2020 EDUCAUSE Horizon Report™
Teaching and Learning Edition

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EDUCAUSE is a higher education technology association and the largest community of IT leaders and professionals committed to advancing higher education. Technology, IT roles and responsibilities, and higher education are dynamically changing. Formed in 1998, EDUCAUSE supports those who lead, manage, and use information technology to anticipate and adapt to these changes, advancing strategic IT decision-making at every level within higher education. EDUCAUSE is a global nonprofit organization whose members include US and international higher education institutions, corporations, not-for-profit organizations, and K–12 institutions. With a community of more than 100,000 individuals at member organizations located around the world, EDUCAUSE encourages diversity in perspective, opinion, and representation. For more information, please visit educause.edu.

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Introduction

Anticipating the future is human nature. As anyone who has tried meditation knows, staying in the present is surprisingly difficult because our minds spend so much time reflecting on the past or anticipating the future. Humans are planners, worriers, and dreamers, and those plans, worries, and dreams are rooted in our mental constructs of the future. For sixteen years, the Horizon Report has provided a construct of the future of educational technology in higher education, based on a structure of three time horizons.

Anticipating the future is risky. As any science fiction reader or future-enthusiast knows, extricating present-state experience from visions of the future is very difficult.[1] The track record of predictions—whether about the stock market, the World Series, world events, or technology—is generally so poor that it's a wonder anyone dares to make them. With technology in particular, we tend to overestimate its short-term impact and underestimate its long-term impact.[2] The Horizon Report has provided ample documentation of predictions, from educational technology experts, of the future impact of educational technology on teaching, learning, and creative inquiry. Unfortunately, its track record has been described as fair to middling.[3] Why would EDUCAUSE bother to continue this publication if its level of accuracy is so low?

In assuming ownership of the Horizon Report, EDUCAUSE recognized the challenges of anticipating the future. We have, in this first major revision of the report's methodology, structure, and content, striven to break the mold of the classic Horizon Report without losing its essential purpose. This recasting of the report recognizes that our thoughts about the future are rooted in the present and how it has changed from the past. The report begins with a scan of our current environment to identify the major trends that are shaping global higher education and teaching and learning. The Horizon Expert Panel named fifteen social, technological, economic, higher education, and political trends that signal departures from the past, that are influencing the present, and that will almost certainly help shape the future. For educational technologies, the report moves away from the time-to-adoption structure, which implied a prediction precision that the project was unable to achieve. In its place, the new report offers evidence, data, and scenarios. The report includes evidence for the trends, as well as panelists' quantitative ratings of factors that often temper actual adoption of emerging technologies and practices in higher education. These factors include impact on learning outcomes, level of risk in adoption, faculty receptiveness, issues of equity and inclusion, and required level of spending.

Anticipating the future is necessary. Today's decisions are always bets on what we think the future will be. The Horizon Report was never meant to be a fun, "cool" list of hyped technologies for the field to debate and debunk. It is meant to inform decision makers and help learners, instructors, and leaders think more deeply about the educational technology choices they are making and their reasons for doing so. And so, our final choice in reimagining the Horizon Report was to provide more-helpful, richer resources to assist the community in considering choices and formulating action plans. In addition to identifying trends and emerging technologies and practices, we offer scenarios for how the future could play out. Will higher education grow in size and importance? Will higher education as we know it fade away or even collapse entirely? Will it remain essentially the same, neither expanding nor contracting? Or will it transform and become almost unrecognizable from today's model of higher education? No one can say, but we have tried to paint those four scenarios to help readers think more expansively about the future of their institutions and our industry so that they can plan and act more thoughtfully today. Finally, the report includes a set of short essays, written from different regional and institutional perspectives, on the implications of the report's findings.

We hope the 2020 EDUCAUSE Horizon Report will enable you to learn, plan, and act. In the months after its release, community members will no doubt talk and write about how it differs from the Horizon Report in previous years. While that lens on the past is interesting, we care more about looking ahead: how does the 2020 EDUCAUSE Horizon Report help you today as you think about what tomorrow will bring? Let us know. We will be listening. And learning from you.

1. John O'Brien, "Back to the Future of EdTech: A Meditation," *EDUCAUSE Review* 52, no. 2 (March/April 2017).
2. This observation seems to be part of technologists' collective consciousness; it has been attributed to many people, from Arthur C. Clarke to Bill Gates, but its actual origin remains elusive. See this page from Quote Investigator (website), January 3, 2019.
3. For two opinions about the value of the Horizon Report's predictions, see Audrey Watters, "The 100 Worst Ed-Tech Debacles of the Decade," Hack Education (blog), December 31, 2019, and Stephen Downes, "Horizon Report Preview 2019," *Stephen Downes* (website), February 28, 2019.

Executive Summary

With the 2020 Horizon Report, we have sought to retain the elements of the report that higher education professionals and leaders have come to value over many years—its focus on the trends, technologies, and practices shaping the future of teaching and learning, based on a methodology that grounds the findings in the perspectives and expertise of a panel of leaders in higher education. We have also sought to innovate and improve upon the report this year, moving our focus away from forecasts for adoption and toward more evocative portraits of possible futures. As in past reports, we solicited the panel's input on the major trends shaping higher education, and this year we also opened up space to hear more directly from our panelists about their reflections on the implications of this research for the future of higher education in their particular contexts.

Trends

Higher education doesn't exist in a vacuum, and it is always and everywhere shaping and being shaped by larger macro trends unfolding in the world surrounding it. We asked the Horizon panelists to provide input on the macro trends they believe are going to shape the future of postsecondary teaching and learning and to provide observable evidence for those trends. To ensure an expansive view of trends outside the walls of higher education, panelists provided input across five trend categories: social, technological, economic, higher education, and political. After several rounds of voting, the panelists selected the following trends as the most important:

Social

- Well-Being and Mental Health
- Demographic Changes
- Equity and Fair Practices

Technological

- Artificial Intelligence: Technology Implications
- Next-Generation Digital Learning Environment (NGDLE)
- Analytics and Privacy Questions

Economic

- Cost of Higher Education
- Future of Work and Skills
- Climate Change

Higher Education

- Changes in Student Population
- Alternative Pathways to Education
- Online Education

Political

- Decrease in Higher Education Funding
- Value of Higher Education
- Political Polarization

Emerging Technologies and Practices

Horizon panelists were asked to describe those emerging technologies and practices they believe will have a significant impact on the future of postsecondary teaching and learning, with a focus on those that are new or for which there appear to be substantial new developments. After several rounds of voting, the following six items rose to the top of a list that initially consisted of 130 technologies and practices:

- Adaptive Learning Technologies
- AI/Machine Learning Education Applications
- Analytics for Student Success
- Elevation of Instructional Design, Learning Engineering, and UX Design in Pedagogy
- Open Educational Resources
- XR (AR/VR/MR/Haptic) Technologies

Having identified the most important technologies and practices, panelists were then asked to reflect on the impacts those technologies and practices would likely have at the institution. We asked panelists to consider those impacts along several dimensions that are of growing importance in higher education: equity and inclusion, learning outcomes, risks, faculty receptiveness, and cost. We also asked panelists to consider whether new literacies might be required by these six technologies and practices.

Panelists see considerable potential for some of these technologies to positively impact student learning and to provide needed support for equity and inclusion. Some technologies and practices on the list are seen as more expensive and riskier than others, and across all six, panelists caution that faculty might not be especially receptive, at least initially.

Scenarios

While we may not be able to use the findings in this report to accurately predict a single future, we can begin to gather and arrange the information we have into logical patterns that can help us envision a number of scenarios for what the future might look like. In this report we attempt to paint brief but evocative portraits of four possible future scenarios for postsecondary teaching and learning:

- **Growth:** The next decade of higher education is one characterized by significant progress, with growth coming from increases in adult and remote learners, expansion of online courses and curricula, and professional certification and microcredentialing programs.

- **Constraint:** Efficiency and sustainability are the guiding social values in this future of higher education, with learners carving out faster and more efficient pathways to completion and institutions harnessing the power of data and analytics for greater precision in designing the learner experience and protecting the institution's return on investment.

- **Collapse:** Higher education as we've known it has largely been shuttered, primarily due to economic reasons (rising costs, declining funding), replaced by a new system of education that prioritizes the needs of the job market and the acquisition of discrete skills over programs and departments unable to provide a return on investment.

- **Transformation:** Several dramatic transformations occur in higher education over the next decade, brought about primarily by climate change and advances in digital technology. Learners enjoy more flexible matriculation and degree personalization options, while institutions explore cooperative network models and seek ways to reduce the cost of education.

Implications Essays

In light of the trends and future scenarios presented throughout this report, what can we say about the implications for institutions now and about what institutions can begin to do today to start preparing for these possible futures? For this new section added to the Horizon Report, we asked nine Horizon panelists to reflect on the report's findings and offer their thoughts on the most important implications for their own higher education context.

The nine perspectives represented in these essays illustrate the ways in which issues overlap, diverge, and intersect in different parts of the world and at institutions of different sizes and types. Some contributors see technologies such as AI and XR as important in addressing the challenges they experience. Others see in the Horizon findings opportunities to approach issues related to access, equity, and cost for their student populations. Still others focused their thinking on the changing demographics of students and the evolution of jobs and skills in the workplace. All share an optimism that the tools and practices identified in the report can produce meaningful and valuable results for higher education institutions and students.

Though not intended to cover all perspectives, these essays can help catalyze thinking and conversations about the ways in which higher education is changing, the opportunities and risks it faces, and the ways in which technology and innovative thinking can help prepare institutions for the future.

Trends: Scanning the Horizon

For the 2020 Horizon Report, we begin with a focus on bigger-picture developments around and within higher education. What can we say about the world in which teaching and learning technologies and practices are taking shape, as well as about the world that institutions, instructors, and learners are going to inhabit in the future? Teaching and learning doesn't take place in a vacuum, after all, and understanding the trajectories of such large-scale trends can only help decision makers and professionals build more responsive and sustainable environments and practices at their institutions.

To help us explore these larger forces taking shape around higher education, we asked the Horizon Expert Panel to survey the landscape and identify the most influential trends shaping higher education teaching and learning. To ensure that we identified a wide array of trends, we asked panelists to look across five categories: social, technological, economic, higher education, and political. This section summarizes the trends the panelists voted as most important in each of these categories, as well as anticipated impacts of and evidence for each trend.

> What can we say about the world in which teaching and learning technologies and practices are taking shape, as well as about the world that institutions, instructors, and learners are going to inhabit in the future?

For each of the trends, there is far more complexity and variability across types of institutions and regions of the world than can be adequately captured in such a brief summary. Indeed, our expert panelists—35 percent of whom represented communities outside the United States, including Australia, China, Egypt, France, Taiwan, and the United Kingdom—routinely reflected on the ways in which trends affect institutions differently across global settings. Where possible, we've tried to account for that variability, though the reader will certainly bring additional experiences and contexts that would further broaden those considerations.

Social

- **Well-Being and Mental Health**
- **Demographic Changes**
- **Equity and Fair Practices**

Technological

- **Artificial Intelligence: Technology Implications**
- **Next-Generation Digital Learning Environment**
- **Analytics and Privacy Questions**

Economic

- **Cost of Higher Education**
- **Future of Work and Skills**
- **Climate Change**

Higher Education

- **Changes in Student Population**
- **Alternative Pathways to Education**
- **Online Education**

Political

- **Decrease in Higher Education Funding**
- **Value of Higher Education**
- **Political Polarization**

Social Trends

Teaching and learning is a human endeavor, conducted by people for the benefit of others. As such, global trends taking shape across societies and within communities—trends reflecting who we are and what we experience as persons, both individually and collectively—inevitably make their way into educational decisions and practices.

Well-Being and Mental Health

Impacts: Well-being and mental health initiatives at colleges and universities, including emerging technology and application solutions, need to support the increasing numbers of students who report experiencing anxiety, depression, and related concerns. Faculty and administrators will need to navigate more frequent encounters with students seeking well-being and mental health help, since students who do not have effective intervention services or treatment available to them will likely be less successful in academic and social activities.

Evidence: The META app—an online platform focused on connecting students with therapists for video or phone therapy sessions—launches and provides a simple, fast counseling tool for college and university students. Institutions in New Zealand and parts of Australia are using the Ripple app from the Australian Childhood Trauma Group. The app focuses on students' feelings and eating and sleeping patterns.

Demographic Changes

Impacts: Ongoing shifts in the demographics of global populations, including migration trends and patterns, are leading to a new outlook on how higher education must serve students in the future. Increasing numbers of nontraditional students and changes in the concept of the "typical" student will continue to force institutions to consider alternative approaches to higher education (e.g., campus housing programs and models, online education). Reflecting student migration patterns, international enrollments will continue to rise, such as with US student enrollments at Canadian institutions and Chinese student enrollments at Australian institutions.

Evidence: The fertility decline that many industrial nations around the world are experiencing suggests a new era in higher education, an era of at least a decade in which the number of students in each year's prospective student pool is smaller than the last. The share of US Millennial women with a bachelor's degree is higher than that of US Millennial men, a reversal from the Baby Boomers and the Silent Generation.

Equity and Fair Practices

Impacts: Equity and diversity goals and agendas are increasingly prevalent in higher education. In some instances, institutional performance goals related to equity of completion outcomes are tied to funding. Professional development among faculty, staff, and administrators can influence the ways in which curriculum is structured, pedagogy is delivered (e.g., culturally responsive), and service and support are rendered to students and the community.

Evidence: Last year, Harvard University became embroiled in controversy over its race-conscious admissions policies. And in April 2019, a Pew study found that US college and university students are twice as likely as faculty to be black and four times as likely to be Hispanic.

Further Reading

Jisc
"Developing Mental Health and Wellbeing Technologies and Analytics"

Southern Education Foundation
"A New Majority Update: Low Income Students in the South and Nation"

Pew Research Center
"6 Demographic Trends Shaping the U.S. and the World in 2019"

Technological Trends

The educational experiences of instructors and learners are always scaffolded and enhanced by systems and tools, whether a paper gradebook and abacus or an online discussion forum and virtual reality lab. Those educational systems and tools often reflect wider technological advances taking hold in other industries and sectors of society, at the same time introducing both promise and risk for global higher education.

Artificial Intelligence: Technology Implications

Impacts: Artificial intelligence (AI) is already being used as part of educational services and as part of curriculum design. Increasingly it will be used by human instructors for providing feedback on student work and for helping with other "virtual teaching assistant" applications. It may also have applications for refining language translation and for improving access for students with visual or hearing impairments.

Evidence: Amazon has introduced the Alexa Education Skills API. A public school district in North Carolina is using Microsoft Translator to improve language options for parents and students.

Next-Generation Digital Learning Environment

Impacts: The next-generation digital learning environment (NGDLE) is creating a transformational shift in how institutions architect their learning ecosystems for learners and instructors. Institutions are increasingly requiring support of open standards in educational technology applications, which enable institutions to offer a more flexible learning experience to more students, synchronously and asynchronously. The agility provided by such an architecture can afford learners and instructors alike the opportunity to "think outside the box" and reconceptualize their approaches to education.

Evidence: Use of the IMS Global LTI (Learning Tools Interoperability) open standard is becoming widespread. The University of Wisconsin has adopted Blackboard Collaborate Ultra as its total learning architecture (TLA) in tandem with the Canvas LMS.

Analytics and Privacy Questions

Impacts: Higher education institutions continue to invest billions of dollars in analytics capabilities, and cost-benefit implications for student privacy will become an increasingly important consideration. Institutions will need to be more proactive in protecting student and employee data and must make careful decisions around partnerships and data exchanges with other organizations, vendors, and governments. Institutional relationships with technologies—and with platforms such as Facebook and Google—should reflect larger cultural preferences and tolerances for privacy.

Evidence: The European Union implemented the General Data Protection Regulation (GDPR) in 2018. China is launching a "social credit" system. Google estimates that its Google Apps for Education (GAFE) will reach 110 million users by 2020.

Further Reading

eCampus News
"4 Ways We Can Start Using AI in Higher Ed to Humanize Teaching"

EDUCAUSE
"7 Things You Should Know About NGDLE"

EDUCAUSE
"Not Sure If They're Invading My Privacy or Just Really Interested in Me"

Economic Trends

Institutions of higher education are both products of and contributors to the economies, environments, and industries that compose the global landscape. In an increasingly connected, open, and scrutinizing world, institutions are expected to be wise and judicious stewards of the resources that enable them to exist and operate. They are also expected to contribute something of value to the larger world and to effectively generate the knowledge and skills that people need to work and live—all at a reasonable cost. Absent this perceived value, institutions of higher education in many countries will likely continue to see declines in funding from supporting governments and industries.

Cost of Higher Education

Impacts: The growth of the private education sector in countries such as Egypt, Germany, and France will see global levels of student debt continue to rise and will establish more "elite" forms of higher education. The rising cost of tuition, combined with decreased funding from public and other sources, will expand the US student debt crisis and lead to multiple long-term economic effects. Students' independence in adulthood (e.g., purchasing a home, having children, contributing to the economy) will be impacted. Institutions need to demonstrate their value and/or adjust to economic realities with new business/funding models.

Evidence: The US Congress is seeking to pass the Employer Participation in Repayment Act, expanding employers' assistance with employee student debt. Institutional adoption of open educational resources (OER) continues to steadily rise.

Future of Work and Skills

Impacts: In order to stay relevant and sustainable, institutions will need to adjust their courses, curricula, and degree programs to meet learners' needs, as well as the demands of new industries and an evolving workforce (e.g., automation, digital literacy, gig economy). Demand for lifelong learning and skills renewal will also increase. Industries will seek to partner with organizations outside institutions of traditional higher education for skills development and workforce recruitment.

Evidence: The World Economic Forum predicts that at least 133 million new jobs will be generated globally by 2022 as a result of the new division of labor between humans, machines, and algorithms. In the fall of 2019, Sheffield College in the United Kingdom opened the Liberty Steel Female Engineering Academy to address the disproportionate engineering skills gap among women.

Climate Change

Impacts: Sustainable living and learning will become a higher priority for higher education institutions as we continue to learn about the effects of climate change and explore strategies for mitigating those effects. More institutions will focus on online learning as a sustainable educational model as students and faculty become less willing or able to commute. Extreme global weather events and droughts will impact students' well-being and educational attainment, particularly in rural and/or under-resourced communities.

Evidence: A global group of colleges and universities is committing to becoming carbon-neutral by 2030. Institutions in California (e.g., UC Berkeley) are sometimes forced to operate on limited power due to widespread power outages, resulting in lost instruction days.

Further Reading

World Economic Forum
"Machines Will Do More Tasks Than Humans by 2025 but Robot Revolution Will Still Create 58 Million Net New Jobs in Next Five Years"

Yale Global Online
"Student Debt Rising Worldwide"

EDUCAUSE
"7 Things You Should Know About Open Education: Content"

Higher Education Trends

Notions of what higher education should be, of what its ultimate purpose or goals should be, and of whom it is intended to serve seem to be constantly in flux in response to larger trends and shifts in human thinking and social, political, and economic relationships. Future models of higher education, as well as future practices in teaching and learning, will need to adapt to these trends and fundamentally rethink what higher education *is*.

Changes in Student Population

Impacts: Global fertility rates have decreased 50 percent since 1960, potentially leading to fewer students and presenting fiscal challenges, especially for smaller and tuition-dependent institutions. Increased student diversity (in age, ethnicity, and other factors) requires institutional leaders to rethink how to achieve their teaching and learning missions and will demand a new emphasis on holistic student success.

Evidence: It has been predicted that US college enrollments will drop by as much as 10 percent by the late 2020s. Minority students today account for roughly half of all high school graduates in the United States.

Alternative Pathways to Education

Impacts: Institutions must rethink their degree pathways to accommodate a changing student demographic and employment landscape. Alternatives include nano- and micro-degrees, competency-based programs, expanded online options, and portable and standards-based credentials, as well as increased collaboration and partnerships with other institutions. Advising programs will use integrated platforms and data.

Evidence: Southern New Hampshire University (SNHU) now awards college credit for Salesforce skills. Through aggregators such as EdX, institutions are offering an increasing number of low-cost master's degree programs.

Online Education

Impacts: Online education is increasingly seen as a scalable means to provide courses to an increasingly nontraditional student population. Faculty must be prepared to teach in online, blended, and face-to-face modes. Higher education institutions are moving to new models for online programs, such as assessment (competency) and crediting (microcredentials and digital badging). Institutions will increasingly engage with online program managers (OPMs) to jumpstart online programs.

Evidence: California's Online Community College initiative gives students access to courses across its community college system. In Canada, fully online student enrollments have been increasing by roughly 10 percent annually over the past five years.

> Global fertility rates have decreased 50% since 1960, potentially leading to fewer students and presenting fiscal challenges.

Further Reading

EconoFact
"Demographic Changes Pose Challenges for Higher Education"

EDUCAUSE
ECAR Study of Undergraduate Students and Information Technology, 2019: Learning Environment Preferences

University World News
"A New Era of Microcredentials and Experiential Learning"

Political Trends

Across the world and within our own communities and homes, we seem to be living through a period of significant political transformation and are experiencing political divisiveness at unprecedented levels. As these political trends continue to take shape, they will undoubtedly have a lasting impact on models and practices of higher education teaching and learning. From policy agendas and legislative battles that target educational standards and funding, to the political discourses that are taking place at campuses and in classrooms, higher education will continue to influence and be a product of the political world around it.

Decrease in Higher Education Funding

Impacts: As public funding for higher education continues to decrease in the United States, institutions must pursue alternative business and funding models to sustain operations. Alternative approaches may include privatization of the industry, microcredentialing, establishing partnerships with other industries or organizations, and other more sustainable models. Meanwhile, teaching, learning, and research practices will be increasingly driven by opportunities to secure funding.

Evidence: The University of Alaska budget was cut by 41 percent in 2019. Continued federal funding for historically black colleges and universities (HBCUs) and other minority-serving institutions (MSIs) continues to be hotly contested in the US Congress.

Value of Higher Education

Impacts: A majority of adults in the United States believe the higher education industry is headed in the wrong direction, due either to the increasing cost of higher education or to the perceived social or political bent of higher education. Millennials tend to believe in the value of higher education, though they express concern over the cost. As overall enrollments continue to decline, institutions will be forced to identify alternative education or business models.

> Tensions ... will lead to self-censorship among faculty and students who feel uncomfortable speaking up on potentially divisive issues.

Evidence: In the 2018–19 academic year, college/university enrollments in the United States declined for the eighth consecutive year, decreasing 1.7 percent in the spring of 2019 compared with the previous spring.

Political Polarization

Impacts: In some instances, heightening tensions between political worldviews have been leading to increasingly heated debates on campuses and, in other cases, to self-censorship among faculty and students who feel uncomfortable speaking up on potentially divisive issues. In the United States, legislation that could benefit higher education will become more difficult to pass through an intensely polarized Congress and entrenched political positions.

Evidence: The Wisconsin Legislature has proposed new free-speech guidelines for the University of Wisconsin system focused on protecting the "expressive rights of others." In 2017, Georgetown University launched its Free Speech Tracker to monitor threats to political, social, and intellectual expression.

Further Reading

APM Research Lab
"APM Survey: Americans' Views on Government Funding and Aid for Public Colleges and Universities"

Inside Higher Ed
"College Enrollment Declines Continue"

Center on Budget and Policy Priorities
"A Lost Decade in Higher Education Funding"

Emerging Technologies & Practices

This section, titled "Developments in Educational Technology" in previous Horizon Reports, is a long-standing tradition in the Horizon research. The 2020 teaching and learning edition continues this convention, albeit with some changes.

For 2020 we have changed the title to "Emerging Technologies and Practices." The traditional title focused too narrowly on the technology. As any close observer of postsecondary teaching and learning knows, technology by itself does not yield the greatest impact on learning; it does so when it is embedded in a scaffolding of support for learners and instructors. For the 2020 report, the panel began with a roster of over 130 candidates and reduced this number through successive rounds of voting to the six presented here.

This shift is not entirely new to the 2020 report. It was visible in the findings of recent editions, which included developments not based solely on new technologies. Examples include MOOCs (2013), flipped classrooms (2014 and 2015), mobile learning (2017 and 2019), and makerspaces (2015 and 2016). Certainly all of these rely on technology to enable the practice, but each is more a practice than a technology. Enlarging the scope of this section to include practices makes it possible to bring into relief a more accurate picture of what is influencing postsecondary teaching and learning. For 2020, for example, this approach enabled us to document the fast-emerging importance of instructional and learning design.

Most conspicuous may be the absence of the traditional adoption framework—the three time horizons over which the developments were predicted to achieve widespread adoption. The reception of past issues of the Horizon Report, particularly in recent years, clearly indicated that the predictions concerning the pace of adoption were no longer a highly valued aspect of the report. Our feedback indicated that the *what* was more important than the *when*. Past findings were in fact inconsistent, with certain developments appearing and reappearing. Some even remained locked in place for some years, such as game-based learning and gamification, which remained in the 2- to 3-year adoption horizon from 2011 to 2014.

Perhaps also more important than the arrival date is the nature and extent of the impact. What kinds of challenges might institutions encounter if they go forward with any of these?

Adaptive Learning

AI/Machine Learning

Analytics for Student Success

Elevation of Instructional Design, Learning Engineering, and UX Design

Open Educational Resources

XR (AR, VR, MR, Haptic) Technologies

And what kinds of benefits might they expect? To gain a sense of possible consequences of adoption, we asked our panelists to evaluate each technology or practice across several dimensions, using a five-point scale (0 = low; 4 = high):

- How useful will it be in addressing issues of equity and inclusion?
- What is its potential to have a significant and positive impact on learning outcomes?
- What is its risk of failure?
- How receptive will faculty be to adopting it?
- What level of institutional funding will be needed to adopt it?

In this way, we asked the panelists not simply to identify what might be impactful but to anticipate just what that impact might be. These results are presented in the charts that accompany the discussions of the technologies and practices.

Finally, it is important to note that these results come from a panel with international participation. More than one-third (37 percent) of the 2020 panelists are from institutions outside the United States. This fact, together with the range of voices contained in the implication essays, provides a global perspective on higher education teaching and learning, identifying the issues we share and on which we can collaborate.

Adaptive Learning Technologies

Adaptive technology appears to be well on its way to becoming a major addition to the set of educational technology tools serving the broader educational practice of personalized learning. The use of adaptive technology is still on the upward slope of the bell-shaped adoption curve. However, even at this early stage, the technology can provide institutions with the opportunity to strategically rethink courses and even entire curricula in the context of student learning and success. At institutions that have taken the holistic approach of adaptive learning (and bearing the costs associated with such an approach), the results are encouraging. In many cases, student course success has improved, and student satisfaction with their experiences is generally high.

Overview

The wider adoption of adaptive technology in higher education commenced in 2011. It began to accelerate in 2015/2016, at a time when the technology was beginning to mature, and there was a great deal of discussion in higher education about the concept of personalized learning. Major grants from the Bill & Melinda Gates Foundation to the Association of Public and Land-grant Universities (APLU) and courseware developers contributed substantially to this acceleration. Today, dozens of universities are using some type of adaptive instructional system to assist students in the learning process.

It is important to distinguish between adaptive technology (aka courseware), personalized learning, and adaptive learning. The first consists of digital platforms and applications that one can buy or build. Personalized learning is a general teaching and learning practice that seeks to more finely tune the course experience to the individual needs of the learners. Finally, adaptive learning is one form of personalized learning in which adaptive technology plays a major role.

Many of the "lessons learned" shared by institutions using adaptive technology reflect experiences from previous implementations of educational technology: technology alone does not produce improved learning outcomes. According to Arizona State University, which has been using adaptive technology since 2011, the technology is necessary but not sufficient to enable student success. After some of its initial pilots did not result in the hoped-for degree of student success, the institution rethought its approach. ASU came up with what it calls the "adaptive-active approach," in which adaptive technology is used in coordination with active learning. For ASU, it was the combination and integration of the technology and active learning engagements that produced the greatest gains in rates of student success.

Adaptive Learning in Practice

Adaptive Learning in Elementary Spanish Language Courses

The University of Central Florida redesigned elementary Spanish language and civilization courses with adaptive learning and OER content to address myriad issues UCF students were encountering in these courses. Preliminary data gathered illustrate increased student mastery, decreased D/W/F rates, and more positive student perception of instruction surveys.

The Alchemy System: Personalized, Flexible, and Scalable Active Learning

The Alchemy learning platform, developed at the University of British Columbia in Vancouver, seeks to solve the challenge of providing students with instant and specific feedback, at scale. Currently in beta release, Alchemy has the ability to adapt delivery to different courses and curricula, scale to accommodate classes of any size, and support flexible learning, potentially personalizing a massive online learning experience.

Professional Literacy Suite

The Professional Literacy Suite (PLS) is the first suite of online digital and professional literacy modules created at a course-wide level at Deakin University. Its three modules include interactive, media-rich elements that are visually engaging and are contextualized in authentic, work-based settings. Since PLS was first embedded in 2016, more than 15,000 students have completed modules across the suite.

Similarly, the Digital Learning Course Redesign Initiative at the University of Central Florida (UCF) supports the redesign of strategic courses that "leverages the benefits of online, blended, adaptive, and active learning." Penn State has piloted courses entailing adaptive technology and found that embedding the technology in a full learning initiative to be essential but also expensive. These headwinds that Penn State encountered are the "strategy-to-execution" gap identified in research conducted by Tyton Partners.

The introduction of adaptive technology allows the role of the instructor to evolve, away from content delivery in the form of lectures during class and toward the roles of leader and coach during active learning exercises. Adaptive systems make this change possible by providing students with all of the instructional resources online and providing instructors with the learning data they needed to be more informed coaches and advisors.

Relevance for Teaching and Learning

It is sometimes said that adaptive technology is only conducive to STEM courses, but recent work at several institutions shows its usefulness in non-STEM courses as well. Responses to the Horizon Report's annual call for exemplar projects resulted in reports about the use of adaptive technology in teacher education (University of Wisconsin–Whitewater), Spanish (University of Central Florida), and professional digital literacy (Deakin University). At ASU, initial work in STEM courses has expanded to include economics, history, psychology, and even philosophy.

In many cases, the results of the use of adaptive technology, especially when paired with course redesign, are positive. After implementing an "adaptive redesign" of a college algebra course, Oregon State University saw the pass rate climb from 65 percent to 77 percent over two years and the withdrawal rate fall from 11 percent to 4 percent. At ASU, some 90,000 students have participated in 25 adaptive-active courses across seven disciplines over the past nine years, and they anticipate an additional 30,000 will do so in the 2019–20 academic year. In ASU's self-paced algebra course, student success rates (course completion with a C or better) increased from 54 percent in 2015 to 84 percent by combing the adaptive instructional system with another innovation they call the "stretch semester." Rather than being placed in a developmental math course, students who start with low math skills continue working on the course in the following semester at no extra cost. The new design has resulted in improved results across all the demographic groups being tracked as part of this redesign process.

Curricular relevance often encourages curricular engagement. Adaptive technology can enable the scripting of course content such that students are offered instructional resources that are more directly relevant to their course of study. At UCF, the kinds of exercises given to students depend in part on their overall course of study: an engineering major would receive different study problems from those received by a student who is a hospitality major.

Adaptive Learning in Teacher Education

At the University of Wisconsin–Whitewater, adaptive learning has allowed for both greater personalization and greater depth of learning for approximately 50 percent of the content in a blended course on teaching science in elementary and middle school. Adaptive learning allows flexibility and efficiency for second-career teachers and also provides opportunities to relearn some basic science content before teaching lessons in classrooms.

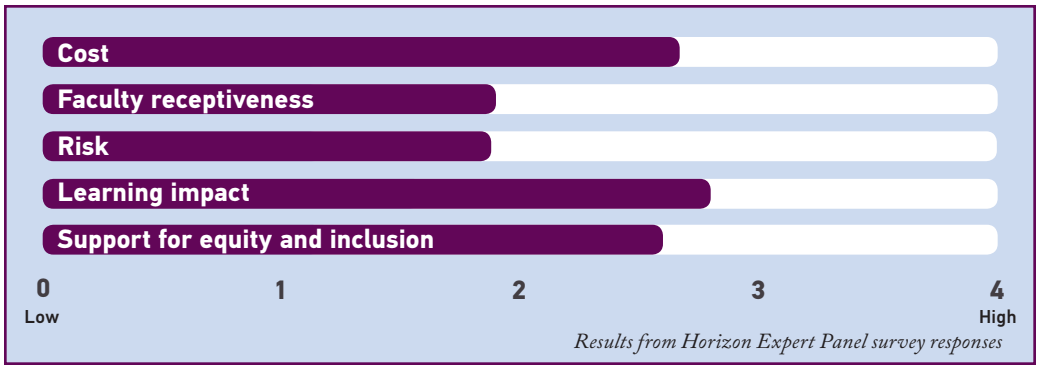
BioSpine

Engaging close to 50 faculty and 10 staff members, Arizona State University has created the world's first adaptive-learning biology degree at ASU's School of Life Sciences. Whether online or on campus, students using this platform encounter a "scaffolded" support structure that personalizes students' learning throughout their four years in the degree program.

An Active, Adaptive Redesign of College Algebra

Oregon State University has redesigned its college algebra course, using an adaptive learning homework system to reorder the content, aid student preparation for class, and support active learning in the classroom. After the introduction of these resources, pass rates increased by twelve percentage points and the withdrawal rates fell from 11 percent to 4 percent.

Dimensions of Adoption: Adaptive Learning Technologies



Results from Horizon Expert Panel survey responses

The results described above, as well as others, demonstrate that adaptive technology has a role to play in a broader program of personalized learning. The critical factor is that its implementation be accompanied by additional support for instructors and students and be targeted at appropriate courses and at the appropriate level of learning. ASU, for example, identifies the bottom two layers of Bloom's taxonomy (remembering and understanding) as the areas where students can do that learning in the adaptive system before class. Then, using a flipped model, the instructor can focus on the remaining four levels (applying, analyzing, evaluating, and creating) and organize activities to be done in class based on active learning processes.

As always, challenges remain. Two of the most prominent are cost and the somewhat embryonic state of the learning and computer science underlying the technology. Redesigning curricula or even individual courses is not a trivial undertaking. There are the "costs" of faculty involvement, instructional designer staff, the preparation of content, technology, and the program of evaluation to measure the impact to inform the next rounds of redesign. In addition, concerns arise about privacy and the ethical use of student data, as well as about ensuring that the technology is designed to be equitable, inclusive, and free from implicit bias. Finally there is the vital question about just what the adaptive system is "thinking" when it issues recommendations to guide students: what kinds of data and algorithms are being used, where do they come from, and are they inclusive?

Further Reading

Every Learner Everywhere
Time for Class Toolkit

EDUCAUSE
An Adaptive Learning Partnership

EdSurge
Want Adaptive Learning To Work? Encourage Adaptive Teaching. Here's How

AI/Machine Learning Education Applications

In an *EDUCAUSE Review* article from August 2019, Elana Zeide defined artificial intelligence (AI) as "the attempt to create machines that can do things previously possible only through human cognition." An *EDUCAUSE Review* article from 2017 penned by Heath Yates and Craig Chamberlain described machine learning (ML) as "teaching machines to learn about something without explicit programming." While ML is based on the idea that machines are able to learn and adapt through repetitive processes, AI refers to the broader notion that machines can execute tasks intelligently. Both of these overlapping advancements are permeating higher education. We are beginning to see elements of them emerge throughout the enterprise, including in learning management systems (LMSs), student information systems (SISs), office productivity applications, library and admissions services, automatic captioning systems, and mobile products, to name a few. Although AI has not yet achieved self-awareness—that is, the ability to autonomously operate—it is able to support lower-order routine and repetitive cognitive tasks normally handled by humans. Moreover, many of these systems can "learn" over time, increasing and improving their accuracy, speed, and fidelity. AlphaZero, an AI-based program developed by Deepmind, recently defeated the world's best chess engine over the course of 100 matches by teaching itself how to improve. Recent consumer advancements, demonstrated in products such as Google's new Assistant, illustrate the potential of text-to-speech, deep-learning, and natural language processing—all elements of AI and ML.

Overview

The exemplar projects in this space illustrate an amazing array of developments that are leveraging these emerging technologies. One of the many such technologies that colleges and universities are harnessing is automated chatbot services. Northwestern University and the University of Oklahoma (OU) have developed AI-based chatbots that allow them to extend off-hours student support and recruiting services. Northwestern's chatbot is integrated into its LMS to answer frequent and routine questions often posed by students and faculty. The chatbot was developed using elements of IBM's Watson Natural Language Processing to leverage decision trees, contextual searches, and issue escalations. Using Google's custom search engine, the chatbot connects to the LMS knowledge base to provide direct links to the documentation library. It can even generate a helpdesk ticket directly from the chat dialog.

Similarly, the University of Oklahoma's recently launched SoonerBot is primarily used for student recruiting, with plans to expand it into other areas. To date, more than 28,000 student interactions have been logged using SoonerBot, contributing, at least in part, to the largest freshman class in OU's history in fall 2019. Complementing this effort, OU libraries launched the Bizzy chatbot in 2018 to support research services. OU began experimenting with AI by creating an Alexa Skill that could answer common questions about the library during off hours and could search Primo and LibGuides.

AI and ML in Practice

Enhancing Customer Support with AI: Building a Canvas Support Chatbot In-House

Northwestern University harnessed the powered of Watson AI services to develop its own customized chatbot to support Canvas. Students and faculty can find answers to common questions using intelligent links to Canvas knowledge bases and even generate a helpdesk ticket directly through the chatbot.

AI Chatbot Pilot Project

Griffith University in Australia developed Sam, an AI chatbot that can be used by students for all manner of questions and support. Using the latest technologies, the system can self-learn the types of search terms commonly used by students. This system is being leveraged across the university to support a variety of student services, including the library, food services, and academic schedules.

Bizzy, the AI Chatbot

Launched in 2017 using Alexa Dots installed in University of Oklahoma residence halls, this technology has grown to include a variety of library services that can be accessed using an AI-based chatbot service. This technology is not only changing the process of search and discovery but is also being leveraged in OU Admissions to recruit students.

At Arizona State University, Echo Dots have been deployed in select parts of residence halls to control smart devices and receive course-related information using AI-powered voice assistance. Utah State University has also developed AI-powered voice assistance technology that disabled faculty use to control the instructional technology within a learning space.

Designing a more generalized application, Griffith University in Queensland, Australia, developed the SAM chatbot, which supports all manner of student life, including library services, residential life questions, and registration and class questions. SAM will soon be embedded throughout the university portal, allowing students to engage with the service on-demand.

Meanwhile, Penn State University is leveraging ML algorithms to predict a student's grade performance—even before courses begin. Using more than 8.5 million records culled from 2005 through 2016, the university developed a model to leverage data from the SIS, including transcript data and information found on admission applications. This predictive algorithm assists university administration in identifying students who might present with higher-than-average academic risks, allowing intervention strategies to be developed in advance. In another ambitious project, the Online Computer Library Center (OCLC), in coordination with seventy librarians and specialists from various organizations, developed Responsible Operations, a product that leverages ML and AI to track and chart engagement with various library services. Responsible Operations explores patronage engagement along seven domains, including workforce development and data science services.

To track the growing database of AI projects, OU has developed the Projects in Artificial Intelligence Registry (PAIR), which supports cross-institutional collaboration and locates and tracks grants in the field of AI. PAIR serves as a global directory of active and archival AI projects and research and might eventually serve as a hub for various initiatives.

Many of these emergent projects realize a significant return on their initial investment. For example, although developing a chatbot can involve a significant time and resource investment that requires specialized development, that investment might yield returns in the form of extended hours and operation of the university to meet the needs of a 24/7/365 audience. Similarly, ML applications might allow the university to surface important data regarding student success metrics.

Student Perceptions of Feedback in Large Courses

Penn State University is using machine learning to cultivate student records from its Student Information System. Using these data, Penn State has developed a predictive algorithm that helps advisors determine how well an advisee might perform in an upcoming term.

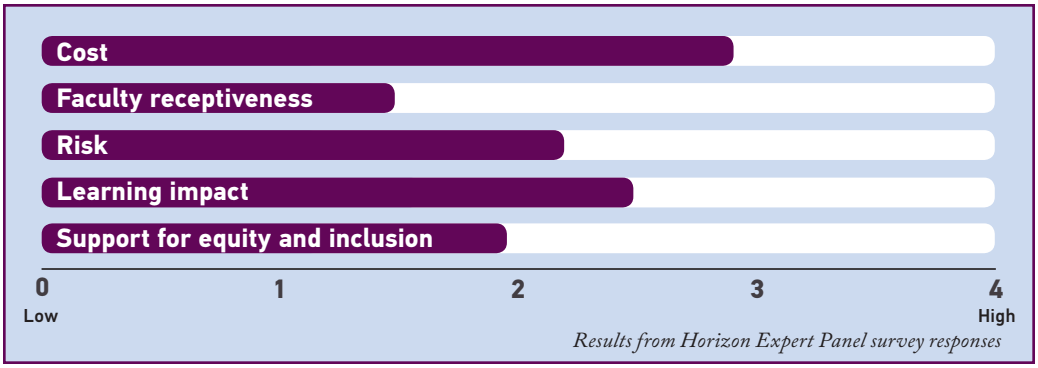
Using Artificial Intelligence to Produce Captions

Texas State University has developed a process for automatically captioning and creating transcripts for videos using artificial intelligence. This service leverages text-to-speech cloud-based technology such as Watson, Azure, and AWS. The result is a service that costs a fraction of human-based systems and, in some cases, is approaching the same accuracy.

Responsible Operations: Data Science, Machine Learning, and AI in Libraries

OCLC worked with an advisory group and more than 70 librarians and other professionals to create a research agenda for libraries to engage with data science, machine learning, and artificial intelligence. The result, Responsible Operations, provides a roadmap for addressing technical, organizational, and social challenges facing the adoption of these technologies.

Dimensions of Adoption: AI (Artificial Intelligence)/ Machine Learning Ed Applications



Results from Horizon Expert Panel survey responses

Relevance for Teaching and Learning

These systems are an important technology solution for many institutions. Elements of AI are now embedded into commercial products such as test generators, plagiarism-detection systems, accessibility products, and even common word processors and presentation products. LMSs now include AI technologies that identify and flag students who are potentially at academic risk. Emergent courseware products include algorithms that measure student performance metrics and generate customized, adaptive learning pathways so that each student receives an instructional experience tailored to their needs. To improve test validity, AI systems can now be used to detect unorthodox or suspicious test behaviors among students and flag them for follow-up.

Implementing these technologies in higher education is not without debate, however. Systems that harness student data and make intelligent intervention decisions based on performance metrics are being closely monitored. So-called "nudge" products and guided learning pathway applications that provide individualized learning interventions have come under scrutiny in some circles. The delicate balance between these emergent technologies, privacy, ethics, and access to student data remains a contested topic. And given that many systems are now cloud-based, this raises the specter of potential data misuse.

Further Reading

New York Times
The Machines Are Learning, and So Are the Students

The University of Oklahoma
OU Uses Artificial Intelligence in Recruitment

Utah State University
Blind Instructor Now Uses Amazon Alexa to Manage Her Classroom

Analytics for Student Success

Over the past decade, institutions of higher education have focused their mission, vision, and strategic planning on student outcomes and high-impact practices that promote student success. The availability of tools that measure, collect, analyze, and report data about students' progress has given rise to the field of learning analytics for student success. Foundational data used for learning analytics include course-level data, such as assessment scores gleaned from the learning management system (LMS), and institutional-level data residing in student information systems, registrar records, financial systems, and institutional research units. The degree to which cross-functional (course- and institutional-level) data are used depends on a complexity of factors specific to individual campuses, such as the availability of technical tools, financial capacity, data availability, leadership support, and campus readiness to promote discussions and planning. The tools used to support analytics also range from vendor-based toolkits to the creation of customized campus applications. As learning analytics becomes more critical to strategic planning at institutions around the world, a range of practices are emerging that provoke both philosophical and policy-related discussions around data privacy, equity, and ethical considerations.

Overview

The elevation of student success as a priority for higher education, coupled with the use of LMSs and tools that allow for cross-functional data integration, has led to increasingly diverse analytics. Over the past decade, institutions have employed analytics for functional support of enrollment management and general student progress, and less commonly for assessing student learning outcomes and individual student success. That is now changing, as the administratively focused measurement of institutional success is now being complemented by fine-grained analysis of student engagement and performance data. The use of analytics for student success is also beginning to emerge beyond the United States and Europe. This shift has given rise to new technologies, different approaches to helping students achieve their goals, and myriad ethical and policy considerations. The following examples highlight a few attempts by institutions to work directly with their data and develop analytics-based applications that support student success.

With increased pressure on advising staff to address student outcomes, the use of analytics as a tool for early alerts and proactive outreach is becoming essential. The Berkeley Online Advising project at the University of California at Berkeley and COMPASS, a project at the University of California, Irvine, are examples of learning analytics tools designed for academic advisors. These tools provide advisors with information that allows for proactive outreach and intervention when critical student outcomes are not met. Both tools represent solutions created internally on campus that are able to maintain data integrity and allow institutions to create solutions in response to unique student needs. These applications not only

Analytics in Practice

Siyaphumelela

Five South African universities are working together to improve their institutional capacity to collect and analyze student data and integrate it with institutional research, information technology systems, academic development, planning, and academic divisions within their institutions to increase student success.

Combining Machine and Human Intelligences for Interventions

Over the past three full semester terms, the University of Maryland, Baltimore County has implemented a predictive analytics pilot "nudge" campaign using Blackboard Predict, enhancing the ability to support students through tutoring or advising.

Berkeley Online Advising

Berkeley Online Advising is a platform developed at the University of California, Berkeley for academic advisors that synthesizes student data from multiple campus services, generates and displays alerts about student academic progress, and provides advisors with new user-focused tools to record data about their in-person and virtual interactions with students.

reflect the changing resources available to advisors but also the need for solutions that can use unique cross-functional data that complicate learning analytics when using vendor-based products.

Applications that give students access to learning analytics are also becoming more common. Enabling students to access and track their individual data through insightful and easy-to-understand visualizations provides a model for giving students greater agency in their own success. As an example, the University of Iowa has deployed a student-facing analytics dashboard, Elements of Success. The capacity to access summary data and curated visualizations allows students to better measure their progress and motivates them to take action when critical outcomes are not achieved.

The maturation of learning analytics in higher education depends on several interrelated factors. Leadership support, a shared vision for student success, cross-collaboration within the institution, the provision of relevant policies, and the coordination of technologies that support cross-functional data are all factors that must align for learning analytics to be successfully implemented at a campus-wide scale. Collaboration across institutions has also been a driver behind the Unizin consortium, while in South Africa, the Siyaphumelela Project represents an effort with broadly similar aims. In that project, five South African universities were awarded a $2.9 million grant for improving institutional capacity to collect and analyze student data, information technology systems, academic development, planning, and academic divisions within their institutions, in order to increase student success. As our understanding improves of how learning analytics can be used to impact student success, our ability to discuss the implications of the results across institutional and national boundaries will mature as well.

Relevance for Teaching and Learning

While the use of learning analytics might provide a promising opportunity for improving student success, its use comes with caveats related to important data gaps and quality issues, concerns about data privacy, and ethical considerations about the impact of using technical tools that label students as being "at risk." Data used for learning analytics do not provide the full suite of information that impacts student success. Frequently missing are factors that are most impactful to learning, such as family responsibilities or work schedules. Indeed, college campuses frequently deploy multiple technologies in a student learning experience that might or might not be coordinated and are created in what is commonly a disjointed framework for data acquisition. Standards such as Caliper and xAPI provide the capacity to address this disjointedness and will help us continue to build on our understanding of learning analytics.

COMPASS: Comprehensive Analytics for Student Success

The COMPASS (Comprehensive Analytics for Student Success) project at the University of California, Irvine is a cross-functional initiative focused on undergraduate student success that brings relevant student data to campus advisors, faculty, and administrators, with the goal of providing actionable information to improve student outcomes.

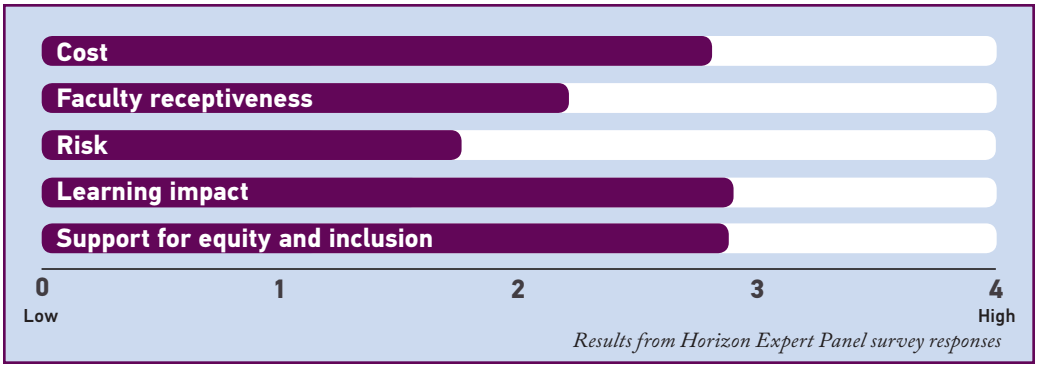
Elements of Success

Using data from Canvas, Elements of Success (EoS), an initiative at the University of Iowa, is a learning analytics platform that provides detailed performance feedback to inform students how they are doing in real time and how to take appropriate action when they still have sufficient time to change their trajectory through the course.

Predictive Modeling for College Algebra Courses

Arizona State University uses a commercial adaptive learning tool (ALEKS) for many of its college algebra classes. Using data from ALEKS, ASU created a daily predictive model, identifying students at risk of not passing college algebra. Instructors are given access to a dashboard showing the current prediction, allowing them to better support students.

Dimensions of Adoption: Analytics for Student Success



Results from Horizon Expert Panel survey responses

Student data are largely protected in higher education. However, the use of learning analytics engenders questions around privacy of student data and the ethical aspects of learning analytics, particularly analytics focused on predictive determinations about student success. Institutions will need to consider policies that outline acceptable use of data, maintenance of FERPA regulations, and other policies associated with student privacy. Likewise, as the use of learning analytics increases, managing vendor relationships relative to how student data are used has become a critical conversation. In response to the growing application and development of learning analytics, the International Council for Open and Distance Education developed a set of guidelines for ethically informed practice. Guidelines such as these will help inform the use of learning analytics and should be key elements of planning as campuses deploy learning analytics applications. In addition, research that assesses the impact of learning analytics is critical in guiding institutions to appropriate use and policy needs.

Progress in learning analytics is most likely to be seen in initiatives that require the purposeful engagement between academic units, which create and use analytics, and other units that support students in daily living. This coordinated effort will be key in creating a roadmap for the ethical and effective use of learning analytics.

Further Reading

EDUCAUSE
Rolling Out Learning Analytics at a National Level

EduGeek Journal
Is Learning Analytics Synonymous with Learning Surveillance, or Something Completely Different?

EDUCAUSE
From Learning to Data Analytics: Some Implications for IT Strategy and Transformation

Elevation of Instructional Design, Learning Engineering, and UX Design

The field of learning design continues to evolve, influenced by not only the continued growth of online course delivery but also an increase in the number of faculty who embrace student-centered learning environments, whether on-campus or online. Over the past few years, the instructional design role has seen growth and professional recognition beyond standard course design and development. Additional responsibilities such as project management, learning analytics, educational research, faculty mentorship and collaboration, and more academic autonomy have elevated the professional identities and expertise of instructional designers. New methods, processes, and scholarly work are emerging from teaching, learning, and technology communities, introducing new pathways and titles such as learning experience designer (LXD) and learning engineer. Many of these roles are well situated to be high-impact agents of change at their institutions, as they embody and promote student-centered and inclusive mindsets in their collaborations with faculty, students, and staff.

Overview

A learning design ecosystem can include many roles, all of which serve the ultimate purpose of fostering student success in learning. Instructional designers and technologists are an integral part of learning design and technology teams. Going beyond simple job titles, we can capture the nature of these and similar roles by using the functional title of learning designer (LD) as an inclusive way to discuss the profession. LDs are skilled in a variety of methods, such as ADDIE and integrated course design, and they possess expertise in how students learn. A typical learning design toolbox is full of creative approaches and methods, evidence-based pedagogical strategies, student-centered activities, robust assessment plans, and innovative ways to use technology in teaching. Collaborating with instructors is at the heart of the learning design ecosystem, with the ultimate goal of creating meaningful learning experiences for all students.

The field is rapidly evolving through the influence of design thinking, user-experience (UX) methods, systems design, advances in the learning sciences, and the emergence of learning analytics. Assessing how students learn, measuring user experiences, applying design thinking to course development, and providing faculty with new foundational digital skills and literacies are examples of additional functions that have boosted LDs into new roles. LDs might find themselves as team leaders overseeing an AGILE design process or creating journey maps as an empathetic lens on course design. The merging of UX, design thinking, and cognitive psychology with instructional systems design gave rise to learning experience design. Today, learning experience design has found a foothold in higher education teaching and learning teams. As teams shift toward holistic learning experience mindsets, they promote a student-centered ethos and better understand the entirety of the student experience. LXDs are very engaged around

Elevation of Instructional Design, Learning Engineering, and UX Design in Pedagogy in Practice

OpenSimon Toolkit

At Carnegie Mellon University, the OpenSimon Toolkit is making the tools of learning engineering available and accessible to everyone. Its ultimate goal is to "improve learning outcomes for individual learners while collectively advancing our larger understanding of human learning."

Center for the Analytics of Learning and Teaching (C-ALT)

Colorado State University's C-ALT is delivering learning analytics in a new way. The U-Behavior tool delivers visual-form learning analytics to the students as a formative assessment strategy. This learner-centered approach helps students reflect on their study behaviors and make changes for better learning.

Center for Extended Learning (CEL)

At the University of Waterloo, the CEL promotes and shares the UXDL Honeycomb model for learning experience design. They place "learners at the centre of the design process, ensuring that [their] courses are useful, desirable, accessible, credible, and intuitive."

digital learning experiences such as gamifying flipped courses, creating virtual learning environments, and designing and developing online courses.

An example of embodying learning experience design principles is the User Experience Design for Learning (UXDL) project at the Centre for Extended Learning (CEL) at the University of Waterloo. The UXDL Honeycomb framework is designed to inform and guide instructional design decisions, creating valuable online learning experiences for learners. UXDL weaves theory and evidence from the field of cognitive psychology into the design process.

Emerging from the digital learning space, the field of learning engineering has garnered attention from higher education and industry. Learning engineering is "an evolving field that focuses on how engineering methodologies can inform and improve learning technologies and related architectures." It has brought a new systems-thinking approach and better tools to measure how, where, and to what extent learning is happening in digital spaces.

The Simon Initiative at Carnegie Mellon University provides an example of how learning engineering is harnessing a cross-disciplinary learning engineering ecosystem. The initiative's goal is to improve student learning outcomes through a continuous feedback cycle of data creation, the application of learning theory, and the design of technology to support learning. Projects such as these expand our capacity to understand how technology impacts learning and how to better design tools and courses to achieve desired learning outcomes.

The blending of these new learning design practices (learning experience design and learning engineering) with instructional design methods has added to existing tensions—and opportunities—around how the work and professional identity of these new roles are defined at an institution, as well as within higher education. This is allowing teams to create exciting opportunities for LDs to move into new areas and collaborate with faculty and campus partners in refreshing ways. For example, leaders of Middlebury College's Office of Digital Learning & Inquiry (DLINQ), took on a paradigmatic shift from a service model to a partner model. The shift necessitated structural changes to the organization, and staff developed new areas of professional development to support the implementation of learning design practices.

Relevance for Teaching and Learning

The elevation of learning design, learning experience design, and learning engineering will continue to reshape how we approach teaching and learning in higher education. At some institutions, learning design initiatives are supporting boundary-spanning partnerships and bringing together a combination of LDs, UX designers, librarians, student accessibility experts, faculty developers, and learning scientists. One challenge around this broader team approach is defining how these units can best collaborate and have the greatest impact on student learning. One consequence of ever-changing demands and functionality within learning design and technology units and between campus partners is the need for increased agility

Explore Learning and Teaching (ExLNT)

The ExLNT platform, developed at Griffith University, is a robust collection of teaching and learning resources, faculty stories of practice, online learning modules, and more that link practice, strategy, and pedagogy. The more than 400 learning and technology experiences have been shared between teaching staff and nonfaculty educators in 88 counties.

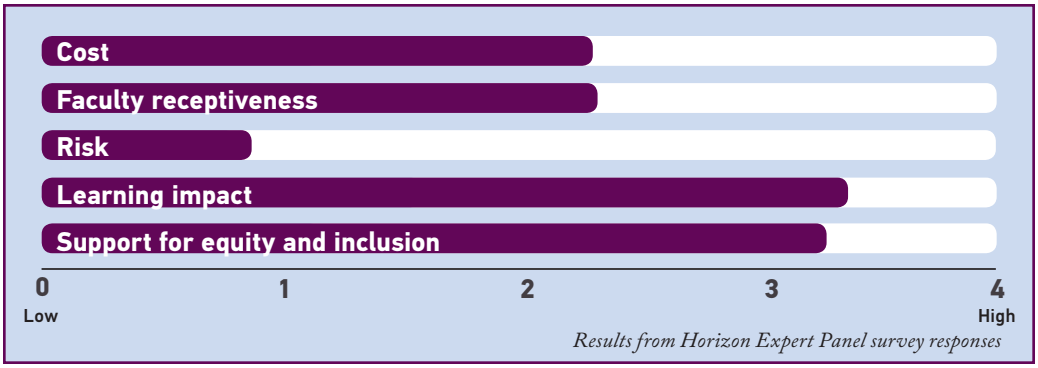
Learning Innovation

The Learning Innovation team and Office of Information Technology at Duke University share their Grouper-based LMS alternative Duke Kits at their public GitHub repository. Faculty can choose from and bring together multiple tools into one student experience by "bringing together the centralized student access points of the LMS with the flexibility and power of an app-based system."

Digital Learning and Inquiry (DLINQ)

At Middlebury College, the DLINQ team transformed its ideology when moving from a service model to a partner model. Through this collaborative mindset, their mission aims to "advance the transformative potential of digital practices and spaces by exploring, partnering to work with, and engaging in conversations teaching and learning with digital technologies with Middlebury faculty, staff, and students."

Dimensions of Adoption: Elevation of instructional design, learning engineering, and UX design in pedagogy



Results from Horizon Expert Panel survey responses

and collaboration between professional staff and faculty. When fostered well, these relationships help everyone meet student needs and in a more significant way.

Learning designers, more than ever before, are being seen as leading experts in teaching and learning on their campuses. They are shifting from service/support roles to being seen as essential collaborators on the design of learning experiences. The impacts of the refreshed learning design field go beyond online learning or on-campus courses. LDs are becoming involved in areas such as co-curricular projects, experiential learning initiatives, and programs for first-generation students.

Through professional development, communities of practice, and new graduate programs, LDs are becoming experts in new areas. New cross-institutional communities and networks, such as ID2ID, are being cultivated to help those in LD roles share their experiences and create ways to grow professionally. As deeper connections are made between the learning design ecosystem and the overall student experience, LDs can bring new knowledge, viewpoints, and innovations to their collaborative work. Through such efforts, LDs will become even stronger agents of change in higher education, leading faculty and administrators closer to inclusive design and student-centered practices. Learning design teams can develop a more intricate and robust understanding of how accessibility impacts learning for all students, faculty, and staff. Ensuring that adequate resources and administration-level buy-in are available to support these efforts is critical to successful adoption of accessibility, universal design, and inclusive teaching practices.

Learning design is not just an evolving field. It's a dynamic field that has significant impact on learning and the holistic student experience, whether online or on campus. How will your institution support, promote, and encourage the growing wave of learning design?

Further Reading

German UPA
Accessibility, Universal Design

EDUCAUSE
A Snapshot of Instructional Design: Talking Points for a Field in Transition

The Ohio State University Pressbooks
"ID 2 LXD" From Instructional Design to Learning Experience Design: The Rise of Design Thinking

Open Educational Resources

The United Nations Educational, Scientific and Cultural Organization (UNESCO) defines open educational resources (OER) as a variety of materials designed for teaching and learning that are both openly available for use by teachers and students and that are devoid of purchasing, licensing, and/or royalty fees. Most scholars generally agree that the OER movement began in earnest around 2001, although the open movement emerged in the mid-1990s, thanks in large measure to an award from the NSF to Cal State University for the Multimedia Educational Resources for Learning and Online Teaching (MERLOT) repository. OER is now a global movement. At the October 2019 UNESCO General Conference meeting held in Paris, multiple governments unanimously agreed to the adoption of a set of standards regarding both legal and technical specifications, thereby clearing a path forward so that open materials can be shared across international boundaries.

Overview

The global higher education community is actively developing and/or curating a wealth of OER materials and resources. Leading much of the international effort are Canada, Western Europe, and areas of South America and the Middle East where open resources are becoming increasingly commonplace. In the United States, OER momentum is building in nearly every type and size of institutional profile, from community colleges and public universities to elite privates. Multi-institutional consortia such as the Community College Consortium for Open Educational Resources (CCCOER) are driving OER adoption in part due to faculty education, exposure, and quality-assurance efforts.

The exemplar OER projects provide a unique glimpse into the efforts that are shaping the movement across the globe. George Mason University, for example, has developed an OER meta-crawler it dubbed "MOM" (Mason OER Metafinder) that allows faculty to search for open resources across a variety of disciplines and international indexes. The University of Minnesota has developed and curated the Open Textbook Library, which includes nearly 700 peer-reviewed titles. The Runestone Academy provides a variety of free textbooks thanks to the efforts of a cross-institutional faculty and student development team. Minnesota State University has launched the Z-Degree initiative that seeks to drive course material costs to zero. EdTech Books provides a catalog of open textbooks that can be easily edited directly within the distribution platform, greatly simplifying the adoption and revision process. And the Open Textbook Network, which includes 120 affiliate member campuses and organizations, promotes educational opportunities, certifications, and other benefits related to OER.

OER in Practice

Mason OER Metafinder

Unlike OER crawlers that search static content libraries, George Mason's OER Metafinder (MOM) launches a real-time, **simultaneous** search across **21** sources of open educational materials, many more available sources than most other crawlers. This provides real-time search results that can update dynamically.

Open Pedagogy Incubator

The Open Pedagogy Incubator is a semester-long program designed to incentivize faculty to go beyond the first step in open education. It brings together a cohort of faculty instructors to develop competencies in open pedagogy through a series of hands-on workshops, curated readings, and cohort discussions.

Alquimétricos Eco-Technological Toys Lab

Alquimétricos is a collection of open-source didactic toys: building blocks to mount structures while learning about geometry, math, architecture, mechanics, physics, chemistry, and more. The initiative is focused on the design of DIY educational materials that are meant to be produced using a wide range of procedures.

To encourage and support such initiatives, countries such as Germany have developed the #OERcamp, which serves as an incubator through informal meetups across the country. To date, nine such events have taken place. Plymouth State University launched what it refers to as the Cluster Pedagogy Learning Community (CPLC), which promotes pedagogy-related initiatives along three broad domains: interdisciplinarity and integration; project-based work that extends beyond the walls of the classroom; and open practices that encourage and empower students to contribute scholastic endeavors to their wider communities and networks. This effort was enthusiastically supported by the institution's governance.

OER not only saves students money but can also provide additional affordances by way of improved inclusivity. For example, the Chang School at Ryerson University, in concert with the Ontario government, has developed a series of open courses on accessibility—including accompanying open textbooks and MOOCs—that have been accessed by more than 5,000 students worldwide. Similarly, the open pedagogy Pathways Project at Boise State University promotes language learning and inclusive access through the development of OER resources and activities in multiple languages. LibreTexts, a predominantly US effort but with ancillaries at the United Arab Emirates University in Dubai, ensures that its entire library of open resources is provided in accessible formats.

OER is rapidly expanding far beyond the traditional textbook boundaries, as well. Stanford University's Center for Health Education developed a mobile application that seeks to promote global health awareness and reduce infant mortality. The Digital MEdIC app includes free public health courses and worldwide medical education. The University of Victoria Libraries in British Columbia has made available an entire series of workshop curriculum, including 3D printing and scanning, video editing, and data visualization using RStudio and Tableau. SUNY Empire State College has developed a free Thesis Generator that guides students in developing a thesis statement for essays. This effort wonderfully illustrates that OER is not only about textbook replacements but also includes online utilities. Finally, Alquimétricos, an international consortium based in South America, has developed a collection of open source didactic toys and building blocks that teach the fundamentals of math, architecture, engineering, physics, chemistry, and other disciplines.

The cost savings resulting from these efforts can be significant. Various models suggest that on average, students spend roughly $82 to $100 per textbook. Studies suggest that up to seventy-five percent of students have delayed purchasing textbooks; sixty-five percent elect not to purchase the textbooks; fifty percent choose majors based on the textbook prices; and thirteen percent have considered dropping their courses due to textbook prices.

Digital Accessibility from Novice to Expert

In partnership with the Ontario Government, The Chang School of Continuing Education at Ryerson University is creating a series of online courses and interactive open textbooks aimed at raising awareness of digital accessibility, improving understanding and implementation of the requirements of Digital Accessibility, and contributing to a culture of inclusion around the world.

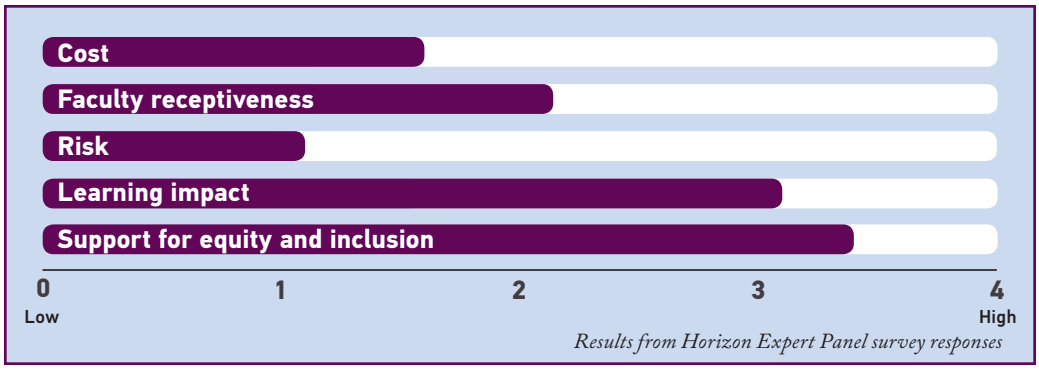
Colorado Department of Higher Education Statewide OER Initiative

Launched in 2017 as a result of Colorado Senate Bill 17-258, a statewide body was empaneled and charged with developing a plan for open resources to benefit college and K-12 students throughout Colorado.

Open Resources for Nursing (Open RN Project)

Funded through a multimillion-dollar Department of Education grant, the Open RN Project, led by Chippewa Valley Technical College, is developing five open textbooks and 25 virtual reality scenarios that will be made freely available to nursing students and faculty everywhere.

Dimensions of Adoption:
Open Educational Resources



Results from Horizon Expert Panel survey responses

Relevance for Teaching and Learning

Clearly, the primary drivers for increased adoption of OER are affordability, access, and digital equity. Reducing or eliminating resource costs can have a profound impact on student recruitment and retention. Some institutions market OER as a value-add for attending their campus. OER may also provide faculty more agency in what learning materials to adopt and use.

Despite the obvious advantages that OER provides, challenges remain. Even though we see evidence of a growing corpus of resources, nearly seventy-three percent of students and fifty-six percent of faculty have never heard of OER, though those numbers are improving. Additionally, "OER" is often conflated with "e-textbooks" and subscription databases that might or might not be open. Clearly, institutions have much work ahead in educating both the faculty and students.

Knowing how to locate such resources also remains elusive. Multiple crawlers and consortia are emerging, but knowing where to find the best discipline-specific resources and how to employ them in a course can be daunting. Additionally, there is a dearth of OER at the upper-division and graduate levels. Most commonly available materials target high-enrollment, lower-division undergraduate general education courses. When resources do exist, faculty may need additional time to reuse, revise, remix, and/or redistribute those materials in a format that is consistent with their pedagogy. Given these constraints, some faculty have turned to discipline-specific professional organizations that provide OER materials at no cost and no obligation.

Further Reading

European Open Educational Resources Policy Project
Open Education Policy Network

Community College Consortium for Open Educational Resources
Community of Practice for Open Education

US Department of Education: Office of Educational Technology
Open Education

XR (AR, VR, MR, Haptic) Technologies

Extended reality (XR) is a comprehensive term for the environments that either blend the physical with the virtual or provide fully immersive virtual experiences. The two most common technologies are augmented reality (AR) and virtual reality (VR). Whereas AR overlays physical objects and places with virtual content, VR is typically a more immersive experience, involving manipulations of and interactions with virtual objects within an entirely virtual environment. Most commonly the immersive experiences are delivered by means of a headset, but AR often requires only a smartphone. Another kind of XR is holography, by which an object is imaged as a three-dimensional representation instead of a two-dimensional image. As a corollary, 3D printing, as the name suggests, reproduces physical objects in three dimensions using a variety of techniques and materials. Higher education is experimenting actively with XR technologies in the curriculum, and despite current hurdles (such as the cost of equipment and the effort it can take to create content), the potential for XR as a learning vehicle is high.

Overview

The global higher education exploration of XR's potential in teaching and learning already exhibits an impressively wide diversity, addressing curricular challenges and opportunities.

It is clear that higher education is not leaning into XR wholesale or naively. The majority of the exemplar project descriptions mention that the institution has set up a lab or a center as the locus for initial XR explorations. These centers, either augmented makerspaces or new facilities, enable collaboration and the sharing of resources and expertise. There are also projects, such as Penn State's immersive Experience Catalogue and North Carolina State's VRPlants, that seek to identify and make available open XR resources for higher education. The University of Leed's XR work in health care has not only provided hundreds of learners with the opportunity to learn skills for safe practice but also enabled work on a European Consensus Statement on guidelines for the use of immersive technologies in dental education.

With respect to accessibility, it is clear that XR can provide learners with disabilities new kinds of access. The University of Nevada Reno provided XR experiences to a student with cerebral palsy, which made the student feel like he was walking. The University of Waterloo created a 360 VR field trip as an equivalent for students unable to participate in a real-world 1.5-kilometer hike over uneven terrain. Gallaudet University, a school primarily for Deaf and hard-of-hearing students, has been experimenting with VR to invent more efficient ways to calibrate new hearing aids.

XR in Practice

Growth of Centers for XR Exploration

Institutions are increasingly establishing labs and centers to focus the potential of XR technology for teaching and learning. Examples from the call for proposals include Grinnell College's Immersive Experiences Lab, the University of Georgia's X-Reality Labs in Engineering Education, Boise State University's GIMM program, and Dartmouth College's Data Experiences and Visualizations Studio.

XR Projects at Leiden University

Leiden University has sought to provide its students with formerly inaccessible experiences through a pair of projects. The first, employing immersive interactive VR experience using 360-degree video, is for emergency care students to increase their confidence in preparation for real-life situations. The second, an AR application called AugMedicine, enables medical students to gain more insight into the complex 3D anatomy of patients after kidney or pancreas transplantation.

Real-World Classroom at the University of British Columbia

This multidisciplinary XR collaboration helps students "see" through disciplinary lenses in real-world contexts. This project constructs geospatial tours to augment students' blended, gamified, experiential learning. From exploring forest ecosystems in Pacific Spirit Park to tracing the embodied journey of Syrian refugees, each UBC geospatial tour makes learning "in the field" more accessible, engaging, and self-paced.

XR is proving to be an effective way to augment traditional forms of pedagogy. Two projects at Leiden University, AugMedicine and emergency care curriculum, enhance traditional teaching methods and fill the "theory-practice gap." Students learning emergency care often "feel overwhelmed during their first encounters with critically ill patients," but use of simulations can bolster a learner's self-confidence in applying learned techniques to real-life emergency situations, providing an important stepping stone between theory and practice. Similarly, the work at the University of Leeds does not replace actual clinical experience but increases time on task and enhances the learners' knowledge so that they are in a position to gain much more from their internships and work experience.

As for cost, looking past the foreground expenses of XR (which are decreasing), it turns out that XR deployment can actually help reduce overall institutional costs. Often the original, analog learning experience is expensive in several respects, such as fiscal cost, logistical arrangements, or hard-to-schedule subject-matter experts. In these cases, the deployment of XR actually reduces these costs and makes the provision of the learning experiences more sustainable and hence available to a wider audience of learners. For its equine veterinary curriculum, the Cornell University College of Veterinary Medicine has developed an XR-based X-ray positioning simulator that, in addition to its pedagogical values, saves a great deal of space, time, and expense, relative to the alternative of having 30 live horses available for a lab. It also has ethical implications in that it enables relevant learning "without the risks and limitations of using live animals and radiation."

Relevance for Teaching and Learning

XR unquestionably has relevance for teaching and learning. The real question is about the breadth and depth of that relevance. Judging from EDUCAUSE research and the exemplar projects collected for the Horizon Report, XR does show great potential for learning, provided its use is embedded in holistic instructional and learning designs.

Over the past three years, EDUCAUSE research has found that XR can be effectively deployed to support skills-based and competency pedagogies; that it can expand the range of hands-on learning experience; and that it can "enable high-touch, high-cost learning experiences to be scaled up." In addition, the exemplar projects reveal that, like OER, XR can offer learners the rich learning experience of co-creating course content. At California State University, San Bernardino, for example, the Immersive Media & Learning Lab enables students to create XR content in partnership with faculty. The lab has recently created a certificate in extended reality production, which can include a course in entrepreneurship to help students with their first XR startup.

There are challenges, of course. EDUCAUSE research notes that the effective deployment of XR faces the twin challenges of requiring time and skills. The use of XR must also "fit into instructors' existing practices, and the cost cannot be significantly higher than that of the alternatives already in use." Also, the greater

Forensic Science at St. Edward's University

As its name suggests, the Crime Scene Investigation (CSI) Virtual Reality (VR) project seeks to provide students with immersive experiences of crime scene investigations. This enables students to "be" at a crime scene or in a crime laboratory, locations that typically are inaccessible to students. This technology can also be used to train university police officers in crime scene investigations.

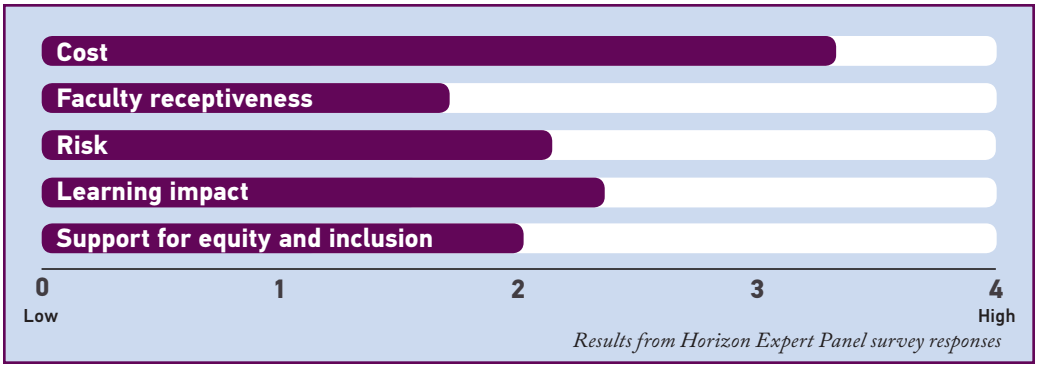
Building Science at Auburn University

At the McWhorter School of Building Science at Auburn University, providing students with site visits can be costly, logistically challenging, and unrepeatable. Using data-capture technology and VR viewing platforms, the school has created 360-degree "active construction" sites that enable students to "revisit" construction sites and allow faculty to introduce students to technology widely used in the construction industry.

Enhancing the Textbook with AR

To enhance learning outcomes and learner engagement, North Carolina State University built an app that adds augmented reality experiences to a textbook on graphic design. Learners can listen to a virtual docent, employ an AR magnifying glass, peer down the corridors of an Italian Renaissance street, and take formative quizzes.

Dimensions of Adoption: XR (AR, VR, MR, Haptic) Technologies



Results from Horizon Expert Panel survey responses

the XR fidelity, the greater the learning impact. On this point, the panel was cautious, judging that XR could be weak in promotion of both learning outcomes and equity and may meet with mixed faculty reception.

A thread that is emerging from early research and experimentation is that XR most strongly benefits learning when closely paired with non-XR learning engagements. One study, involving the use of VR for a writing course, found that students who used both VR and a textbook achieved "significantly greater writing complexity" than students who used either VR alone or the textbook alone. HoloAnatomy (Case Western Reserve University and the Cleveland Clinic) was created in anticipation of a new medical school building for the CWRU School of Medicine, a building with no cadaver labs. Initial testing of HoloAnatomy has shown that using this XR environment is at least as effective in achieving desired learning outcomes as traditional cadaveric dissection. Despite this initial success, CWRU has retained some cadaveric dissection, finding value for medical students in, as a representative of CWRU said, the "exposure to and demystification of death, viewing anatomical variance and the rite of passage associated with dissection of the human body."

Looking ahead, it is clear that equipment costs will decrease while XR capabilities increase. Combined with major advances in wireless and cellular network performance, such as Wi-Fi 6 (802.11ax) and 5G, it seems very likely that XR experiences will become more immersive and more powerful over time and that, given the improvements in network capacities, it will be possible to deliver those experiences to both residential and remote learners.

Further Reading

VirtualSpeech
A History of VR

Online Learning and Distance Education Resources
Virtual and Augmented Reality

Chronicle of Higher Education
Virtual Reality Comes to the Classroom

Scenarios

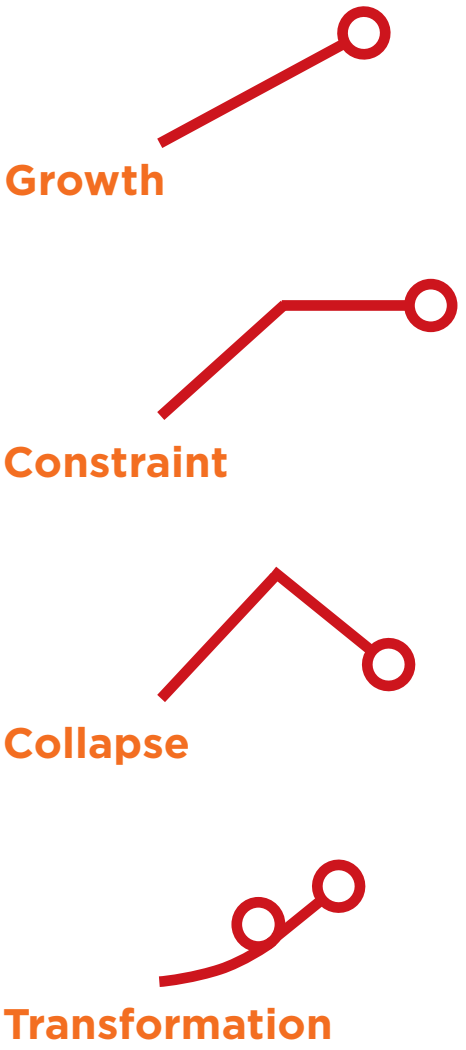
Today, planning for the future is probably as complex and as challenging as it has even been. Given well-known challenges such as the pace of change and the rapid diffusion of artificial intelligence, planning needs imagination, flexibility, and a willingness to consider options from a variety of possible futures. Any action plan we formulate today is based on assumptions about what is likely to happen tomorrow. But if we lock our action plans too firmly to a specific set of assumptions, what happens if the future turns out differently, and those assumptions are not realized? Should that happen, then we may be pursuing a course of action that is out of sync with actual events and might even work against our interests.

Any action plan we formulate today is based on assumptions about what is likely to happen tomorrow.

Clearly, plans that enable us to navigate diverse futures are more robust than plans that are cemented to a single version of the future. In this section we are using a tool from the Institute for the Future: envisioning alternative futures. By doing so, we can be more imaginative in our planning and equip ourselves with the flexibility we need to encounter what does eventually occur. This section of the Horizon Report is an exercise in anticipating alternative futures for higher education.

We provide four such scenarios. Each is written from an imaginary viewpoint in the year 2030, reflecting on the course of higher education through the decade of the 2020s. We are using the institute's four scenario archetypes or generic shapes of change. The first is growth, a scenario that takes current trajectories into a future in which higher education largely flourishes but leaves some of its issues inadequately addressed. The second is constraint, in which higher education continues but with a diminished role. Third is collapse, a scenario in which higher education is beset by rapid breakdowns and forces of change outside its control. Finally, in the transformation scenario, higher education establishes a successful new paradigm for itself.

We have taken this "all four points of the compass" approach to provide distinct future alternatives. These archetypal scenarios will enable you to anticipate a variety of possible futures in your planning for what might come our way.



Growth

Higher education across the decade of the 2020s saw some significant progress, even if it has not been able to attain its complete agenda. The decade has been characterized by overall growth, together with some unrealized goals and even some setbacks.

Much of the growth has come from a significant increase in adult learners who are either returning for additional learning or seeking postsecondary credentialing to keep pace with the job market. Under the impact of significant technology advances—most notably AI, machine learning, and ever faster networks—the "range" of higher education grows ever larger, able to scale its efforts and reach more remote learners than ever before.

Growth has certainly not been uniform across all institutional types. In the United States, the predominant sector of student growth has been among individuals with some college credits but no degree (numbering roughly 30 million in 2020), while the decline in the number of high school students has followed the trajectories anticipated at the outset of the decade. As a result, growth has been seen mainly in institutions able to provide online courses that address the so-called "three keys": affordable cost, schedule convenience, and expedited credit transfer. This growth was initially concentrated in the so-called mega-universities, but other institutions have joined them in offering "three keys curricula."

Not all of this growth is seen in fully online enrollments: institutions that can offer so-called "three keys curricula" in hyflex formats to local adult learners also enjoy enrollment growth. By forming innovative consortia, many smaller institutions have been able to avoid closure. Still, many others could not adjust, and the rate of closures remained steady throughout the decade. The growth of higher education in the 2020s did come at an additional price: some of the traditional disciplines, particularly in the humanities, continued to be cut or curtailed across the postsecondary sector.

Aside from the 2022–23 recession, the economy has been able to sustain modest growth, although nothing like that of the late 2010s. The wealthiest of the private institutions have increased the family income discount boundary, enabling a greater percentage of students to attend free of charge or for a steeply discounted rate. Coupled with a modest though definite recovery in state funding for public institutions, the decade saw overall increases in attendance.

Progress was made on equity and inclusion, though not as much as many had hoped, and those issues persist. Factors such as the slow but steady scaling of adaptive learning, as well as the gradual acceleration of growth of open educational resources, contributed to increased success among nontraditional students. But the total cost of effectively implementing these tools has slowed adoption, especially for smaller, tuition-dependent institutions. The rates of D/F/W for key courses have fallen overall between five and eight percent, falling a bit short of the hoped-for nine to eleven percent.

Employers remain focused on skills directly relevant to their industry. Higher education accommodates this priority by offering options to certify competencies in academic courses and through the use of the comprehensive learner record, which enables students to document the full scope of their postsecondary learning and so exhibit the relevance of their portfolio to potential employers. Colleges and universities (especially at the associate's level) also see success with fast-track microcredential programs, which have proven especially popular with adults returning to complete and renew their education.

All the attention focused on fully online curricula has not meant that that the traditional residential experience was neglected. For example, XR technology quickly improved in realism and accuracy while its costs decreased steadily, making it available to a much wider student audience. In this way, XR provides compelling learning experiences and new possibilities for students with a range of learning challenges. It has been a decade of the "globalization" of the residential learning experience, with courses and course experiences involving students and instructors from international institutions, due in part to the increase in digital network capacities noted earlier. Advances in analytics have also enabled institutions to fine-tune their support of their learners, enabling myriad support and intervention strategies.

Constraint

Everyday life is organized around norms and practices that reflect the values of efficiency and sustainability. Societies and industries around the world failed in previous decades to swiftly and adequately respond to global climate change and environmental depletion, and the need for restraint in material and energy consumption is the new global reality. In higher education, institutions have continued to face escalating financial pressures as a result of shrinking enrollments and decreased funding from state and other sources. In an era of efficiency and constrained resources, higher education has struggled to appeal to emerging student populations and to lay claim to new and compelling value propositions that justify substantial investments of resources and time from learners.

Evolving to fit within these new realities, higher education has adopted a culture of operating and accomplishing more with less. Parents brag at dinner parties about the "carbon footprint credits" their children are earning on their educational journey. News headlines chronicle students' times to degree completion—one story tells of a woman who obtained her bachelor's degree in less than three months. Most institutions have shuttered their least profitable and most resource-intensive sports programs, redistributing funds to flourishing esports. For the third year in a row, NCAA's "Woman of the Year" award goes to an esports athlete.

In this new reality, institutions' drive to greater efficiency and longer-term sustainability has resulted in educational experiences focused on cutting out the "waste." To remain solvent and relevant, institutions must move learners toward course and degree completion as quickly as possible. Online education has become the default mode for course delivery, and innovations in extended reality continue to enable more, and more efficient, pathways to skills acquisition. Degree programs and courses across most institutions have been thinned out, leaving only what is demonstrably needed for hard skills and jobs acquisition.

In this economy of frugality, institutions have little tolerance for guesswork and little room for potentially underperforming students who would diminish the institution's return on investment. With the ubiquity of comprehensive personal, learning, and behavioral data and advanced predictive analytics capabilities across the higher education landscape, decisions about students and programs have become far more precise.

Advanced algorithms make student enrollment selections and determine scholarship allocations. They construct personalized learning pathways for each student based on the student's most likely learning and career outcomes. Students predicted to be headed toward noncompletion are advised either to pursue alternate learning/career paths or to withdraw entirely. These predictive structures are balanced by improved standards and practices that significantly reduce the socially biased outcomes of analytics.

As data speak louder down the halls of higher education, the voices of faculty and students have become softer. Faculty are encouraged to teach "only what is needed and applicable" and students to learn only the same. Course and learning experience design is managed according to ever-expanding data repositories of "what works," resulting in increased public confidence in course efficacy. Student electives are viewed as a luxury of a less restrained past, as is the thought that students should map and select their own courses on a whim.

There are winners and losers in this version of higher education. With the pains of limited resources and constraint have come the relief of minimizing waste and the carving out of new possibilities for sustainability and even growth into new, less resource-intensive modes of learning. The precision of data-led program and course decisions has contributed to measured improvements in learning outcomes and degree completions, and public confidence in and attitudes about higher education are beginning to shift in positive directions.

Where higher education can no longer offer or achieve what it once could, given its new constraints, other industries have stepped in to fill the gaps. Industries and corporations have supplemented learner needs with job-based training and microcredentialing opportunities. Elite universities have carved out a niche as strongholds of liberal arts education. And as all institutions learn to build and operate more efficiently and sustainably, they find themselves positioned to engage with their environments, communities, and learners more measuredly and responsibly.

Collapse

In the late 20th and early 21st centuries, higher education faced mounting headwinds on several fronts. Despite—and, in some cases, because of—the steps taken by colleges and universities to address those challenges, higher education as it had existed for many generations essentially collapsed, replaced by a new ecosystem of education.

Many of the root causes of this collapse were economic. Increases in the cost of higher education began to outpace inflation, creating a wide and growing gap between the price of a degree and the ability of many students to pay. State funding for public institutions was gutted, accelerating the pace at which a college degree became widely unaffordable. Federal subsidies for student loans did not bridge that gap, leaving institutions with unsustainable funding models consisting of very high tuition rates and growing discount rates—the amount the average student actually paid. This dynamic was seen at all but the wealthiest institutions, those with endowments measured in the billions of dollars. Despite higher education's goals to increase social mobility and decrease inequality, the significant differences in how much individual students paid to attend college exacerbated those very problems.

Confronted with high cost overruns and severe budget deficits, many institutions hired business-minded administrators to try to save the institutions. In many cases, this approach included cutting programs and eliminating departments—especially those in the humanities—that were deemed unable to provide a return on investment. In an environment when a bachelor's degree might cost many times the average annual income, degrees with lower earning potential became easy targets.

The devaluation of broad, liberal education further undercut confidence in higher education and the importance of a degree from an accredited college or university. This erosion exacerbated and accelerated a long-running trend of declining enrollment in higher education, made worse by the aging of the population and shrinking birth rates. Institutions began to merge, to combine their efforts to survive. Those that were not attractive for mergers shut their doors.

At first, only one or two institutions closed every couple of months, but the pace continued to pick up such that before too long, dozens of institutions were disappearing each month. No institution type was immune from the collapse. Clayton Christensen's prediction that 50% of institutions would close turned out to be woefully underestimated.

Meanwhile, employers from virtually all industries and from companies of all sizes began to focus on demonstrated skills in their hiring practices. No longer content hiring a recent graduate, employers insist on knowing, at a very granular level, what those graduates can *do*. Completion of a degree is less important than specific competencies. Colleges and universities attempted to reorient their programs to focus on discrete skills, rather than degrees or even certificates, and to provide evidence of those skills. But students discovered that they can acquire those skills elsewhere, without the overhead and cost of enrolling in a conventional institution of higher education. Partnerships between large companies and higher education institutions have morphed into corporate training alone, without the need for institutional participation.

Online education has become a central pillar of postsecondary education for most learners. It meets students' needs for low-cost, flexible education that can be pursued on one's own terms, alongside other obligations and limitations. Corporations, trade associations, governments, and other entities provide this education, replacing the legitimacy of accredited colleges and universities with that of the job market—useful and successful programs are those whose students can get jobs, earn promotions, change careers, and continue their learning throughout their careers.

The few institutions that retain any semblance of higher education as we knew it cater exclusively to the wealthiest of the wealthy, the one-tenth of one percent. Everyone else who seeks education beyond high school finds the training they need in a piecemeal, cafeteria model in which individual students assemble the competencies needed to pursue their chosen field of work. Colleges and universities have been disintermediated, replaced by a very different system of education.

Transformation

Looking back from our perspective in 2030, we can see that the dramatic transformations of global higher education in the 2020s were powered by two primary forces: the dangers posed by climate change and the advances in digital technology. The urgent threats from climate change had significant global impacts, resulting in new opportunities for higher education. The threat of political destabilization due to climate-related catastrophes caused the political winds to shift, away from polarization and toward cooperation and collaboration. Education was recognized as a valuable resource, both as a supplier of the research needed to find ways to reverse the climate trends and contain the worst of its effects, and as a key agent in credentialing the global workforce across all demographics with the learning needed to address the climate-related challenges.

Aided by more flexible accreditation standards, many higher education institutions have transformed fundamental aspects of their business models. For example, students now have matriculation options. One is time-delimited enrollments: registering for a set period (typically three to six years), during which time they can avail themselves of any and all learning experiences provided by their institution. Alternatively, students can matriculate for life, returning as needed to their institution for additional learning, making obsolete the concept of alumni. Still a third model is that of subscription: while paying a monthly subscription fee, individuals can access the full range of the institution's learning opportunities.

As the decade progressed, many institutions formed cooperative networks or alliances, many of which are international in scope. Many of these multinational alliances have been able to achieve rapid growth across the decade. Students enrolled at any member institution can take courses or get certifications at any other partner school, either online or in a residential program. Increasingly through the decade, it has become the offerings of the institution's alliance that persuade students to enroll at a specific institution. Institutions trade teaching students across the alliance, much like corporations trading carbon credits.

Learners gained considerable agency in the course of the 2020s, as options rapidly increased in number. One example is the academic degree: it lives on but in a highly transformed, "a la carte" state. Students can eschew the pursuit of the traditional degree altogether and instead devote their time in higher education to collecting skill certifications, badges, and microcredentials. For students seeking degrees, they can now compose their own degree pathway, with the advice of faculty advisors, drawing on all the resources of their institution's network alliance. The number of students seeking degrees in traditional disciplines has sharply declined, as more and more students elect to design their own personal major. The traditional transcript officially merges the full record of all of a student's learning and accomplishments (called in the early 2020s the "comprehensive learner record"), resulting in the comprehensive transcript we have today.

The wealthiest and largest institutions saw that, in order to repair the negative image of higher education from the previous decade, they needed to address one of the key issues: cost. These institutions set up a new foundation for student scholarships. Early in the decade they began contributing a percentage of their endowment income, creating a fund to reduce the cost of higher education for many students across all institutional types. By partnering with other philanthropic foundations, this initiative has contributed to the overall sharp decline in student debt, which fell by as much as two-thirds in some countries.

By 2027, most incoming students had the option to have an AI companion. Taking on all the functionality of the old smart phones, these AI companions provide oversight, nudging, adaptive mentoring, research assistance, feedback on assignments, and friendly encouragement. Students can select the level and frequency of the assistance provided by the companion. In surveys, many students say that they "have confidence" in the AI companion and seek the companion's advice on a range of academic and personal issues. Roughly 75% of residential students now use AI companions, and as a consequence the rates of depression and other markers of mental distress have decreased significantly.

Implications: What do we do now?

As a first step in a strategic planning process, you collect and identify the trends, trajectories, and signals that shape the present and seem to have enough momentum to inform the future. Once you have constituted this picture, the next step is to step back and ask: What are the implications? How should they inform my plans for the future?

To take this next step and explore the implications of the report's findings, we introduce a new section to the Horizon Report. We asked some members of the expert panel to identify the most important two or three implications for their own higher education context and discuss how these implications might play out. One thing you discover very quickly when working with an international panel is that not all the findings are equally relevant across national boundaries. What for one context might be an acute issue (for example, student debt in the United States) might not be an issue elsewhere. Hence it is a valuable exercise to have panelists review the body of findings and identify the key implications for their situation. Taken together, these essays provide a nuanced snapshot of the key issues in global higher education.

Of the nine essays collected here, four are about non-US higher education segments: Australia (Gibson), Canada (Veletsianos), Egypt (Bali), and France (Lundin). We have three by US authors, covering different segments in US higher education: community colleges (Bulger), baccalaureate institutions (Gannon), and master's institutions (Weber). We have also included a corporate perspective (Engelbert) and global perspective (Alexander).

Taken together, these essays provide a nuanced snapshot of the key issues in global higher education.

Obviously, nine essays do not come close to covering all the facets of global higher education. Although incomplete, their value lies in part in the global perspective on higher education that it affords. The reader can have a better sense of which issues are unique to a specific segment and which are shared across national and institutional boundaries.

Australian Higher Education

David.C. Gibson, UNESCO Chair of Data Science in Higher Education Learning & Teaching, Curtin University

Many of the findings in the 2020 Horizon Report contain implications for Australian higher education. For example, the emerging trends of adaptive learning technologies, artificial intelligence and machine learning educational applications, and analytics for student success imply that **Australian higher education needs to be developing new tools, approaches, and methods of data science applied to technology-enhanced learning and teaching.**

In Australia, interest is rising in the transformative and disruptive potential of data science as a new scientific method.

There are 43 universities in Australia, 40 of which are public universities. The country's higher education institutions have the highest ratio of international students per population in the world by a large margin, with 812,000 international students enrolled in the nation's universities and vocational institutions. Further, the Organisation for Economic Co-operation and Development (OECD) ranks Australia fourth in the world for high-quality research, adding to its attraction for students as well as researchers.

In Australia, interest is rising in the transformative and disruptive potential of data science as a new scientific method. In this context, data science includes global computational resources as co-production partners in exploratory and confirmatory research, as well as drivers of innovation, for example, to solve the challenge of personalization at scale. Data science brings a focus on using advanced computing to create and test complex models of the processes and outcomes of learning and teaching. Learning analytics, for example, uses data science methods with static and dynamic information to model the processes and outcomes of learners interacting within digital learning environments—aggregating, assessing, and analyzing that information for real-time prediction and optimization of learning processes, learning environments, and educational decision-making.

Relevance to the Challenges Facing Higher Education in Australia

The purpose of driving innovation and improvements in learning and teaching in higher education with data science and learning analytics is to better understand the concepts and mechanisms of learning and to enable effective new interventions and methods involved in teaching, research, and creating positive impacts in communities. Four considerations underscore the relevance of transforming research, teaching, and policymaking guided by the emerging themes in the 2020 Horizon Report—in particular, the implications for data science and learning analytics.

- **Literacy, fluency, and control over data are linked.** As fluency with data becomes a vital skill, the effect of disintermediation—the removal of intermediaries of time, complexity, and access between the user and the data needed for better decision-making—creates a positive feedback cycle for increased control and autonomy.
- **Global differences in learning analytics will continue to impact the uses, meanings, and methods of using data to make decisions.** Local cultural settings and perspectives will be more important than globally generalizable inferences from data.
- **New educational research is needed for analytics theory and methodology.** Because data science is impacting a new science of education, similar to how the first scientific revolution helped part the curtains of myths about the world, it may take decades or longer to realize some of the benefits of this latest revolution.
- **Bridging data science and learning science requires multidisciplinary frameworks.** Such frameworks help people apply their current understanding to gain new insights by seeing the world in a new way, with new tools and capabilities. An implication of this aspect is a vision

of multidisciplinary learning in teams with experts and novices alike working together to solve problems where neither has a complete understanding due to the problem's complexity.

Ways in Which Higher Education Institutions Can Act

Practitioners, researchers, and policymakers in Australia, each with their unique yet intersecting roles to play, need to work together to develop the world's knowledge base. People involved in education need the confidence to teach, conduct research, and put practical skills into practice to use data science approaches and methods as part of a new scientific method of improvement of higher education learning and teaching. For example:

In order for evidence-based practice to be led by analytics:

Policymakers and researchers need to develop learning analytics policy that focuses on leadership, professional learning, enabling mechanisms, and data governance.

To promote the adoption of learning analytics:

Practitioners can engage to enable organizational change to support stakeholders to use learning analytics for learning.

To inform and guide data services providers and users:

Policymakers should promote trustworthy, ethical quality assurance through mechanisms such as standards, accreditation processes, audits, and recommendations.

To impact learning through the use of analytics tools:

All stakeholders need to work together to ensure that the educationally relevant data literacy levels (knowledge, understanding, and capacity for decision-making) of all stakeholders are raised.

To leverage the relationship between instructional design and learning analytics, and to extend to course and curriculum analytics (such as through AI):

Researchers and practitioners can use learning analytics to inform the advancement of instructional design for quality learning, teaching, and assessment.

To understand the impacts of combining data types from all sectors (health, socioemotional, socioeconomic status, etc.) on interactions with people to improve data models and leverage AI and related technologies:

Everyone has a role to play to ensure that the control and ownership of data are clear, transparent, and in the hands of the person who is the subject of the data (e.g., EU-GDPR, ISO standard on privacy).

Higher education institutions that respond to the implications of the 2020 Horizon Report with key actions such as these strengthen their institutions while helping to advance the science and practice of learning and teaching.

Author Bio

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Canadian Higher Education

George Veletsianos, Professor, Royal Roads University

Canada's postsecondary education sector consists of five major kinds of organizations: universities, colleges, polytechnics, apprenticeships, and private vocational colleges. Enrollments in Canadian public colleges and universities was around 2.05 million in 2016/2017, with most of those enrolments in the university sector. Canada's education system is under the purview and responsibility of its ten provincial and three territorial governments, and there is no single or unifying educational system or policy at the national level. Although higher education institutions across Canada face similar challenges (e.g., financial, technological, and political pressures), it is important to acknowledge that what I describe below will not apply uniformly to all provinces, territories, and institutions.

> In Canada, it is broadly understood that an educated and skilled citizenry is key to social, political, cultural, and economic prosperity.

I focus here on one significant implication for Canadian higher education arising out of the six emerging technologies and practices identified in this year's Horizon Report: there is an urgent and pressing need to invest in professional learning and development of current faculty, near-future faculty (i.e., graduate students), and senior leaders in the use of digital technology in education. Adopting, or merely *considering* to adopt, any of the technologies or practices identified in the 2020 Horizon Report requires these three groups of individuals to become fluent in pedagogy and in the role technology plays in education.

This implication is relevant because an improved understanding of educational technology and its relationship to pedagogy will allow current faculty, future faculty, and senior leaders to make evidence-informed decisions around the use, adoption, and even rejection of emerging technologies and practices in their efforts to enhance learning, teaching, equity, diversity, inclusion, and student success.

The results of the 2018 and 2019 Canadian National Online and Digital Learning Surveys reveal a need to prepare Canadian faculty members to teach online, even though online learning is an established field of practice. Now imagine an environment that includes any two or three of the elements identified in the 2020 Horizon Report, and it becomes clear that the landscape that higher education is potentially facing in the near future involves practices much more complicated than online teaching.

It is paramount, therefore, that faculty, graduate students, and senior leaders understand

- *what*, if anything, these innovations make possible for education,
- *how* these innovations could be used in appropriate ways, and
- *whether* these innovations should be used.

In the words of Seymour Papert, faculty, graduate students, and senior leaders need to be able to criticize the technologies and practices listed in the Horizon Report and understand other people's criticisms of them. Among the most pressing issues to understand may be the collection, retention, use, and sharing of data that underpin many of these approaches, including learning analytics, artificial intelligence, machine learning, and adaptive learning.

Canadian institutions of higher education could act upon this implication in the following ways:

- Offer pedagogical training for all faculty, near-future faculty, and senior leaders. Such preparation should go beyond preparing faculty to *use* these technologies and instead focus on preparing everyone to gain further pedagogical expertise and become digitally fluent. Such training for instance, might invite senior leaders to explore whether tools their institution is currently using allow students to request that data collected about them be deleted.

- Embed required pedagogical training for doctoral students in graduate coursework.
- Require educational technology vendors to provide additional information pertaining to their products. For instance, vendors could be asked to provide learning efficacy reports and make transparent the black-box algorithms that some of their products are using.
- Develop practices that support and foster resilient relationships among professionals working together toward the design and development of digital learning experiences (e.g., teams consisting of faculty, instructional designers, data scientists, assessment experts, and so on).
- Identify the new roles and activities faculty might be asked to take on in the near future, and support individuals in gaining skills and knowledge relevant to those roles. For instance, do near-future faculty need to be able to recognize the limits of the recommendations provided by learning analytics dashboards? Will they be required to collaborate with artificial intelligence systems? Institutions should prepare individuals for such activities.
- Invite critical reflection on whether educational institutions *should* be adopting particular technologies. Some of these technologies, for instance, enable the automation of various aspects of teaching, including assessment, development of learning paths, and so on. Institutions of higher education are able to adopt some of these practices. Should they? Which technologies should we adopt? Which ones should we reject? Which ones should we resist?

In Canada, it is broadly understood that an educated and skilled citizenry is key to social, political, cultural, and economic prosperity. Empowering faculty, graduate students, and senior leaders with the knowledge and skills around the emerging educational landscape will enable them to make informed, appropriate, and ethical decisions toward serving our students and society to the best of our abilities.

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Egyptian Higher Education

Maha Bali, Associate Professor of Practice, American University in Cairo

Egyptian higher education includes 24 public, government-funded universities all over Egypt and 26 private universities, centered mostly in Cairo. The private institutions enroll 20.6% of the 2.8 million students in tertiary education in Egypt. Recent higher education reform focused on quality, accreditation, and internationalization.

Recent policies have ensured integration of information and communication technology (ICT) at universities. Across Egypt, the wider context is an internet penetration rate of 44% and mobile penetration that exceeds 100%—more than one mobile per person. Most quality online content, however, is not in Arabic.

Open education might help Egyptian higher education address inequities in access to quality resources, since free public education has failed to achieve that.

The key challenge facing higher education in Egypt is access to high-quality education for massive numbers of learners across the country. Many learners lack access to good education, and even those who have access face the threat of unemployment.

Implications of Open Education (Including Open Educational Resources)

Open education might help Egyptian higher education address inequities in access to quality resources, since free public education has failed to achieve that. Quality international textbooks in fields such as medicine are typically in English and quite expensive, so textbooks are often copied illegally. Quality open material in Arabic and for the Arab context is scarce, despite recent initiatives. Since 2016, the Egyptian Knowledge Bank has made many subscription-based educational and research materials available to all, but this content is not openly licensed and so cannot be translated or adapted freely.

Egyptian and Arab universities could create, share, reuse, and adapt OER in Arabic, offering locally relevant content to the least-advantaged learners/educators. They might reuse, translate, or adapt existing OER in other languages, such as what the Edraak Arabic MOOC platform does with international MOOCs and what MIT has done collaboratively with the American University in Cairo and American University of Beirut.

However, Arab MOOCs often involve elite institutions, mostly follow Western epistemologies, and do not employ innovative pedagogical practices. The large number of learners taking MOOCs implies a hunger for lifelong learning in the Arab world, and although MOOCs are not accredited, there is potential for MOOCs to serve as proxies for a person's lifelong learning potential to employers.

Institutions and policy makers must build on quality assurance initiatives to include online and open education. Although OERs are free to use, funding is needed to develop the digital literacies and capacity of local educators to enable them to choose which content to develop and how. That said, projects that are funded from outside the region need to be monitored carefully to avoid reproducing historic imbalances in the control of knowledge, given that the Research on OER for Development Project (ROER4D) has found that "educators and students in the Global South [are often] deprived of participatory parity" (i.e., equitable decision-making power) in such projects.

Implications of Artificial Intelligence

Artificial intelligence (AI) can offer educational opportunities to large numbers of students. Applications such as adaptive learning programs, teacher bots, and automated essay grading can provide interactive educational material to learners in remote areas without access to expert teachers (e.g., agricultural sector). At the same time, however, AI can displace some human roles, exacerbating youth unemployment rates. AI also carries the risk of reproducing biases because of how it is trained. Challenges include creating locally relevant AI, using data ethically, and designing for equitable participation involving content experts and teachers alongside programmers.

Interviews with faculty developers in two universities in Egypt and South Africa showed general optimism about AI removing some menial tasks from the responsibilities of teachers who have large classes. However, there is skepticism about AI's ability to replace human teaching in activities such as judging writing style, and some have expressed concern that policy makers could use AI to justify replacing (young) human labor. Also, inequalities would be reproduced if the less privileged received AI-powered education while the privileged continued to have human teachers. Several interviewees warned about "valorizing" human grading, since less-privileged learners often receive little human contact in mass higher education.

Training AI with Arabic data is challenging because much data from Egypt and Middle Eastern countries is inaccurate, unavailable, and mostly not open. Therefore, the needed data foundation for training AI is shaky, and crowdsourcing of data in Egypt remains insufficient. Infrastructure for AI (data storage capabilities and network bandwidth) is inadequate. Arabic is more complex to treat with natural language processing than Latin text, although open-source algorithms have been adapted to work on Arabic data.

AI can mitigate but also exacerbate inequalities and reproduce biases unless all stakeholders are involved in policy making and the creation and testing of algorithms. The Open AIR project is researching AI ethics, including gender equality, youth employment, and participation of marginalized groups in the formation of African AI policies. Interest has also been growing in teaching AI in universities in Egypt and UAE. Egypt has an AI policy in progress, which hopefully will ensure that technology is not used "to [further] marginalize" people, and AI policies must ensure that data collection does not promote surveillance or infringe upon privacy and civil liberties.

Conclusion

The implications for openness and AI are intertwined, as open resources and open data feed into the possibilities for AI in underrepresented regions. In the Arab world, "any hope of the equitable social distribution of the results of development will disappear in the absence of a democratic climate that provides popular oversight and fights corruption." In Egypt and the region, it is necessary to prioritize urgent and substantive reforms to the educational systems before making space for technological solutions and to recognize the ways in which the broader sociopolitical context, including limitations on freedom, may constrain the potential of such interventions.

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French Higher Education

Brigitte Lundin, Director of Pedagogical Innovation Support Center I-Site MUSE, Montpellier University of Excellence

Most French universities and other postsecondary schools are clustering, creating institutions with large and diverse student populations. (For a general overview of the French system of higher education, please visit Campus France.) The challenge is, therefore, to provide both individuals and large numbers of students with relevant and effective learning opportunities. This can be done only with the help of emerging technologies.

> The main challenge will be to adapt, change, and find ways to remain providers of diplomas that are worthwhile, effective, and available to all.

In the light of these developments, experts in French higher education have identified three potential implications from the Horizon Report's findings.

Large Numbers Versus Personalized Learning

The technologies and practices of learning analytics, artificial intelligence (AI), and UX design are developing quickly. These developments are in turn enabling the transformation of learning models (for example, personalize learning paths) and of traditional academic credentialing (for example, the cultivation of microcredentials). This evolution is still fledgling in France. Personalized learning, student-focused educational strategies, and learning analytics are currently used mainly for purposes such as preventing students from dropping out.

As for AI, French higher education is getting administratively ready for the challenge. However, implementing AI will require drastic changes in mindsets and threaten institutional balance. The role of teachers will be enhanced, but only if they are flexible and succeed in providing pedagogical content for all and for each at the same time. Universities' traditional missions of knowledge transmission and expertise building are being challenged by the private sector. Nanocredentials are gradually becoming goods to sell and buy.

Learning by Living

Immersive experiences, extended reality (XR), and serious gaming are key trends in educational technology. Opinions about the implications related to virtual reality devices differ among experts. Some consider them gadgets, while others think that they are the future of learning. Consensus has emerged, however, around several points. XR technologies are widely seen as relevant to professional training frameworks focused on sciences and technologies. They are particularly relevant in medical schools, where the "never the first time on the patient" simulation rule is compulsory. They are also effective tools when training to intervene in hostile environments, such as nuclear, space, or military.

XR technologies are rather embryonic in French higher education, mainly being tested in engineering schools, where budgets are high and the numbers of students tend to be smaller.

The mainstream adoption of XR technologies faces several challenges. Although the equipment is affordable, the price of software and its level of obsolescence are high. Mainstreaming is hindered by equipment availability and, in the case of large student populations, logistics. Here again, one has to recognize the important role of teachers and experts in the design and the pedagogical content of learning and training software. The ways to face this challenge are to foster and recognize experimentation, supporting the pioneers to prepare the ground for mainstream deployment.

Learning by Moving

Learning spaces are continuing to evolve, and the French system is witnessing the development of flexible learning spaces, both physical and virtual. This transformation has a

strong impact on pedagogical innovations, especially on the relationships and new interactions between students, teachers, institutions, and technologies.

Several important challenges confront this trend. This transformation is very new and unbalancing, the main implication being a breaking down of walls between all the sectors involved in higher education. Consequently, university actors need to be coached in learning space co-design, as well as pedagogical changes. Virtual learning spaces are also undergoing changes, which reflect the much broader evolution of online networks. Through the rapid spread of virtual learning devices, communities are being born, following the models of social networks, with both their flaws and their benefits.

On the other hand, the French higher education system is launching a Virtual Campus concept, which is a way to respond to strong societal needs. The aim is to link areas that suffer from social and technological isolation.

Conclusion

Generally speaking, French universities are being challenged in their roots, their identity, and their future. Walls are dissolving because of the evolution of learning spaces, physical and virtual alike. Diplomas are increasingly providing a customizable learning framework to better cater to a learning population that is growing in diversity in terms of age, the ways they access education, the roles of learners and faculty, and other dimensions, resulting in a complex landscape for higher education.

The main challenge will be to adapt, change, and find ways to remain providers of diplomas that are worthwhile, effective, and available to all. The institution will have to find a balance point between, on one hand, the highly specialized training that students need in order to be experts in a field of study and, on the other hand, the broad education in various competencies that students will need in order to contribute to society as professionals. Overall, pedagogical innovation reflects the importance of experts in human learning complexities in an interrelated framework of political, social, and economic elements.

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Campuses Most at Risk from Climate Change

Bryan Alexander, senior scholar, Georgetown University; president, Bryan Alexander Consulting

The 2020 Horizon Report identifies climate change as one of five economic trends that are exerting influence globally and on higher education in particular. This essay elaborates on that trend, exploring how it plays out across the field of education and technology. In particular, climate change intersects powerfully with two other trends. The climate crisis can accelerate the present-day growth in online learning (one of the higher education trends) as a way to keep education flowing in a changed environment. A growing commitment to equity (a social trend), inflected by climate change, seems likely to revise how digital education is conducted. Taken together, all three of these trends could reshape education as we know it.

The 2020 Horizon Report identifies climate change as one of five economic trends that are exerting influence globally and on higher education in particular.

A significant number of campuses around the world are likely to confront climate change challenges. Rising sea levels might threaten those located on or near oceanic coastlines, while institutions in the hottest climates might face dangerously higher temperatures if not desertification. Increasingly severe weather might afflict colleges and universities located in areas most susceptible to storms, flooding, and fire. Geographically remote institutions might find their infrastructure to be fragile under worsening conditions. Some campuses are likely to be in the path of growing waves of climate refugees. Meteorological stresses can pressure polities into behaviors or policies detrimental to higher education.

Taken together, the trends of climate change, online learning, and equity and fair practices are likely to combine in a major expansion and revision of online learning over the next generation.

Campuses most at risk of climate change face major strategic challenges, including to their physical and financial bottom lines. Expanding their online teaching offerings is a way for them to continue conducting their instructional mission, even when their brick-and-mortar facilities are compromised, as through cloud-hosted digital content and virtually connecting students and instructors who cannot be physically colocated. A digital curriculum is cheaper and easier to relocate than one that's embodied in the analog world. Networked instructors can teach from a variety of locations, not just campus classrooms.

Rising insistence on equity and fair practices supports such an online learning expansion, as it offers a rationale for reaching learners otherwise excluded by the forces of climate change, which already tend to fall hardest on the poorest and most marginal populations. Growing requirements to not only provide access to education for the underserved but to aid them in attaining good outcomes add extra urgency to online teaching and learning initiatives. Additionally, political instability driven by climate change (unrest, mass migration, civil strife, failed states) can heighten social inequalities, making the educational mission even more salient.

Online learning needs to be restructured in several ways to meet these powerful forces. First, teachers, students, and support staff must be able to work together effectively, which requires improved infrastructure: bandwidth, electrical power, and/or long-lived batteries. This could entail reducing digital teaching's demands, perhaps by scaling down to avoid more intensive forms (video, VR, animation, etc.). This could also involve academic collaboration with private or public infrastructure projects (e.g., municipal Wi-Fi, SpaceX Starlink, 5G networks). It might also involve developing deeper digital presences than most colleges and universities now have, in order to back up physical resources problems, such as blockchain-backed credentials, distributed and cloud hosting, and solid disaster recovery plans (for example, LOCKSS [Lots of Copies Keep Stuff Safe]).

Second, digital teaching must be configured to meet populations often lacking in the social capital needed to fully take advantage of the opportunity. This entails careful design, user testing, and iteration, along with a key focus on universal design principles and listening carefully to people typically lacking in social presence. Further redesign might be needed to more carefully fit content and pedagogy to specific cultural contours. It will likely be very politically and logistically challenging to accomplish all of this.

Third, exclusively online learning might be insufficient for this purpose, as face-to-face support can strongly enhance the digital. Institutions might find it advisable to set up physical sites for labs, library resources, advising, and collaborative learning spaces, possibly distributed over a large geographical area. Finally, effective institutional oversight will be needed to monitor progress in connecting with and supporting the most marginal populations.

To accomplish this online learning expansion in the context of rising temperatures and commitment to equity will require a great deal of effort. Aside from the required digital investments already mentioned, others will also be needed. Professional development for faculty and support staff alike is essential, as decades of online teaching and learning have taught us. Continuous research is also needed in multiple disciplines, from education to computer science. Collaborations across professional domains and institutions are essential. An additional challenge arises if populations call for less, rather than more, digital work due to the fact that online learning's panoply of devices and functions release dangerous amounts of carbon. In fact, this effort faces numerous political challenges.

Colleges and universities are likely to experience an accelerated migration, not across national borders but from the physical to the digital world, driven by the need to reach all populations in an increasingly challenging environment. Done well, a massive expansion into online learning could let these academic entities fulfill their missions while aiding people desperately in need of support. It will be difficult to complete this migration, especially in a chaotic epoch, but the trends discussed here make it the best course to follow.

Author Bio

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US Community Colleges

Stephanie Bulger, Vice Chancellor, Instructional Services, San Diego Community College District

Community colleges were founded in the United States in the early twentieth century with an open-admission policy to higher education. Today, 1,051 public, tribal, and independent community colleges have a successful history of helping individuals transfer to a university after the first two years of an undergraduate education; earn a short-term certificate or associate's degree and enter the workforce; or take courses for personal enrichment and professional growth. Close to half (41%) of all undergraduates are community college students. Community colleges serve a diverse student body of Asian Pacific Islander (6%), black (13%), Hispanic (25%), multiracial (3%), and white (46%) students, offering them pathways to good-paying jobs and university transfer. For more information about community colleges and the individuals they serve, see Fast Facts 2019 from the American Association of Community Colleges.

Close to half (41%) of all undergraduates are community college students. ... Community colleges are at the center of providing solutions for the skilled-workforce gap.

Today, some community colleges exceed the distressing statistic reported in research that 40% of community college students completed a degree or certificate within six years. Community colleges must continue to remove structural and cultural barriers embedded in their college campuses to reverse low completion. Colleges are examining the entire student experience, from registration to course taking, and implementing changes that make it easier for students to navigate the college campus and successfully integrate their course experiences with their lives. Community colleges that are using predictive analytics software are discovering patterns among students who are likely to fail a course or drop out, directing those students to the extra support they need, before they need it. Data on where students spend their time, gathered through location-tracking software, are identifying the behaviors of successful students and providing information about successful habits to develop. Community college cultures that employ analytics technologies empower cross-functional groups to review the data and then develop and test interventions. Their creative endeavors are mitigating declines in retention and persistence, increasing course success, and seeing gains in completion data.

To meet completion goals, community colleges will need to actively explore ways in which artificial intelligence/machine learning can be used to improve student learning. Adaptive learning applications, developed by publishers and companies, have demonstrated success helping students who might be academically underprepared for college-level coursework review course content as often as needed to grasp concepts and learn material. Chatbots that are developed using artificial intelligence and machine learning technologies, which give personalized guidance and real-time support to students filling out financial aid forms or registering for classes, are in sync with the culture of care of community colleges.

Community colleges are at the center of providing solutions for the skilled-workforce gap. Community colleges need to connect learning environments with equity-based pedagogical practices in workforce development models that combine on- and off-the-job training (e.g., apprenticeship, mentorship, and internship). Principles of universal design anticipate learner variability and provide multiple paths to successful outcomes. Community colleges should create actionable plans for implementing these principles within career training programs and career services to increase the success of individuals who have not been successful with "one size fits all" approaches to higher education. New resources, from both public and private sources, for faculty professional development in universal design instructional practices on the applicable technologies that can be used in both digital and physical settings should assist in this effort.

In addition to using open educational resources (OER) to reduce the cost of educational materials, community colleges should test the potential of OER to improve student learning. An *InsideHigherEd* article in July 2019 reported a downward trend in student spending on course materials and textbooks over the past decade due to strategies designed to reduce textbook costs. Yet, OER can be time consuming to develop and support. The OER librarian in community colleges can play an important role in facilitating and increasing adoption.

Community colleges, which are known for small class sizes and committed teaching faculty, are the ideal sites to incorporate the five activities that define openness (retain, reuse, revise, remix, and redistribute) into pedagogy, which will result in a more engaging and personalized learning experience for students and improve learning outcomes. Government and private investments in professional development for faculty should catalyze this potential. The Community College Consortium for Open Educational Resources (CCCOER), founded in 2007 at Foothill-DeAnza College in California, could be a vehicle for providing this critical leverage to colleges and universities.

Community college students tend to have multiple family and life responsibilities; often weigh food and housing costs against the cost of their education; and frequently navigate a complex system of policies, procedures, and practices on a community college campus. Community colleges are creative and responsive institutions that use technology in ways that are yielding results in student completion and success. The suggestions above, many of which community colleges are engaged in, would further successful efforts.

For more information about community colleges, see the American Association of Community Colleges and the League for Innovation in the Community College.

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US Baccalaureate Colleges and Universities

Kevin Gannon, Director of the Center for Excellence in Teaching and Learning, Professor of History, Grand View University

Nearly 575 four-year colleges and universities, public and private, have the Carnegie Classification of "baccalaureate college." According to the Classification Summary Tables at the Carnegie downloads page, this sector represents approximately 11% of US postsecondary educational institutions and about 4.5% of total US postsecondary enrollments.

This sector is perhaps the most diverse in US higher education in terms of institutional mission, size, academic profile, and student demographics, making generalizations difficult. Yet it is clear that baccalaureate institutions of all types must reckon with two significant challenges: accelerating changes in student demographics, and the issues raised by the increasing use of data analytics in strategic planning and regular operations.

The simultaneous decline and diversification of the postsecondary student population is a central feature of the smaller-college landscape, impacting current operations as well as future enrollment trends and strategic planning. Because most baccalaureate institutions use funding models that rely heavily on tuition revenue, even slight enrollment fluctuations can have major ramifications for their financial health and sustainability.

The overall decline in the US birthrate affects both current and near-future enrollment trends. The decline is even more pronounced when examined by US region. The Northeast and Upper Midwest are seeing the most significant declines in the traditional college-age population; these are also the regions with the largest numbers and highest concentration of baccalaureate institutions. States such as Vermont and Iowa (predominately rural, with a population that skews older and is declining more quickly than average) are the leading edge of this trend, and they each have seen several institutional closures in the past decade.

> Institutions will need to embrace equity and inclusion as genuine practices and not just admissions boilerplate.

Baccalaureate institutions find themselves competing against one another for a piece of a shrinking enrollment pie. Institutions that skillfully navigate these demographic trends may not see significant enrollment increases; indeed, simply holding steady is a successful outcome. Two strategies are central for this success: attracting a more diverse student population, and then retaining those students through graduation at a rate higher than the national average for baccalaureate institutions. To do so, institutions will need to embrace equity and inclusion as genuine practices and not just admissions boilerplate. A larger proportion of postsecondary students are from traditionally underserved groups. They are increasingly likely to experience obstacles including food insecurity and even homelessness, issues associated with increasing financial precarity throughout the United States. In this fraught political climate, as more students from minoritized and marginalized identities are enrolling, institutions must ensure various environments serve and affirm all students, not just those from dominant groups. Approaches to student success must be holistic, involving units across campuses, not just academic affairs or advising.

The use of data analytics offers great promise for baccalaureate institutions but also raises significant questions that will need to be answered to use these tools effectively. Vendors offer data analytical products and consulting at a scale that very few, if any, baccalaureate institutions would be able to replicate in-house. In that regard, institutional contracts with these third-party entities offer the chance to increase capacity without the associated capital and infrastructure expenditures. Integrating their historical data into these platforms lets institutions aggregate a remarkable body of information to better analyze questions and trends shaping their student recruitment, retention, and persistence. The ability to do so can pay large dividends when it comes to efficiently and strategically allocating resources and targeting development opportunities.

There are caveats, however. Faculty and staff feeling the pinch of institutional austerity and budget-cutting may not be receptive to the high costs of these platforms and services. Integrating existing student information systems with a new platform is a time-consuming and far from seamless process. Smaller institutions may not be prioritized as highly as larger clients by vendors with technical support and consultations, leaving smaller institutions feeling as though they're receiving less than they were promised. Most important, having access to more and better organized student data means institutions must adopt robust, effective privacy policies. Just because one *can* look at a student's entire academic file doesn't mean you *should*. All stakeholders—faculty, staff, and students—need assurances that this information will be used ethically.

Larger-scale analytics offers significant opportunities for baccalaureate institutions to use evidence effectively in driving strategy and to allocate resources where they will have the greatest impact on student success and institutional health. However, this potential can only be fulfilled if motivations and processes are transparent and collaborative.

To confront the changing landscape of higher education and the new demographic realities that characterize their students, baccalaureate institutions must continue to emphasize their historical commitment to access, support, and student success but do so in ways that acknowledge the larger socioeconomic structures of inequality and resource scarcity from which increasing numbers of their students are drawn. An institutional commitment to equity and inclusion, operationalized in part through the ethical and collaborative use of data technologies, offers the most promise for successfully navigating an increasingly complex and uncertain terrain.

Author Bio

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US Master's Colleges and Universities

Nicole L. Weber, Director of Learning Technology, University of Wisconsin–Whitewater

The University of Wisconsin–Whitewater is an example of an institution that is classified in the Master's Colleges and Universities (Larger) Carnegie category. As I talk with colleagues at similar institutions, two key trends identified in the 2020 Horizon Report are prominent in our conversations: declining state funding and demographic changes (e.g., declining traditional-aged student population). These challenges have presented some campuses with fiscal uncertainty but also with new opportunities to grow.

The competition to serve adult and lifelong learners may drive master's colleges and universities to explore developing new programs that leverage alternative pathways.

Implications for Master's Colleges and Universities

As master's colleges and universities face challenges related to declining state funding and demographic changes, they will need to adapt to new student populations and needs to thrive. This means extending enrollment to populations they may not have served much (or well) in the past (e.g., nontraditional students, students of color, rural students, students who may need more remedial academic support). This may lead campuses to think about key trends in the 2020 Horizon Report such as **alternative pathways**, **online learning**, and the **future of work and skills** more than ever before.

The competition to serve adult and lifelong learners may drive master's colleges and universities to explore developing new programs that leverage **alternative pathways** (e.g., nano- and micro-degrees, competency-based programs, portable credentials, stackable certificates) to better meet learner and workforce needs. While learner-centered approaches in course design are not new to higher education, alternative pathways might find resistance depending on campus culture because they tend to look different from typical residential bachelor's and master's degrees. When getting started with alternative pathways, campuses might think about how to adapt traditional structures in new ways. One way to do this is to design new master's degree programs more flexibly by viewing courses as building blocks that roll up into stackable certificates that can be taken to earn a particular certificate or as part of a larger degree, as needed by individual learners. To prepare for alternative pathways, graduate schools and schools of continuing education will need to partner with centers of teaching, learning, and technology to provide design consultation and faculty development opportunities to support the effective integration of technologies (e.g., adaptive learning) in this new model.

While many campuses currently offer online courses, master's colleges and universities may look to increase **online learning** as a strategy to attract students outside their residential market. Depending on prior investments in online learning, campuses might struggle to scale up online programs and courses, which might lead them to engage with online program managers (OPMs). As many campuses attempt to grow online programming within their institutions, they will need to invest in online faculty development, course development, quality assurance processes, and the elevation of instructional design, learning engineering, and UX design in pedagogy. Instructional designers, as well as others in similar roles, must prepare now for their evolving role and upskill around trending needs related to their positions.

To truly be successful in the 21st century, campuses will need to meet demands related to the **future of work and skills** by bridging the divide of workforce development and liberal education. Master's colleges and universities will need to adjust courses, curriculum, and degree programs to focus on how to prepare learners to meet the needs of an ever-evolving workforce. This means creating a campus culture that does not support an "either-or" proposition of liberal education and workforce development, but rather one that embraces the "both-and" mentality to human and technical skills. To do this effectively, campuses will need to be attuned to how students

learn and adopt practices to become more intertwined with the needs of the workforce, leveraging workforce reports and establishing advisory boards of professionals in the field to prepare students to be career-ready graduates and educated citizens.

Summary

Master's colleges and universities must identify ways to meet challenges that stem from demographic shifts and decreased state funding in ways that meet learner needs and remain relevant to workforce demands; otherwise, they could face mergers and closings. Everyone has a role to play. Provosts and chief information officers (CIOs) must invest in the future of their campuses. Deans must support their faculty in developing quality programs and courses in different models to meet learner and workforce needs. Teaching, learning, and technology centers must become strategic partners with provosts, CIOs, deans, and faculty to develop programs to stay at the cutting edge of the intersection between pedagogy, technology, and student success in support of campus strategic planning efforts and new directions. This is not the time for vacuums or silos—it requires deep and diverse teams who can collaborate and partner to incorporate various perspectives to develop a vision for success focused on meeting learner and workforce demands.

Author Bio

Nicole Weber has extensive experience designing and teaching online courses, providing faculty development for online teaching, and exploring emerging learning technologies. In her current role at the University of Wisconsin–Whitewater, she is a strategic partner with leadership, faculty, and staff to vision digital pedagogy and a learning technology ecosystem that supports student learning and success.

Corporate Perspective on AI/Machine Learning

Nicole Engelbert, Vice President, Oracle

Higher education is in a period of extraordinary exuberance around the transformative potential of technology. Vendors have invested heavily in new solutions to address admissions, instruction, student success, alumni engagement, and more. Unbridled enthusiasm for technology is not unprecedented, with institutions having navigated previous boom-and-bust cycles. The unique element of this one, however, is the largely untested belief that the success of artificial intelligence (AI) and machine learning (ML) in transforming sectors such as retail and media will transfer easily, with similar result, to the higher education industry. How many times has delivering an Amazon- or Netflix-like recommendation experience been cited as the business drive for a new technology project?

Unbridled enthusiasm for technology is not unprecedented, with institutions having navigated previous boom-and-bust cycles.

Implications for Vendors in the Higher Education Industry

As the competitive landscape for AI and ML solutions swells, the conversation about the potential of these technologies to improve academic outcomes will become increasingly cacophonous, making it difficult for institutions to discern hype from reality and ultimately decide which solutions to select.

Roles for the Technology-Solution and Service-Provider Community

At least initially, the adoption paths for AI and ML will have more in common with the unruly cow paths that created London's streetscape than New York's planned grid, as there are myriad buyers, users, and entry points for these solutions. The reality that AI and ML will enter higher education through both intentional and unintentional choices will further intensify this disorder. AI and ML will cross the campus gates through purchases by departments, individual faculty, and even students from consumer-market sources, which might hamper these technologies' ability to improve academic outcomes in meaningful ways, at scale.

Intentional institutional investments in AI and ML will grow through stand-alone intelligence solutions for student success, as well as enterprise systems, such as learning management systems (LMS), student information systems (SIS), and constituent relationship management (CRM) solutions with embedded or bolted-on AI and ML capabilities. Consequently, the rewards will be great for vendors able to bring rich AI and ML functionality to market rapidly, resulting in unprecedented R&D for some, marketing spend for others, and both for a lucky few. In such an environment, the rise of unclear jargon, competing claims, and vaporware is nearly unavoidable. Moreover, because the veracity of many vendors' claims that their solutions support learning with AI and ML will be difficult to discern, establishing best practice will be painful. Taken together, these market conditions will foster uncertainty and ultimately slow institutional adoption and its impact on academic outcomes over the medium term.

On the other end of the intentionality spectrum, AI and ML will hitch an incognito ride through the campus gates on faculty and students' consumer-market experiences. Netflix recommends TV shows for me to watch based on my profile and viewing habits, so why doesn't the SIS recommend which courses I should take, the LMS recommend which materials I should study, or the retention dashboard recommend which students need advisement? The pressure from end users will intensify for these types of capabilities and, if unmet, will likely drive the same behavior that resulted in an explosion of feral IT over the past decade. To be certain, "the cat is out of the bag" for leveraging AI and ML for recommending services in the consumer market. It is imperative for solution providers to invest in vehicles—such as centers of excellence, independent research, and consortia—to help develop the capabilities of colleges and universities to avoid the potential implications of bias at scale or of threats to data privacy that could result from bringing these capabilities into the institutional environment.

A Call to Action

The extent to which higher education realizes the tremendous potential of AI and ML to improve academic outcomes depends, at least in part, on technology vendors reducing the market uncertainty surrounding new solutions. Progress can be made in three key ways:

- **Market education:** Commit to creating industry knowledge about the mechanics of AI and ML and best practice with these technologies in higher education.
- **Transparency:** Use standard terminology to reduce confusion about what is or is not AI and ML, and communicate clearly the requirements for effective deployment.
- **Social responsibility:** Rigorously assess the potential for bias in the recommendations and optimization delivered by AI and ML tools, lest past discrimination be recreated at scale.

At the End of the Day

"With great power comes great responsibility." Whether attributed to Voltaire or Stan Lee, this quote is deeply relevant to the rise of AI and ML technologies in higher education. Technology vendors must be better partners. We must see ourselves as members of the higher education community, actively fostering the kind of industry that advances our society. A commitment to education, transparency, and social responsibility will be critical to ensuring the best future with AI and ML. The genie is out of the proverbial bottle; now we must help ensure that it is a force for good.

Author Bio

Nicole Engelbert is responsible for engaging institutions globally to inform the development of Oracle's Student Cloud solution. Prior to Oracle, she served as the Director of Research & Analysis at Ovum, where she advised institutions on their technology strategies. Engelbert holds a BA in classics from Union College and an MEd in educational administration and policy analysis from Columbia University.

Methodology

The Horizon Report methodology is grounded in the perspectives and knowledge of an expert panel of practitioners and thought leaders from around the world who represent the higher education, teaching and learning, and technology industries. This year's group included returning and first-time Horizon panelists, all sought out for their unique viewpoints, as well as their contributions and leadership within their respective domains. The panel represents a balance of global contexts, with members contributing from North America, Europe, Asia, Australia, and Africa. We also sought balances in gender, ethnicity, and institutional size and type. Dependent as the Horizon Report is on the voices of its panel, every effort was made to ensure those voices were diverse and that each could uniquely enrich the group's work.

This year's expert panel research followed a modified Delphi process, in addition to adapting important elements from the Institute for the Future (IFTF) foresight methodology. Following the Delphi process, our expert panelists were tasked with responding to and discussing a series of open-ended prompts, as well as participating in subsequent rounds of consensus voting (see sidebar "Panel Questions"), all focused on identifying the trends, technologies, and practices that will be most important for shaping the future of postsecondary teaching and learning. Ideas for important trends, technologies, and practices emerged directly from the expert panelists and were voted on by the panel. EDUCAUSE staff provided group facilitation and technical support but minimal influence on the content of the panel's inputs and discussions. This was done to protect the core intent of the Delphi process—that an organized group of experts themselves discuss and converge on a set of forecasts for the future, on the basis of their own expertise and knowledge.

The framing of the questions and voting across each round of panel input was adapted from IFTF's foresight methodology and drew upon the IFTF trends framework and process for collecting "signals" and "impacts" for trends. Ensuring an expansive view across all the many factors influencing the future of higher education, the IFTF "STEEP" trends framework enabled our panel to focus on **S**ocial, **T**echnological, **E**conomic, **E**ducational (typically "environmental" in the standard IFTF framework), and **P**olitical trends. This effectively broadened the panel's input and discussions beyond the walls of higher education to more explicitly call attention to the larger contexts within which teaching and learning takes place. These larger trends—and the current evidence and anticipated impacts of these trends—served as the grounds on which the panel built its discussions on the emerging technologies and practices influencing postsecondary teaching and learning.

As they provided their inputs and engaged one another in discussion, panelists were encouraged to share news articles, research, and other materials that would help reinforce their inputs and provide evidence for their particular viewpoints on current and future trends. In addition to enriching the panel's discussions and supporting the panel's voting and consensus processes, these materials were collected by EDUCAUSE staff for use as evidence and further reading in the writing of this report. In the Delphi and IFTF methodologies, these collected materials also serve the purpose of ensuring that the panel's future forecasts are sufficiently grounded in "real" data and trends, not merely science fiction.

Throughout the Horizon research process, panelists provided feedback to EDUCAUSE staff about the panel experience and voiced any content or methodology concerns they might have had. These open exchanges with the panel afforded EDUCAUSE staff numerous opportunities to make real-time adjustments to the panel experience and methodology and to gather input for long-term improvements to future iterations of the Horizon project. This was a collaborative effort, through and through.

Panel Questions

The following questions were designed to elicit an open range of responses from the expert panel and then to narrow those responses to a consensus through rank-order voting. Voting on trends was done separately for each of the five STEEP trend categories: social, technological, economic, educational, and political.

STEEP Trends

Round 1 (for each STEEP trend category): Please list any trends you see in today's world that you believe are going to shape the future of higher education teaching and learning. Provide evidence/signals of each trend, and detail the impact you believe that trend will have.

Round 2 (for each STEEP trend category): The list below summarizes the trends provided by this year's Horizon panel. From this list, please select those trends you believe will have the most influence on the future of higher education teaching and learning. (Please select up to 12.)

Round 3 (for each STEEP trend category): The list below summarizes the 12 most influential trends, as selected by the Horizon panel in last week's round of voting. From this list, please rank order what you believe will be the three most influential trends for the future of higher education teaching and learning.

Emerging Technologies and Practices

Round 1: We're interested in hearing from you about those emerging technologies and practices that you believe will have a significant impact on the future of higher education teaching and learning. Include with each tech or practice, if possible, a brief explanation of why you believe this tech or practice will have a significant impact on the future of higher education teaching and learning, as well as an example that comes to mind of a program or institution that exemplifies this emerging tech or practice.

Round 2: Please select the top 12 techs and practices you believe will be most impactful for the future of global higher education teaching and learning.

Round 3: Panelists provided ratings on the following dimensions for each of the top six techs and practices:

- Do you anticipate the adoption of <tech/practice> will require new kinds of literacies on the part of learners and instructors?
- How useful will <tech/practice> be in helping institutions address issues of equity and inclusion in teaching and learning practice?
- Thinking about the evidence of impact currently available, how would you rate the potential of <tech/practice> to have a significant and positive impact on learning outcomes?
- Thinking about the probability that this tech or practice will succeed or fail at the institution, how would you rate the level of risk involved in adopting <tech/practice>?
- Overall, how receptive would you say faculty would be to adopting <tech/practice>?
- Relative to institution size and budget, how much institutional spending would you anticipate would be required to adopt <tech/practice> across the curriculum?

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