional education. While recognizing these differences, we might nevertheless see the

[1] There is greater overlap between the bibliographies if we count authors rather than specific titles.

lack of overlap between these two literature reviews as a sign of a rapidly emerging field in which there is not yet a consensus on the seminal literature.

Both literature reviews conclude that online technologies can be effective in student assessment, but their conclusions are qualified by the wide variety of technologies and practices that are in use. Gikandi et al. find that:

> ...effective online formative assessment can foster a learner and assessment centered focus through formative feedback and enhanced learner engagement with valuable learning experiences. Ongoing authentic assessment activities and interactive formative feedback were identified as important characteristics that can address threats to validity and reliability within the context of online formative assessment....
>
> The benefits of online formative assessment discussed here are facilitated through a variety of approaches that emerge from the reviewed literature including self, peer and e-portfolio assessment. Each of these techniques utilizes a variety of online tools such as asynchronous discussion forums, self-test quiz tools, and e-portfolios. It is important to note that these techniques overlap and can be intertwined and applied synergistically. Online formative assessment through these techniques can facilitate a multidimensional perspective to assessment for learning. The effectiveness of these techniques depends on innovative and appropriate utilization in order to make online formative assessment an effective pedagogical strategy. (p. 2345)

Gilbert et al. highlight these findings from the empirical studies they reviewed:

- "Tutors can use technology-enhanced methods to implement effective learning designs that would not otherwise be possible because of factors such as time constraints, student numbers and geographical or temporal distribution...
- Effective regular, online testing can encourage student learning and improve their performance in tests...
- Student retention and inclusion can be increased by using technology-enhanced methods. Exam anxiety can also be reduced...
- Using technology-based methods does not disadvantage women or older students...
- Automated marking can be more reliable than human markers and there is no medium effect between paper and computerized exams...
- The success of assessment and feedback with technology enhancement lies with the pedagogy rather than the technology itself; technology is an enabler...
- Technology-enhanced assessment is not restricted to simple questions and clear-cut right and wrong answers, much more sophisticated questions are being used as well...
- Modern technology can be matched to the learning characteristics of the contemporary learner...
- Testing the assessment and feedback to ensure it is reliable and valid and piloting it with people who are similar to or understand the targeted students are important stages in the development process...
- It is important to prepare students to take the assessments that use technology enhancement by practicing with similar levels of assessment using the same equipment and methods..." (Gilbert et al., pp. ii-iii)

Online evaluation as formative assessment#

Angus and Watson (2009) found "robust evidence" for gains in student learning from regular online testing. They conducted research at the University of New South Wales with over 1,500 students using controls to discount for prior student aptitude, in-course mastery, gender and student effort

(as measured by voluntary class attendance). They looked at whether students who took voluntary online quizzes were more likely to score a high mark on the final exam, regardless of how well they scored on the quizzes. They find that:

> exposure to regular (low-mark) online testing significantly improves student learning as measured by a final proctored examination. Importantly, this result is independent of a student's actual performance on each online quiz....
>
> If students were 10% more likely to sit for all four quizzes, they could expect to receive around 2.5% higher on their final examination, ceteris paribus... (pp. 256, 268)

The effect was about twice as large before controls, suggesting that studies without controls are likely to exaggerate the benefits of online quizzes by a factor of two. In the study, 92% of students agreed that assessment helped their learning. However, Angus and Watson caution that the benefits of online testing can be lost if the automatic marking and online assessment features are not well thought through.

The online quizzes used by Angus and Watson did not take advantage of any interactive online features, as described in the Bowen et al. (2012) research cited above. These are discussed further in Part 2 below ("*Learning resources that adapt to the student*").

McSweeney and Weiss (2003) conducted a similar study using a tool known as Math Online, which produces randomly generated multiple choice questions around specific skills. The study included data from 12 different sections from an applied calculus course with approximately 25-35 students in each section. Each instructor taught two sections concurrently – one that used Math Online and one that did not. They found that the sections using Math Online had a significantly higher average mark than the control group. The large gains made by the Math Online sections required active encouragement by the instructor. In the second year of the trial, class time for the online sections was reduced to take into account the average additional time students were spending out of class using the tool. Even with the reduced teaching time, the effects remained.

Hagerty and Smith (2005) compared pre- and post-semester summative assessments in an introductory algebra class. They found that students using a proprietary web-based learning system known as ALEKS (Assessment and Learning in Knowledge Spaces) outperformed others (across four sections, n=119) by 8% on average (significant at $p < 0.001$ level). The authors also found via regression analysis that students' learning increase as a result of prior mathematical scores was higher for students using the online learning system than for those who did not.

Online evaluation as a proxy for traditional methods of summative assessment

Several studies have shown that, in specific learning situations, summative assessments of student performance are the same whether conducted through online assessments or traditional paper-based assessments (Bonham, Deardorff & Beichner, 2003; Engelbrecht & Harding, 2004). Smith (2007) found that online quiz scores in an undergraduate science course showed a high correlation with final examination marks and in fact were a better predictor of final examination marks than were laboratory or assignment marks. Online summative assessment has advantages in terms of reduced marking time and prompter feedback for students.

Online summative assessment has nevertheless been criticized for encouraging superficial learning such as recall of facts and basic applications. Smith (2007) and Gijbels et al. (2005) have noted that the validity of summative assessment depends on the nature of the underlying knowledge structures being assessed.

One response to this criticism has been to use online formative evaluation as a way of addressing the shortcomings of online summative evaluation. Steve Joordens, Shakinaz Desa and Dwayne E. Paré (2009) argue that properly designed online peer evaluations can deepen learning in ways that complement multiple-choice final examinations:

> Economic and logistic pressures are pushing universities to rely more on more on multiple choice assessments of learning. This is a problem because multiple-choice tests are not suited to teaching cognitive skills such as critical thinking, analyses based on quality discriminations, and the creation of new perspectives based on a unique synthesis of information. ... [P]eer-assessment assignments seem to represent the perfect complement to well constructed multiple-choice tests. A well constructed multiple-choice task can assess the lower levels of Anderson and Krathwohl's [2001] hierarchy and the peer assessment assignments can support the development of the skills reflected in the higher levels. The result would be students who not only possess knowledge, but also the skills to criticize, analyze, synthesis, and create. (p. 15)

Bouzidi and Jaillet (2009) tested the validity of online peer assessment through an experiment in which 242 students, enrolled in three different courses, took part. The results showed that "peer assessment is equivalent to the assessment carried out by the professor in the case of exams requesting simple calculations, some mathematical reasoning, short algorithms, and short texts in the fields of computer science and electrical engineering" (p. 257). They note that validity required an assessment by at least four peers. Cho et al. (2006) reached similar conclusions from a study involving short papers written by 708 undergraduate and graduate students in several fields of study at four universities, as did Smith (2012) in a study of third-year undergraduate students.

These studies are consistent with the general finding in the literature that peer evaluations (online or otherwise) can be effective in promoting learning, depending on how they are done. In a review of the literature on peer feedback, Evans (2013) finds that (1) student training and regular experience are essential for making peer assessment effective for learning; (2) multiple markers are preferred over single markers; (3) giving feedback has more impact on future performance than receiving impact; (4) peer assessment should not be the only form of assessment; and (5) the academic ability of the feedback giver and recipient is important.

Further implications of instructor-directed peer assessment using online facilities are discussed in Part 2 below ("*Optimizing student-instructor interaction time"*).

Critique of this work

The literature on the relationship between online evaluation and learning quality is subject to a number of standard problems. There are too few studies that are truly experimental, and some of the experimental studies do not have strong controls for possible differences between students and faculty in the online setting compared with those in the face-to-face setting. Students who receive regular online feedback may be devoting more time to their studies than students who receive no feedback, and so the learning effect may be attributable to time-on-task rather than to the medium itself. The range of academic disciplines and institutional types in the experimental literature is less than ideal; we especially noted the lack of studies involving community colleges.

We also noted that the learning outcomes evaluated in many of these research studies did not include important aspects of higher education, e.g., the professional formation of students through reflective practice or the development of productive dispositions for building and mobilizing knowledge. Similar limitations apply to many of the comparison studies of instructional formats cited earlier: their comparative data rely on standardized objective examinations with prescribed correct answers, from a single course. These forms of outcomes evaluation may not adequately consider capabilities developed as across-the-curriculum themes or measures focused on "problem solving,

creativity, team work and communication skills" (Toner, 2011, p. 8). The implications of online learning in these areas may currently be indirect. In other words, leveraging online resources and resources methods in appropriate instructional areas may allow institutions to redirect effort to sustain and advance outcomes in other areas. We return to this theme in Part 3 ("*Protecting and enhancing the learning that matters most")*.

Section 2: Productivity and Costs

Effects on unit costs of instruction

Speculation on a radical reduction in the cost of education

A prominent stream in the literature suggests that online instruction will have a radical effect on the cost of higher education. Proponents of this view suggest that online institutions will derive advantages from transferring content at a marginal cost of zero, substituting online networks for face-to-face socialization, and using peer assessment or machine assessment to reduce the costs of assessment by faculty.

Christensen and Eyring (2011; 2012) provide a vision of how online education will affect traditional institutions:

> [I]in addition to what they save by eschewing the research activities, summer break, athletic teams, and campus infrastructure of the traditional university model, online degree providers enjoy significant advantages in the delivery of instruction. Online courses are developed centrally, allowing for a lower cost of development and more systematic focus on cognitive learning outcomes. Through innovative learning systems, remedial assistance can be provided online at reduced cost relative to face-to-face tutoring. Online learning is both low cost and of increasingly high quality. It is a classic disruptive innovation....
>
> Even the strongest [traditional] universities will do well to re-focus their activities. Most university communities will need to go further, asking fundamental questions about what they can do well and abandoning much of what they have undertaken in a spirit of emulation. Those that continue to imperfectly imitate Harvard's strategy will find their costs increasing and their market share shrinking, whether they accept the metaphor of a higher education marketplace or not. (Christensen & Eyring, 2012, p. 53)

In a study of the future of universities in Australia, Ernst and Young (2012) has predicted that:

> digital technologies will transform the way education is delivered and supported, for example through applications that enable real-time student feedback, and the way education is accessed in remote and regional areas – both in the developed and developing world. Digital technologies will also fundamentally transform the way value is created within higher education and related industries. For example, new technologies will enable public and private providers to specialise in parts of the value chain – content generation, content aggregation, mass distribution, certification, commercialisation and so on. New technologies will enable media companies to enter the university sector, either in partnership with incumbents, or potentially in their own right. (p. 9)

Evidence of cost reductions

There is remarkably little empirical literature that documents the costs of online education relative to face-to-face education. One of the primary barriers to doing a cost analysis is defining which costs are to be included and over what period of time. Before any course reaches the point where the

marginal cost of content transfer is zero, it must face the cost of start-up and transition, which may be substantial.

Patricia W. Neely and Jan P. Tucker (2010), former instructors at Kaplan Higher Education, provide evidence on the costs of introducing online instruction in a traditional university environment. They argue that:

> While online education may be more cost effective in some situations, college decision makers need to consider the full range of cost implications associated with these online offerings. The unbundling of faculty roles in online distance education programs is one cost consideration that is often overlooked. As the faculty role has become more distributed, so have the costs associated with providing instruction and instructional support. (p. 1)

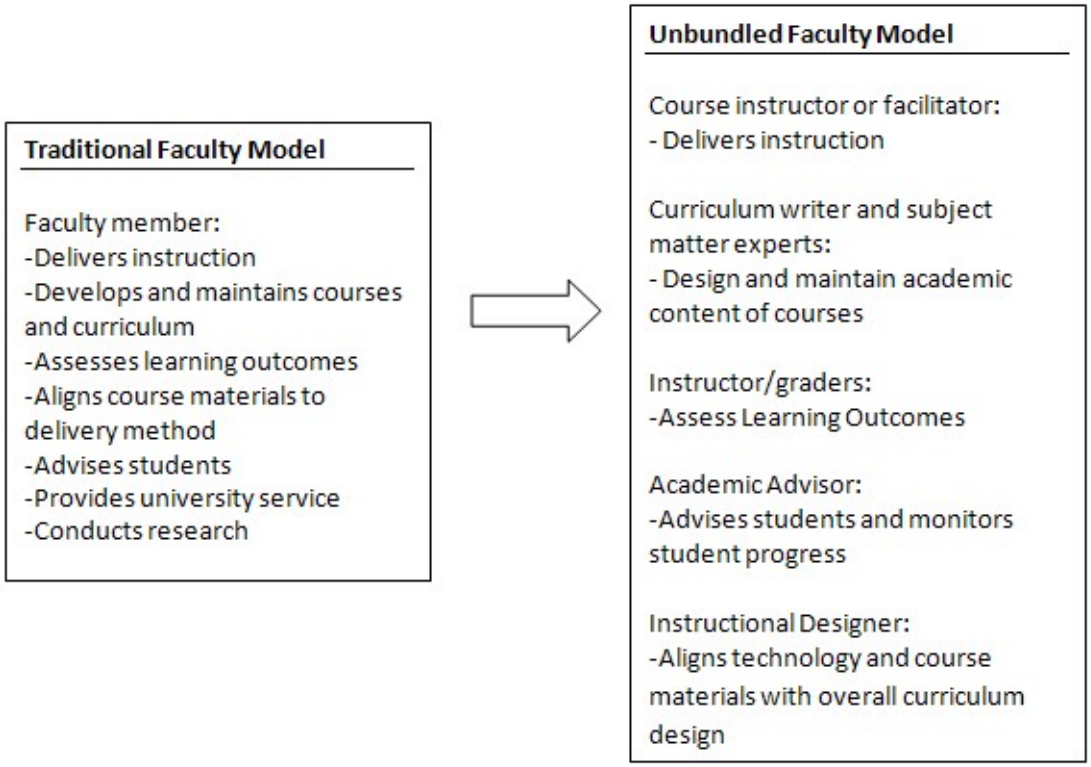


Figure 1. This figure illustrates the unbundling of a traditional faculty role.

Source: Neely and Tucker, 2010, p. 2.

Their study found a cost of $3,676 for the instructional support provided to a single course with the unbundled faculty model. The unbundled faculty role seems significantly less expensive than the cost of a traditional faculty member's course support at $8,986 per course. However, they said, it may understate the cost of the online model, because it makes no provision for faculty time devoted to course development and maintenance, or to administrative and university service. It also does not provide for the time of department chairs and lead faculty in coordinating the design, development and implementation of new courses, faculty supervision and training.

Neely and Tucker ultimately decline to declare whether online instruction is less expensive. They simply conclude that "it is difficult to identify and assign costs for instructional activities in higher education, particularly when comparing the traditional faculty model with the unbundled faculty model" (p. 4).

Bowen, Chingos, Lack and Nygren (2012; see also Bowen, 2013) did exploratory simulations for two types of traditional teaching models: (1) a model in which students are taught in sections of roughly 40 students per section; and (2) a model in which all students attend a common lecture and are then assigned to small discussion sections led by teaching assistants. They compare the current costs of each of these traditional teaching models to simulated costs of a hybrid model in which more instruction is delivered online, students attend weekly face-to-face sessions with part-time instructors, and the course is overseen by a tenure-track professor (with administrative responsibilities delegated to a part-time instructor).

They declined to publish a detailed model on the grounds that it was highly speculative, i.e., it required many assumptions about how a university would manage its online instruction. They did report, however, "the crude models we employed suggest savings in compensation costs ranging from 36% to 57% in the all-section model, and 19% in the lecture-section model" (pp. 25-26). They also speculate on other cost advantages, including:

- Reduced demand for space
- Scheduling savings
- Ability to accommodate higher enrolments without increasing the demands on tenured faculty
- Reduced recruitment costs for new faculty
- Reallocation of faculty time towards smaller, more advanced classes

Barriers to the reduction in cost

Cost studies are sensitive to assumptions made about potential institutional barriers to online learning. The literature suggests that these may be barriers to scaling up the use of learning technologies:

- There is no "burning platform" to drive disruptive change. If financial constraints happen, it may be easier to manage them using traditional means (such as larger classes and more part-time faculty), rather than to re-think how a university or college operates.
- Offering large-scale online courses seems to centralize decisions about what should be taught, and so it may raise questions about the academic freedom of individual faculty.
- Universities and colleges are paid for the courses they teach. They may receive little or no revenue for recognizing learning that happens elsewhere, and so have little or no incentive to recognize learning other than what they themselves offer.
- Governments typically pay for teaching, not learning. Governments pay universities and colleges for the time spent on teaching (such as credit hours or weeks of instruction). If a student can master a course in a few hours online, governments are uncertain how much to pay for this.
- People in higher education tend to measure quality by faculty-student ratios. Any course where one faculty member teaches thousands of students may be seen as low quality.
- In the absence of other reliable measures of quality, people in higher education tend to measure quality by cost. Low-cost education may be perceived as poor quality, so students and faculty may avoid it.
- There are many uncertainties about the potential market for online education. Students who find it difficult to attend a physical campus may need a fully online degree, but these degrees have been relatively rare. To the extent that a degree requires some physical

presence on campus, the potential market may overlap heavily with the market of students that universities and colleges already have. In other words, scaling up online education may scale down face-to-face education, which brings its own cost issues.

To the extent that online education reduces costs, there is no consensus about who should or would benefit from the reduction. Students seek lower tuition fees; governments seek reduced subsidies for higher education; university employees seek better compensation. This situation presents a principal-agent problem: it is difficult to motivate change when those affected by change will not receive the contemplated financial benefit.

Part 2: Environmental scan of emerging developments

The environmental scan part of our research study focused on emerging developments in online learning and their potential impacts on Ontario higher education. The environmental scan addresses recent developments which have not yet been evaluated in traditional journals.

> *"The environmental scan…provides organizational planners with common understandings of trends and issues for the future…to develop a vision …focused on "futuring."*
>
> Hinton, Karen (2012)
> *A Practical Guide to Strategic Planning in Higher Education*

Our focus is limited to rapidly emerging advances with strategic implications, at a level of depth which would highlight the institutional and system planning issues. The following emerging developments are discussed:

- Affordable and open textbooks
- Adaptive interactions with learning resources
- Optimizing student-instructor interaction time
- Targeting instructional effort based on student program data
- Minimizing marginal costs via Massive Open Online Courses

These emerging developments have been selected from a longer list identified in our initial environmental scan. Some "slow-but-steady" developments were lacking in breakthrough examples with strategic institutional impact, e.g., ubiquitous connectivity (Looi et al., 2010) or connected learning (Ito et al., 2012). Although we recognize the potential value of Semantic Web developments (Anderson & Whitelock, 2004; Ohler, 2008; Keller, 2011), we did not find convincing examples of value-generation for higher education stakeholders at this time. We also did not find analysis of Open Educational Resources used to supplement existing instructional models with impacts on cost.

Consideration of exciting developments at the pedagogical/epistemological frontier – rather than the technological – merits a separate report to include Social Pedagogies (Bass & Elmendorf, 2011) and students as Producers of Knowledge (Cormier, 2012). However, no analysis of Massive Open Online Courses could ignore Connectivist pedagogies and knowledge networking as noted briefly below.

Based on our analysis of these emerging developments, we identify several common themes across the individual developments:

- Aligning Support to the Student's Individual Learning Needs
- "Thinking Globally, Acting Locally" to Achieve Benefits at Scale
- Transparency and Knowledge Intensity in Instructional Design
- Reputational Capital From and For Online Learning
- The Challenge of Investment at/for Scale

For a summary of the emerging developments see Appendix 1.

Section 1: Emerging Developments

Affordable and open textbooks

Student purchases of textbooks and other required materials are often perceived as an issue solely of cost (to students, and potentially to government student assistance programs), but in fact cost and educational quality go hand-in-hand. If students do not purchase required materials, the quality of their education suffers. A survey (Allen, 2011) by the US-based Student PIRGS organization provides some initial estimates of the scope of these issues:

> The survey polled 1,905 undergraduates from 13 campuses in Spring 2011. The major finding was that 70% of respondents had decided against buying at least one assigned textbook due to cost. While some of these students reported sharing or borrowing instead, 78% still believed they would generally do worse in class without their own copy of the required text.

E-textbooks may reduce costs for students, but the financial benefits may not be static over time:

- Rickman et al. (2009) compared several laptop-based textbooks with their print counterparts and found that the e-version was up to 50% less expensive. This calculation does not include the cost of the laptop or other electronic device. It also does not consider the potential advantages of e-textbook features such as review quizzes, recommended and targeted review readings, interactive learning activities, or video segments to reinforce important instructional concepts. Further benefits may come through easier access and a reduction in the non-monetary costs associated with a book being out of stock.
- A more recent analysis in the US has suggested that the cost difference between digital and paper textbooks is small or non-existent, taking into account the heavy discounting of paper textbooks by online retailers (Seithel, 2012). This analysis also points out that students can reduce the all-inclusive cost of a paper textbook by selling it.

In Korea, which has adopted a goal of introducing e-textbooks throughout the K-12 system, the cost for the first five years (2012-2016) has been estimated by Korean education officials at about $13.53 US per student per month (Kim & Lee, 2012, p. 99). These costs include hardware, software and maintenance.

We know of only two experimental studies that examined the relationship between online textbooks and student learning at the postsecondary level. Deone Zell and Hillary Kaplowitz (2012) carried out two experiments involving students in a Management and Organizational Behavior course at California State University Northridge. Each experiment involved identical populations and teaching methods (n=657, 480), with instruction carried out in a large lecture hall seating 160 students/class. The independent variable was digital versus print textbooks. Learning was measured as the student's grade for the course, based on multiple-choice questions (90% taken from textbook content). Comparisons were controlled for incoming GPA, age and gender.

In the first experiment, the instructors advocated the print textbook, but told students a digital version was available for free if money was a real problem. Sixty-five per cent of students read the book free online, 31% bought the print book and 4% bought the digital book. Average marks for these three groups were 79.7%, 83.6% and 80.6%, respectively (after controls). The difference between the first two groups was statistically significant (.02 level).

In the second experiment, the instructors advocated either print or a new digital "package" that provided a choice of formats for various devices. They did not advocate the free web version, based on the previous finding that it was less effective, but they understood that some students would still

use it. Forty-six per cent of students purchased the print book from the book store, 37% purchased the digital book, and the balance chose other options. Average marks for these two groups were 84.3% and 81.2%, respectively (after controls). The difference was significant at the p = .01 level.

Their conclusions were:

- Print textbooks seem to lead to better grades than digital.
- The choice of device does not seem to make a difference.
- What students do with the device seems to make a difference (for example, the technology allows students to annotate, highlight, search, copy/paste and bookmark). However, this effect is hard to disentangle from the choice of device.

They suggest that students need to be taught how to use the distinctive features of e-books in their study strategies. They also suggest that acclimation is the great unknown, i.e., students may become more comfortable with e-books as they use them more and as technology improves.

Sun, Flores and Tanguna (2012) also find that the effect of e-textbooks on student learning depends heavily on whether students are aware of and make use of the additional features embedded in the text. They surveyed students in business and psychology courses at one U.S. university who were randomly assigned to use either a print textbook (n=91) or an e-textbook (n=137).

> The results suggest that e-textbooks influence the learning experiences of college students differently depending on how they are involved in using e-textbooks during the instruction. For students who use e-textbooks in class, the use of e-textbooks influences the learning experiences in two related but separate ways. First, they believe that the helpful features provided by e-textbooks may directly enhance their learning outcomes. Second, e-textbooks are likely to enhance their involvement in the courses, which will reinforce the learning outcomes. On the other hand, for those who do not use e-textbooks in class, their expected Learning Outcome mainly depends on the perceptions of E-textbook Helpfulness alone. This is also supported by the descriptive statistics, which show that students who used the e-textbook in class experienced a higher level of involvement and had more realistic learning outcome expectations than those who did not. (p. 73)

The authors acknowledge the limited sample size and they measure student perceptions of learning rather than learning itself. They conclude that much of the value of e-textbooks comes when instructors use them to teach differently, such as encouraging students to use exercises embedded in the e-textbook that provide immediate feedback.

Korea, which has introduced e-textbooks in large portions of its K-12 system, has done extensive evaluations of the effect of digital textbooks on student learning at the K-12 level. These studies (summarized in Kim & Lee, 2012, pp. 112-115) show that students using digital textbooks had higher learning achievement than students using printed textbooks in a range of academic subjects, grade levels, and urban and rural settings. The studies have the limitation of being only one or two years in duration, and they apply to K-12 learners rather than the higher education learners who are our focus.

Several institutions and higher education systems in the US have begun to use e-textbooks to address issues of quality and cost. One direction involves online versions of standard textbooks, often with low-cost options for printed copies or access beyond an academic term or year. The Ontario Undergraduate Student Alliance has cited data from the Canadian Publishers' Council to indicate that the acceptability of online texts to students will increase dramatically as the price point comes down (Carpenter, 2010).

Efforts by individual instructors can be valuable. Faculty participating in the *Make Textbooks Affordable* campaign in the US have adopted a *Faculty Statement of Intent*[2] that links their teaching responsibilities and the adoption of lower-cost textbooks:

> As faculty members, we affirm that it is our prerogative and responsibility to select course materials that are pedagogically most appropriate for our classes. We also affirm that it is consistent with this principle to seek affordable and accessible course materials for our classes whenever possible. This includes "open textbooks," which are offered online to students at no cost.
>
> Therefore, we the undersigned declare our intent to:
>
> 1. Seek and consider open textbooks and other open educational resources when choosing course materials.
> 2. Give preference to a low or no cost educational resource such as an open textbook over an expensive, traditional textbook if it best fits the needs of a class.
> 3. Encourage institutions to develop support for the use of open textbooks and other open resources.

Some jurisdictions are making concerted efforts at the institutional and system levels to scale up affordable textbook options:

- *Indiana University:* Students who participated in the e-texts pilot studies at Indiana University (Osborne, 2012; Indiana University, 2013) reported that they read more assigned material, highlighted and annotated more, and were better prepared for discussions and exams. There is an institutional commitment to ongoing development, in particular to address challenges in making full use of pedagogical opportunities in the new medium and in establishing scalable agreements with publishers.
- *California State University Affordable Learning Solutions (CSU, 2012):* The Calstate system initiative for affordable learning resources is the most comprehensive to date. The ALS program builds on the system's leadership in open resources3 and leverages the student base across 23 institutions to achieve scale in publisher agreements and co-development of resources. The options available include open textbooks (as discussed below), purchase and rental offerings of online versions of traditional texts, and new online resources developed to take advantage of new media possibilities.

Another option for affordability and quality in required texts and other resources is to engage faculty in collaborations to create and adapt open textbooks that are available for use by educators and students without charge, with an open source license that facilitates reuse and adaptation (Bucher, 2011). This can allow for high-quality baseline materials with more affordable customization at the local level. There are also several emerging large-scale initiatives which illustrate how the potential of open textbooks can be leveraged by collaboration across multiple institutions:

- State University of New York Open Textbooks: This is part of the larger Open SUNY Resources initiative, in which the State University of New York system aims to "to build on existing repositories of digital artifacts…make vast amounts of high quality, credible material available to faculty and learners, and also become a world leader in creating new resources" as well as "a research initiative…utilizing the expertise of SUNY faculty to identify best practices and… development initiatives in support of online learning" (SUNY,

[2] http://www.studentpirgs.org/open-textbooks/faculty-statement
[3] E.g., the faculty communities and peer review in the CSU-led MERLOT network, www.merlot.org

2013). The first 15 open textbooks to be supported under the project include works in anthropology, English, education and music.

- British Columbia Open Textbook project: Open textbooks will be made available for the "40 most highly enrolled first- and second-year subject areas in the provincial post-secondary system" (British Columbia Newsroom, 2013), 26 in first year and 14 in second year. Online versions will be free and open; print copies will be available as an option with a target price of $35. A review committee of faculty will ensure high quality and a grants program will support adaptation of existing open textbooks to meet BC requirements and creation of new open resources as required.
- Washington State Board of Technical and Community Colleges Open Course Library: In 2011, the Washington State Board capped the cost of course materials at $30 per course for their 81 highest-enrolment courses and invested in faculty collaborations to provide high-quality materials in an Open Course Library (many adapted from other open resources). Sixty-two per cent of students surveyed stated they learned more from the open materials. Eighty per cent of students rated the redesigned content as either "good" or "excellent" on a five-point scale (Caswell, 2012).

Ongoing Developments: We should note that none of these initiatives requires faculty to use the open textbooks provided. The intent is to ensure that high-quality open textbooks are available and known to faculty as they make their decisions on course texts. Several of the open textbook initiatives at the system level are informally cooperating and moving toward a more formal alliance.

Quality and Cost Implications: None of these promising developments has as yet generated sufficient data to demonstrate a sustainable model for Ontario institutions.[4] While costs to students seem certain to decline over time, significant faculty and institutional effort will be required to foster change and track impacts. Some institutions may choose to be pioneers in order to build reputational capital, but policy incentives and returns on investment may be required to achieve solutions at scale.

Learning resources that adapt to the student

The affordable and online resources described above use faculty teaching knowledge to engage student interest and develop conceptual understanding. Adaptive resources for online learning take this knowledge mobilization one step further to replicate some of the actions that effective teachers would provide to support student-content interactions, in particular by adapting learning tasks, feedback and trajectories to the needs of individual students.

> Different types of adaptive learning solutions aid the effort to improve learning in different ways. Some companies, for example, offer technology platforms within which instructors can design and deliver their own courses, while other companies provide wholly developed and self-contained courses across a variety of disciplines. Some of these tools use a rules-based approach and focus on moving students down a linear path through a given curriculum, whereas others rely on complex algorithms to allow for multiple pathways through a collection of learning objects. Some applications focus on optimizing memory, whereas others focus on problem-based learning in context, for example, within the context of a simulation. (Education Growth Advisors, March 2013)

Adaptive learning resources have not received the same publicity that has accompanied other recent developments. However, a coalition of technology providers and higher education institutions across sectors has focused attention on the many new initiatives in this area (Fain, 2013) and

[4] Non-traditional institutions, such as Western Governors University, have been successful in bundling resource costs into tuition, creating a strong incentive for institutional effort to manage resource costs.

funding from the Bill and Melinda Gates Foundation promises to accelerate information gathering (Education Growth Advisors, April 2013) and scale up interest, experimentation (Jarrett & Rajan, 2013) and critical analysis (Simonite, 2012; edSurge Wiki, 2013).

While many of the new developments come from commercial suppliers, the most widely known example is the Open Learning Initiative (OLI) developed at (and based on research from) Carnegie Mellon University. We noted above the findings by Bowen et al. (2012) in their use of the Carnegie Mellon OLI in six public institutions in the US.

OLI offers resources for 18 course frameworks[5], which can be re-used in both online and hybrid formats. For example, the OLI statistics course frameworks have been used by faculty at research universities[6] and in the Carnegie Foundation's Statway™ developmental math course for community colleges and state universities across eight US states. Table 1 lists other OLI course framework resources and links to a report on an adaptation for a political science course at Georgetown University.

OLI resources provide traditional textbook-like content, interactive simulations and problem-solving exercises. Extensive modeling of student learning and effective teaching underlies the interaction design. It is also an affordable resource: independent learners can access any of the course resources without charge; "academic" learners enrolled in a registered course pay a $25 fee and in return instructors receive a full record of student progress and activity.

> No machine in the world will ever be able to substitute for an enthusiastic and inspiring teacher. The advantage of an Open Learning Initiative (OLI) resource is that it does not replace the teacher, but works in conjunction with the teacher. With OLI, class time can be used far more effectively.
>
> *Oded Meyer, Georgetown University, http://gli.georgetown.edu/oli/*

Quality and Cost Implications: Adaptive learning systems offer both quality and cost benefits to students, combining low-cost resources at scale with more effective instruction through embedded teaching knowledge. The effects on institutions are less clear. In principle, faculty time could be redeployed to other areas of instruction: adaptive learning systems to date have focused on "technical knowledge" where student progress can be readily assessed against "correct answers", not on other educational goals involving creativity, reflective practice, decision-making processes, professional formation, etc. In practice, redeploying faculty time to higher value activities will require significant stakeholder collaboration for experimentation with instructional, funding and support models.

Optimizing student-instructor interaction time

A key contribution of emerging developments in online learning lies in the potential to redeploy faculty time: away from activities where high value can be generated by scalable online resources or tools and toward activities where interpersonal interaction between instructors and students generates the most value. In this section we consider some examples of productive online learning methods generating high value *within* course learning activities. In the next section, we consider how insights about student online learning *across* activities in courses can be aggregated and analyzed by online tools that allow faculty to better target their time for interacting with students at the point of greatest need.

[5] Our thanks to David Wiley of Utah State University for suggesting the "open course framework" label: each faculty member extends or adapts the framework resources to create a particular course offering. See http://www.lumenlearning.com/courses

[6] e.g., University of California at Berkeley, University of Texas at Austin, and the University of Kansas.

***Calibrated Peer Review**:* Many of the adaptive learning examples listed in the previous section occur in courses in which the knowledge students develop can be assessed against "right" answers or pre-determined outcomes. For subject matter where more creative and individual work needs to be assessed, other methods are required to reduce instructor workload while simultaneously improving learning outcomes. Calibrated Peer Review, initially developed at the University of California Los Angeles to manage feedback on student writing assignments, is now used at over 1,500 institutions across higher education. While there is a technology infrastructure[7] enabling use in large classes, the key development is a process of faculty-directed student activity in which students learn to provide feedback and assessment for peer assignments and in the process improve their own writing (Sadler & Good, 2006).

Some excerpts from the UCLA instructors' guide (CPR 2012) highlight the redesigned process and roles:

> Four steps make up each Calibrated Peer Review (CPR) assignment: Writing, Calibration Training, Peer Review and Reflection:
>
> 1. Students first write and submit an essay on a topic and in a format specified by the instructor.
> 2. Students assess three 'calibration' submissions against a detailed rubrics…[since there are pre-determined outcomes for these submissions] Feedback from the system at this stage is vital...
> 3. Once students have mastered the calibration evaluations, each student is given anonymous submissions from three other students. They use the same rubric to evaluate their peers' work…
> 4. Each student receives the peer reviewers' evaluation and comments on their work, their own performance grade on the calibration training, and a grade for their own submission and their reviews of peer work (along with the other reviews of the peer submission they assessed).
>
> The instructor focuses on high-value activities (although they may also participate as 'peer' reviewers):
>
> 1. Design the assignment (or re-use one shared by others); create calibration submissions and rubric.
> 2. Set up the grading criteria for the assignment, weighting the various components described above in a way that is consistent with the goals of the course.
> 3. Manage problems that may arise if there are defaulting students or inconsistent grading.
> 4. Adjudicate the few student submissions that require more advanced expertise.

Evaluations across multiple institutions (Sadler & Good, 2006) show consistent improvement (~10%) in students' final exam results – regardless of exam type – and gains in critical review and self-reflection capability. These improvements in learning outcomes are accompanied by reduction in instructor workload.

Faculty-directed "student-sourcing" of responses to student questions: Some faculty have reported communication challenges in supporting online learning. For example, some students may expect that instructors will be online with them to respond quickly to issues and an initial overload of emails or other online communications. Advances in online tools and processes have provided

[7] In addition to the low-fee technology hosted by UCLA, a number of variants and extension are available or emerging. See http://ipeer.ctlt.ubc.ca/wiki/whatis; http://turnitin.com/en_us/products/peermark; http://ose.utsc.utoronto.ca/ose/ose_new_v/article.php?id=3456&page_issue=201203&cid=19

better filtering and facilitating of such interactions, effectively "crowd-sourcing" many aspects of guidance and advice through student-to-student interactions under the control of instructors.

Piazza (2012) is a recent example of question-and-answer collaboration spaces for students and faculty:

- Students (and instructors) pose questions or ask for help in the course workspace. Other students and instructors can then respond with answers.
- Each question posed has one space for a students' answer that students can contribute to and edit (technically a wiki), and one space for an instructors' answer to be created and edited.
- Instructors endorse questions or answers to recognize contributions and direct interactions.
- Questions and answers can be anonymous; instructors report that students take ownership of the interaction space and respond to – or edit out – unproductive comments.
- An effective mobile app allows interactions anytime and anyplace.

There is growing anecdotal evidence that features like these, ubiquitously available through a simple interface, can provide both quality and cost benefits for students and faculty.

***Just-in-Time Teaching*:** Another tactic to optimize student and faculty effort is to increase the value generated from classroom time. One development that has attracted considerable recent publicity is the "flipped classroom" approach, in which the primary introduction to course content occurs outside of scheduled classes and time in class is focused on motivating applications, challenging conceptions, solving problems and fostering student collaborations. A popular tool for flipped classrooms is the Khan Academy (Khan, 2013) collection of 4,000 video clips, each about ten minutes in length. In response to earlier criticism, the Khan Academy infrastructure now includes much more adaptive learning and analytics technologies beyond the original, intuitive[8] videos.

The idea of moving the initial exposure to course topics outside the classroom approach is not new in higher education: it was well documented in the 1990s.[9] Nor is it simply a case of moving classroom presentations onto video:

- "If a student does not understand the subject matter and cannot ask questions as he or she moves along, watching video is no different than reading textbook chapters" (edSurge, 2012).
- "If you structure your class exactly the same way you have always done but call it flipped, effectively what you have done is added an extra hour of class for every hour of class the student has."[10]

A more reliable and research-informed scalable approach is Just-in-Time Teaching (Carleton, 2013):

> Just-in-Time Teaching has the potential to help students develop study skills that will serve them throughout their learning careers. At the heart of the JiTT process is a set of

[8] There have been numerous critiques of the original lack of pedagogical content knowledge in the Khan Academy resources: "I teach the way that I wish I was taught. The lectures are coming from me, an actual human being who is fascinated by the world around him." See https://www.khanacademy.org/about
[9] See the "castle top" design diagrams in Dee Fink, *Creating Significant Learning Experiences: An Integrated Approach to Designing College Courses*, Jossey-Bass Publishers, 2003.
[10] Richard Taylor, president of a lecture-capture technology company, quoted in Kevin Makice. "Flipping the Classroom Requires More Than Video", Wired Geek Dad weblog post, April 13, 2012. See http://www.wired.com/geekdad/2012/04/flipping-the-classroom

> concept questions that students answer online prior to class [using resources from the course], e.g., multiple choice questions requiring a description of students' reasoning. The resulting responses typically reveal student misunderstandings and conceptual errors related to the course material. Before class the instructors note which concept questions caused difficulties, sample and analyze the student responses, and use the identified learning gaps to adjust planned classroom interactions "just in time". (Camp et al., 2010, p. 25)

Just-in-Time Teaching thus combines initial resource-based exposure to course topics with data-driven faculty-student (and student-student) interactions. It has been used in many subject areas with positive results for student outcomes on standard exams (Novak & Middendorf, 2004), for development of longer-term study skills (Camp et al., 2010, p. 30) and for higher-level learning.[11] For Just-in-Time Teaching to be effective, instructors must design effective questions to address their course goals (Carleton, 2011), support students in altering their study habits for ongoing engagement with course content (Camp et al., 2010, p. 28), integrate cooperative interactions amongst students (Watkins & Mazur, 2010) and demonstrate the value of this engagement through thoughtful tailoring of instructor-student interactions in line with the real-time evidence about student needs (Carleton, 2013). Some institutions have developed programs to help faculty develop capability in these design requirements (e.g., Indiana University, 2011).

There is good evidence to indicate that teaching which follows the Just-in-Time principles can have positive impacts on the quality of learning experiences and student outcomes. Scaling up Just-in-Time Teaching also has potential impact on costs:

- Class time can be optimized when students come to class better prepared and faculty are able to invest time on specific topics that need clarification. Some institutions[12] use hybrid courses with rich online resources and reduced classroom hours to achieve efficiencies.
- The data generated about where (and why) students are encountering challenges can be applied to improve resources and learning design. It can also be analyzed to identify which students would benefit from targeted interventions early in a course or at a program level, with subsequent benefits for retention and completion.

Quality and Cost Implications: Individual instructors in Ontario have implemented methods such as the ones described here to improve the quality of student learning experiences and redirect instructional time. Policy changes at the institutional level may be needed to support such changes and achieve an institutional return in terms of quality and productivity.

Data about patterns of student behaviour can also be aggregated automatically to provide further insights and improvements – in both quality and costs. The next section describes the emerging developments in this area of rapidly evolving methods, collectively referred to as Learning Analytics.

Learning analytics: using real-time data on learning activity to target instructional effort

The adaptive learning systems described above use data from student activity to construct pathways of topics and tasks to engage students, embedding faculty teaching expertise within the online tools. In contrast, the related development of Learning Analytics provides data about student learning to faculty and other educators, to enable them to tailor their interactions with students to maximum effect.

[11] http://journalism.indiana.edu//syllabi/ccookman/J462portfolio/index.htm
[12] E.g., http://cdl.ucf.edu/research/rite/dl-impact-evaluation/#Success

Learning Analytics has been defined as "the interpretation of a wide range of data produced by and gathered on behalf of students in order to assess academic progress, predict future performance, and spot potential issues" (Johnson et al., 2011, p. 28). The important recent advance is the movement beyond recording *checkpoints* (when students complete tasks) to analysis of *process* data about what activities students undertake within a task (Lockyer et al., 2013). Such analyses hold great promise for identifying where and how to target instructional effort; realizing this potential is still very much a work-in-progress. We will illustrate the potential using one example with a strong research base which has been successfully scaled up for institutional impact.

Purdue University: Course Signals

Course Signals was developed at Purdue University and is now being made available to other institutions and serving as a model for other such tools.[13] Course Signals (Purdue, 2011) was designed to monitor students' behaviour patterns and relate them to academic performance in order to determine if they are at risk of earning a low grade. The twin goals are:

- to enable students to get early indicators of how they are doing in a course so that they can make adjustments to produce better results, including reaching out for help or extra resources.
- to help faculty to intervene with timely suggestions to their students about actions which lead to improvements in student learning.

The underlying mechanism in Course Signals (and similar systems) is a Predictive Student Success Algorithm to collect and analyze multiple data points [selected by course faculty], focusing more on the process of student task activity than on the task checkpoints. "For example, the system might look at whether students have read assigned online course materials, done practice assignments, attended tutorial sessions after class or participated in online class discussions. Combined with the student's test grades and demographic information, these data points help to predict how well a student will do in the course" (Tally, 2009). This information is delivered early in the academic term, typically in the first and second years of a student's program.[14]

In addition to simple "dashboard" visualizations to indicate faculty concerns – e.g., green, yellow or red on-screen traffic lights – students also receive messages, selected by faculty, to offer tips on improving performance or simply encouraging them to keep up their good work. The messages are delivered via the course Web site, through e-mail, or can be sent by text message or automated voicemail (Purdue, 2011).

> *"I want my students to perform well, and knowing which ones need help, and where they need help, benefits me as a teacher*."
>
> Purdue University faculty member using Course Signals

Course Signals was piloted in the 2006-2007 and 2007-2008 academic years with nearly 2,000 students, where a double-blind study found that "67 percent of students receiving a Yellow or Red warning improved their effort and grade. For students who received a Red light only, 78 percent improved their grade and effort during the mid-term period" (Purdue, 2011). Since then, over 23,000 students across 100 courses have been impacted and

[13] E.g., Sheila MacNeill and Jean Mutton. *Case Study: Engaging with Analytics*. CETIS Analytics Series *2*(1), March 2013. See http://publications.cetis.ac.uk/wp-content/uploads/2013/03/CETIS-Analytics-Series-Vol-2-No-1.-Case-Study-Engaging-with-Analytics.pdf . See also Tim McKay, Kate Miller, and Jared Tritz, What to Do with Actionable Intelligence: E2Coach as an Intervention Engine, Proceedings *of the 2nd International Conference on Learning Analytics*, ACM Press, 2012. See http://sitemaker.umich.edu/ecoach/files/lak_2012_submission.pdf

[14] Similar efforts in later years seem to have more limited impact, as student learning behaviours are already established.

over 140 instructors have utilized the system. Plans call for expansion to include as many as 20,000 students a semester by 2014, based on the success shown to date (Arnold & Pistilli, 2012, p. 268):

> There is a 10.37 percentage point increase in As and Bs awarded between Course Signals (CS) users and previous semesters of the same courses not using CS. Along the same lines, there is a 6.41 percentage point decrease in Ds, Fs, and withdrawals awarded to CS users as compared to previous semesters of the same courses not using CS…Students report positive experiences with Course Signals overall (89% of respondents stated CS provided a positive experience and 58% said they would like to use CS in every course)…Students also find the visual indicator of the traffic signal, combined with instructor communication, to be informative (they learn where to go to get help) and motivating (74% said their motivation was positively affected by CS)...Faculty can provide action-oriented and helpful feedback much earlier in the semester, which students appreciate. Faculty also say that students tend to be more proactive as a result of Signals interventions.

Faculty teaching expertise is critical to making the Course Signals interventions work: "Student success was related to the type, and performance or outcome orientation of both summative and formative feedback students received from instructors."

Ongoing Developments: Because of the scope of investment and potential market required to develop sophisticated algorithms for analysis of student data, commercial partners have become involved in many current initiatives.[15] In addition to the issues these partnerships raise, there are also significant uncertainties about privacy concerns and the potential impacts on the role of assessment (UNESCO IITE, 2012). A number of institutions have elevated the exploration of learning analytics to the strategic level – e.g., University of Michigan's Provost's Task Force on Analytics (UM-LATF, 2012; UM-CRLT, 2012) and Stanford University's Analytics Lab (MacKay, 2013) – despite the challenges of doing so (Macfadyen & Dawson, 2012). Efforts have also begun to build a larger community of institutional collaborators, including liberal arts colleges (Taylor & McAleese, 2012), community colleges and teaching-led universities.[16]

Quality and Cost Implications: The quality implications are clear from the Course Signals example. Cost implications are less clear: a number of pioneering institutions report increased student retention and completion, which lowers the cost-per-graduate. Appropriate funding policies could provide the return on investment to encourage institutional investment in the necessary infrastructure and expertise. We were not able to locate any analyses of the financial benefits and costs for emerging developments, although some institutions have put forward ambitious claims based on preliminary internal evidence (Kolowich, 2013).

Minimizing marginal costs via Massive Open Online Courses

What would happen if the emerging developments we have described became more integrated? An online infrastructure of this scale could lead to course offerings in which marginal costs for additional students declined to the point where new enterprise models for higher education became effective.

The first online learning experiences labeled as Massive Open Online Courses[17] (MOOCs) were developed by Stephen Downes (National Research Council of Canada) and George Siemens

[15] E.g., http://www.educause.edu/ero/article/no-more-excuses-michael-m-crow-analytics
[16] e.g., Open Academics Analytics Initiative: Marist College, Cerritos Community College, College of the Redwoods, Savannah State University. See.https://confluence.sakaiproject.org/pages/viewpage.action?pageId=75671025
[17] The term MOOC was coined in 2008 by Dave Cormier (University of Prince Edward Island).

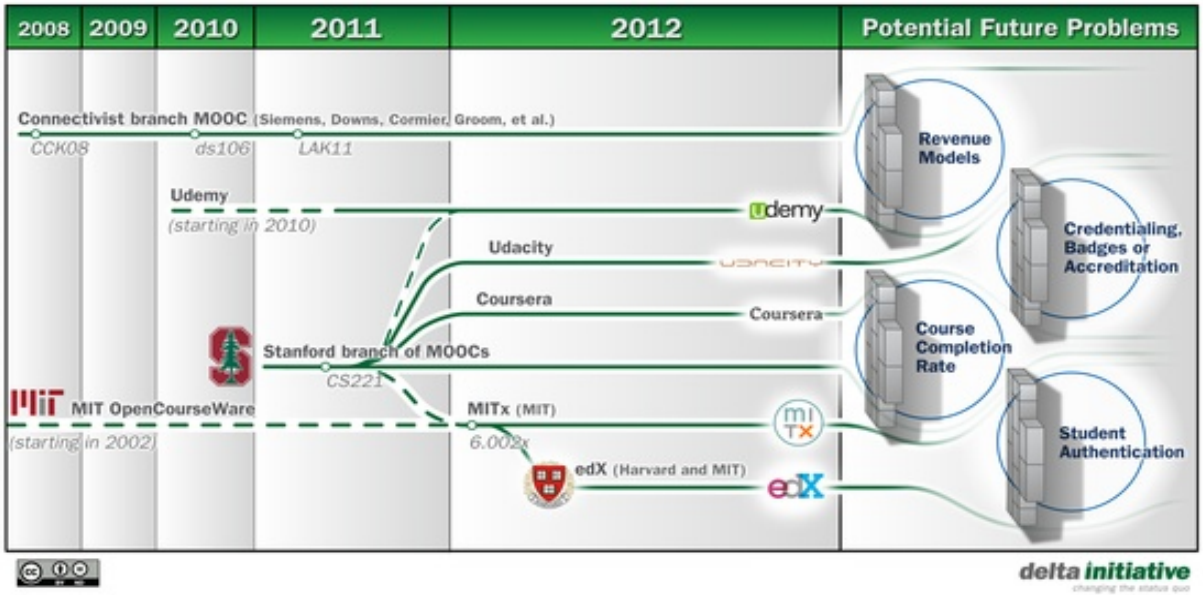
(Athabasca University). These early MOOCs were intended both as online credit courses and as collective experiments with inquiry-based networked learning:

> A MOOC integrates the connectivity of social networking, the facilitation of acknowledged expert(s) in a field of study, and a collection of freely accessible online resources…a MOOC builds on the active engagement of several hundred to several thousand "students" who self-organize their participation according to [their own] learning goals, prior knowledge and skills, and common interests. (McAuley, Stewart, Siemens & Cormier, 2010, p. 4)

These initial developments are now referred to as cMOOCs[18], or connectivist MOOCs, because the intent was to bring together two types of innovation: large scale, and a teaching and learning model that is learner-directed and expert-facilitated, with the roles of learner and expert being fluid. The next generation of MOOCs brought attention to the innovations around large scale and open enrolment but did not necessarily incorporate the teaching and learning innovations that characterized cMOOCs. This new generation started in 2011 through online courses offered by instructors at Stanford, Harvard and MIT. These courses typically used an instructor-directed model with traditional teaching and learning roles and methods (lectures, quizzes, etc.). They are now referred to as xMOOCs[19], after the Harvard/MIT platform edX. Their goal was to provide open access to curriculum resources and teacher presentations from the institutions, with a massive scale achieved by online distribution of materials and automated or peer-sourced feedback on student assignments.

In addition to MOOCs offered directly by higher education institutions, early developers launched several private companies in order to secure investment in the required infrastructure, as illustrated in Figure 1 below (Hill 2012 – Four Barriers), created in July 2012 by technology consultant Phil Hill and – like much of the writing on MOOCs – rapidly becoming out of date.

Figure 1: Emergence of High Profile Providers and Platforms for MOOCs



[18] Suggested by Stephen Downes and presented in "MOOCs are really a platform" by George Siemens. Elearnspace. http://www.elearnspace.org/blog/2012/07/25/moocs-are-really-a-platform/.
[19] Siemens, 2012, op cit. The definition given here draws on http://moocnewsandreviews.com/ultimate-guide-to-xmoocs-and-cmoocso/#ixzz2RmEeXfvd

The huge initial enrolments for no-fee non-credit courses – "Coursera now has 214 courses attracting 2.4 million students from 196 countries" (Smale, 2013) – along with the much smaller but still impressive (Gee, 2012) number of students completing the requirements, have attracted enormous attention, with MOOCs being seen as a possible "game-changer" (Contact North, 2013) for higher education.

Subsequent developments have included the following variations:

- Caps on no-fee students enrolled in MOOC-like credit offerings ("Little Open Online Courses", Kolowich, September 6, 2012)
- Blended learning models which integrate MOOCs with on-site teachers-as-coaches (Grush, 2013)
- Platform providers experimenting with revenue generation to continue no-fee access (Kolowich, February 21, 2013)
- Institutions rethinking tuition fees when MOOCs reduce costs for some aspects of instruction (Kolowich, October 16, 2012)
- Various efforts to translate MOOC participation into credit in higher education programs (Jaschik, 2013; Kolowich, February 7, 2013)

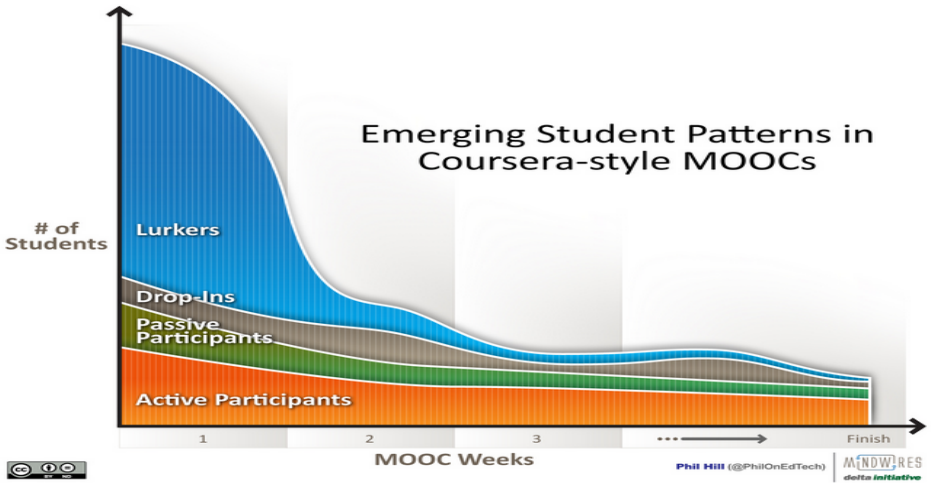
Many of these new developments, however interesting in their own right, seem to move further and further away from the original goals around quality, access and cost (Watters, 2013). Meanwhile, MOOC evolution continues: the *Chronicle of Higher Education* maintains a timeline (Chronicle, 2013) with ongoing updates, although little rigorous data is yet available.

Phil Hill[20] has shown that a large share of active participants who enrol in an xMOOC do in fact complete the course. However, the overall course completion rate may be low because of a large number of enrollees who are lurkers or drop-ins – in other words, they simply sample one or a few items, or they simply want to learn about one topic in the course. Figure 2 shows Hill's visualization of the data.

*"**Lurkers** – These students are the majority of xMOOC participants, where people enroll but just observe or sample a few items at the most. Many of these students do not even get beyond registering for the MOOC or maybe watching part of a video.*

***Drop-Ins** – These are students who become partially or fully active participants for a select topic within the course, but do not attempt to complete the entire course."*

Figure 2: Emerging Student Patterns in MOOCs: A Graphical View



[20] Hill, P. "Emerging Student Patterns in a MOOCs". Guest post in the E-Literate Blog. Mar 6, 2013. http://mfeldstein.com/emerging_student_patterns_in_moocs_graphical_view/

There are also numerous discussions of troubling issues in higher education that are highlighted or reinforced by the MOOC phenomenon[21], such as the following:

- The idea that MOOC offerings should come from "the best universities" with "top-quality content" ignores the sources of the reputational prestige in higher education[22], the different contexts of higher education and the evidence from studies (Loverude, 2003) of open resources unsuccessfully applied in new settings. Coursera, for example, has suggested that one potential business model could involve "smaller colleges licensing the courses devised by the bigger universities" (Smale, 2013).
- Focusing on the aspects of learning that are most easily scaled – presentation of content and feedback on assignments with prescribed correct solutions – could potentially cause us to shortchange more important capabilities for learners. (We return to this theme in Part 3.)

The rapid evolution of MOOCs has produced a diversity of analyses and analogies for potential impacts:

- "MOOCS will do to higher education what Google News did to journalism. Commoditized courses will be as free as commoditized news… The worst thing that a university can do is act like MOOCS never happened, and continue to offer large passive lecture classes as the default mode" (Kim, January 1, 2013).
- "When the car you are driving goes out of control in a skid, turn in the direction of the skid. You get control back much more quickly that way. If you refuse to acknowledge the skid, or fight it, you lose control completely and crash. But the teaching side of higher education will only thrive if it's able to turn into the skid and use the new resources to its advantage" (Reed, 2013).
- "MOOCs can aggregate demand across geography. There does not need to be an enormous local demand for your institution's area of specialty, as online learning allows learners from anywhere to participate…Directing resources towards faculty within your school's area of excellence will generate strong downstream returns" (Kim, January 14, 2013).

These widely varying analyses demonstrate the challenge of predicting exactly how and why MOOCs are likely to have strategic impacts on higher education. The comments in the text box below from Steve Gilbert[23] give a concise summary of the challenges faced by colleges, universities and government agencies in dealing with all of the emerging developments we have described. There is, though, a consensus among observers that online learning has crossed some sort of threshold, however murky the details.

[21] One positive result of the attention to MOOCs has been renewed attention to foundation issues in online learning, e.g., the Manifesto for Teaching Online (http://onlineteachingmanifesto.wordpress.com/the-text/) and the Digital Learning Bill of Rights (https://github.com/audreywatters/learnersrights/blob/master/bill_of_rights.md)

[22] As described by John Daniel, former head of the Open University in the UK and Athabasca University in Canada: "A first myth is that university brand is a surrogate for teaching quality. It isn't. The so-called elite universities that are rushing into xMOOCs gained their reputations in research. Nothing suggests that they are particularly talented in teaching, especially teaching online… Placing their xMOOCs in the public domain for a worldwide audience will oblige institutions to do more than pay lip service to importance of teaching and put it at the core their missions. This may be the real revolution of MOOCs." Making Sense of MOOCs: Musings in a Maze of Myth, Paradox and Possibility, Journal of Multimedia in Education, 2012, http://www-jime.open.ac.uk/jime/article/view/2012-18.

[23] http://tltgroup.roundtablelive.org/FridayLive?eventId=620752&EventViewMode=EventDetails

- New technologies almost always enable the production of new information resources much sooner than we can figure out how to use them for educational purposes.
- Entrepreneurs and innovators outside (or on the periphery) of education almost always figure out how to begin using the new resources before traditional educational institutions do.
- Independent self-motivated learners almost always figure out how to begin using the new resources before teachers and other professional educators do.
- Some of the better ways of using the new resources will not emerge for a long time, until educators begin thinking in new ways and perceiving new kinds of possibilities for using them.

Steven W. Gilbert, President, The TLT Group, in a briefing for the Smart MOOC Higher Education Research Subgroup on ways to use MOOC offerings in traditional institutions

Section 2: Some common themes across emerging developments

Aligning support to the student's individual learning needs

Many faculty members – and students – have strong negative reactions to the notion of MOOCs with very high ratios of students to instructional staff or to other instructional designs with limited contact between students and instructors. They are well aware of the contributions of student-instructor interactions to learner success in traditional instructional formats (and often less aware of the potential for interactions with other students and with highly interactive resources incorporating models of learning as well as content).

Steve Gilbert's comment that self-motivated learners are well positioned to explore new pedagogical designs and support structures provides a good insight for understanding these concerns. Successful learners in both xMOOC and cMOOC designs to date have not been typical undergraduates: they typically have higher levels of self-direction and self-motivation. Related learner characteristics, independent of prerequisite content knowledge, may also serve as catalysts for learner success with different instructional designs and support structures:

- For staying on track with course work, a more self-managed learner will likely receive less benefit from interventions generated by a learning system such as Course Signals.
- For developing interest in course subject matter, a more self-motivated learner is likely to benefit less from the enthusiasm that an instructor can convey in live or recorded lectures.
- For resolving problems in completing learning activities, a more self-reliant learner is likely to derive more benefit from student-to-student interactions for problem resolution and less likely to require interactions with instructional staff.
- For identifying and researching topics for deeper reflection and analysis, a more self-directed learner is likely to require less direct interaction with instructors and to benefit more from collaborations with other learners.

In these terms, the cMOOC pedagogy and support structure is likely to work well for a learner with all of the above characteristics. Further action research would be valuable to determine how developing more student capability for self-managed learning early in their programs could pay off later in reduced support costs and scaling up instruction.

An xMOOC pedagogy and appropriate structure could provide more direction, and depending on the instructional design could provide more or less motivational support. Both could be regarded as "low end disruptions" in classical innovation theory (Christenson, 1997) – providing a low-cost service to users whose needs do not require the full spectrum of services provided by existing

suppliers – so the typical progression of a disruptive innovation might be anticipated. There are two qualifications which make this picture murky:

- Low end disruptions are typically aimed at an existing supplier's "least profitable" customers. However, the learner characteristics described above are the most desirable: a key goal of higher education is to raise all students to a high level of self-direction, self-management, etc., and such students are prized by institutions and faculty alike.
- cMOOCs may be better considered as "new market disruptions" in innovation theory, as they result in different roles and relationships[24] between students, faculty and institutions.

> *Everyone is talking about bending the cost curves by getting 80% of education for 50% of the cost. Question – can we get 120% of education (measure the outcomes however you wish) for 80% of the current cost? This is a different kind of challenge and it cannot even be framed without fundamentally rethinking how we structure and deliver educational experiences. It almost surely requires technology to mediate it.*
>
> comment at a U.S. Department of Education conference on higher education productivity

In fact, as the quotation in the attached sidebar suggests (deMillo, 2012), our challenge in higher education is to raise quality and lower costs at the same time. The key to achieving this appears to be using scalable approaches wherever we can, i.e., where the more labour-intensive methods "overshoot" the needs of students and we have the opportunity to redirect that effort into more productive activities to support higher quality in learning outcomes.

San Jose State University, a public institution within the California State University system, shows how one public institution is beginning to apply this approach to address the issues of quality and productivity in their educational mission. SJSU has previously experimented with a "different strokes for different folks" approach to aligning instructional resources with student needs. For example, like many institutions at all levels of public higher education, San Jose State enrols a significant number of high school graduates whose capability in mathematical concepts and quantitative reasoning are not at the level required for college-level work.

Based on assessment tests conducted early in first semester, the university directed some students into competency-based modules using online learning and large lecture sections for motivational and modeling by instructors. Other students who lacked the required content knowledge were redirected into small classes staffed by faculty and supplemental instruction sessions with teaching assistants. Students in the large sections were monitored and redirected into the small sections if their capabilities in self-management and related skills required the additional support of the smaller environment. The instructional model only worked because the cost savings from the large sections with online learning were used to invest in the smaller sections required by a substantial minority of students (where online learning was also used, but in a setting with rich opportunities for person-to-person interaction).[25]

Against this background, it is not surprising to note that San Jose State is participating in both an edX experiment (Harris, 2012) (with the MIT Electronics and Circuits resources used in a "flipped classroom" model) and the SJSU Plus MOOC pilot in the Udacity platform (Harris, 2013) for

[24] Advocates for cMOOCs may view xMOOCs as a backward step pedagogically. "The xMOOCs may look like higher ed adopting the internet. But they're discrete, pre-sanctioned, linear delivery methods for knowledge. They roll back 30+ years of pedagogical best practices, and revert to the "sage on the stage" method of mass transmission. They assume what needs to be known is known. They don't even begin to address the emergent domain of knowledge or all the cultural shifts occurring as hierarchy is challenged by heterarchy." George Siemens/Bonnie Stuart/Dave Cormier posted September 17, 2012 in the discussion of their forthcoming book *The Internet Happens to Higher Education*. See http://www.xedbook.com/?p=21#comment-3335

[25] http://elixr.merlot.org/case-stories/course-preparation--design/transforming-course-design/increasing-student-success6

developmental mathematics and statistics. The latter MOOC is intended as a model for a scalable approach in which individual learners with appropriate characteristics can be successful in the MOOC environment with online support from faculty, course mentors, etc., while additional support can be made available on-site to other learners as needed. This could create a more seamless blended approach to replace the previous dichotomy between very large and very small sections and support processes.

For many educators in Ontario higher education, these are novel design decisions for instructional plans: creating support levels with flexibility to not overshoot or undershoot student needs, in order to focus resources where they are most needed. We are more used to treating support resources – including faculty time – as a fixed quantity to be assigned optimally within a given course, rather than seeing the resources as part of a larger common pool where savings in achieving one capability can be applied to ensure that developing other learner capabilities can be maintained or enhanced. As the mini-case (Mehaffy, 2012) in the sidebar suggests, competition among institutions across jurisdictions may force us to rethink our instructional models if we are not proactive in advancing quality and productivity in parallel. There are challenging policy issues in tackling this at the departmental, faculty and institutional levels.

> Lamar University in Texas worked with an experienced commercial firm for a new online Masters of Education program. Courses typically have 300-500 students, a faculty member serves as the principal designer and lead instructor, and facilitators (one for every 25 students) work with individual students. The Masters of Education program was offered at a 40 percent reduction in tuition and a 40 percent reduction in time to completion. The first semester, more than 4,000 students signed up, threatening graduate programs across three states.

Reaching global learners and traditional students

One early criticism of the recruitment of high-profile universities as providers of MOOC content was their apparent ambivalence in seeking visibility for educational offerings they did not want to accredit as suitable for their traditional student body. This confusion as to purpose has been short-lived (like much of what has happened with MOOC developments in the past two years!) and leading institutions in the MOOC consortia are now articulating how their MOOC involvement aligns with their missions and goals. The focus has clarified around both reaching outwards to a global audience and reaching inwards to benefit their traditional student body. For example:

- Harvard University has articulated a strategy for bringing the benefits of its work on edX into more traditional campus-based courses, “developing online Harvard courses and modules for distribution on edX and also for use in Harvard residential and extended online education” (HarvardX, 2013).
- Stanford University’s institutional participation in the Coursera consortium is part of a larger strategy to “continue Stanford’s leadership in providing high-quality educational experiences to its students and to people around the world… future offerings of online courses may allow Stanford undergraduates to take a wider range of courses while resident at overseas campus. Stanford may also develop hybrid or online certificate programs based on online courses” (Stanford Online, n.d., “About”). Stanford has strengthened its commitment with an executive appointment of a Vice-Provost for Online Learning and a staff team including a Teaching and Learning Innovation team as well as platform and production support (Stanford Online, n.d., “Meet”).

A similar integration philosophy is evident in the plans of Canadian partners in large MOOC consortia:

- The University of Toronto describes its MOOC partnerships with Coursera and edX as intended to "pilot new web-based courses online for free and create new opportunities for hands-on learning in the classroom" (University of Toronto, n.d., emphasis added).
- The University of British Columbia describes its intent in the same consortium as "to conduct practice-based research initiatives and experiments, which will enhance the learning experience of students in distance, blended, and physical classroom environments" (Wong, 2013, emphasis added).

Other strategies have emerged to match the mission, goals and character of particular universities, e.g., Vanderbilt (Bruff, 2013), Drexel (Hartman, 2013) and Duke with its administration's dual approach in Coursera and Semester Online[26] (Tuchler, 2012). On the other hand, a review of strategic options[27] at Yale University concluded that "online initiatives must complement and enrich traditional teaching", with concerns about particular methods, e.g., "we do not believe that peer grading has a place for courses where Yale is granting course credit" (Bloom, 2012).

It is not only high-profile universities that can explore MOOC approaches to better serve the needs of traditional students. We discuss below several initiatives by community colleges that are focused primarily on meeting local needs while providing secondary benefits to a wider audience. Other blends of outreach and "inreach" are likely to emerge. The challenge for Ontario institutions will be to serve their own students while simultaneously positioning themselves for distinctive excellence within the broader higher education landscape. The "Special Topics" MOOC in the text box below is one "straw man" illustration of how new models for distinctive excellence might emerge.

"Special Topics" Undergraduate MOOC: Many degree programs in Ontario institutions – at both undergraduate and professional graduate levels – include an optional "Special Topics" course in the final year, in which emerging developments in the subject area are explored jointly by students and instructors. Such courses already contain many elements of cMOOC pedagogy which emerged in Canada; offering them as cMOOCs would allow recent alumni to participate as *drop-ins* for specific topics of interest (as described in Figure II above) at little or no marginal cost to the institution.

Benefits to the offering institutions could include improving the quality of their existing programs by extending learning beyond the degree award, strengthening relationships with alumni[28], and providing an opportunity for wider impact and visibility beyond the institution's existing student base via drop-in learners from a global audience. Reaching such students, who might not have heard of the individual institution, would require participation in a highly visible collaboration; some options for doing this are considered below in the section discussing *The Challenges of Investing at/for Scale*.

The increasing visibility of instructional design

The emerging developments that we have described are increasing the visibility of instructional resources, and the underlying pedagogical designs, in openly available courses. Students become more aware of how they are being taught, and pedagogical failures may gain a higher public profile (Kolowich, 2013 – Stumble). Students will be making choices about what instructional model and provider to utilize based on much richer data on instructional design and effectiveness.

[26] The plan is still in flux: recently a faculty committee at Duke voted against the Semester Online plan. http://www.insidehighered.com/news/2013/04/30/duke-faculty-reject-plan-it-join-online-consortium
[27] Yale has recently announced plans to join Coursera, http://blog.coursera.org/post/50511208530/yale-university-joins-coursera.
[28] Alumni needs are highlighted in the Yale strategy described in footnote 43.

Institutions considering Massive Open Online Courses as a means to attract new undergraduates, professionals looking to increase career capability, or international students must weigh the opportunity and threat from greater visibility about what happens within a course. Failures in this environment become highly visible, which we believe is one reason the Futurelearn consortium led by experienced open/distance learning provider OU UK is taking longer to get its courses into the field.

It is an open question whether successes will be equally visible: can institutions – or a regional brand for Ontario – gain credibility in the marketplace through constructive alignment that matches students with what they need to be successful… while practicing productive alignment that leverages what can be done at scale to support high quality learning in what cannot be done well at scale? Transparency by Design, a recent attempt to provide more informed choice for online learners by a consortium of institutions which offer online degrees, was not successful at achieving a self-sustaining enterprise model, although the partners concluded that the effort was "ahead of its time" rather than off-target in its intent (Morrison, 2013).

As illustrated in our discussions on Learning Analytics and Adaptive Learning, many elements of the learning design cycle are becoming more knowledge-intensive. That is, more pedagogical content knowledge is being applied in design and embedded in resources as learning models; in parallel, more understanding about student learning is being derived from data about the learning experience to feed back into future designs, resources and services. While much of the focus on MOOCs and other online learning developments has been on how "the internet is happening to higher education", we need to keep in mind that another aspect of scaling up instruction is this collection and mobilization of instructional knowledge at scale. Ontario higher education has to plan for a competitive environment where teaching in higher education becomes more knowledge-intensive, with deeper knowledge about teaching and learning having more impact, visibility and reward in the marketplace.

Reputational capital from and for online learning

Much of the early "rush to MOOCs" by high-profile institutions raised fears that the chief motivation was to not be left out of an exclusive club of "best universities" offering "top quality content." We have already noted the shift away from exclusivity, with MOOC offerings by other public and private universities and community colleges (sometimes with external partners as catalysts for collaboration and implementation). Additional platform providers have also opened the door for MOOC offerings by any interested partners, such as the Canvas Network open platform from Instructure Inc., which has offerings from a variety of accredited institutions and independent organizations (Instructure, 2013). Existing providers of online programs are also beginning to use MOOCs as learning platforms, e.g., some public universities with fully online degrees now plan to offer the initial course in the program as a free, open and credit-bearing MOOC, in the expectation that enrolment in these programs will increase as a result (Academic Partnerships, 2013).

Apprehensions about being left out are therefore now more focused on visibility with the larger public (including international students, professionals seeking non-degree offerings and other institutional stakeholders [Kolowich, 2012 – UVA]) and positioning as innovative institutions. For example, the Futurelearn consortium of 17 UK universities was formed in late 2012 with leadership and majority ownership by the UK Open University. The drivers appear to have been strategic for both the Open University, in preserving its position as a pre-eminent global provider of open learning, and for the UK higher education sector to "write the next chapter in the story of British higher education" (Futurelearn, 2012) (and to compete more effectively with the US-dominated MOOC partnerships [Olds, 2012]).

The more important impact on reputation from MOOCs – and the other emerging developments in online learning – may be on online learning itself. Until recently there was still some perception that a top tier of institutions would be best served by ignoring the potential for online learning for their mainline offerings. That perception has ceased to be an obstacle for institutions seeking to leverage online learning to enhance quality, access and productivity.

Consider as another example the Semester Online[29] consortium, formed in 2012 among well-known US universities who plan to offer their first fully online, credit-bearing courses to undergraduates who are not enrolled at any of their institutions. As one Provost stated, "I don't think the idea of offering credit online is, anymore at least, such a strange one… [T]he issue everybody is facing is how to do it" (Kolowich, 2012 – Elite).

The description of this change by Phil Hill is concise and to-the-point:

> The real significance of xMOOCs…is that they are acting as the foreign element triggering the end of the status quo. The key method of this change was the removal of the core assumption that online learning is necessarily inferior to face-to-face education. This assumption changed when the elite of the elites – Stanford, Harvard and MIT – publicly declared from the highest levels of the administration that online learning and educational technology was here to stay. The current generation of xMOOCs served their role as foreign element that dismantled the late status quo. The transforming idea will most likely not be xMOOCs as they now stand – there are multiple models of online education that are now being evaluated in a new environment.
>
> The late status quo has been dismantled and we will not go back. We don't know how quickly changes will come or in what form, but change driven by online education is upon us. (Hill, 2012 – Dismantling)

The challenge of scale

Many of the emerging developments we have described have come to fruition or prominence through investments by agencies external to higher education or by institutions with substantial endowment income. Publicly supported institutions may consider that the current fiscally constrained environment across public systems of higher education leaves them poorly positioned to address on their own the opportunities (and threats) of the emerging developments at the required scale. Matt Reed, writing from the viewpoint of a US community college dean (Reed, 2012), makes the case for a system level investment as follows (with a specific focus on Massive Open Online Courses, although a similar case can be made for other developments):

> I don't know whether MOOCs are the next big thing, a passing fad, or version 1.0 of something that will be really great by version 3.0. (If I had to guess right now, I'd pick the third option.) But for a college with performance-based funding to put much into them right now would be madness. They're high-risk, especially in the short term. When your margins are already thin, there's just no room for that magnitude of error.
>
> At a system level, though, this is penny wise and pound foolish. Experimentation is messy, wasteful, and expensive. It has to be. That's how it works. And it's the only reliable source of real progress. I don't think the choice is between safety and risk. It's between certain decline and the possibility of tremendous improvement. But

[29] http://semesteronline.org/

> getting to the latter requires having the risk capital now to try new things. For example, if the first few rounds of MOOCs involve catastrophic attrition, then [as an institutional executive] I want no part of them unless my budget can handle it.
>
> By the time the bugs are fixed – or the next thing has come along – we'll be that much tighter and less able to adapt. Moments of technological breakthrough are not the times for austerity or jamming the brakes. They are the times for risk capital and taking chances [at the system level]. I hope the state systems figure that out before we have to start yet another round of cuts.

Beyond the high-profile universities which have recently been most visible in pushing forward with new forms of online learning, a variety of institutional and system strategies have evolved to address the challenge of strategic selection and management of investments in emerging developments. Some have relied on external funding from philanthropic sources or government agencies:

- Several US community colleges are experimenting with hybrid instruction using resources developed and shared by institutions with a stronger resource base, e.g., Mass Bay and Bunker Hill (MA) community colleges using edX resources adapted from MIT's Open Courseware (edX, 2012; Grush, 2013). Others are developing new MOOCs as open offerings to be made available to their peer institutions, e.g., community colleges creating free offerings in developmental education using commercial MOOC platforms: Cuyahoga[30] (OH), Wake Technical[31] (NC), and Mt San Jacinto[32] (CA). All of these colleges are supported in their endeavours by grants from the Bill and Melinda Gates Foundation. These grants are on the order of $50,000.
- On the other end of the investment scale are three US community colleges experimenting with modular competency-based programs in Information and Communications Technology in partnership with Western Governors University, supported by a $12 million grant from the U.S. Department of Labor: Sinclair (OH), Broward (FL) and Austin (TX) (Sinclair, 2012).

These investments are regarded by the funding agencies as pilots from which many institutions can benefit by using the resources and learning from the results of the initial innovators. Such "system" benefits are also at the heart of emerging state strategies to leverage emerging developments across public institutions of higher education:

> *"The information required to make large and decisive investments in the face of disruptive technology simply does not exist. It needs to be created through fast, inexpensive, and flexible forays into the market and the product ... Failure and iterative learning are, therefore, intrinsic to the search for success with a disruptive technology."*
>
> Clayton Christensen
> *The Innovator's Dilemma* (1997), p. 227

- The Florida State University System has decided to move forward by establishing an online university division and research lab within a public university, to serve as an innovation hub for the state universities (Jordan, 2013). (A similar role has been proposed in Australia by the University of New England [UNE, 2011].)
- In contrast, the University of Texas system has established the University of Texas Institute for Transformational Learning as a coordinating hub to foster and link up innovations across the state's public universities, including serving as catalyst for the state partnership with edX for MOOC experiments. The stated goals include the following (University of Texas, 2012):

[30] http://www.tri-c.edu/onlinelearning/Pages/mooc.aspx
[31] http://www.waketech.edu/introductory-algebra-review-mooc
[32] http://www.msjc.edu/PublicInformationOffice/Pages/MSJC-to-Offer-Free-Online-Writing-Course.aspx

  - "to establish University of Texas institutions as world leaders in developing and implementing best-in class resources for online learning;
  - to expand access to educational programs that will improve learning and reduce costs
  - to promote a culture of educational innovation across the University of Texas System." (Kolowich, 2012 – Texas)
- In some cases an individual institution is positioning to support others system-wide. For example, San Jose State University plans to expand its leadership role within the California State University, by creating a "*Center for Excellence in Adaptive and Blended Learning* to train faculty members from other campuses interested in offering the MITX engineering course through edX and other blended online courses in the future" (HarvardX, 2013 – SJSU).

Other US state systems have similar efforts underway to leverage the investment of public funds for optimal benefit. Another system-level approach has been to encourage collaborations of peer institutions to share development risks and lessons, such as the Futurelearn initiative described above. The partners in Futurelearn include the UK Open University with an institutional focus on non-traditional learners, several other high-profile universities whose interest appears to be focused on reputational capital and visibility with potential international students, and the UK government which is supporting the initiative as of national importance (Futurelearn, 2013).

Part 3: Observations and policy implications

The policy implications for government of fully online education are substantially different from those of hybrid education.

Fully online education presents opportunities for major economies of scale. By definition, these economies can only be achieved if a large scale is reached. The scale exceeds the size of a single university or college, and so there are opportunities for the government or government agencies to encourage scale that is not limited by institutional boundaries.

By contrast, hybrid education – the mix of online and in-class instruction – creates opportunities for improved learning at a scale that fits well within the size of established colleges and universities. The potential learning improvements are substantial and are strongly to be encouraged, but they fit reasonably well within the traditional government policy framework for higher education.

The link between the two is money. Universities and colleges in Ontario have struggled for almost three decades with revenue increases per student that have been, on average, about equal to consumer price inflation. Faced with rising costs, particularly for people and compensation, institutions have typically modified traditional forms of instruction by increasing class sizes, hiring lower-cost part-time faculty, or both. Neither the government nor the students seem eager to pay more than they are already paying.

Fully online education has the potential to provide a high-quality education – for some students, in some fields of study – at significantly lower unit costs than traditional forms of instruction. The cost savings have the potential to help fund the cost of improving traditional learning, including the costs of introducing hybrid models that lead to better learning outcomes.

The challenge is to make it happen. Here we assess some of the implications for the provincial government and its agencies. In the following section we look at the implications for higher education institutions.

Implication for the Ontario government and its agencies

Fully online instruction

The evidence we have reviewed suggests that, for a range of students and many academic subjects, fully online instruction produces learning that is on par with face-to-face instruction. The students most likely to benefit are those who are academically well prepared and highly motivated to learn independently. Students who are not well prepared to learn at the postsecondary level or do not have the motivation to devote the necessary time to learning are less likely to benefit from online learning and may in fact do better in a face-to-face setting.

The former group – well-prepared and motivated students – is large enough that the provincial government, as the entity with overall responsibility for higher education, should have an interest in making sure they have online learning opportunities available to them. These opportunities should serve students' learning needs, and – if carried out at large scale – should produce cost efficiencies for higher education institutions, the student or both.

A practical plan: The government might set a target that, within three years, a specified list of high-demand university and college programs will be available to Ontario students on a fully (or primarily) online basis. The quality of these programs should be on par with existing face-to-face programs; for example, undergraduate university programs should qualify the student to enter graduate or

professional school, and programs should qualify for accreditation in disciplines where this is the norm.

In addition, the government might set a target that, within three years, a specified list of high-demand courses will be available online and will be accepted for credit at all Ontario universities and colleges that offer a program in that discipline. The list should include high-demand entry-level courses, and it should also include upper-year courses. The latter may be of special benefit to students who dropped out of a face-to-face program and now wish to complete a credential.

Implementing the plan will require developing specific roles for each university and college. This is different from a free-for-all in which multiple competing programs and courses are developed by universities and colleges that choose to do so, at significant expense to students and the public. We know from Ontario's experience with college-to-university transfer that a multiplicity of local initiatives does not lead to a system that is easy for students to understand and navigate (Boggs & Trick, 2008; Trick, 2013). Even university-to-university transfer has been promised more often than it has actually been achieved (Usher, 2012). Yet the financial benefits of online instruction depend on achieving economies of scale. A set of high-quality programs that qualify the student for admission to any Ontario graduate school, and a set of high-quality courses that are accepted for credit by every Ontario institution, will be preferable to a multiplicity of courses and programs that operate at small scale.

A national and international perspective: There is no reason why every online program and course needs to be invented in Ontario. Part of the government's plan should be to identify programs and courses that are offered online in other jurisdictions and to determine whether they meet Ontario quality standards. If so, there may be no need to ask any Ontario institution to re-invent them. The government might charge the appropriate quality assurance bodies of the Council of Ontario Universities and Colleges Ontario with the task of assessing out-of-province online programs to see if they meet Ontario quality standards. Alternatively, the Minister might use his powers under Section 7(1)(3)(a) of the *Postsecondary Education Choice and Excellence Act, 2000*, to refer this task to the Postsecondary Education Quality Assessment Board.

Appropriate financial incentives: There is little financial incentive for universities and colleges to recognize credits earned at another institution. Like most jurisdictions, Ontario pays universities and colleges to provide instruction. An institution that recognizes credits earned elsewhere loses the student's potential tuition revenue, and it may lose a portion of its government grant. This reality is at odds with the government's interest in the financial benefits that come with high-quality online education that achieves economies of scale. It may also be at odds with students' interest in receiving appropriate credit and credentials for learning they have achieved. While other jurisdictions have considered legislation to require universities to accept credits earned from online providers[33], it has not been Ontario's practice to legislate in this area. An appropriate accountability arrangement, backed by financial incentives or disincentives, will be essential to ensuring that credits are recognized at every institution. Such an arrangement should be introduced in the near term, so institutions can take it into account in developing their online strategies.

Assurance for students: Students who are considering whether to take an online course or an online program need certainty about whether online education will meet their goals. This includes certainty about whether their online credits will be accepted for transfer at an Ontario institution and whether their online program of study will be recognized if they subsequently apply to graduate or

[33] State legislators in California and Florida have introduced bills that would have the effect of requiring publicly funded universities to accept credits from online providers that have been found to meet the state's quality standards. See Rivard, 2013 and Lewin, 2013.

professional school. They also need certainty about how they will be treated for purposes of the Ontario Student Assistance Program (OSAP). The growth in online education will put pressure on OSAP's process for designating whether an online course or program, including those offered by out-of-province institutions, will be recognized for purposes of student assistance.

Recognition of differences among students: Optimistic visions of online learning suggest that it will open doors to higher education for many students who may not currently attend for reasons of geography, language, discomfort with mainstream academic culture, or scheduling conflicts associated with heavy work and family responsibilities. Opening these doors should be an important public goal. The literature we have reviewed on non-traditional students makes us cautious about assuming that these students will be primary beneficiaries of fully online education, at least in its current forms. These students may be most in need of the academic and personal supports that traditional campuses provide.

Shaping and leveraging emerging developments: As outlined in Part 2, emerging developments in online learning offer significant potential to affect both quality and productivity. However, the number of opportunities and scope of investment required will make it challenging for individual universities and colleges to take a leadership role. By working with other institutions within and beyond the province, Ontario colleges and universities can utilize and help shape emerging developments in online learning. Coordination will be required to ensure that economies of scale are achieved in an environment of rapid technological change. Some existing approaches to such collaborations are described in Part 2; these include designating one or more lead institutions with special strategic positions or establishing a new entity to coordinate cross-system partnerships. Coordination can help ensure that the costs of innovation and the costs of transition are appropriately shared across institutions.

Building policy and regulatory capacity: Addressing these policy issues will stretch Ontario's policy and regulatory infrastructure.

- Traditionally academic planning in Ontario has been decentralized to the universities and colleges. We now need a plan for identifying and developing online programs and courses that will serve the whole province.
- Traditionally quality assurance has been delegated to the associations representing the universities and colleges, or to PEQAB in the case of private or out-of-province applicants. Now we need a process for evaluating courses offered by institutions that may never set foot in Ontario.
- Traditionally credit transfer has been seen as a voluntary activity, aided by occasional government encouragement and by an agency – the Ontario Council on Articulation and Transfer – that is designed to focus on college-university transfer. Now we need a process for evaluating online courses that will transfer to all Ontario universities and colleges that offer a relevant program of study, with incentives to ensure that transfer credit is actually given.
- Traditionally Ontario has allowed the gatekeepers to graduate and professional programs to make admissions decisions in private; but increasingly we will need transparent admissions processes that assure students that they will receive fair consideration regardless of how or where their undergraduate education was delivered.

An effective government strategy will begin by recognizing these new policy goals and adapting existing regulatory infrastructure to meet the goals.

Hybrid instruction

In contrast with fully online instruction, the policy issues associated with hybrid instruction fit well within current government policy frameworks. This is not to say that the frameworks are ideal. It simply means that the challenges of improving current policies are not significantly affected by the advent of hybrid instruction.

The development and implementation of hybrid instruction is typically carried out by universities and colleges through their normal internal processes. The Strategic Mandate Agreements put forth by universities and colleges in 2012 propose improving the quality of undergraduate instruction through a number of strategies, including hybrid learning (HEQCO, 2013). There is no need to evaluate the quality of hybrid courses as a separate category. Instead, all of the innovations in instruction deserve to be evaluated using the same standards that apply to traditional instruction. The results of these evaluations should be made public, so all institutions can learn from them.

Likewise we see no special funding issue with respect to hybrid instruction. Ontario's funding formulas for universities and colleges are premised on providing equal funding per student in similar programs of study, while permitting each institution flexibility to determine how funding is deployed within the institution. We should care deeply that funding is deployed to improve the quality of student learning, but funding hybrid courses differently from other courses is not likely to advance this goal.

The same can be said about hybrid education with respect to promoting inter-institutional transferability and other public goals. Introducing effective forms of hybrid learning may have a transformative effect on many academic programs, but it requires few new government policies that are distinctive to hybrid education.

Implications for Ontario universities and colleges: Protecting and enhancing "the learning that matters most"

We conclude that the purpose of adopting online learning should be to preserve and sustain what we value most in higher education: instruction that enables learners to develop new ways of knowing – and doing and being – that will prepare them to face the challenges of our times. This may at first seem paradoxical, since much of this "learning that matters most" may be the least amenable to scale up with online learning.

A near-universal system of higher education, operating in an economy that produces limited increases in government revenue and in students' family incomes, needs to find areas where productivity can be improved. Students, educators and institutions need to take full advantage of emerging advances in online learning if higher education faculty and institutions are to preserve and extend what matters most to us in higher education.

William Weitzer, writing from the viewpoint of "institutions which strategically provide both liberal arts and professional degrees", makes a strong case that they – and by extension others across the higher education spectrum – will be required to incorporate emerging developments into their planning to focus scarce resources on what matters most for institutional mission and goals:

> There are many reasons to think again about the value of MOOCs…most importantly, these on-line resources offer institutions the opportunity to realign their costs so that they can apply resources to strategic priorities…It is this last reason that is critical to the future of many institutions of higher education, including those trying to prepare students who are career ready and prepared for life. Doing so is an expensive proposition. It involves

> providing intimate settings where faculty, students and even staff interact and learn from one another.
>
> While these settings are the opposite of a MOOC, they do not need to be in opposition. Faculty and staff should be asking themselves how students can utilize MOOCs and other on-line resources to enhance the classroom experience…The goal should be to reserve classroom time for activities that can only be done in the classroom…faculty time can be reallocated to the more intimate experiences that achieve instructional and institutional goals. (Weitzer, 2012)

The same conclusion is reached by Michael Staton, coming from a different perspective as an "educator turned entrepreneur" (Inigral, 2013):

> If institutions that currently manage the entire bundle [of instructional and student support services] can start to allow technology to work its magic and see themselves as providers atop of whatever can be conveniently and effectively achieved through online learning, then those institutions will be able to focus on enhanced quality and lower cost for the services best left to in-person environments. (Staton, 2012, p. 34)

What is striking to us about these viewpoints – and the additional quote (Marks, 2012) in the sidebar – is the agreement that what is least likely to be done effectively at scale and with technological mediation is precisely what matters most in higher education. In Staton's words, what matters most is:

> *"Colleges like mine have little to fear from Coursera and its cousins. They are in the self-improvement business. We are in the self-formation business."*
>
> Jonathan Marks, Ursinus College

> Modeling and coaching in identity formation: providing a role model of what students aspire to be, and coaching that includes consistent check-ins and recurring exploratory conversations…The more complex and human the task, the more qualitative the feedback needs to be, and the more important interpersonal communication becomes as part of the feedback cycle to approach mastery…Developing competency is more than "stuff to learn" that will ultimately be assessed by a test. Embedded within current curricula is meta-content: models of thinking and doing that are demonstrated by the instructor to foster development by the student. Learners also understand that they will be tasked with collaborative efforts and interactions in a project-based environment that will challenge and improve their ability to work with others. As students move deeper into their programs, they begin to understand the rules and formats of knowledge exploration, creation and sharing, how to navigate complex bodies of knowledge to gain insights, solve problems, and lead people. (Staton, 2012, p. 26)

Recent legislative moves in other jurisdictions suggest a significant dissatisfaction at a political level with the lack of agility in higher education institutions for adapting to emerging developments in online learning. While any political developments in Ontario would undoubtedly take a different form, we believe that institutional stakeholders need to consider the need to "do before you are done to." Only by taking the initiative to leverage the benefits of online learning can we ensure that quality and productivity are addressed in parallel, and in particular that we can scale up educational quality and productivity – as we must – without compromising the learning that matters most to us.

The emerging developments we have reviewed have a breadth and depth which require a collective effort from Ontario institutions to move forward at a pace that follows closely the global leaders in these areas. This challenge can be summarized as: to scale up educational quality and productivity by leveraging emerging developments in online learning without compromising the

learning that matters most to us. Addressing this challenge will require an exceptional effort at three levels:

- within institutions to engage students, faculty, and academic leadership in commitments to pilot studies and to scaling up successes – for both quality and productivity;
- across institutions in collaborations to share knowledge and resources on where, when and how we can take advantage of emerging developments in online learning most effectively; and
- at the systems level, by cooperation across college and universities sectors, the Ministry of Training Colleges and Universities, and the Higher Education Quality Council

Collective effort at these three levels will allow Ontario to move forward on the following key activities:

- Supporting collaborative action research pilot studies to examine benefits and costs of emerging developments in online learning, with joint stakeholder commitment to scale up successful pilots being a condition of participation;
- Collectively monitoring exemplars within and beyond Ontario to assess impacts of potential Ontario investment and collaborations;
  Exploring strategies to leverage emerging developments in online learning to reinforce and highlight a distinctive excellence for Ontario higher education.

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Appendix 1

Table 1: Summary of Emerging Developments

Emerging Developments	Opportunities	Subjects and Institutions	Consortia and Systems	Policy Issues	Potential Next Steps
Affordable and Open Textbooks	***Quality:*** • affordable interactive resources • more students using texts ***Cost:*** • reduce cost to students • cost savings to other stakeholders? • *student comments*	Biology (California State Univ.) Mathematics (Scottsdale CC) Physics (FL Community College) Physics (Dalhousie, U of Calgary) Writing (Colorado State University) Indiana University	• California State University • Open SUNY • BC Open Textbook project • Washington State Board of Technical & Community Colleges • Colorado Community College System Digital Textbook Program	• Policy to redistribute budget and savings to support change • Support for faculty contribution and adaptation of open resources • Need to evolve from contribution to community • Innovations to link eTexts with collaboration and networking	• Support collaborative action research pilot studies to examine benefits and costs, with joint stakeholder commitment to adopt and scale up successful pilots • Collectively monitor exemplars to assess potential impacts of Ontario investment and collaborations
Adaptive Interactions with Learning Resources	***Quality:*** • presentation and pace of learning activity targeting individual student need + embedded cognitive model • feedback on activity and outcomes • solid research evidence for success ***Cost:*** • saves instructor & student time	Carnegie Mellon University: • Anatomy and Physiology • Elementary French 1 • Introduction to Chemistry • Introduction to Psychology • Media Programming • Statistical Reasoning (+ adaptation to social science course at Georgetown)	Statway™ (Carnegie Foundation for the Advancement of Teaching)	• Policy structure to redistribute time savings to support change • Increasing media richness may limit adaptability by individual faculty	• Support collaborative action research pilot studies to examine benefits and costs, with joint stakeholder commitment to scale up successful pilots • Collectively monitor exemplars to assess impacts of potential Ontario investment and collaborations
Optimizing Interaction Time for Students and Instructors	***Quality:*** • faster answers to student queries • more effective use of class time by tailoring activity to student needs ***Cost:*** • optimizes instructor & student time • potential cost impacts if time can be redeployed for productivity gains	*Student-sourced Support/ Feedback*: • Piazza (faculty at Stanford, Georgia Tech, MIT, Tarrant County CC, etc.) • *Calibrated Peer Review* (UCLA) • *Just-in-Time Teaching* • Indiana University • IU/PU Indianapolis • Glendale Comm. College		• Policy and processes to convert reduction in instructional work into progress on other priorities • One-time time investment for faculty & students to adapt to new role expectations • Operational metrics for efficiency and quality	• Support collaborative action research pilot studies to examine benefits and costs, with joint stakeholder commitment to scale up successful pilots • Collectively monitor exemplars to assess impacts of potential Ontario investment and collaborations
Learning Analytics: Using Real-time Data on Learning Activity to Target Instructional	***Quality:*** • early targeting of at-risk students enables pre-emptive interventions • data-driven program	Purdue University		• Impact on retention, completion, competence, and costs on a per-graduate and per-student basis); • New business models and	• Support collaborative action research pilot studies to examine benefits and costs, with joint stakeholder commitment to scale up

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Emerging Developments	Opportunities	Subjects and Institutions	Consortia and Systems	Policy Issues	Potential Next Steps
Effort	improvement ***Cost:*** • improves retention & completion			ROI • Start-up investment for faculty & students to adapt to new role expectations	successful pilots • Collectively monitor exemplars to assess impacts of potential Ontario investment and collaborations
Minimizing Marginal Costs per Student via Massive Open Online Courses	***Quality:*** • xMOOC (*Instructional Delivery*) could improve access opportunity for suitable students and content • cMOOC (*Knowledge Network*) could improve access and individualization for suitable students and content ***Cost:*** • scales up at low incremental cost	Too early to identify models and pedagogies which will be seminal: • Community Colleges with xMOOC (Instructional Delivery) offerings? • San Jose State University? • Harvard and MIT in edX? • Commercial suppliers? (Coursera, Udacity)	edX (especially University of Texas system participation) Futurelearn (UK) Open2Study (Australia)	• Potential impact on reputational capital and international visibility • Appropriate scale for involvement of Ontario institutions (Consortia of peer institutions? Provincial consortium? Inter-provincial consortium? External partnering?)	• Explore strategies to reinforce and highlight distinctive excellence for Ontario higher education • Support collaborative action research pilot studies to examine benefits and costs, with joint stakeholder commitment to scale up successful pilots

Higher Education Quality Council of Ontario

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