NMC

Horizon Report > 2018 Higher Education Edition

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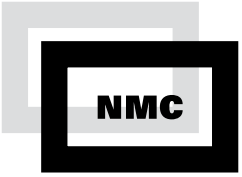

The *NMC Horizon Report: 2018 Higher Education Edition* is a collaboration between the New Media Consortium and the EDUCAUSE Learning Initiative, an EDUCAUSE Program.

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Executive Summary

What is on the five-year horizon for higher education institutions? Which trends and technology developments will drive educational change? What are the critical challenges and how can we strategize solutions? These questions regarding technology adoption and educational change steered the discussions of 71 experts to produce the *NMC Horizon Report: 2018 Higher Education Edition* brought to you by EDUCAUSE. This Horizon Report series charts the five-year impact of innovative practices and technologies for higher education across the globe. With more than 16 years of research and publications, the Horizon Project can be regarded as one of education's longest-running explorations of emerging technology trends and uptake.

Six key trends, six significant challenges, and six developments in educational technology profiled in this higher education report are likely to impact teaching, learning, and creative inquiry in higher education. The three sections of this report constitute a reference and technology planning guide for educators, higher education leaders, administrators, policymakers, and technologists.

The 2018 expert panel agreed on two long-term impact trends: advancing cultures of innovation and an increase in cross-institution collaboration. Whereas the long-term trends indicate a broad evolution in higher education, the mid-term trends are more pragmatic. The proliferation of open education resources is a mid-term trend that has matured beyond reusable, low-cost content toward defining complete programmatic initiatives. A rise in new forms of interdisciplinary studies is introduced in this report for the first time as a mid-term trend that will drive technology adoption in the next three to five years through the tools that advance multidisciplinary collaboration. The physical learning environment design on campuses remains a short-term trend, one the panel believes will continue to influence pedagogical practice and advance technology adoption in the near future. The panelists also once again agreed that a growing focus on measuring learning continues to push technology adoption, a trend in this report since 2013. This reoccurrence might be explained by the increased sophistication of the technology by which we can measure learning and the efficacy of that technology.

Regarding the major obstacles for higher education, authentic learning experiences and an advanced need to improve digital literacy are considered to be the solvable challenges—those that are already being addressed by programs at individual institutions. Challenges we understand but for which solutions remain difficult to scale include advancing digital equity and adapting traditional organizational models to more flexible designs that advance the future of the workplace. The experts identified political and economic pressures as those that create a wicked challenge—one that is difficult to define and even more challenging to solve. Similarly, rethinking the roles of educators is also considered a complex problem to define and solve. As educational technology is rapidly advancing and evolving, it is difficult to discern how to overcome these challenges to advance and scale technology adoption to increase student success, at least in the discernible future.

The panel identified technological developments that could support these drivers of innovation and change. Analytics technologies are expected to be increasingly adopted by higher education institutions in one year's time or less to make use of student data that can be gathered through a proliferation of sources. Makerspaces fit along a similar adoption horizon as institutions continue to create and integrate these spaces into the curriculum. The time-to-adoption for adaptive learning technologies and artificial intelligence is estimated within two to three years, acknowledging the advances in these technologies and their promise to positively impact teaching and learning. Mixed reality and robotics are expected to be more prominent in colleges and universities within four to five years.

The three key sections of this report constitute a reference and technology-planning guide for educators, higher education leaders, administrators, policymakers, and technologists. It is our hope that these essays and the resources provided to complement each topic will help inform the choices that institutions are making about technology to improve, support, or extend teaching, learning, and creative inquiry in higher education across the globe. Education leaders worldwide look to the Horizon Project as key strategic technology planning references, and it is for that purpose that the *Horizon Report: 2018 Higher Education Edition* is presented.

NMC Horizon Report > 2018 Higher Education Edition at a Glance

Key Trends Accelerating Higher Education Technology Adoption

2018 2019 2020 2021 2022

Short-Term
Driving technology adoption in Higher Education for the next one to two years

Growing Focus on Measuring Learning
Redesigning Learning Spaces

Mid-Term
Driving technology adoption in Higher Education for the next three to five years

Proliferation of Open Educational Resources
The Rise of New Forms of Interdisciplinary Studies

Long-Term
Driving technology adoption in Higher Education for five or more years

Advancing Cultures of Innovation
Cross-Institution & Cross-Sector Collaboration

Significant Challenges Impeding Higher Education Technology Adoption

Solvable
Those that we understand and know how to solve

Authentic Learning Experiences
Improving Digital Literacy

Difficult
Those that we understand but for which solutions are elusive

Adapting Organizational Designs to the Future of Work
Advancing Digital Equity

Wicked
Those that are complex to even define, much less address

Economic and Political Pressures
Rethinking the Roles of Educators

Important Developments in Technology for Higher Education

2018 2019 2020 2021 2022

Time-to-Adoption Horizon: One Year or Less

Analytics Technologies
Makerspaces

Time-to-Adoption Horizon: Two to Three Years

Adaptive Learning Technologies
Artificial Intelligence

Time-to-Adoption Horizon: Four to Five Years

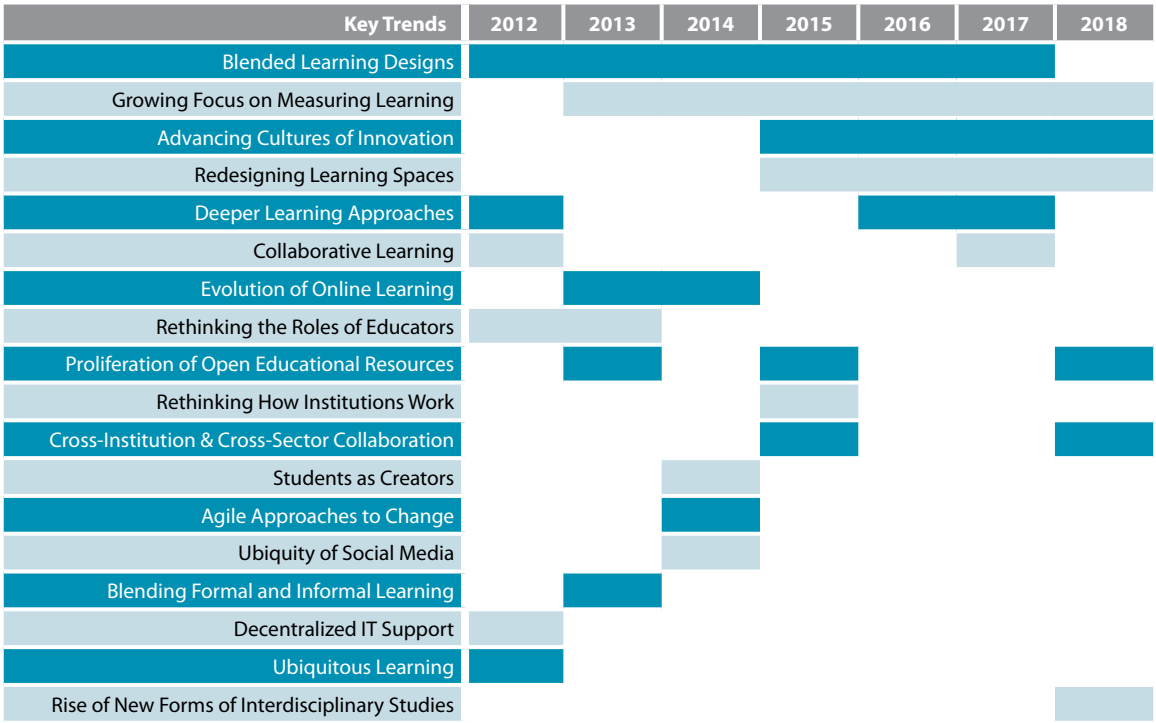
Mixed Reality
Robotics

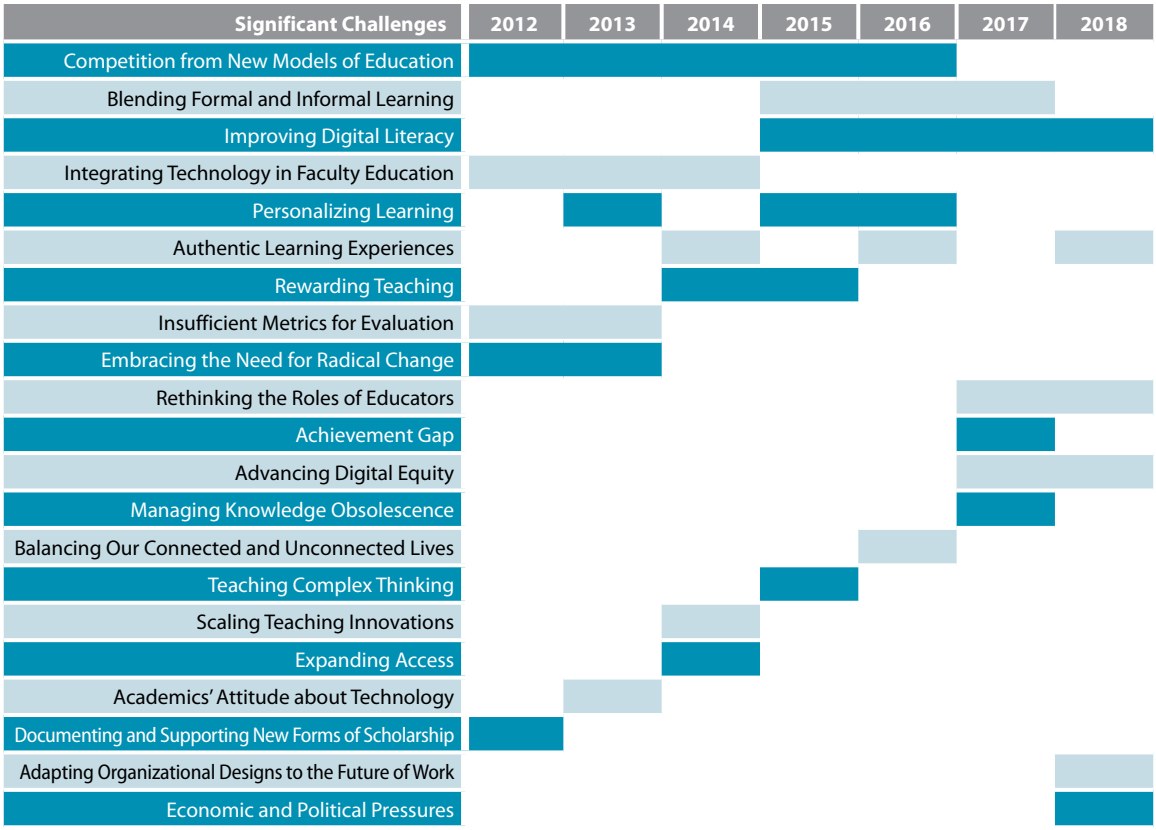
Introduction

The *NMC Horizon Report: 2018 Higher Education Edition* research and topic selection was completed by the NMC Higher Education Expert Panel in December of 2017, with EDUCAUSE completing the production and publication of the work in the summer of 2018. The internationally recognized Horizon Report series was established by the NMC in 2002 to identify and describe important developments in educational technology poised to have an impact on technology planning and decision-making in higher education around the globe. The Horizon Report highlights six trends, six challenges, and six developments relating to educational technology and practices that are likely to enter mainstream use within their focus sectors over the next five years (2018–22).

Over the 16 years of the NMC Horizon Project, there have been numerous overlaps from edition to edition, as individual technologies have matured or become obsolete. It is important to note that while topics may repeatedly appear, they only represent the broad strokes of educational change; each trend, challenge, and technology development evolves over time, informed by innovative campus approaches and by technological advances every year. Several trends have consistently been selected by the panel, including the focus on measuring learning and the redesign of learning spaces; the recurrence of these trends suggests that the panel views an ongoing progression of these trends in higher education. Certain topics reappear over time as well. Open educational resources (OER), for instance, have been a trend since 2013, yet initial advances in the authoring platform or curation method of open resources is now overshadowed by campus-wide OER initiatives and sophisticated publishing options that blend adaptive elements into an OER text. The chart below shows the findings from the past six higher education editions and from the 2018 edition. (For consistency, in some cases the topic names

Seven Years of the NMC Horizon Report Higher Education Edition




Significant Challenges
2012
2013
2014
2015
2016
2017
2018
Competition from New Models of Education
Blending Formal and Informal Learning
Improving Digital Literacy
Integrating Technology in Faculty Education
Personalizing Learning
Authentic Learning Experiences
Rewarding Teaching
Insufficient Metrics for Evaluation
Embracing the Need for Radical Change
Rethinking the Roles of Educators
Achievement Gap
Advancing Digital Equity
Managing Knowledge Obsolescence
Balancing Our Connected and Unconnected Lives
Teaching Complex Thinking
Scaling Teaching Innovations
Expanding Access
Academics' Attitude about Technology
Documenting and Supporting New Forms of Scholarship
Adapting Organizational Designs to the Future of Work
Economic and Political Pressures
Developments in Technology
2012
2013
2014
2015
2016
2017
2018
Analytics Technologies
Adaptive Learning Technologies
Games and Gamification
The Internet of Things
Mobile Learning
Natural User Interfaces
Bring Your Own Device
Makerspaces
Flipped Classroom
Wearable Technology
3D Printing
Tablet Computing
Artificial Intelligence
Next-Generation LMS
Affective Computing
Mixed Reality
Robotics
Quantified Self
Virtual Assistants
Massive Open Online Courses

have been slightly modified from the report where they originally appeared.) Taken together, the topics featured in the report from year to year tell a larger story about the overarching themes driving progress in—or impeding—teaching, learning, and creative inquiry.

In the pages that follow, 18 topics selected by the 2018 NMC Higher Education Expert Panel related to the educational applications of technology are explored. The topics are placed directly in the context of their likely impact on the core missions of universities and colleges, and they are detailed in succinct, nontechnical, and unbiased presentations.

Individual topics in the report are published as two-page spreads to make them useful as stand-alone essays and guides. Taken together, they generate a holistic vision of how they all coalesce. In some instances, the challenges represent the obstacles hindering positive trends from scaling, while the technologies are accelerators, revealing a convergence between all three sections.

Larger themes have emerged as the trends, challenges, and developments have been analyzed. Each topic can be placed into one (or more) of six meta-categories that reflect movements in higher education.

Expanding Access and Equity

People expect to be able to learn and work anywhere, with constant access to learning materials and to one other. Colleges and universities have made great strides in generating more methods and platforms for faculty, students, and staff to collaborate and be productive wherever they are. The advent of always-connected devices has provided more flexibility in how, when, and where people learn, and many institutions have updated their IT infrastructures accordingly. But simply having a device that turns on and connects to the internet is not sufficient. Support of success in learning requires digital equity as well. All aspects of the learning environment must be equally accessible and usable for all learners and instructors. This includes considerations such as universal design for learning, adaptive learning engagements, and overall affordability.

Spurring Innovation

If education is viewed as a vehicle for advancing the global economy, then it must be the North Star that enables societies to illuminate new ideas that solve pressing challenges and to create opportunities to shape a better future. In this sense, institutions are incubators of inventions and developments as well as the most important product of all: graduates who not only fulfill evolving job market needs but redefine and improve the workforce they enter. Advancing cultures of entrepreneurial thinking and designing new forms of artificial intelligence are just two of many areas of higher education that are spreading innovation.

Fostering Authentic Learning

Project-based learning, challenge-based learning, and competency-based learning—all of these pedagogical trends are in service to creating hands-on, real-world experiences for students. As higher education institutions prioritize active learning over rote learning, learners are becoming partners in learning, invention, and knowledge creation. The embedding of maker culture in higher education has made students active contributors to the knowledge ecosystem. They learn by experiencing, doing, and creating, demonstrating newly acquired skills in more concrete and creative ways. Students do not have to wait until graduation to change the world. However, institutions continue to be challenged to generate these opportunities in spaces and with paradigms that lean on traditional practices.

Leveraging Data

What good is a new approach or technology deployment if the results are not carefully measured and analyzed, with the program adjusted based on the results? Institutions are becoming more adept at capturing a bevy of programmatic data. This same principle has been applied to tracking student performance, engagement, and behavior and leveraging such data to inform decision-making across departments and campuses. This information is also fueling more personalized learning experiences through adaptive learning tools that analyze areas for improvement and deliver content tailored to each student. As this data-driven theme proliferates in higher education, leaders must consider how to scale the data in a way that presents a more holistic picture of student success and makes it useful across all disciplines. Embracing a culture of sharing that breaks down silos while maintaining ethical and privacy standards will be paramount.

Improving the Teaching Profession

The emphasis on hands-on, technology-enhanced learning has impacted every facet of campus life, with teaching as a central force. With students inventing, iterating, and collaborating regularly, instructors have been trans-

planted from their position as "sage on the stage" to "guide on the side." There is a need for mentoring and coaching as students work through complex problems to explore new frontiers and gain concrete skills. As student-led class discussions delve deeper into the material, faculty must balance the student-centered approach with subtle but effective facilitation. However, institutions are often set up in ways that indicate a value on research over teaching. As such, educators are not always sufficiently motivated to improve their teaching craft or rewarded when they do. Programs that recognize and scale positive teaching practices are a necessity. Further, just as there is a need to advance digital literacy among students, faculty must also engage in ongoing professional development, with support from institutions.

Spreading Digital Fluency

Technology and digital tools have become ubiquitous, but they can be ineffective or distracting if they are not integrated into the learning process in meaningful ways. The contemporary workforce calls for digitally savvy employees who can seamlessly work with different media and new technologies as they emerge. A major element of fostering this fluency is recognizing that simply understanding how to use a device or certain software is not enough; faculty, staff, and students must be able to make connections between the tools and the intended outcomes, leveraging technology in creative ways that allow them to more intuitively adapt from one context to another. Ownership of this movement must be shared and supported among institutional divisions as digital fluency is an important thread that runs through practically every facet of teaching and learning.

In the report that follows, icons appear next to each topic, indicating which of these meta-categories applies to it, to illuminate the connections between topics. The report's first two sections focus on an analysis of the trends driving technology decision-making and planning, and the challenges likely to impede the adoption of new technologies. Each includes an explicit discussion of the trend or challenge's implications for policy, leadership, and practice in higher education–focused institutions and organizations. The inclusion of these three elements acknowledges that it takes a combination of governance, vision, and action to advance positive trends and surmount pressing challenges. Relevant examples and readings conclude each topic for further elaboration.

The report's third section focuses on important developments in technology—consumer technologies, digital strategies, enabling technologies, internet technologies, learning technologies, social media technologies, and visualization technologies—all positioned to impact higher education over the next five years. Each development contains a discussion of its relevance to teaching, learning, or creative inquiry and concludes with a set of project examples and further readings.

Taken together, the three sections constitute a straightforward guide for strategic planning and decision-making for postsecondary education leaders across the world.

Key Trends Accelerating Technology Adoption in Higher Education

The six trends described in the following pages were selected by the project's expert panel in a series of Delphi-based voting cycles, each accompanied by rounds of desktop research, discussions, and further refinements of the topics. These trends, which the members of the expert panel agreed are very likely to drive technology planning and decision-making over the next five years, are sorted into three movement-related categories—long-term trends that typically have already been affecting decision-making and will continue to be important for more than five years; mid-term trends that will likely continue to be a factor in decision-making for the next three to five years; and short-term trends that are driving educational technology adoption now, but will likely remain important for only one to two years, either becoming commonplace or fading away in that time.

While long-term trends have already been the topic of many education leaders' discussions and extensive research, short-term trends often do not have an abundance of concrete evidence pointing to their effectiveness and future directions.

The NMC Horizon Project model derived three meta-dimensions that were used to focus the discussions of each trend and challenge: policy, leadership, and practice. Policy, in this context, refers to the formal laws, regulations, rules, and guidelines that govern institutions; leadership is the product of experts' visions of the future of learning, based on research and deep consideration; and practice is where new ideas and pedagogies take action, in universities and colleges and related settings. Below are summaries of the six key trends that will be explored more in-depth in this section, with citations and resources included.

Long-Term Trends: Driving Ed Tech adoption in higher education for five or more years

Advancing Cultures of Innovation

As campuses have evolved into hotbeds for entrepreneurship and discovery, higher education has become widely regarded as a vehicle for driving innovation. The focus of this trend has shifted from understanding the value of exploring new ideas to finding ways to replicate that exploration across unique and diverse learning institutions. Ongoing research examines how institutions can nurture cultures that promote experimentation. A significant element in advancing this movement is the call for higher education to accept failure as an essential part of the learning process. The act of integrating entrepreneurship into higher education further acknowledges that every big idea has to start somewhere, and students, faculty, and staff can be equipped with the tools needed to spark real progress. To keep pace, institutions must critically assess their curriculum and institutional culture and change their evaluation methods to remove barriers that limit the development of new ideas.

Cross-Institution & Cross-Sector Collaboration

According to the World Higher Education Database, there are more than 18,500 postsecondary institutions in 186 countries across the world. Today's global environment, which is increasingly connected via technology, allows institutions to unite across international borders and work toward common goals concerning teaching and learning, research, and shared values. By forging partnerships, institutions facing financial constraints can pool their resources so that faculty and learners can access a larger variety of digital course materials, data, and technologies than might otherwise be unavailable locally. Increasingly, institutions are joining forces to combine their intellectual capital or to align themselves strategically with innovative efforts in the field. Cross-sector collaborations and partnerships are also becoming more common, with industry looking to institutions for research and development to solve pressing challenges and institutions looking to business to prepare students for the digitally focused workforce, aligning programs and degree pathways with industry needs.

Mid-Term Trends: Driving Ed Tech adoption in higher education for the next three to five years

Proliferation of Open Educational Resources

The Hewlett Foundation defines open educational resources (OER) as "high-quality teaching, learning, and research materials that are free for people everywhere to use and repurpose." OER gained momentum in 2001 when MIT founded the OpenCourseWare initiative, making instructional materials for nearly 2,000 courses available free online. OER became an issue on the world political stage in 2012 with the adoption of the Paris OER Declaration, which explicitly linked OER to the Universal Declaration of Human Rights, which states that "Everyone has the right to education." Adoption

of OER has been driven largely by efforts to reduce the costs associated with higher education, though perhaps the most powerful potential outcome of OER is the opportunity for institutions to develop a broader set of investments in course development and infrastructure.

The Rise of New Forms of Interdisciplinary Studies

Multidisciplinary approaches to higher education are being introduced by institutions that see valuable alternatives to a traditional, singular degree path. Faculty members, administrators, and instructional designers are creating innovative pathways to college completion through interdisciplinary experiences, nanodegrees, and other alternative credentials, such as digital badges. Researchers, along with academic technologists and developers, are breaking new ground with data structures, visualizations, geospatial applications, and innovative uses of open-source tools. Further, widespread social movements have opened up global conversations about gender, race, class, and politics, which have catalyzed efforts to support new disciplines. These emerging areas could lead to exciting new developments in education, but effective organizational structures must exist to support the collaborations.

Short-Term Trends: Driving Ed Tech adoption in higher education for the next one to two years

Growing Focus on Measuring Learning

This trend encompasses the interest in assessment and the wide variety of methods and tools that educators use to evaluate, measure, and document academic readiness, learning progress, and skill acquisition. As societal and economic factors redefine the skills needed in today's workforce, colleges and universities must rethink how to define, measure, and demonstrate subject mastery and soft skills such as creativity and collaboration. The proliferation of data-mining software and developments in online education, mobile learning, and learning management systems are coalescing toward learning environments that leverage analytics and visualization software to portray learning data in a multidimensional and portable manner.

Redesigning Learning Spaces

As universities engage with strategies that incorporate digital elements and accommodate more active learning in the physical classroom, they are rearranging physical environments to promote these pedagogical shifts. Educational settings are increasingly designed to support project-based interactions with attention to greater mobility, flexibility, and multiple device usage. To improve remote communication, institutions are upgrading wireless bandwidth and installing large displays that allow for more natural collaboration on digital projects. Some are exploring how mixed-reality technologies can blend 3D holographic content into physical spaces for simulations, such as experiencing Mars by controlling rover vehicles, or how they can enable multifaceted interaction with objects, such as exploring the human body in anatomy labs through detailed visuals. As higher education continues to move away from traditional, lecture-based lessons toward more hands-on activities, classrooms are starting to resemble real-world work and social environments that foster organic interactions and cross-disciplinary problem solving.

The following pages provide a discussion of each of the trends highlighted by this year's expert panel, including an overview of the trend, its implications, and a set of curated recommendations for further reading on the topic.

Advancing Cultures of Innovation

Long-Term Trend: Driving Ed Tech adoption in higher education for five or more years

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Overview

For centuries, higher education has been a key locus for scholarship and discovery—the innovative yet disciplined acquisition and dissemination of knowledge. Whether achieved by integrating entrepreneurship into education, supporting internal changes, or encouraging pedagogical and technological ingenuity, innovation continues to dominate the conversation around higher education's mission. In a recent Online Learning Consortium and Learning House survey, 68 percent of schools ranked student success as a top-three goal for innovation, with just under half considering it their top goal. Their report—*The State of Innovation 2018*—defined innovation as "The implementation of new initiatives in order to drive growth, increase revenue, reduce cost, differentiate experience, or adjust the value proposition."[1] Other priorities included creating new degree programs, decreasing costs, creating alternative credentials, and developing new teaching methods.[2]

A cultural shift toward participatory learning has brought faculty, staff, and students onto more equal ground and has encouraged a collaborative approach to problem solving, with a greater diversity of voices and perspectives represented. Traditional hierarchies and power dynamics are being reconsidered to enable a flow of information and ideas. New and innovative teaching models and the technologies that enable them—such as in-class engagement and assessment tools, and hybrid and fully online courses—continue to democratize experiences and broaden access for students worldwide.[3] Many colleges and universities are finding new ways to position themselves in an age of increasingly smart technologies, including artificial intelligence, virtual reality, and machine learning; a burgeoning and highly competitive global gig economy; and a virtual marketplace focused on securing data collection, analysis, sharing, and privacy, both now and in the long term. Various consortia are collaborating to foster innovation in learning. Among these is Canada's Council of Ontario Universities, which includes evidence-based online simulations as well as the country's first research hub focused on digital inclusion to support users with disabilities, varying language needs, and diverse cultural preferences.

Rather than retrofitting an existing environment to be conducive to innovation, some countries are bringing it into the equation from the beginning. The Russian government, for example, established Innopolis, a new "innovation city" in Tatarstan focused on education.[4] In fall 2016, Innopolis University—the higher education institution constructed as part of the city—welcomed its first student cohort. Along with K–12 "feeder" schools, the state-of-the-art university aims to produce highly skilled graduates for the local workforce, and it can serve as a model for other countries seeking to build similar metropolitan tech and innovation hubs from the ground up. Students are also involved in this effort; for example, Pakistan's student-founded Social Innovation Hub at Lahore University provides research and consultancy services, publications, and early-stage incubation opportunities for entrepreneurs interested in building sustainable social enterprises that contribute to economic growth and society at large.

Implications for Policy, Leadership, or Practice

Recently, the Organization for Economic Co-operation and Development and France's Institute of Research for Development hosted a convening of higher education researchers, science policy experts, and development agencies to discuss the ways in which

colleges and universities can encourage, support, and capitalize on the research and innovation happening within institutions. They agreed that three of the most significant recent developments in academia are an internationalization of higher education and research, an increased reliance on performance-based funding, and a "new generation of policies for increasing returns from research to innovation."[5] Considering the ways in which learning environments and other physical resources such as makerspaces can engender innovation will be critical.[6]

Institutions and consortia that support and encourage cross-campus collaboration are well poised to launch and iterate on innovations in areas such as teaching and learning, student services, campus operations, and technology transfer. Institutions such as Carnegie Mellon University (CMU) have established offices solely dedicated to the latter. Its Center for Technology Transfer and Enterprise Creation (CTTEC) offers resources for university-affiliated entrepreneurs, provides legal guidelines for inventors on intellectual property and related topics, and facilitates negotiations for commercial tech transfer agreements—all while ensuring institutional compliance with regulations.[7] Over the past decade, 261 companies have been created through CTTEC: 158 indirect start-ups by faculty, students, and staff and 103 direct start-ups that licensed CMU-owned intellectual property through CTTEC.

Across many institutions, *employability* is a watchword, if not a driving force, to guide on-campus innovation centers as well as curricula, including student projects. At Falmouth University in the United Kingdom, photography students are already gaining experience with a new dimension of professional photography while still in the classroom: learning the intricacies of running a successful independent enterprise. As part of MAYN Creative, the university's agency, students receive critical feedback both internally and from external clients; as a result, they are learning how to incorporate changes and find solutions before entering the professional world as solopreneurs or small business owners. The institution has also begun forming collaborative partnerships with industry players that are seeking fresh talent. The benefits for students are a mix of intangible and substantial: they gain real-world experience within the "safe" zone of academia while earning compensation for their professional pursuits.[8]

For Further Reading

The following resources are recommended for those who wish to learn more about advancing cultures of innovation.

Crafting an Innovation Landscape
educau.se/craftinnov
(Shirley Dugdale and Brian Strawn, *EDUCAUSE Review*, February 13, 2017) The Innovation Landscape Framework can help coordinate physical planning with organizational initiatives, engage a wide range of stakeholders, and enable a culture of innovation across campus.

Higher Education and Silicon Valley: Connected But Conflicted
educau.se/stanfordprofs
(W. Richard Scott and Michael W. Kist, *Stanford News*, August 10, 2017) Two Stanford University professors explore the cultural and economic factors motivating these entities to collaborate.

How to Launch a Campus Innovation Center
educau.se/launchinnov
(David Rats, *Campus Technology*, February 17, 2016) This article offers elements to consider before getting too far into the process. (Hint: having a well-articulated mission and vision in place will be more important and provide more longevity than the novelty factor.)

How to Navigate Public-Private Partnerships in Higher Ed
educau.se/navpartner
(Rita Karma and Charles A. Goldman, *The RAND Blog*, May 26, 2017) A RAND Corporation study of 12 Texas public universities shows that large-scale online courses can generate income to support other important activities, such as graduate research.

The State of Digital Learning in Australia
educau.se/stateofdli
(Ashley Coolman, *Learning Design News—Smart Sparrow*, January 5, 2018) Australian universities are innovating in digital learning and successfully improving student outcomes along the way. The five dimensions of learning innovation laid the foundation of this research and report; the initial survey consisted of questions mapped to each dimension.

World Bank Higher Education Innovation Initiatives
educau.se/tertiedu
(Patricia da Camara, *Understanding Poverty*) The advent of and innovation in tertiary education can also serve to uplift economically depressed areas, and numerous projects aim to do so—among them, those led and financed by the World Bank.

Cross-Institution & Cross-Sector Collaboration

Long-Term Trend: Driving Ed Tech adoption in higher education for five or more years

According to the World Higher Education Database, there are more than 18,500 postsecondary institutions in 186 countries across the world.[9] Today's global environment, which is increasingly connected via technology, allows institutions to unite across international borders and work toward common goals concerning teaching and learning, research, and shared values. By forging partnerships, institutions facing financial constraints can pool their resources so that faculty and learners can access a larger variety of digital course materials, data, and technologies than might otherwise be unavailable locally. Increasingly, institutions are joining forces to combine their intellectual capital or to align themselves strategically with innovative efforts in the field. Cross-sector collaborations and partnerships are also becoming more common, with industry looking to institutions for research and development to solve pressing challenges and institutions looking to business to prepare students for the digitally focused workforce, aligning programs and degree pathways with industry needs.

Overview

Leaders across a variety of sectors are working together to form collaborative initiatives that connect postsecondary institutions with industry. Incorporating the viewpoints of a diverse set of stakeholders, including students and faculty, is critical to furthering research initiatives, improving learning experiences, and developing technological advancements to support the increasingly connected world. Likewise, cross-sector collaborations—particularly between industry and higher education—can equip students with the skills they need to keep pace with evolving workforce needs. Because these collaborations span local and international boundaries, technology is both a focus for innovation initiatives and the medium for facilitating successful collaboration. Further, education leaders are developing a new vision, referred to as the meso scale, that combines these two collaborative opportunities into practices that are "shared among institutions and between education and the private sector."[10]

Cross-institution collaborations often share resources to mitigate financial restraints and enact social change. *The Chronicle of Higher Education* highlights this concept of "networked universities" working together to reduce institution and student costs, and it outlines four factors for success: achieving buy-in from all leadership levels, identifying peer organizations, leveraging technology to facilitate key administrative services, and building faculty trust and confidence in the programs.[11] Technology has played a crucial role in enabling such collaborations. The Teagle Foundation conducted a three-year study across eight institutions to better understand how collaborative online learning platforms could offer high-quality, cost-effective liberal arts education. Findings indicated that structured collaboration to "redesign academic offerings with technology" yielded positive results at the institutional, faculty, and student levels in terms of lower cost and higher success rates.[12] The University of Hong Kong and the Education University of Hong Kong announced a joint initiative, Connect*Ed, that leverages popular social media applications to create dynamic virtual communities of learning where students share their experiences across a variety of health disciplines in efforts to advance cultures of professionalism through best practices.[13]

While cross-institutional collaborations focus on sharing high-quality—and often digitally enabled—resources to reduce costs, the impetus for cross-sector initiatives is two-fold: to develop students' skillsets to match those of the 21st-century workforce, and to use research and innovation centers on campus to generate and iterate new ideas. For example, the European Commission recently approved the +CityxChange program, which aims to develop sustainable technology-enabled solutions in efforts to create smart cities. The Norwegian University of Science and Technology will lead the project, which spans seven cities across Europe and combines efforts from 11 organizations, ranging from large enterprises to nonprofits to educational institutions.[14] Another notable cross-sector collaboration is the partnering of China's Peking University with the Germany-based pharmaceutical company Boehringer Ingelheim to advance research and spur medical discoveries at the forefront of science and technology.[15]

Implications for Policy, Leadership, or Practice

Although a variety of collaborations between higher education and industry have emerged, more-explicit frameworks and guidelines are needed to define how these partnerships should proceed to have the greatest impact. The need for this is clear in the many conferences devoted to creating and improving standards for optimal partnerships, including the Yes We Must Coalition National Conference, which focuses on cross-

institutional collaborations to scale efforts at degree attainment for underrepresented student populations[16]; Dalhousie University's workshop aimed at fostering cross-institutional collaboration throughout Nova Scotia by leveraging educational technology[17]; and the University-Industry Interaction Conference, which will convene more than 500 education leaders and policymakers in London to outline potential cross-sector collaborations between knowledge, financial, and start-up businesses.[18] One promising model stems from Africa's increased focus on producing 21st-century learners to build a "digital continent." The framework, Digital4Development (D4D) Public-Private Governance Model, identifies synergies across various sectors, including education, that can be modeled for effective policies within collaborations.[19]

With numerous collaborations coming to fruition and many more on the horizon, leaders across disciplines and sectors are developing pathways to foster growth, share best practices, and expand their reach. For example, two US-based educational leaders recently launched the Empirical Educator Project, which aims to identify potential cross-sector collaborations, align projects based on institutional needs and capabilities, and highlight the technology tools helping spur innovation to increase student success.[20] In addition, three Detroit universities have developed a consortium in the city's postsecondary education sector focused on increasing enrollment of underrepresented student populations and equipping them with the skills required to meet the local economy's needs.[21] Institutions are also working across international borders to advance change. The Japan-US Digital Innovation Hub is an ambitious partnership between 16 universities—eight in the United States and eight in Japan—that will create education projects aimed at developing the skillsets required to be successful in the digital age.[22]

The *Stanford Social Innovation Review* addresses the need for today's leaders to obtain and develop a skill-set from a variety of different sectors over the course of their professional careers; it also highlights the ability of postsecondary collaborations to begin developing these skillsets in students.[23] A notable example is Ravensbourne University London's cross-sector project, which emphasizes the benefits of collaborative projects for students and industry partners. By partnering academic teams with the university's Enterprise and Innovation Centre, teachers are able to embed industry-standard curriculum into the classroom, which allows students to gain real-world working experience by leading projects with actual clients. Additionally, industries benefit from the added client-relations management that students can provide; they can also encourage students to present new ideas and processes that are not yet stifled by the typical business culture, which can lead to untapped innovations in current systems.[24]

For Further Reading

The following resources are recommended for those who wish to learn more about cross-institution and cross-sector collaboration.

Bridging the Gap: Cross-Sector Collaboration for Skills Development
educau.se/bridgegap
(McGraw-Hill Education, October 11, 2017) The CEO of McGraw-Hill Education moderates a panel discussion that surfaces collaborations aimed at bridging the gap between the skills taught at postsecondary institutions and the skills needed by future employers.

Institutional Collaboration on MOOCs in Education—A Literature Review
educau.se/instcoll
(Anne-Mette Nortvig and René B. Christiansen, *International Review of Research in Open and Distributed Learning*, September 2017) This research explores the barriers and enablers for creating a national massive open online course program across Denmark.

Institutions' Use of Data and Analytics for Student Success: Results from a Landscape Analysis
educau.se/datastudent
(Amelia Parnell, Darlena Jones, Alexis Wesaw, and D. Christopher Brooks, NASPA–Student Affairs Administrators in Higher Education, 2018) As this report describes, three leading member-based associations conducted a survey to examine how student and institutional data could be used to make informed decisions for student success.

Museum-University Partnership Initiative
educau.se/mupimatch
(National Co-ordinating Centre for Public Engagement, 2018) During this two-year project, the Museum-University Partnership Initiative developed a matchmaking guide that identifies alignment for programs as well as funding to spur these types of collaborations.

Stronger Together: Increasing Connections Between Academic and Public Libraries
educau.se/collablib
(Maureen Richards, *Collaborative Librarianship*, July 11, 2017) This article shares the positive outcomes possible when academic and public libraries work together to share resources, and it highlights one easy solution: hyperlinking.

Supporting Postsecondary Success: Understanding the College Access and Success Landscape in Boston
educau.se/bostoncas
(Eliot Levine, Jill Capitani, and Sarah Young, The Boston Foundation, May 2018) This report showcases a well-executed, cross-sector collaboration between a Boston-based university, a nonprofit, and a national government agency aimed at increasing access to higher education.

Proliferation of Open Educational Resources

Mid-Term Trend: Driving Ed Tech adoption in higher education for the next three to five years

The Hewlett Foundation defines open educational resources (OER) as "high-quality teaching, learning, and research materials that are free for people everywhere to use and repurpose." OER gained momentum in 2001 when MIT founded the OpenCourseWare initiative,[25] making instructional materials for nearly 2,000 courses available free online. OER became an issue on the world political stage in 2012 with the adoption of the Paris OER Declaration,[26] which explicitly linked OER to the Universal Declaration of Human Rights, which states that "Everyone has the right to education." Adoption of OER has been driven largely by efforts to reduce the costs associated with higher education, though perhaps the most powerful potential outcome of OER is the opportunity for institutions to develop a broader set of investments in course development and infrastructure.

Overview

OER, which can be acquired by anyone, are part of a decades-old movement around open resources that are used at no cost and can be modified by anyone.[27] Just as the open-source and open-access communities seek to make certain work products freely available, the OER community aims to do the same for curricular materials. Adopting OER is an alternative to contracting with commercial publishers, whose textbook costs are frequently passed down to students. In contrast, OER are made available under open licenses, such as those from Creative Commons,[28] to ensure that they provide the "5R" legal permissions to users: the rights to retain, reuse, revise, remix, and redistribute the content. With OER, instructors have the freedom and flexibility to adapt materials to their specific local needs.

A primary driver of OER adoption is that they decrease textbook costs for students. From 2002 to 2012, textbook costs in the United States increased by 82 percent—triple the rate of inflation[29]; indeed, College Board estimates that, as of 2018, textbooks cost full-time undergraduates a minimum of $1,220 per academic year.[30] According to a 2014 US study, 65 percent of students said that they had not purchased an assigned textbook because it was too expensive, despite being concerned that not buying it would hurt their grade.[31] The European Commission's Joint Research Centre has developed a support framework for higher education institutions to reduce costs and other barriers to education.[32] The impact of widespread OER adoption can be magnified when embedded in an overall strategic direction for the institution. The adoption of OER presents an opportunity for instructors to rethink their pedagogies and for institutions to shape how teaching and learning is connected to the broader institutional strategy.[33]

OER encompass a wide range of materials, including full courses, course materials, modules, textbooks, videos, assessments, and software. Many OER repositories exist. Some institutions make versions of their course materials available as OER. Examples include the OpenCourseWare initiative and MERLOT, which offers peer-reviewed OER across a range of resource types, disciplines, and audiences.[34] Moving beyond individual courses, Lumen Learning offers collections of OER to support specific degrees,[35] and OpenStax continues to decrease student textbook costs with Rice University's open publishing initiative.[36]

Implications for Policy, Leadership, or Practice

The U.K.'s Open University was one of the earliest higher education institutions to adopt OER institution-wide, having launched the OpenLearn platform in 2006.[37] Many other institutions around the world have followed suit,[38] while projects such as OER Africa are promoting OER adoption across entire regions of the globe. Further, government policy has followed institutional policy in many regions. Europe has invested heavily in open education: In 2013, the European Commission unveiled the Opening Up Education action plan, which encompasses multiple dimensions of open education, including pedagogy, collaboration between individuals and institutions, leadership, strategy, and policy.[39] China has likewise integrated OER into government policy through the Ministry of Education's Chinese Quality Courses Project, which funds the development and maintenance of OER and mandates that teaching excellence awards consider OER development.[40] The United States lags on the policy front. In September 2017, the Affordable College Textbook Act was once again introduced in both the US House of Representatives and the Senate "to expand the use of open textbooks

in order to achieve savings for students" and establish a grant program under the Department of Education to create and expand OER use and require its evaluation. It is unlikely that ACTA will pass, however, as it has been unsuccessfully introduced to two previous Congresses.

In the United States, the OER Degree Initiative, led by Achieving the Dream, seeks to further accelerate OER adoption by redesigning courses and degree programs to use OER. In Europe, the European Commission's OpenEdu Project is increasing rates of adoption.[41] Among other goals, such projects aim to reduce costs for students and determine whether OER degree options enable students to complete more college credits and thus progress more quickly toward degrees. Regardless of who creates OER, however, sustainability is an issue; while OER may be free to use and reuse, *open* is not synonymous with *free*: OER, like anything else, entail costs for creation and distribution. Stephen Downes articulates several sustainability models for OER,[42] while David Wiley articulates several models for sustaining OER initiatives.[43] The CARE Framework builds on both to address how an individual, institution, or organization can be a good OER steward, by both developing OER and supporting others in doing the same.[44]

Some US institutions have heavily invested in building OER degree options, launching degrees with "zero textbook cost," or *Z-degrees*. In 2013, Tidewater Community College became the first accredited US institution to launch such a degree; after four academic years, the program has served 10,200 students, with total textbook cost savings of more than $1 million. Further, a smaller percentage of students dropped courses using OER compared to those using traditional textbooks, and a greater percentage achieved a grade of C or better in both face-to-face and online courses. Such initiatives are gaining traction as entire systems adopt OER. In 2016, the University System of New Hampshire launched a year-long open education initiative,[45] while in 2017 the New York state budget included $8 million to provide OER to students in the City University and State University of New York systems.[46]

For Further Reading

The following resources are recommended for those who wish to learn more about the proliferation of OER.

A Collaborative Approach to OER Policy and Guidelines Development in the Commonwealth: The Case of Botswana, Cameroon, and Sri Lanka
educau.se/collabpol
(Ishan Sudeera Abeywardena, Shironica P. Karunanayaka, Michael N. Nkwenti, and Lekopanye Tladi, OER Africa, 2018) One of many publications from OER Africa, this paper discusses the process of OER policy development across Botswana, Cameroon, and Sri Lanka.

Factors Influencing Open Educational Practices and OER in the Global South: Meta-synthesis of the ROER4D Project
educau.se/opened
(Cheryl Hodgkinson-Williams, Patricia Arinto, Tess Cartmill, and Thomas King, The Research on Open Educational Resources for Development project, 2017) This report synthesizes findings from multiple studies conducted by the Research on Open Educational Resources for Development (ROER4D) project over its five-year lifespan.

Launching OER Degree Pathways: An Early Snapshot of Achieving the Dream's OER Degree Initiative and Emerging Lessons
educau.se/degreepath
(Rebecca Griffiths et al., SRI International, 2017) Led by Achieving the Dream, the OER Degree Initiative seeks to boost college access and student success by supporting the redesign of courses needed for a degree using OER in place of proprietary instructional materials.

Opening the Textbook: Educational Resources in US Higher Education, 2017
educau.se/opentex
(Julia E. Seaman and Jeff Seaman, Babson Survey Research Group, 2017) This study found that while awareness and adoption of OER remains low among faculty in higher education, both show significant year-to-year increases.

Policy Approaches to Open Education—Case Studies from 28 EU Member States
educau.se/polopen
(Andreia Inamorato et al., European Union, 2017) This study provides the first-ever EU-wide overview of the state of play with policies on open education involving all 28 member states. The study provides a full account of each member state's understanding of open education and strategic policy approach.

Survey on Governments' Open Educational Resources (OER) Policies
educau.se/surveyoer
(Sarah Hoosen, UNESCO, 2012) This study is several years old but remains the most recent global data available on government OER policies, regional activity by education level, and funding.

The Rise of New Forms of Interdisciplinary Studies

Mid-Term Trend: Driving Ed Tech adoption in higher education for the next three to five years

Multidisciplinary approaches to higher education are being introduced by institutions that see valuable alternatives to a traditional, singular degree path. Faculty members, administrators, and instructional designers are creating innovative pathways to college completion through interdisciplinary experiences, nanodegrees, and other alternative credentials, such as digital badges. Researchers, along with academic technologists and developers, are breaking new ground with data structures, visualizations, geospatial applications, and innovative uses of open-source tools. Further, widespread social movements have opened up global conversations about gender, race, class, and politics, which have catalyzed efforts to support new disciplines. These emerging areas could lead to exciting new developments in education, but effective organizational structures must exist to support the collaborations.

Overview

One of the ways in which higher education is at a crossroads is the existential crisis with respect to some traditional disciplines, such as the humanities and history. The increasing interest in interdisciplinary studies offers one way to address the crisis: maintaining the relevance of traditional academic disciplines by fostering new and creative programs of study. Although the advantages of interdisciplinary studies might be self-evident, this trend does conflict with long academic traditions of specialization; interdisciplinary studies can be tenuous. The first in a series of studies on interdisciplinary study in higher education lists ten characteristics that are essential to successful interdisciplinary collaborations, at the top of which are leadership, management, and effective communication. The author warns that the "lack of 1 or more of these 10 characteristics is what causes many higher education [interdisciplinary] ventures to fail."[47] The article lists several organizations that are particularly effective in promoting interdisciplinary collaboration, such as the Association des États Généraux des Étudiants de l'Europe and the Interdisciplinary Research Group in Organizational Communication at the University of Ottawa, Canada.

Interdisciplinary studies could potentially solve many complex problems, including emergent issues on the fringes of science, mathematics, fine arts, and the humanities. The founding vision for Humboldt University of Berlin was the provision of a rounded, interdisciplinary experience for its students. Today, its leadership is experimenting with new teaching methods and academic modules such as Diversity of Knowledge, where students of different majors explore topics from multiple angles, as well as multidisciplinary student-led research teams designed to foster internal debate and critical inquiry.[48] Washington State University (WSU) announced major realignments in terms of combined personnel and resources. WSU's Department of Foreign Languages and Cultures will merge with its Department of Critical Cultures, Gender and Race Studies and its General Studies Humanities and Social Sciences programs to form an entirely new School of Languages, Cultures and Race. With this reorganization in place, undergraduate and graduate students will access courses addressing important current issues that provide in-demand skills and diversity training.[49]

This cross-pollination is also intended to encourage greater collaboration among faculty, staff, and researchers and to address the rapidly changing competencies students need to succeed in the world of work. If today's students will indeed hold a series of jobs throughout their career, as predicted by Argentinean and Nigerian education leaders, then an academic background that enhances their intellectual flexibility and adaptability will surely be an asset.[50] Creating an experiential curriculum (or permitting students to develop their own) offers myriad possibilities, as well as a new share of potential complications related to issues such as course scheduling and acquiring the requisite credits for graduation.

Implications for Policy, Leadership, or Practice

Today the STEMM disciplines (science, technology, engineering, mathematics, and medicine) are seeing dramatic increases in the number of majors and investment by institutions and foundations. But a report from the National Academies of Sciences, Engineering, and Medicine warns against hyperspecializing within these disciplines. A press release announcing the report asserts that an "emerging body of evidence" shows that STEMM integration with the humanities "is associated with positive learning outcomes that may help students enter the workforce, live enriched lives,

and become active and informed citizens."[51] Attesting to the growing interest in interdisciplinary studies, the National Academies' report also includes a 20-page compendium of more than 200 programs in the United States alone that are interdisciplinary by design.[52]

In a similar vein, Katherine Bergeron, the president of Connecticut College, recognized this need for interdisciplinary education when she noted that future professions will take graduates all over the world to work in industries that have yet to be defined.[53] The desire to adapt higher education to suit modern needs and challenges has led entire institutions, or schools situated within them, to reconsider their current structure. At Hiram College, a liberal arts school in Ohio, discussions about a sweeping redesign of the institution are under way. Among the proposals are to create new interdisciplinary majors in several fields, including fine, performing, and digital arts; crime and justice; and sports management. The institution cited the need to address "urgent challenges of our time" as a catalyst for these changes, which will impact its faculty positions and departments.[54]

Interdisciplinary studies and initiatives can happen at both the macro and micro levels within institutions. One model is an interdisciplinary center within a school, such as the Cukier, Goldstein-Goren Center for Mind, Cognition and Language at Tel Aviv University's Sagol School of Neuroscience. More than 160 researchers, representing disciplines such as life sciences, medicine, social sciences, exact sciences, education, humanities, and arts, are studying neuroscience and collaborating on a framework for teaching and research in the discipline.[55] The Applied Communication, Leadership, and Culture program at the University of Prince Edward Island is a new interdisciplinary undergraduate degree that expands the traditional liberal arts curriculum to include cultural awareness, visual communication, and workplace-generated projects to prepare undergraduates for a variety of careers.[56] At the micro level, faculty and students at Northeastern University have formed a new interdisciplinary lab, the Violence and Justice Research Laboratory, housed in the School of Criminology and Criminal Justice. The disciplines participating in the lab include psychology, criminal justice, sociology, public health, medicine, and social work.[57]

For Further Reading

The following resources are recommended for those who wish to learn more about new forms of interdisciplinary studies.

Challenge-Led Interdisciplinary Research Programs
educau.se/challenge
(Tamantha Stutchbury, Chris Gibson, Lorna Moxham, Clive Schofield, and Geoffrey Spinks, University of Wollongong, Australia, 2013) This white paper reports on challenge-led research programs as an innovative response to the need for a new approach to building interdisciplinary capacity.

A Conference on Interdisciplinary Social Science Studies That Spans Continents
educau.se/filelearn
The Academic International Conference on Interdisciplinary Social Science Studies (ICISSS) provides a platform for academics, practitioners, consultants, scholars, researchers, and policy makers of different backgrounds and experiences to present papers and share their experiences, new ideas, and research.

Interdisciplinary Education and the Student Voice
educau.se/interdisc
(Michael Hogan, *Psychology Today*, April 20, 2017) This blog addresses the need to better understand what it takes to be a good interdisciplinary practitioner. Reflecting the research of a new Bachelor in Arts and Sciences (BASc) at University College London, the author summarizes extensive interviews with students enrolled in this program, which launched in 2012.

Interdisciplinary Global Studies
educau.se/integcyb
(Daryl Bockett, *The International Journal of Interdisciplinary Global Studies*, 2018) The Conference on Interdisciplinary Social Sciences regularly publishes research in the form of submitted stand-alone articles and curated journals, which are geared toward a variety of disciplines.

Role of Interdisciplinary Studies in Higher Education in India
educau.se/indiahe
(Auditi Pramanik, *Journal of Education and Human Development*, June 2014) Published by the American Research Institute for Policy Development, this white paper explores the ways in which new hybridized courses of study have enabled the growth, expansion, and status of interdisciplinary academic inquiry as a field in its own right, and how that approach helps students broaden their disciplinary perspective and job opportunities.

The University of the Future Will Be Interdisciplinary
educau.se/futureuni
(Zahir Irani, *The Guardian*, January 2018) The author of this article argues that cross-disciplinary programs (where one field of expertise serves to inform another) and interdisciplinary programs (where the fields are integrated) enable more context-specific learning tailored to industry needs and job readiness.

Growing Focus on Measuring Learning

Short-Term Trend: Driving Ed Tech adoption in higher education for the next one to two years

This trend encompasses the interest in assessment and the wide variety of methods and tools that educators use to evaluate, measure, and document academic readiness, learning progress, and skill acquisition. As societal and economic factors redefine the skills needed in today's workforce, colleges and universities must rethink how to define, measure, and demonstrate subject mastery and soft skills such as creativity and collaboration. The proliferation of data-mining software and developments in online education, mobile learning, and learning management systems are coalescing toward learning environments that leverage analytics and visualization software to portray learning data in a multidimensional and portable manner.

Overview

According to a recent study by Georgetown University's Center on Education and the Workforce, the economy will have 165 million jobs by 2020 and 65 percent of them will require some form of higher education. Of the 55 million jobs that must be filled by 2020, 5 million requiring postsecondary credentials are estimated to go unfilled due to new job creation and Baby Boomers leaving the workforce. Although this may suggest a gap between qualified graduates and workplace needs, some instead posit a communications gap in learners' abilities to articulate what they have learned and connect it to workforce needs.[58]

So great is the need to measure learning and verify skills that a host of third-party providers have emerged to certify what individuals have learned and can do, regardless of where they obtained their skills.[59] This process measures learning and codifies it into competencies, thereby simplifying employers' ability to recruit qualified talent. Employers are increasingly seeking what is called the "T-shaped" graduate: the combination of deep vertical knowledge in a particular domain with a broad set of horizontal soft skills such as teamwork, communications, facility with data and technology, an appreciation of diverse cultures, and advanced literacy skills.[60] Institutions therefore need to assist faculty in measuring the learning that leads to skill development so that graduates can showcase and articulate the wide-ranging knowledge and skills they have developed both formally and informally via internships, study abroad programs, supplemental coursework, and so on.

The ability to measure learning supports competency-based hiring. To help learners develop proficiencies and skills, institutions are increasingly offering microlearning experiences and alternative credentials to document all forms of learning. A recent study of US colleges and universities found that 94 percent offer alternative credentials.[61] Southern New Hampshire University, for example, is building an assessment platform designed to map in-demand soft skills.[62] The University System of Maryland's Center for Academic Innovation is developing digital microcredentials to help students showcase their knowledge and demonstrate their career readiness.[63] As a broader example, the Education Design Lab has partnered with 12 institutions and more than 50 employers to develop learning experiences and microcredentials supporting soft-skill development such as critical thinking, collaboration, and resiliency.[64] The creation of granular learning experiences and the increased documentation of learning and skills via alternative credentials indicates a larger trend toward measured learning and personalization.

Implications for Policy, Leadership, or Practice

A shift in postsecondary credentialing is taking place. Although there are more than 4,000 certifying bodies in the United States, only 10 percent are accredited.[65] To the extent that accreditation continues to be valuable in the future, higher education institutions are still in the best position to certify knowledge and make transparent the skills learners gain from their experiences. The need for increasing transparency necessitates the transformation of the traditional transcript. This new transcript would capture a broad range of learning experiences from multiple institutions, perhaps including factors such as research, service learning, internships, study abroad, badges, and co-curricular achievements—along with discrete competencies and outcomes—to better represent what students have learned and are capable of doing.[66]

Given this move toward greater measurement of learning and evidence-based skills, students should understand the knowledge and skills they will gain before they begin and eventually complete a learning experience of any kind. To this end, platforms are emerging, such as Connecting Credentials, with universal taxonomies that help learners and employers make sense of and compare the value of all postsecondary creden-

tials.[67] Workcred is another example of a system that helps both learners and employers understand how particular credentials translate into competencies and applicable skills.[68] These platforms and frameworks are still in their infancy, but they point to a shift toward measured and outcome-based learning in support of adult and lifelong learners who need agility, quality, and transparency in their learning experiences.

Royal Melbourne Institute of Technology (RMIT) is developing RMIT Creds through its 21CC Initiative to complement and enhance its traditional programs, providing the skills and capabilities industry has requested and graduates need. RMIT Creds has two delivery models: its open access model offers a diverse portfolio of microcredentials, adaptable to multiple careers and open to all, while its *embedded model* exists within its formal programs. RMIT Creds is being developed to provide a more integrated, seamless way for students to acquire critical skills and personal attributes tailored to a particular career choice. Moving forward, the 21CC initiative will work more broadly across RMIT to develop microcredentials to fulfill the breadth of industry capabilities and skills identified for the future workforce.[69] Another example is Grading Soft Skills (GRASS), a European lifelong learning project in which eight educational institutions from four countries are working together to award badges for soft skills. For example, students at the University of Belgrade who took a Java programming course on a voluntary basis could earn badges for collaboration and communication skills as well as for hard skills such as programming in Java.[70] In the United States, students in the Illinois State University Honors Program can showcase their accomplishments—including academic excellence, research, and leadership—on their transcripts.[71] Oregon Tech Online currently offers more than 20 microcredentials in health care and information technology and may expand to other assessment-based offerings, including exams, awards, and the successful completion of coding boot camps.[72] In 2014, Harvey Mudd College began offering microcredentials to students who participate in scientific and high-performance computing workshops and have demonstrated certain levels of competency in programming in environments such as Matlab and Mathematica.[73]

For Further Reading

The following resources are recommended for those who wish to learn more about the growing focus on measuring learning.

10 Things We've Learned from 21st Century Skills Badging
educau.se/learnbadg
(Education Design Lab, June 2017) Education Design Lab shares findings from its 21st Century Skills Badging Challenge, including results of its pilot, which included more than 300 university students and 50 employers.

Credentials Reform: How Technology and the Changing Needs of the Workforce Will Create the Higher Education System of the Future
educau.se/credref
(Jamie Merisotis, *EDUCAUSE Review*, May 2016) This article summarizes the shift in postsecondary credentialing and the needs of the 21st-century workforce; it also discusses how colleges and universities can be positive agents in supporting this change.

Demographic Shifts in Educational Demand and the Rise of Alternative Credentials
educau.se/demoshift
(Jim Fong, UPCEA; Peter Janzow, Pearson; and Kyle Peck, Penn State University, 2016) This research explored the role that alternative credentials play in higher education as reported by 190 institutions, including community colleges, baccalaureate colleges, masters' colleges or universities, and doctorate-granting universities.

Royal Melbourne Institute of Technology (RMIT) 21CC (Micro-credentialing) Project
educau.se/rmit
(Royal Melbourne Institute of Technology, July 2018) RMIT is a global university of technology, design, and enterprise with a proud 130-year history of partnering with industry to develop educational experiences. RMIT developed a leading role within the digital credentialing community both nationally and internationally.

SURFnet Whitepaper on Open Badges and Micro-Credentials
educau.se/enmicro
(SURFnet, 2016) In 2016, SURFnet's Open and Online Education project studied the opportunities that badges might offer in Dutch higher education, which served as the foundation for this white paper on open badges and microcredentials.

Today's Comprehensive Record: An Evolutionary Case Study
educau.se/comprec
(Rodney Parks and Jesse Parrish, *EDUCAUSE Review*, July 2017) Models for curricular gains—including badges, certificates, competencies, and experiential transcripts—become more accessible and valuable. This article discusses the expansion and evolution of the academic transcript.

Redesigning Learning Spaces

Short-Term Trend: Driving Ed Tech adoption in higher education for the next one to two years

As universities engage with strategies that incorporate digital elements and accommodate more active learning in the physical classroom, they are rearranging physical environments to promote these pedagogical shifts. Educational settings are increasingly designed to support project-based interactions with attention to greater mobility, flexibility, and multiple device usage. To improve remote communication, institutions are upgrading wireless bandwidth and installing large displays that allow for more natural collaboration on digital projects. Some are exploring how mixed-reality technologies can blend 3D holographic content into physical spaces for simulations, such as experiencing Mars by controlling rover vehicles, or how they can enable multifaceted interaction with objects, such as exploring the human body in anatomy labs through detailed visuals. As higher education continues to move away from traditional, lecture-based lessons toward more hands-on activities, classrooms are starting to resemble real-world work and social environments that foster organic interactions and cross-disciplinary problem solving.[74]

Overview

According to widespread research and several meta-analyses, active learning is the most effective mode for learning.[75] Internationally, higher education has embarked on an evolutionary path away from reliance on the lecture to active learning engagements—a shift visible in the design of its learning spaces. The diffusion of active learning practices is mirrored in the rapid growth of the active learning classroom (ALC) in higher education. Attendance at ALC-related events has increased significantly, and EDUCAUSE research identified the ALC as the top strategic technology for 2017.[76] Together with makerspaces, ALC designs increasingly promote coursework that helps learners discover, invent, solve problems, and create knowledge.

A study at Seattle Pacific University suggests that a course conducted in an ALC increases student engagement and also motivates instructors to engage in more active learning.[77] Another study conducted at Iowa State University investigated how learning space design can impact learner engagement. The study found that removing the spatial barrier between learner and instructor is a key ingredient of active learning engagements and that flexibility and openness were important factors in promoting a community of learners.[78] As part of the 4TU project in the Netherlands, four technical universities—Eindhoven, Twente, Delft, and Wageningen—are aiming to develop expertise in engineering education, including by integrating makerspaces into the curriculum.[79] An Eastern Kentucky University research project studied student usage patterns in learning spaces to determine natural "hot spots"— locations in a room's design that learners use most heavily for specific course activities.[80] The variety of options in a campus library often can allow nuanced spaces.

As promising as the new learning space technologies are, some studies caution against over-reliance on them. These studies suggest that learning in classrooms that are equipped with the basics of moveable furniture and copious writing surfaces often can be on par with the learning in high-end, technology-laden ALCs. Moreover, the complexities of learning space technology itself can discourage faculty adoption of ALCs and even impose impediments. Given the significant costs associated with building and maintaining high-end ALCs, most institutions can outfit only a small portion of their classrooms in this manner. This has prompted discussion around issues of access equity and led to proposals for an alternative in the form of *learning-ready classrooms*. Such classrooms are equipped with basic, affordable active learning technologies that institutions can implement in more classrooms.[81] Leaders in learning space design can take these discussions as a starting point for developing an institutional learning space master plan that includes various ALC designs and diffuses active learning engagements as widely as possible.

Implications for Policy, Leadership, or Practice

Several tools are available to assist institutions with learning space policies, as well as with managing strategic and tactical aspects of learning spaces. The Learning Space Rating System is a set of criteria for scoring a classroom's design with respect to its support for active learning.[82] FLEXspace is an international collection of detailed examples of learning spaces.[83] Examples of toolkits for learning space design include the U.K. Higher Education Learning Space Toolkit[84] and North Carolina State University's Learning Space Toolkit.[85] McGill University has published its own guidelines for designing teaching and learning spaces.[86]

Resources such as these can assist with the creation of learning space master plans, which in turn can promote the alignment of learning space designs with an institution's overall strategic priorities.

Successful leadership in learning space development requires a holistic approach. On one hand, research indicates that the design of learning spaces impacts instructor and learner perceptions and engagement levels and can lead to gains in learning outcomes.[87] However, learning space design alone does not guarantee better learning outcomes. Unless the course designs are explicitly adapted to take advantage of the room, outcomes may fall short of expectations. Further, students unfamiliar with ALCs and active learning practices may even resist them.[88] To succeed in adopting and implementing these practices, an institution's teaching culture must evolve.[89] Even when using an ALC, much depends on the instructor. Ultimately, the goal of greater learner achievement results from a confluence of factors beyond classroom design, including instructor development, tailored course design, and ongoing student support.

To maximize flexibility and ease of use, learning space technology is becoming fully wireless, supported by wireless projectors and roving mobile devices.[90] Experimentation is also under way with voice activation for learning space technology, often using off-the-shelf products such as Alexa to leverage a room's technology through a natural language interface.[91] Institutions and vendors are already experimenting with the integration of extended reality (XR) technologies—that is, virtual, augmented, and mixed reality—into learning spaces to support both individual and team learning.[92] XR applications span the range of academic disciplines. Dynamic Anatomy is a project at Leiden University and the Leiden University Medical Center to explore the application of virtual reality in medical education.[93] Visual display walls, which are similar to XR technology, are becoming a standard part of learning space strategy at various institutions. Examples include Indiana University's IQ-Wall[94] and Georgia State University's interactWall, which lets students examine close-up images of human organs and take 360-degree tours of Mayan archaeological sites. Stanford University has equipped one of its spaces with a synthetic acoustic system consisting of 40 hanging microphones and 76 speakers to support both class-wide discussion and small group work.[95]

For Further Reading

The following resources are recommended for those who wish to learn more about redesigning learning spaces.

Educational Equity and the Classroom: Designing Learning-Ready Spaces for All Students
educau.se/eduequity
(Maggie Beers and Teggin Summers, *EDUCAUSE Review*, May 7, 2018) The authors advocate for a universal design approach to learning spaces, arguing that high-end ALCs are typically expensive and account for only 2–5 percent of the classrooms on a campus. As an alternative, they make the case for ubiquitous "learning-ready" spaces that support the needs of all students.

FLEXspace
educau.se/flexspac
FLEXspace is an open and international collection of detailed examples of learning spaces. Each learning space description may contain classroom details, floor plans, photos, and the room's LSRS score.

A Guide to Teaching in Active Learning Classrooms: History, Research, and Practice
educau.se/activclas
(Paul Baepler, J.D. Walker, D. Christopher Brooks, Kem Saichaie, and Christina I. Peterson, Stylus Publishing, 2016) This book offers a thorough treatment of ALC-related teaching topics and challenges, such as managing student resistance and convincing students that working in an ALC is beneficial.

Journal of Learning Spaces
educau.se/jourls
(University of North Carolina at Greensboro) This open, peer-reviewed journal—which is published biannually by the UNCG library—includes research reports, position pieces, case studies, and book reviews and addresses all aspects of learning space design, including operation and pedagogy.

Learning Space Rating System (LSRS)
educau.se/lsrs
(EDUCAUSE) The Learning Space Rating System (LSRS) project provides a set of measurable criteria to assess how well a classroom's design supports and enables active learning. The LSRS credits form the basis for a rating system that will allow institutions to benchmark their environments against best practices in the higher education community.

The U.K. Higher Education Learning Space Toolkit
educau.se/lspace
(Universities and Colleges Information Systems Association) This document offers a thorough treatment of learning space design in higher education and is written, as the authors describe, "from the point of view of the professional support services who play a key role in such projects."

Significant Challenges Impeding Technology Adoption in Higher Education

The six challenges described on the following pages were selected by the project's expert panel in a series of Delphi-based cycles of discussion, refinement, and voting; the expert panel was in consensus that each is very likely to impede the adoption of one or more new technologies if unresolved.

Because not all challenges are of the same scope, the discussions here are sorted into three categories defined by the nature of the challenge. The Horizon Project defines solvable challenges as those that we both understand and know how to solve; difficult challenges are ones that are more or less well-understood but for which solutions remain elusive; and wicked challenges, the most difficult, are categorized as complex to even define, and thus require additional data and insights before solutions will be possible. Once the list of challenges was identified, they were examined through three meta-expressions: their implications for policy, leadership, and practice. Below are summaries of the six significant challenges that will be explored more in-depth in this section, with citations and resources included.

Solvable Challenges: Those that we understand and know how to solve

Authentic Learning Experiences

Authentic learning experiences that connect students with real-world problems and work situations are still not pervasive in universities. *Authentic learning* is an umbrella term for several important pedagogical strategies that seek to immerse learners in environments where they can gain highly practical, lifelong learning skills; these strategies include vocational training, apprenticeships, scientific inquiries, and course projects situated in the community. Additionally, advocates of authentic learning underscore the importance of metacognitive reflection and self-awareness as cornerstones. An increasing number of institutions have begun bridging the gap between academic knowledge and concrete applications by establishing relationships with the broader community; through active partnerships with local organizations, learners can experience the future that awaits them outside the campus.

Improving Digital Literacy

The use of technology encompasses 21st-century practices that are vital for success in the workplace and citizenship. Digital literacy transcends gaining discrete technological skills to generating a deeper understanding of the digital environment, enabling intuitive and discerning adaptation to new contexts and co-creation of content. Institutions are charged with developing students' digital citizenship, promoting the responsible and appropriate use of technology, including online communication etiquette and digital rights and responsibilities in blended and online learning settings. This expanded concept of digital competence is influencing curriculum design, professional development, and student-facing services and resources. Due to the multitude of elements of digital literacy, higher education leaders must obtain institution-wide buy-in and provide support for all stakeholders in developing these competencies. Frameworks are helping institutions assess current staff capabilities, identify growth areas, and develop strategies to implement digital literacy practices.

Difficult Challenges: Those that we understand but for which solutions are elusive

Adapting Organizational Designs to the Future of Work

Increasing attention is being paid to the organizational structure of colleges and universities to better align them with the practices of the 21st-century workplace. Technology, shifting information demands, and evolving faculty roles are forcing institutions to rethink the traditional functional hierarchy. Institutions must adopt more flexible, team-based, matrixed structures to remain innovative and responsive to campus and stakeholder needs. At Ithaka S+R, researchers are beginning a new study to examine the effect of academic organizational structure on decision-making. The findings from this project have implications for institutions' structures and policies. In order to adapt, higher education institutions are examining flexible designs, but they often face steep learning curves and resistance among staff.

Advancing Digital Equity

This challenge was introduced in last year's Horizon Report, with a particular focus on accessibility to broadband internet. In 2017, UNESCO reported that 41

percent of the population in developing countries was online. Further, a 2018 International Telecommunication Union report stated that all 47 least-developed countries "have launched 3G services and over 60% of their population are covered by a 3G network." Although this advancement in internet access is crucial to fostering digital equity, other barriers have surfaced. A lack of high-speed internet, disproportionate access based on socioeconomic status and gender, and recent legislative decisions have hampered progress. Efforts to mitigate these issues are necessary to promote full participation, communication, and education within global society. This challenge directly impacts education because online learning is enabled by high-speed internet access. Furthermore, the bring your own device (BYOD) movement has widened the access gap because not all students have the technology—smartphones, tablets, and laptops—needed to participate.

Wicked Challenges: Those that are complex to even define, much less address

Economic and Political Pressures

Higher education faces a crossroads in sustainability. A spate of collapses for both for-profit and nonprofit institutions in the past two years is calling into question traditional economic models. Some colleges and universities are unable to provide adequate financial aid, which is critical for bolstering enrollment and making education attainable for underserved communities. Further, federal policy shifts are threatening key sources of funding; for example, tightening immigration policies could translate into a decrease in international students—a key population for some institutions. With faculty and researchers unable to depend on government-funded grants as a source for devising progressive programs and exploring emergent themes, support from corporations and private foundations is more important than ever. However, such partnerships must be nurtured in ways that lead to real student success. External pressures are also requiring institutions to rethink learning paradigms.

Rethinking the Roles of Educators

Educators are increasingly expected to employ a variety of technology-based tools, such as digital learning resources and courseware, and engage in online discussions and collaborative authoring. Further, they are tasked with leveraging active learning methodologies such as project- and problem-based learning. This shift to student-centered learning requires instructors to act as guides and facilitators. Adding to this challenge is the evolution of learning through the rise of competency-based education, which further customizes the academic experience to students' needs. As these technology-enabled approaches gather steam, many institutions are rethinking the primary responsibilities of educators. Related to these shifting expectations are the implications of societal changes and evolving faculty models, in which an increasing percentage of classes are being taught by non-tenure-track instructors.

The following pages provide a discussion of each of the challenges highlighted by this year's expert panel, including an overview of the challenge, its implications, and a set of curated recommendations for further reading on the topic.

Authentic Learning Experiences

Solvable Challenge: Those that we understand and know how to solve

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Overview

A growing amount of learning takes place outside traditional institutional venues. Learning of course continues to happen in class meetings, laboratory sessions, and study in the library. Today, however, learning increasingly comes through job-shadowing initiatives and study-abroad programs; through project-based learning with industry and start-ups; and via on-site apprenticeships, virtual internships, and capstone projects for external clients. Such activities are often a key element of authentic learning. Authentic learning is active and experiential, and it can provide students with many of the skills they need when they enter the world of work. Further, it shows students the real-world impact that their academic work can have. For example, the University of Buenos Aires offers extension projects that link academic studies to the community. These projects help students develop critical thinking and reflective capacities, as well as see the direct impact of their decisions and subsequent actions.[96]

Course experiences situated in real-world contexts can provide students with the intellectual momentum needed in a growing job market. In the United States, more than six million jobs currently remain unfilled, while across Asia, youth unemployment, underemployment, and job dissatisfaction are on the rise.[97] In addition, most African countries are facing shortages of human resources and capacity in science, technology, engineering, and mathematics, as well as in agriculture and health disciplines, as the continent's current pattern of skills production does not match labor market demand or development needs. A lack of investment in high-quality facilities and human resources also remains a significant obstacle.[98] Authentic learning has the potential to shrink these gaps by equipping students with the knowledge and skills needed in today's workplace.

For students, authentic learning augments theory to offer a glimpse into the world of work and a concrete idea of how they might fit within it. Authentic learning can take place early in a student's academic career to complement in-class instruction, or it can serve as part of a professional's midcareer pivot. Through internships, apprenticeships, and job-shadowing scenarios, students are trained or mentored and often earn a stipend or college credit. Simultaneously, they have the flexibility to explore interdisciplinary fields—such as game design, neuromarketing, and informatics—or try out specific roles without having to commit to a full-time engagement. Many companies and higher education institutions recognize the mutual benefit of partnerships; those in industry offer various programs as a means for building their talent pipelines and giving back to the broader community, while academics and students can gain access to leading experts, state-of-the-art facilities, and new methods being tested in practice. These relationships are available to institutions of various types and sizes. A recent report from the American Enterprise Institute asserts that, with the right strategies in place, community colleges "may be able to provide the widest on-ramp to expanding apprenticeships."[99]

Implications for Policy, Leadership, or Practice

In 2017, the U.K. government introduced the Apprenticeship Levy to change the way apprenticeships are funded and to ultimately meet an ambitious goal to create three million apprenticeships by 2020. These authentic learning experiences provide students with a university-level qualification and employment experience while sharing the cost of education with employers.[100]

Learning by doing is a key tenet of authentic learning

and figures prominently in education frameworks such as the Lumina Foundation's Degree Qualifications Profile[101] and the Association of American Colleges and Universities' LEAP initiative.[102] Such programs help educational leaders to evaluate new or restructured programs' affordability, as well as their capability to provide high-quality learning for all students—including those historically underserved by higher education.[103] In many industrialized nations, shorter technical programs that incorporate authentic learning experiences also tend to reduce dropout rates and increase labor participation. In countries such as the United States, Germany, Sweden, and Switzerland, dual programs that combine on-the-job apprenticeships with technical or vocational training have led to youth labor participation rates between 50 and 65 percent.[104] Another example is found at the University of the Western Cape in South Africa, which sets the foundation for students' authentic learning in perpetuity, as becoming a lifelong learner is one of the three "graduate attributes" that all students are expected to attain.[105]

The trend toward incorporating authentic learning experiences into degree programs continues to grow globally as institutions are pressured to compete for prospective students. This incorporation may involve embedded experiences within a program's curriculum. For example, at Kinneret College, an institution in Israel, upperclassmen can enroll in an elective tourism management course that allows them to assist in the administration of a Mediterranean cruise. According to Dr. Uzi Freund-Feinstein, "We want our students to have a firsthand experience of the elements that are drawing increasingly younger consumers into one of the highest growth categories in tourism."[106] Although the students have the same accommodations as regular passengers, they also participate in operational meetings with the ship's dining, housekeeping, engineering, marketing, and sales staff—and they are graded on presentations and field reports that articulate their experiences.

For Further Reading

The following resources are recommended for those who wish to learn more about fostering authentic learning experiences.

Authentic e-Learning in Higher Education
educau.se/desprin
(Jan Herrington, University of Wollongong, 2006) This paper argues that e-learning technologies afford the design and creation of truly innovative authentic learning tasks in higher education environments. The paper also includes a framework outlining 10 elements of authentic tasks.

Innovative Colleges That Give Students Real-World Experiences
educau.se/innovcol
(KQED Mindshift excerpt from Nikhil Goyal's book *Schools on Trial*, 2017) Innovative colleges often share particular characteristics, including small class sizes; a focus on interdisciplinary, seminar, and project-based classes; close contact between professors and students; and opportunities for students to do apprenticeships, real-world projects, or research for credit.

University-Industry Collaboration in Science and Technology in Kuwait and the United Arab Emirates
educau.se/unind
(Rebecca Stern, Afreen Siddiqi, Laura Diaz Anadon, and Venkatesh Narayanamurti, Belfer Center for Science and International Affairs, Harvard Kennedy School, 2017) This policy brief provides new insights into the current state of and future opportunities for strengthening university-industry collaboration in science and engineering in the Persian Gulf; it also presents key findings and policy recommendations.

Vanderbilt Center of Teaching: Extending Learning Outside the Classroom
educau.se/teachoutsi
(Lily Claiborne, John Morrell, Joe Bandy, and Derek Bruff, Vanderbilt University Center for Teaching) From the collaborative learning atmosphere that results as relationships develop outside the classroom to the deep learning that occurs when students practice in the real world what they have theorized about at their desks, field experiences are unmatched in the learning potential they offer.

Why Companies and Universities Should Forge Long-Term Collaborations
educau.se/compunicoll
(Kenneth R. Lutchen, *Harvard Business Review*, 2018) Industry and academia stand to benefit from long-term cooperation; companies gain greater access to cutting-edge research and scientific talent at a time when corporate R&D budgets are increasingly under pressure, and institutions gain access to financial support and research partners at a time when government funding is shrinking.

Work-Based Learning in the States
educau.se/workblearn
(Pat Steele and Anne Kilzer, webinar, National Skills Coalition) This webinar provides an overview of the Work-Based Learning Toolkit and a federal policy update. The presenters also discuss apprenticeship initiatives in their states.

Improving Digital Literacy

Solvable Challenge: Those that we understand and know how to solve

The use of technology encompasses 21st-century practices that are vital for success in the workplace and citizenship. Digital literacy transcends gaining discrete technological skills to generating a deeper understanding of the digital environment, enabling intuitive and discerning adaptation to new contexts and co-creation of content.[107] Institutions are charged with developing students' digital citizenship, promoting the responsible and appropriate use of technology, including online communication etiquette and digital rights and responsibilities in blended and online learning settings. This expanded concept of digital competence is influencing curriculum design, professional development, and student-facing services and resources. Due to the multitude of elements of digital literacy, higher education leaders must obtain institution-wide buy-in and provide support for all stakeholders in developing these competencies. Frameworks are helping institutions assess current staff capabilities, identify growth areas, and develop strategies to implement digital literacy practices.

Overview

Digital literacy is complex and ever-changing, relevant to all disciplines. It impacts how information is taught, learned, and shared, and it shapes both the technical and social skills needed to succeed. Academic experiences are increasingly influenced by the ways in which students discover, gather, and use the information they encounter. This creates challenges in terms of institutional innovation and resource allocation, and it also ushers in opportunities to prepare students for knowledge work, which is increasingly accomplished online. In its 2017 report *Digital Literacy in Higher Education, Part II*, the NMC explained how digital literacy is a top priority for higher education, citing a World Economic Forum prediction that by 2020, "35% of the skills considered vital for workplace success will have changed. […] Fields such as robotics, autonomous transportation, biotechnology, and genomics call for skill sets that revolve around a blend of technical savvy, creativity, and complex thinking." [108]

In a recent speech at the U.K. Department of Education's inaugural Skills Summit, Secretary of State for Education Justine Greening explained that U.K. businesses will need approximately 1.2 million new digitally skilled workers by 2022. When considered on a global level, this need represents a call to action for colleges and universities in countries with larger or expanding economies. Those institutions that have made digital literacy and technology a priority will thrive, according to Robin Ghurbhurun, principal and CEO of Richmond upon Thames College and a Jisc Board of Trustees member.[109]

The growing importance of digital literacy is documented in the results of the EDUCAUSE Learning Initiative's annual Key Issues survey, in which digital literacy leaped from 11th in the 2016 survey to 3rd in 2017 (and was 5th in 2018).[110] Despite its growing importance, it remains a complex topic that can be challenging to pin down. Vanderbilt University established an ad hoc group of faculty, administrators, and staff that created a working definition of digital literacy on campus and produced a white paper recommending how to implement digital literacy to advance the university's mission.[111]

Implications for Policy, Leadership, or Practice

As digital literacy becomes increasingly important in higher education, initiatives to promote it need explicit definition and support. Those served by higher education also recognize the need for improved digital literacy and articulate where colleges and universities may be falling short. In its report *Student digital experience tracker 2017: the voice of 22,000 U.K. learners*, Jisc showed that 80 percent of higher education students felt that digital skills are important in their respective careers; however, only half indicated that their courses are preparing them to enter the digital workplace. Jisc Chief Executive Paul Feldman said, "The full benefits of technology to support learning are yet to be realized, with technology more commonly used for convenience rather than to support more effective pedagogy."[112] In its 2017 student and faculty studies, EDUCAUSE determined that higher education has a good way to go in adequately promoting literacy. One finding was that "only half of faculty agreed or strongly agreed that their students are prepared to use institutionally specific technology," and another was that "only 25% of students said that they ask their instructors, and only 6% ask their teaching assistants, for technology support for school-related activities."[113]

At most campuses, the library has long been in the forefront of issues such as information literacy. Recently, some libraries are recasting this issue in terms of the broader, more encompassing framework of technical facility, information literacy, and digital creativity. In 2018, the Virginia Tech University Libraries launched a framework for digital literacy to empower learners to "navigate the complex digital world as both consumers and creators, enabling them to achieve their personal, academic, and professional goals."[114] The library at the University of Queensland in Australia also developed a strategic framework for information and digital literacy that is shaping the university's academic policies and practices. Overall, university leaders recognize librarians' potential to serve as digital facilitators, connectors, and collaborators.[115]

To further advance digital literacy skills, higher education institutions are working to make them a part of formal curricula. Librarians at the University of Western Cape in South Africa recently used the Association of College and Research Libraries' Framework for Information Literacy to create an online tutorial that facilitates collaboration between librarians and instructors in developing curricula to help students to better use digital resources.[116] The University of Edinburgh in Scotland has developed a self-paced course, "23 Things for Digital Knowledge," that helps students develop digital and online skills through experimentation and application.[117] Singapore Management University (SMU) hosted a "Digital Literacy Day" where a panel of academic and industry experts discussed current job trends and ongoing efforts to develop a digitally competent workforce, starting at the postsecondary level.[118] Yet some faculty members have cautioned that digital literacy isn't secured solely through a degree program. "Students cannot completely rely on obtaining such skills from their universities," said Swapna Gottipati, assistant professor of information systems at SMU. "They need to go and get skills from other places—through internships, projects, workshops, or additional short courses."[119]

For Further Reading

The following resources are recommended for those who wish to learn more about digital literacy.

4 Things to Consider When Teaching Digital Literacy to College Students
educau.se/4thidiglear
(Laura A. Pasquini, EdTech, 2017) With so much emphasis on educating postsecondary students about digital literacy, there are many details to consider with regard to which materials and modes to use in teaching it. Laura Pasquini shares several insights in this article, including that it's critical to start with broad topics and let the conversations and questions flow from there.

Can a New Approach to Information Literacy Reduce Digital Polarization?
educau.se/digipol
(Jeffrey R. Young, EdSurge, 2018) Michael Caulfield, director of blended and networked learning at Washington State University in Vancouver, Washington, has created a manual for higher education institutions to use in teaching students how to discern propaganda from reputable information. This article examines the pros and cons within the subcategory of information literacy.

Developing the Digital Literacies of Academic Staff: An Institutional Approach
educau.se/digilit
(Barbara Newland and Fiona Handley, *Research in Learning Technology*, 2017) To get a handle on the complexities of digital literacy, the University of Brighton in the U.K. has created a Digital Literacies Framework (DLF) to help guide its academic staff. The DLF outlines 38 literacies, which are divided into four categories, and includes research demonstrating where they've succeeded and where work still needs to be done.

Empowerment, Experimentation, Engagement: Embracing Partnership Models in Libraries
educau.se/emexenem
(Brian Mathews, Stefani Metko, and Patrick Tomlin, *EDUCAUSE Review*, 2018) Gone are the days when university libraries were limited to housing books and periodicals and librarians were disconnected from institutional academia. This article shows how today's libraries and librarians are contributing to preparing students for life beyond higher education.

Information Literacy Model for Higher Education Institutions in India
educau.se/infolit
(Swapna G. and B. S. Biradar, *International Journal of Digital Library Services*, 2017) This paper addresses information literacy challenges and opportunities that India's higher education institutions are facing as they prepare their students to meet the demands of an increasingly digital age.

Adapting Organizational Designs to the Future of Work

Difficult Challenge: Those that we understand but for which solutions are elusive

Increasing attention is being paid to the organizational structure of colleges and universities to better align them with the practices of the 21st-century workplace. Technology, shifting information demands, and evolving faculty roles are forcing institutions to rethink the traditional functional hierarchy. Institutions must adopt more flexible, team-based, matrixed structures to remain innovative and responsive to campus and stakeholder needs. At Ithaka S+R, researchers are beginning a new study to examine the effect of academic organizational structure on decision-making. The findings from this project have implications for institutions' structures and policies. In order to adapt, higher education institutions are examining flexible designs, but they often face steep learning curves and resistance among staff.

Overview

The traditional structure of higher education has been upheld across nearly a thousand years of geographical and cultural borders and through centuries of societal, economic, and political change.[120] Some higher education officials argue that the need for reliance on the traditional hierarchy has become obsolete because of the internet and unprecedented challenges that higher education faces today.[121] Colleges and universities are finding new ways to integrate faculty from distance and interdisciplinary programs, incorporating a variety of teaching and learning models and mediums, introducing new schools through on-campus mergers or new constructs, and offering more-flexible degree paths and credential options. They're doing so as a means to break the "iron triangle" of postsecondary affordability, quality, and access. They're also making changes to prepare for a "new age" of lifelong learning by incorporating cloud-based software and other technologies—such as social networks, mobile computing, and big data—that are helping create digital learning ecosystems that serve lifelong learners.[122]

Organizational leaders are approaching change management in a variety of ways. Access to data has made business structures more transparent and, in some cases, has further democratized decision-making to ensure that staff, faculty, and leadership have a voice. According to leaders from the U.K.'s University of Surrey, King's College London, and Open University, this approach can help postsecondary institutions be more inclusive, develop future strategies, and improve their graduate outcomes.[123] Attempts to avoid bureaucracy also align with a streamlined workforce and cost elimination. Emphasis has been placed on designing better business models through a stronger focus on return on investment. This involves taking a strategic approach that connects financial practice (such as analyzing cost metrics and resource allocation) with institutional change models and goals.[124]

Recent research described in the report *Competency-Based Education: A Study of Four New Models and Their Implications for Bending the Higher Education Cost Curve* demonstrates the opportunity that focusing on competencies offers institutions to "break away from traditional, higher-cost instruction models that have proven resistant to change."[125] A few postsecondary institutions, such as Purdue University, Alliant International University, and Rasmussen College, have created college benefit corporations. These represent an alternative business model that "could help colleges adapt to rapid changes and pressures being imposed on the sector."[126]

Implications for Policy, Leadership, or Practice

Faculty roles have been and continue to be impacted by organizational change, as well as by broader economic movements. Reflective of today's "gig economy," two-thirds of faculty members are now non-tenure, with half working part-time, often in teaching roles at several institutions. This stands as a stark contrast to 1969, when almost 80 percent of faculty were tenured or tenure-track; today's figures are nearly inverted. Their wages are applying pressure to traditional organizational structures. Indeed, data from the American Community Survey suggest that 31 percent of part-time faculty are living near or below the federal poverty line. This growing contingent workforce of independent contractors and adjunct instructors is putting pressure on institutions to provide better working conditions, including job security, career mobility prospects, health care, and other benefit considerations,[127] and even to change academic spending patterns.[128] Rethinking tenure programs represents another change to organizational designs that aligns with the future of work. At the University of British Columbia, the revised promotion and tenure guide encourages the creation and use of open educational resources (OER). Pre-

tenure faculty can now receive formal recognition in promotion and tenure for engaging in OER activities.[129]

Organizational structures are continuing to evolve on the administrative side as well. With an emphasis on supporting student success, many institutions are rethinking their student services, which include financial aid, academic advising, and work-study programs. Much of this change is happening within the context of *digital transformation*, an umbrella term that denotes the transformation of an organization's core business to better meet customer needs by leveraging technology and data. Academic advising—one of the structures of higher education hierarchy projected to continue its evolution—is one area in which institutions are experimenting with new models.[130] This work is also evident through the Integrated Planning and Advising for Student Success (iPASS) cohorts, which support tech-enabled advising with funding from the Bill & Melinda Gates Foundation.[131] Other student-centered focus points that impact both faculty and administrative personnel include working with faculty and programs to convert courses to flipped and blended models; providing a variety of online learning options so students have enough courses to choose from at key points in their academic career; using technology to monitor student progress and success metrics and execute intervention protocols; and partnering with industry to provide digital badges and certificates to enhance career opportunities.[132]

At the March 2017 General Assembly of the German Rectors' Conference, a number of resolutions echoed the ways in which decision-making serves as a key differentiator of the higher education system—specifically, how competition between institutions demands more effective leadership structures. "This [competition] creates tension between local and central structures, and consequently the potential for conflict." Given this, an institution's administration "plays an overarching role that is indispensable for the support processes," and decision-making should occur at both the local and central levels.[133]

For Further Reading

The following resources are recommended for those who wish to learn more about adapting organizational designs to the future of work.

7 Things You Should Know about Leading Academic Transformation
educau.se/7thingslat
(EDUCAUSE Learning Initiative, 2015) Higher education's teaching and learning mission is under significant pressure, and colleges and universities are exploring a reorientation around learner success through new course models, learning space designs, and ways of assessing academic progress. Factors include a focus on stakeholder-centered design, relevance of credentials, and the strategic use of technology.

The Future of Work and What It Means for Higher Education
educau.se/futurwork
(Jeffrey J. Salingo, Workday, 2017) The changing workplace and dual economic threats of automation and the gig economy are necessitating a shift in the purpose and structure of higher education, which must evolve in order to sufficiently equip students for a future of self-directed learning.

Infographic: The Evolution of Student Success
educau.se/evolss
(Ed Venit, EAB infographic, 2016) Since student success emerged as a priority in the middle of the 20th century, the structure and models involved have undergone a number of evolutions. Fifty years ago, "student success" referred primarily to student engagement; today it has come to include the first-year experience, degree planning and progress, career development, and much more. This infographic charts how the definition of student success has evolved through six "eras" and ten practice areas over time.

Rethinking and Researching Transformation in Higher Education: A Meta-Study of South African Trends
educau.se/rrtransf
(Petro du Preez, Shan Simmonds, and Anne H. Verhoef, AOSIS Publishing, 2016) This meta-analysis of more than a thousand articles focusing on transformation in South Africa's postsecondary landscape reveals specific approaches and contexts that have influenced how the nation conceptualizes, explores, and researches the topic of change management and adaptation in higher education.

Seven Principles for Effective Change Management
educau.se/effectch
(Deloitte, 2016) Effective transformation requires an institution-wide approach to improve and enhance organizational models, operating processes, technology, leadership, and talent models. This article offers seven steps colleges and universities can take to deliver more desirable outcomes.

Advancing Digital Equity

Difficult Challenge: Those that we understand but for which solutions are elusive

This challenge was introduced in last year's Horizon Report, with a particular focus on accessibility to broadband internet. In 2017, UNESCO reported that 41 percent of the population in developing countries was online. Further, a 2018 International Telecommunication Union report stated that all 47 least-developed countries "have launched 3G services and over 60% of their population are covered by a 3G network."[134] Although this advancement in internet access is crucial to fostering digital equity, other barriers have surfaced. A lack of high-speed internet, disproportionate access based on socioeconomic status and gender, and recent legislative decisions have hampered progress. Efforts to mitigate these issues are necessary to promote full participation, communication, and education within global society. This challenge directly impacts education because online learning is enabled by high-speed internet access. Furthermore, the bring your own device (BYOD) movement has widened the access gap because not all students have the technology—smartphones, tablets, and laptops—needed to participate.

Overview

The rise of the internet revolutionized how technology is used. While institutions have integrated digital devices into teaching and learning practices, access to and comfort with these tools are uneven. In this context, *digital equity* refers to equal access to technology, as well as to educators who have the training to implement digital solutions. According to the National Digital Inclusion Alliance, the focus of access has shifted from the availability of broadband infrastructure to "the adoption of a residential broadband connection."[135] Although internet access is still not evenly distributed, countries within Central Africa and Southern Asia report some of the highest adoption rates.[136] A number of countries have reported higher education attainment rates through digital learning solutions, like massive online courses (MOOCs) and open educational resources (OER).[137] So, while internet penetration has increased significantly, providing global high-speed internet remains a crucial component of this equity challenge, and it must be addressed.

Digital equity also encompasses tool implementation and an understanding of tool use. For learning tools to be effective, educators must have access to adequate and ongoing training and professional development—before instructors can help students navigate tools for consumption and creation, they must be digitally fluent themselves. The time and financial commitments for these opportunities pose roadblocks for many institutions. Further, a deeper dive into the student-aged populations reveals a significant gap in usage based on gender, with a higher percentage of male users than female users globally.[138] Technology plays an important role in advancing higher education availability for underrepresented student populations and ensuring the accessibility of web materials for students with disabilities. According to a Connected Learning Alliance report, digital inequities correlate to the economic status of both learners and institutions—highly affluent educational institutions often use technology in more progressive ways, and OER disproportionately benefit these schools.[139]

Advancing digital equity is a quintessential social justice issue that impacts both developing nations and underrepresented groups throughout the world. In the United States, net neutrality protections—defined as ensuring that internet service providers offer equal access to all content[140]—has been at the forefront of many political debates. Prior to the rollback of regulations that upheld net neutrality,[141] many leaders in higher education opposed that move on the grounds that the consequences will disproportionately affect community colleges and smaller institutions that lack the financial resources to ensure their content is prioritized online. Additional concerns include the inability to leverage technologies to provide higher education opportunities to anyone, in any location, exacerbating the digital divide.[142]

Implications for Policy, Leadership, or Practice

The expansion of technology access, in terms of adoption across a variety of sectors, has been unparalleled. This growth has outpaced the creation of formal policies to ensure equal access. However, countries are leveraging online and blended learning as one way to increase access and advance digital equity. For example, Malaysia's higher education system and its government's efforts to democratize access to it have grown significantly, in part because the government developed a blueprint that highlights blended learning environments as avenues to increase "enrollment and

completion rates for those from disadvantaged social backgrounds."[143] Digital solutions have also been identified to support postsecondary students with disabilities. Canada's OCAD University Open Research Repository published a report that defines disabilities in the context of formal education and cites a variety of research-supported guidelines aimed at improving access.[144]

Education leaders are exploring the effects of bolstering digital equity within formal learning systems, predicting achievable outcomes and identifying lingering challenges. Studies are investigating how advancing digital equity can help close the achievement gap in academic performance between groups of students.[145] Other research cites various social, cultural, and political aspects that bar access for marginalized populations and necessitate better strategic planning.[146] In Australia, one report viewed digital inequity through the lens of an especially disenfranchised group—incarcerated students. As many aspects of education continue to move online, rules blocking prisoner access to the internet persist. This inhibits prisoners' ability to receive a postsecondary education, which is a crucial factor in decreasing recidivism. The study of incarcerated students takes the concept of access a step further, emphasizing the need for education leaders to incorporate marginalized student populations into their existing and future pedagogies.[147]

While well-defined solutions do not yet exist, many institutions are advancing digital equity through programs and pilots. The New School, a New York–based university, has developed a Digital Equity Laboratory that aims to address persistent structural inequities within technology. The laboratory is intended to serve as an accelerator for innovative policy, practice, and research to develop practical opportunities that promote equitable models of digital access.[148] Massive open online courses (MOOCs) are another avenue to advancing digital equity by increasing distance learning opportunities. The book *Routledge International Handbook of Schools and Schooling in Asia* reports that "low- and middle-income populations make up 80% of MOOC users."[149] Indira Gandhi National Open University rolled out 11 free MOOCs in 2017, with plans to release over 40 more courses and broadcast 32 television channels comprised of educational programming for university students.[150]

For Further Reading

The following resources are recommended for those who wish to learn more about advancing digital equity.

Achieving Equity in Higher Ed
educau.se/achieveq
(Ruth Simmons et al., Postsecondary Success, March 26, 2018) This podcast episode shares five educators' perspectives on strategies to advance equity in and beyond higher education.

How Is Technology Addressing the College Access Challenge? A Review of the Landscape, Opportunities, and Gaps
educau.se/techadd
(Pullias Center for Higher Education and Get Schooled, 2018) For students, the first step toward degree completion is navigating the complex application process. This report reviews technology applications that have contributed to closing the college opportunity gap.

Information Communication Technology in the Educational System of the Third World Countries as a Pivotal to Meet Global Best Practice in Teaching and Development
educau.se/icted
(Akarowhe K, *American Journal of Computer Science and Information Technology*, December 29, 2017) This article highlights the need for digital learning solutions to increase educational opportunities in developing countries and outlines the benefits, hindrances, and possible solutions.

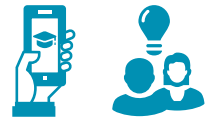
Internet Access and Education: Key Considerations for Policy Makers
educau.se/intacc
(Internet Society, November 20, 2017) This Internet Society briefing tasks policymakers with developing guiding frameworks to ensure that technology-enabled pedagogies improve the quality of education for all learners.

Training Instructors to Use Tech Tools
educau.se/traininst
(Amy Rottmann and Salena Rabidoux, *Inside Higher Ed*, July 26, 2017) Two higher education leaders share strategies on how to better prepare teachers to incorporate educational technology into teaching and learning practices.

University System of Maryland Gives 21 Grants to Promote Open-Source Textbook Use
educau.se/usmtext
(Michael Brice-Saddler, *The Diamondback*, April 9, 2017) The University System of Maryland allocated 21 mini-grants to its state universities to expand OER in an effort to lower costs and increase access to otherwise expensive learning materials.

Working Group on Education: Digital Skills for Life and Work
educau.se/digskil
(UNESCO, September 2017) This report explores the role of education in advancing digital equity as the rise of technology and ICT adoption in a majority of sectors continues to move the needle toward a "digital society."

Economic and Political Pressures



Wicked Challenge: Those that are complex to even define, much less address

Higher education faces a crossroads in sustainability. A spate of collapses for both for-profit and nonprofit institutions in the past two years is calling into question traditional economic models.[151] Some colleges and universities are unable to provide adequate financial aid, which is critical for bolstering enrollment and making education attainable for underserved communities. Further, federal policy shifts are threatening key sources of funding; for example, tightening immigration policies could translate into a decrease in international students—a key population for some institutions.[152] With faculty and researchers unable to depend on government-funded grants as a source for devising progressive programs and exploring emergent themes, support from corporations and private foundations is more important than ever.[153] However, such partnerships must be nurtured in ways that lead to real student success. External pressures are also requiring institutions to rethink learning paradigms.

Overview

Institutions across the world have felt the pain of insufficient resources, while enrolled and prospective students suffer in the face of rising tuition. The US Department of Education's National Center for Education Statistics reports that the number of financial aid–eligible colleges and universities declined by 5.6 percent between 2015–16 and 2016–17, the fourth consecutive decrease since 2012.[154] Many Australian universities are vocalizing concerns after the government announced significant cuts to higher education, a 7.5 percent tuition increase, and a questionable performance-based funding stream. Among the spending cuts being considered are those to research grants and programs that provide aid to low-income students.[155] Regional campuses are being hit especially hard, with 15 percent of anticipated funding being frozen.[156] In Great Britain, Brexit is raising concerns that potentially stricter visa policies will create barriers for international students and thus problems for local institutions already struggling with student demand. Further, the costs associated with conducting research, which is critical for economic innovation, have surpassed what tuition covers.[157]

The dimensions of this challenge are nuanced by the location, history, and business model of each institution, yet the common denominator is that colleges and universities across the board are feeling financial pressures while pursuing missions to ensure affordable education. Forging partnerships to recoup costs can cause institutions to make political decisions based on requests from funders rather than on proven institutional needs. When the University of Oklahoma partnered with the History Channel to provide a new online introductory history course, questions arose about whether the history department was consulted in the process, and several faculty members argued the course's substance and approach did not meet or raise the current value of the history degree.[158] The course was quietly eliminated two years later. Although there is much potential for industry–higher education partnerships, they must be designed and implemented in ways that yield authentic and measurable student gains.[159]

Of course, innovation and partnerships are luxuries in war-torn countries, where education is secondary to a focus on survival. Many refugees who fled Syria and Iraq, for example, now reside in the European Union and countries where local governments and institutions are devising accessible and affordable education strategies. Germany's Kiron University launched a crowdfunding campaign to support the tuition-free enrollment of refugees in five different degree tracks. Meanwhile, the World University Service of Canada places refugees in universities across the country with funding from grants and student unions.[160] The Prime Minister of Malaysia recently announced that the country would become an inclusive education hub for refugees who are willing to relocate there or who have access to online courses.[161]

Implications for Policy, Leadership, or Practice

During periods of economic tumult, policy changes are more likely to directly impact the affordability of higher education because tuition rates and caps are often associated with governmental response to student debt. In the United States, the American Association of State Colleges and Universities reports that a national slowdown in state tax revenues is prompting many policymakers to slash or reconsider investments in higher education, raising issues such as performance-based funding and dual enrollment.[162] Institutions are exploring alternative avenues for reducing costs, including adopting open educational resources.[163] In

a number of European countries, policymakers have ensured tuition-free enrollment at public institutions, sparking a flurry of interest from international students. The Norwegian government has done so, deeming higher education a vital stimulant for the health of the national economy.[164] Further, Iceland's Student Innovation Fund enables students to gain real-world experience working with institutions and companies on research projects.[165]

Institutional leaders are finding creative ways to circumvent budget challenges, such as pooling resources around technology, research, and innovation agendas.[166] A transatlantic partnership between Arizona State University and Dublin City University is leading to a growing body of research on and applications for Internet of Things technologies, including the development of smart stadiums as a precursor to smart campuses.[167] Australia and Singapore formed the Comprehensive-Strategic Partnership to deepen cooperation on education programs.[168] Their forthcoming 2018 Innovation Festival will feature hackathons and workshops that convene university students, researchers, scientists, and others from both countries to collaborate on building science and business initiatives.[169]

Despite economic downturns, institutions are finding solutions to support innovation among faculty, staff, and students. For example, in 2017, George Washington University pledged to expand agreements between corporations and faculty as a solution to competition for federal funding. Subsequently, a professor was awarded a $5.3 million grant with a patent company to investigate plasma-based cancer treatment.[170] Oxford University champions opportunities for its community to start new businesses. Oxford University Innovation has raised more than £500 million in external investments, while its Startup Incubator has nurtured 70 Oxford University entrepreneurial ventures since 2011, including DeepReason.ai, "a Knowledge Graph Management System that can integrate seamlessly with various enterprise, and public, data sources to perform fast and intelligent reasoning."[171]

For Further Reading

The following resources are recommended for those who wish to learn more about the economic and political pressures confronting higher education institutions.

177 Private Colleges Fail Education Dept.'s Financial-Responsibility Test
educau.se/177priv
(Chris Quintana and Joshua Hatch, *The Chronicle of Higher Education*, 2017) With 112 nonprofit and 65 for-profit institutions failing the latest US Department of Education test for financial responsibility, questions arise about institutions' operational strategies. However, the scoring methodology has been met with mixed feelings.

The Decline of the Midwest's Public Universities Threatens to Wreck Its Most Vibrant Economies
educau.se/midpub
(Jon Marcus, *The Atlantic*, 2017) This article articulates concerns over a lack of adequate federal funding for university research, which has been declining in the United States since 2008. As this article highlights, state universities in the Midwest receive significantly less in endowment money than major private institutions, even though they enroll more students.

From Status Quo to Status Go: Scaling Innovation in Higher Ed
educau.se/scalinno
(Vincent Del Casino Jr., *The Evolllution*, 2018) This article's author, a VP of academic initiatives and student success, refutes the narrative that higher education does not adapt to the continuous shifts in political climate. He posits that innovation and creative change are more common in institutions than typically perceived.

The High Human Costs of Defunding State Universities
educau.se/defustat
(Seth Sandronsky, *Capital & Main*, 2017) Leaders and practitioners from the California State University system convened at the state capitol to discuss and bring greater visibility to the funding issues plaguing its institutions and hampering faculty and student success.

South Africa Embraces Free Higher Education, But Concerns Remain
educau.se/saembr
(Ellie Bothwell, *Times Higher Education*, 2018) More than 90 percent of South African households are being promised free education, but institutional leaders express anxiety over the program's lack of sustainability; they also worry that the process to manage registration has yet to be fine-tuned.

Struggling Universities Will be Shut Down, Not Saved—It's Not Fair for Students
educau.se/struguni
(Gillian Evans, *The Guardian*, 2018) This article details the complex relationship between government and higher education in the U.K. While regulators may perceive shutting down institutions as an important weeding out process, the students enrolled in defunded universities become victims to lost recognition of learning.

Rethinking the Roles of Educators

Wicked Challenge: Those that are complex to even define, much less address

Educators are increasingly expected to employ a variety of technology-based tools, such as digital learning resources and courseware, and engage in online discussions and collaborative authoring. Further, they are tasked with leveraging active learning methodologies such as project- and problem-based learning. This shift to student-centered learning requires instructors to act as guides and facilitators. Adding to this challenge is the evolution of learning through the rise of competency-based education, which further customizes the academic experience to students' needs. As these technology-enabled approaches gather steam, many institutions are rethinking the primary responsibilities of educators. Related to these shifting expectations are the implications of societal changes and evolving faculty models, in which an increasing percentage of classes are being taught by non-tenure-track instructors.

Overview

Academic titles such as professor of biology, assistant professor of linguistics, and adjunct instructor of political science may communicate specific subject-matter expertise, but they fail to capture the breadth of knowledge needed to effectively educate current college and university students. In their service to the teaching and learning mission, faculty are increasingly expected to serve as learning architects, guides and facilitators, and assessment specialists.[172] They are expected to understand and employ the latest technological tools for learning, teaching, and assessment in interactive classrooms; work with a variety of course models, including face-to-face, blended, flipped, and online learning; and nurture in their students skills such as critical thinking for evolving professional careers.

Postsecondary educators have always been expected to structure current information into a curriculum and make it interesting for all students. But never has the role demanded a heightened level of technological expertise and a sense of mounting pressure to attract, teach, and retain students who are bombarded by countless digital distractions via mobile devices. An article in the *Baraton Interdisciplinary Research Journal* addresses how information and communications technology (ICT) is shifting traditional teaching methods in academia; it concludes that "teachers should make a paradigm shift in their roles as knowledge experts to a learning facilitator, since their ICT-savvy students have a lot to share with each other and their teachers."[173] As educators rethink their roles, perhaps one of the biggest shifts is a willingness to more fully embrace the realities of teaching virtually. Indeed, some faculty have sought not only to embrace digital learning but to humanize it. For example, some are exploring various uses of technology that incorporate hand-drawn elements into online lectures,[174] while others are portraying characters to bring ancient languages to life.[175] Still others are taking advantage of virtual reality, such as health program faculty members who are using it to put students in the position of patients.[176]

As the working world changes, so too must the roles of educators and higher education continue to evolve. Diane Harrison, president of California State Northridge, suggests that higher education has only begun its efforts to reinvent itself.[177] In the U.K., university faculty members are collaborating with industry professionals to develop degree apprenticeships that will better connect higher education to technical skills and employment.[178] In addition to changing how classes are taught, technology has added a more complex dynamic to the faculty-student relationship. Universities and colleges stress that faculty members should have a more personal connection with their students. Today, text messages, websites, email, instant messaging, and social media have led to a new landscape in which faculty are always accessible and visible to their students. While this appears to be a plus for students and parents looking to ensure faculty attention and accessibility, it places further demands on educators to seemingly always be on call.[179]

Implications for Policy, Leadership, or Practice

Educators must position themselves to respond to rapid changes in technology and its impact on teaching. In her research, University of Nigeria Professor Grace Offorma examined what universities must do to support the goals of Sustainable Development. This focus begins with rethinking university teaching, including everything from institutions' organizational structure, to curricula, methods, and instructional media. According to Offorma, "It requires a teaching process that is action-oriented, [involves] reconstruction of knowledge and active participation of learners with appropriate resource materials."[180]

Faculty members' evolving roles naturally involve the medium through which they teach; how dramatically this shifts also impacts institutions at large. Wawasan Open University in Malaysia was established in 2006 to offer working Malaysians access to quality higher education via open distance learning. With its foundation in distance learning, WOU hosted a roundtable workshop in 2016 for education experts to look deeper into new forms of teaching, learning, and assessment in an interactive world. WOU Professor Santhiram Raman said, "Online learning, flexible learning, mobile learning, OERs and MOOCs, collaborative platforms supporting peer-to-peer learning and co-creation of knowledge supported by learning analytics are some of the interesting developments of our time that could lead to transformational changes in the way higher education institutions conduct their core activity and view the scope of their markets."[181] For example, technologies such as lecture capture systems mitigate the need for faculty to revisit challenging content during class time, as recordings are available online and can sometimes be augmented with supporting resources for challenging concepts.[182]

As educators' roles have been transformed by new methods, media, and modalities, students' drive to enroll in online classes has heightened, signaling a shift toward virtual teaching. A 2018 Babson Survey Research Group report showed that between fall 2015 and 2016, the number of students enrolling in at least one online class increased by 5.6 percent, growing again this year to mark 15 consecutive years of enrollment increase.[183] Nevertheless, interest in the face-to-face dimension remains strong. The 2017 ECAR studies of undergraduates and faculty found that student and faculty preferences regarding learning environments are closely aligned, with 79 percent of students and 71 percent of faculty expressing preference for hybrid course models.[184] These studies further suggest that faculty remain interested in increasing engagement with options and technologies, including collaboration tools, video and media, and open educational resources (OER).

For Further Reading

The following resources are recommended for those who wish to learn more about rethinking the roles of educators.

5 Trends Poised to Shake Up Higher Education in 2018
educau.se/5trenshak
(Autumn A. Arnett, Education Dive, 2018) See what one higher education industry expert sees as the top factors that will shape colleges and universities this year and what it means for educators, students, and higher education institutions as a whole.

International Trends in Higher Education 2016–17
educau.se/trendglob
(International Strategy Office, Oxford University, 2017) This in-depth report from Oxford University addresses worldwide developments and changes in higher education. Specifically, it investigates changes that impact "international student mobility, international research collaborations, the relationship between universities and governments, rankings, and international expansion in the form of branch campuses."

It's Official—Higher Education Students Want Staff to Be Better with Digital, Not to Use More of It
educau.se/bettdigi
(Tabetha Newman and Helen Beetham, Jisc, 2017) When it comes to using digital resources and technology in the classroom and beyond, teachers and staff need to up their game. This is according to the 22,000 students surveyed, who indicated that they don't necessarily need more technology—they want instructors to better understand and use the tools they already have.

Knowledge for Professional Learning
educau.se/knowpl
(Institute of Educational Technology, The Open University) The Institute of Educational Technology highlights its research on professional learning, which has impacted higher education institutions in the U.K. and internationally. This article also offers insights into the students enrolled in MOOCs and the faculty who teach them.

Rethinking Higher Education and Its Relationship with Social Inequalities: Past Knowledge, Present State, and Future Potential
educau.se/socineq
(Theocharis Kromydas, Palgrave Communications, 2017) The issues of social justice and inequality are topics that have risen to points of people's interest, conversations, and actions. This research delves into these issues as they pertain to higher education and the roles it can play in making a difference in educating people of all economic backgrounds.

Rethinking Higher Education for Thailand 4.0
educau.se/thaihe
(Prompilai Buasuwan, *Asian Education and Development Studies*, 2018) Thailand 4.0, a policy adopted by the Royal Thai Government, was intended to foster creativity, innovation, inclusivity, and sustainability. This research discusses the key challenges and gaps that higher education institutions in Thailand are facing in following the policy's implementation.

Important Developments in Educational Technology for Higher Education

The six developments in educational technology detailed in this section were selected by the project's expert panel using the Horizon Project's Delphi-based process of iterative rounds of study, discussion, and voting. In the NMC Horizon Project, educational technology is defined in a broad sense as tools and resources that are used to improve teaching, learning, and creative inquiry. While many of the technologies considered were not developed for the sole purpose of education, they have clear applications in the field.

The technology developments that the members of the expert panel agreed are very likely to drive technology planning and decision-making over the next five years are sorted into three time-related categories—near-term developments that are expected to achieve widespread adoption in one year or less; midterm developments that will take two to three years; and far-term developments, which are forecasted to enter the mainstream of education within four to five years. Each technology development opens with an overview of the topic.

The initial list of topics considered by the expert panel was arranged into categories that were based on the primary origin and use of the technology. The potential applications of the featured technologies, specifically in the context of global higher education, were considered in a series of online discussions by the expert panel.

The expert panel was provided with an extensive set of background materials when the project began that identified and documented a range of existing technologies used in education and other areas. The panel was also encouraged to consider emerging technologies whose applications for higher education institutions may still be distant. The panel also proposed developments in technology that were new to the NMC Horizon Project; a key criterion for the inclusion of a new topic in this edition was its potential relevance to teaching, learning, and creative inquiry in higher education.

In the first round of voting, the expert group reduced the master set, shown on the next page, to 12 developments in technology that were then researched in much greater depth by the NMC staff. Each was then written up in the format of the NMC Horizon Report and used to inform the final round of voting. Technology developments that do not make the interim results or the final report are often thoroughly discussed. Sometimes a candidate technology does not get voted in because the expert panel believes it is already in widespread use in higher education, or, in other cases, they believe it is more than five years away from widespread adoption. Some technology developments, while intriguing, do not have enough credible project examples to substantiate them.

A key criterion for the inclusion of a new technology development in this edition was its potential relevance to teaching, learning, and creative inquiry in higher education.

There are currently seven categories of technologies, tools, and strategies. These are not a closed set but rather are intended to provide a way to illustrate and organize technologies into pathways of development that are or may be relevant to learning and creative inquiry. The list of seven categories has proven fairly consistent, but new technologies are added within these categories in almost every research cycle; others are merged or updated. Collectively, the categories serve as lenses for thinking about innovation; each is defined below.

> **Consumer technologies** are tools created for recreational and professional purposes and were not designed, at least initially, for educational use—though they may serve well as learning aids and be quite adaptable for use in colleges and universities. These technologies find their ways into institutions because people are using them at home or in other settings.

> **Digital strategies** are not so much technologies as they are ways of using devices and software to enrich teaching and learning, whether inside or outside the classroom. Effective digital strategies can be used in both formal and informal learning; what makes them interesting is that they transcend conventional ideas to create something that feels new, meaningful, and 21st-century.

> **Enabling technologies** are those technologies that have the potential to transform what we expect of our devices and tools. The link to learning in this category is less obvious, but this group of technologies is where substantive technological innovation begins to be visible. Enabling technologies expand the reach of our tools, making them more capable and useful.

> **Internet technologies** include techniques and essential infrastructure that help make the technologies underlying how we interact with the network more transparent, less obtrusive, and easier to use.

> **Learning technologies** include both tools and resources developed expressly for the education sector, as well as pathways of development that may include tools adapted from other purposes that are matched with strategies to make them useful for learning. These include technologies that are changing the landscape of learning, whether formal or informal, by making it more accessible and personalized.

> **Social media technologies** could have been subsumed under the consumer technology category, but they have become so ever-present and so widely used in every part of society that they have been elevated to their own category. As well-established as social media technologies are, they continue to evolve at a rapid pace, with new ideas, tools, and developments continually coming online.

> **Visualization technologies** run the gamut from simple infographics to complex forms of visual data analysis. What they have in common is that they tap the brain's inherent ability to rapidly process visual information, identify patterns, and sense order in complex situations. These technologies are a growing cluster of tools and processes for mining large data sets, exploring dynamic processes, and generally making the complex simple.

The following pages provide a discussion of the six technology developments highlighted by the 2018 Higher Education Expert Panel, who agree that they have the potential to foster real changes in education, particularly in the development of progressive pedagogies and learning strategies, the organization of teachers' work, and the arrangement and delivery of content. As such, each topic includes an overview of the technology; a discussion of its relevance to teaching, learning, or creative inquiry; and curated project examples and recommendations for further reading.

Consumer Technologies
> Drones
> Real-Time Communication Tools
> Robotics
> Wearable Technology

Digital Strategies
> Games and Gamification
> Location Intelligence
> Makerspaces
> Mind Uploading
> Preservation and Conservation Technologies

Enabling Technologies
> Affective Computing
> Analytics Technologies
> Artificial Intelligence
> Dynamic Spectrum and TV White Spaces
> Electrovibration
> Flexible Displays
> Media Production Technologies
> Mesh Networks
> Mobile Broadband
> Natural User Interfaces
> Near Field Communication
> Next Generation Batteries
> Open Hardware
> Software-Defined Networking
> Speech-to-Speech Translation
> Virtual Assistants
> Wireless Power

Internet Technologies
> Bibliometrics and Citation Technologies
> Blockchain
> Digital Scholarship Technologies
> Internet of Things
> Next Generation LMS
> Syndication Tools

Learning Technologies
> Adaptive Learning Technologies
> Microlearning Technologies
> Mobile Learning
> Online Learning
> Virtual and Remote Laboratories

Social Media Technologies
> Crowdsourcing
> Online Identity
> Social Networks
> Virtual Worlds

Visualization Technologies
> 3D Printing
> GIS/Mapping
> Information Visualization
> Mixed Reality
> Video Walls
> Virtual Reality

Analytics Technologies

Time-to-Adoption Horizon: One Year or Less

A growing focus on measuring learning is an accelerating trend in educational settings, and analytics technologies are the cornerstone. This category of technologies encompasses a diverse array of tools and applications that turn data into information. Data are the currency of the digital economy driving the information age, in which finding ways to collect, connect, combine, and interpret data to more clearly understand learner capabilities and progress can fuel personalized and adaptive learning experiences.[185] In the past 20 years, measuring student learning has evolved from passive and latent metrics including semester/quarter grades, grade-level promotion, and graduation rates to interactive and real-time metrics that recommend adjustments to meet learners' needs and inform faculty decisions about curriculum and pedagogy.[186] Understanding how to use new data tools and developing analytic skills, including data literacy, computational thinking, and coding, is essential for faculty and students to advance the understanding and use of big data in educational settings.

Overview

Consumer technologies and services have long embraced collecting and analyzing user data to improve customer experiences and increase efficiency. Higher education's early forays into analytics generally concerned administrative processes and since then have spread to include learning analytics focused on student success. The vast data collected by institutional systems can be used to track student activities, behaviors, performance, and interests to tell a story about individual learners' experiences. Analytics can benefit areas including students' time to degree, learning outcomes, recruitment, alumni relationship management, and research productivity.[187] Analytics technologies can move colleges and universities from having a surplus of data but a deficit of information to being able to make data-informed, research-based decisions for students and for the institution. As analytics tools and capabilities increase, an area of growing concern are the ethical issues surrounding the ways data are used.[188]

The principle underlying analytics is similar for education and commercial pursuits—examining large amounts of data, looking for correlations and patterns that would otherwise be difficult or impossible to discern, and using that information to personalize and improve the experiences of end users.[189] A range of specific tools powers analytics, including database management systems, data warehouses (structured data) or data lakes (unstructured data), business intelligence reporting tools, visualization software, modeling and predictive analytics tools, and text analysis functions.[190] These technologies are typically implemented not by individual instructors but rather at the enterprise level of information technology architecture. Student information systems and LMSs increasingly feature real-time analytics dashboards with separate views for instructors, students, advisors, and administrative staff.[191] These different perspectives support users in various roles across a campus in their efforts to describe and understand both *what* happened and also *why* it happened.

Institutions that can effectively harness the power of the data they collect, combined with sophisticated algorithms and machine learning that can analyze the data, will see benefits in both administrative and academic functions. Analytics can identify at-risk students and trigger interventions, while also informing adaptive learning tools that can help advanced students stay challenged. Gartner describes the power of analytics as being both predictive[192] (what will happen) and prescriptive[193] (how we will make it happen). Harnessing the power of analytics technologies is key to achieving a better model for optimized learning.[194]

Relevance for Teaching, Learning, or Creative Inquiry

The ability to survey historic, demographic, behavioral, programmatic, performance, social, and other quantifiable aspects of students and analyze vast amounts of such data provides an unprecedented opportunity for colleges and universities to improve student outcomes. The findings from analytics services can also be invaluable in helping individual students understand how to guide and improve their own learning. Empowering students to discover the educational paths that best suit them—and to be able to customize their learning path in real time—is one of the most significant opportunities for analytics. In this way, analytics technologies are changing expectations for how students navigate through the curriculum and degree programs.

In many ways, higher education today is undergoing a transformation from what it was just a generation or two ago, and central to much of that transformation is the introduction of technology into virtually all of an institution's administrative and academic functions. Many institutional faculty and staff, however, are unfamiliar or uncomfortable using technology in some of the ways that it promises to disrupt teaching and learning. Organizations such as the Learning Analytics Collaborative help make sense of the practical applications of analytics in education by bringing together a global community of educational visionaries, researchers, and data scientists to address issues like analytics-powered deeper learning approaches, to address concerns about data privacy, and to inform practices to humanize machine learning and AI support.[195] Other kinds of organizations, such as the Bill & Melinda Gates Foundation, have invested heavily in digital learning solutions that harness the power of analytics technologies to create personalized and adaptive learning experiences for students.[196] When adaptive technologies are paired with a learner dashboard, students stay informed of their individual progress and faculty can discover opportunities to make course corrections to better meet students' learning needs.

Analytics technologies can also enable students to investigate educational and career options. LinkedIn[197] and Khan Academy[198] are using analytics to provide customized college and career pathway recommendations, and institutional analytics services can help students understand how various course options would accelerate or slow their progress toward particular degrees. Meanwhile, analytics is becoming an academic subject in its own right. Arizona State University Online now offers a graduate certificate in Advanced Analytics in Higher Education, which "prepares professionals to conduct advanced analytics and assist university personnel in making data-driven decisions for higher and postsecondary education."[199] In the U.K., the Higher Education Commission released a report that said "Learning analytics has the potential to be enormously powerful for improving the student experience of university,"[200] and Jisc is leading an effort that includes 50 institutions to develop a national learning analytics service.[201]

Analytics Technologies in Practice

The following links provide examples of analytics technologies in use that have direct implications for higher education.

Driving Persistence and Retention with Data
educau.se/baysoul
The American Women's College at Bay Path University, an access institution supporting largely nontraditional students, is committed to using learning and engagement analytics to drive intervention strategies aimed at student success and completion.

Learning Analytics Fellows Program
educau.se/indss
The Indiana University Bloomington's Learning Analytics Fellows Program supports faculty-driven research projects that use learning analytics to better understand and improve student engagement, retention, and success.

Lehman 360
educau.se/leh360
Developed by Lehman College/City University of New York, Lehman 360 brings student data from multiple data sources into a single, easy-to-use view that allows students to stay up-to-date with the information they need in an attractive mobile interface.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about analytics technologies.

Institutions' Use of Data and Analytics for Student Success
educau.se/datass
(Amelia Parnell, Darlena Jones, Alexis Wesaw, and D. Christopher Brooks, EDUCAUSE, April 11, 2018) This joint report by EDUCAUSE, AIR, and NASPA examines the current landscape of institution's' use of data and analytics for student success.

Learning Analytics
educau.se/edtecla
(Office of Educational Technology, US Department of Education) This brief and companion publication summarize data mining and data analytics as it applies to learning. It outlines the research possibilities and practical applications of analytics in educational environments as related to the US Department of Education's National Educational Technology Plan. Specifically, it addresses ways to use online learning system data to improve instruction.

Machine Learning, Big Data and the Future of Higher Ed
educau.se/machle
(Vincent Del Casino Jr., *Inside Higher Ed*, March 21, 2018) Analytic technologies have much to offer colleges and their students, but we need to be mindful that the risks don't outweigh the gains.

Makerspaces

Time-to-Adoption Horizon: One Year or Less

The turn of the 21st century signaled a shift in the types of skills with value in a rapidly advancing world. The question of how to renovate or repurpose classrooms to meet the needs of the future continues to be addressed through makerspaces—workshops that provide tools and learning experiences to help people carry out their ideas. Makerspaces are rooted in the maker movement, a following that comprises artists, technology enthusiasts, engineers, builders, tinkerers, and others with a passion for making things. In this landscape, creativity, design, and engineering are making their way to the forefront of educational considerations, as tools such as 3D printers, robotics, and 3D-modeling web-based applications become accessible to more people. A recent addition to makerspaces is extended reality (XR), which eliminates limitations to physical space by harnessing 3D imagery to simulate a 360-degree view of an environment. Proponents of makerspaces for education highlight the benefit of engaging learners in nurturing higher-order problem-solving through hands-on learning.

Overview

A renewed emphasis on tangible innovations and inventions has brought makerspaces to the forefront of academic priorities. Makerspaces are empowering a new generation of creators, bringing together experts and novices from a variety of disciplines to design, build, invent, and rethink various products. In the process, they are transforming the educational landscape by promoting a hands-on aspect of learning once reserved for professionals in specific trades or those in product-focused roles. Makerspaces have emerged as promising experiential learning environments that support the development of future-ready skills, such as collaboration, critical thinking, creativity and innovation, communication, and problem solving.[202] *Popular Science* reports that there are nearly 1,400 makerspaces globally.[203] While initially hailed as a bridge between higher education and industry, makerspaces have enabled students to design, prototype, create, and iterate using computers, power tools, 3D printers, arts and crafts, and electronics. They have also brought a playful, active, and hands-on dimension to the student experience.[204]

University makerspaces and fabrication laboratories ("fab labs") vary considerably, based on the goals of each space and the types of making they support. Some institutions, such as the University of Delaware, use the makerspace as a way to introduce design and creative thinking methods into the engineering curriculum. Other makerspace programs, such as the think[box] at Case Western Reserve University, have a community outreach dimension to encourage local entrepreneurship.[205] In many cases, the spaces marry traditional and technological tools—it might not be surprising to find students alternating between using a sewing machine or laser cutter and designing using CAD software. Unlike a traditional lab, these spaces are typically open to students of any major, for purposes that are curricular, extracurricular, or simply of personal interest.[206]

There is no "one size fits all" version of academic makerspaces in terms of equipment or staffing guides. However, some institutions, such as the University of Washington, have created guides for others to use, with recommendations on tools and equipment, space configuration, and furniture.[207] Other institutions, such as the University of Calgary, supply maker pedagogy resources, materials selection criteria, and project ideas.[208] Academic makerspaces serve a powerful, highly democratized research purpose. As the Royal Society's Joanna Dally and Francis Downey noted in a recent article, "An increasingly connected global network of makerspaces and home-based researchers is also generating ground-breaking knowledge."[209]

Relevance for Teaching, Learning, or Creative Inquiry

Makerspaces can serve as a source for strong community ties. In fact, some government funding has been earmarked for such endeavors. For example, thanks to a $350,000 grant from the California Community Colleges Maker Initiative (CCCMI), Sierra College can support full-time personnel who will create partnerships with community makerspaces near three of the college's campuses. CCCMI, which has awarded funding to 25 community colleges statewide, focuses on preparing graduates for STEM careers through the development of makerspaces, entrepreneurship, and maker-themed curriculum, as well as hands-on internships with local employers. Additionally, current and former students can teach others as makerspace instructors in areas such as 3D printing and Arduino programming.[210]

International academic partnerships with strong maker components are also on the rise. The new Global Innovation Exchange graduate program, developed by the University of Washington and Tsinghua University in China, enables students to create and iterate in a learning environment constructed around a vast makerspace with built-in facilities and tools for brainstorming.[211] This technology innovation program involves close collaboration with business and technology companies. Such facilities can also extend beyond academic programs to serve as a practical bridge between education and industry. For example, the FABlab Design and Technology Centre at Namibia University of Science and Technology is currently the largest makerspace on the African continent, serving as a laboratory for students and local entrepreneurs to bring their ideas to life.[212]

Just as today's librarians are redefining their roles—shifting from "stewards of physical information to educators on digital literacy"—institutions are reexamining library facilities, which are increasingly viewed as a space that "engenders creativity and collaboration."[213] At North Carolina State, the Hunt Library is the institution's "library of the future." The library features a variety of spaces catering to makers, including a creativity studio, a gaming lab, recording studios, and, naturally, a makerspace. As in many academic makerspaces, NC State students can access resources beyond their own academic departments and engage in interdisciplinary collaboration with others from a variety of majors.[214]

Makerspaces in Practice

The following links provide examples of makerspaces and makerspace programs that have direct implications for higher education.

Coconino Community College iLab
educau.se/coconino
The Cococino Community College iLab was versioned as a space to bring students, faculty, and the community together to foster ingenuity, creativity, and innovation.

Elon Kickbox
educau.se/elonkb
Elon Kickbox is a semester-long mini-grant program for students to use the campus makerspace. The program includes an introduction to a design process, a $300 Visa card, a project sponsor (a faculty or staff person with content expertise), a Maker Mentor (a student staff person who can help them find and learn the equipment in the makerspace), and regular meetings with other Kickboxers.

The Maker Kits Project
educau.se/usqmake
The University of Southern Queensland Maker Kits project encourages the growth of maker culture and maker skills with a grant-funded pilot program to deliver 120 free maker kits to distance, online, and on-campus USQ students across Australia.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about makerspaces.

Identifying and Sharing Best Practices in International Higher Education Makerspaces
educau.se/besprache
(Vincent Wilczynski and Malcolm N. Cooke, American Society for Engineering Education, 2017) The makerspace trend has rapidly spread internationally, with many higher education institutions adding facilities to create maker communities. This paper details the history behind the International Symposium on Academic Makerspaces, which drew 300 participants from 115 universities and included sessions with presenters from Austria, Brazil, Bolivia, China, Canada, Guatemala, New Zealand, Pakistan, Peru, South Korea, and the United States.

The International Symposium on Academic Makerspaces (ISAM)
educau.se/isam18
ISAM gathers and shares knowledge and best practices that institutions of higher education can use in various ways, including to form student maker communities; get students excited about using these spaces; perpetuate a culture of safe, fun, and responsible use; measure and maximize educational and social impact; and select appropriate practices, programming, safety policies, training, staffing, and equipment.

Makerspaces in Higher Education: The UR-Maker Experience at the University of La Rioja
educau.se/hemake
(Alpha Pernia-Espinoza et al., University of Helsinki, 2017) Makerspaces could become a bridge between universities and industry, particularly in science, technology, engineering, and math (STEM) careers. This paper evaluates makerspaces in the world's top 10 universities in engineering, as well as three of the most well-known Spanish facilities and the new campus makerspace created at the University of La Rioja.

Adaptive Learning Technologies

Time-to-Adoption Horizon: Two to Three Years

Encompassed by the personalized learning movement and closely linked to learning analytics,* adaptive learning *refers to technologies that monitor student progress and use data to modify instruction at any time. Adaptive learning technologies "dynamically adjust to the level or type of course content based on an individual's abilities or skill attainment, in ways that accelerate a learner's performance with both automated and instructor interventions."[215] Enabled by machine learning, these technologies can adapt to a student in real time, providing both instructors and students with actionable data. The goal is to move students through a learning path, empowering active learning, targeting at-risk student populations, and assessing factors affecting completion and student success. Advocates for adaptive learning believe that it can be a solution for the "iron triangle" of educational challenges: cost, access, and quality.[216]

Overview

Faculty can no longer simply move through their syllabi, teaching the carefully crafted curricula and grading tests and papers at predetermined dates. Higher education is increasingly focused on learning outcomes, and waiting until grades are finalized is too late to ensure that students are acquiring the skills and knowledge necessary to succeed. Adaptive learning tailors educational content and activities to the particular needs of each student, increasing the likelihood of progress for all learners. Emerging adaptive learning technologies and data related to real-time assessments have captured the attention of higher education administrators; indeed, 92 percent of chief academic officers surveyed believe that it could improve student learning outcomes.[217] Ithaka S+R surveyed a group of these leaders, who indicated that they viewed intelligent adaptive learning technologies as the most promising initiatives for improving the quality of student learning.[218] These results were first reported in early 2016, and colleges and universities are continuing to incorporate adaptive learning technologies, given financial and faculty support.

In 2017, National University in California launched a four-year, $20 million project to develop a personalized education platform. The project integrates adaptive and competency-based learning and predictive analytics for student retention, with the goal of incorporating the new platform into 20 general education courses for 2018. National University is regarded as an online learning pioneer—nearly 60 percent of its enrolled students attend online—and it was among the first universities to admit students on a rolling basis each month, rather than through a traditional system.[219]

Many institutions are tapping into adaptive learning technology resources available through companies and ed tech start-ups such as CogBooks and Smart Sparrow, as well as through long-established academic publishers such as Pearson and McGraw-Hill Education. For example, a biochemistry professor at Qatar University looking for a way to offer an online and blended learning experience for his first-year chemistry students did so using a digital teaching and learning environment that let him increase active learning among his students and engage them in group discussion and problem solving.[220] The professor believes it has not only increased the rigor of his course but that the technology also has boosted student success.[221] A variety of adaptive learning technologies support student learning by testing their understanding as they go, which helps build confidence and competencies.

Relevance for Teaching, Learning, or Creative Inquiry

Adaptive course materials have the potential to assist a wide variety of learners. For example, Oregon State University has deployed adaptive learning technology to create chemistry labs that can be personalized by the instructor for students; these labs assist both students requiring remediation as well as those who can accelerate their progress.[222] The application of adaptive learning technology is not limited to the STEM disciplines. Through its humanities and European languages and studies discipline, the University of Western Australia is examining how desktop and mobile digital technologies impact students who are learning a second language. In 2017, a web-based e-learning platform for beginners studying Italian was added to the curriculum. This resource offers automated, adaptive, and personalized exercises, providing real-time feedback. Data from this project will be used to help professors cater to each student, including those

most at risk, and develop ideas to continue improving teaching and learning experiences; teachers will thus be better able to cater to students' needs, identifying at-risk students earlier and collecting data for further research.[223]

Research into the impact of adaptive technologies is not limited to student success and performance. In a transcontinental research project, the University of Leeds in the U.K. and the University of Cape Town in South Africa are investigating how digital technologies, including the development of adaptive learning paths, are affecting staff, students, and employers. The Unbundled University: Researching Emerging Models in an Unequal Landscape project is examining the relevance of a traditional university. In addition to looking at how digital technology is disrupting higher education, their research explores how the involvement of alternative providers and external partners is impacting higher education. The project represents an international collaboration between two research-intensive universities separated by a continent and many other contexts yet facing overlapping challenges."[224]

In some ways, adaptive learning technologies are making college more affordable. North Carolina's Central Piedmont Community College is among the largest community colleges in the Carolinas. In 2014, the institution joined a Bill & Melinda Gates Foundation–funded Next Generation Courseware Challenge project, and in 2015 it began implementing Smart Sparrow's BioBeyond technology. According to one biology instructor, the adaptive technology has enabled the institution to replace more costly traditional lab kits and textbooks, which saved students nearly $200 each.[225]

Adaptive Learning in Practice

The following links provide examples of adaptive learning technologies and programs that have direct implications for higher education.

CS1301x
educau.se/gtxpython
Georgia Institute of Technology leverages adaptive learning technologies with a custom McGraw-Hill Smartbook and artificial intelligence autograder infrastructure.

How People Learn
educau.se/harvhpl
How People Learn is a project funded by the Chan Zuckerberg Initiative to create an online, personalized course that will be part of a common core experience for all incoming master's students at Harvard Graduate School of Education.

Mixed Realty—Paramedic Mass Casualty
educau.se/humber
Humber College educates first-responder professionals by using the talents of Media Studies students in game programming, game animation, and graphics. Participants are invited to explore the immersive world of virtual reality and its potential to enhance paramedic student resilience in preparation for real-world stress exposure.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about adaptive learning technologies.

Adaptive Learning in Medical Education: The Final Piece of Technology Enhanced Learning?
educau.se/meded
(Neem Sharma, Iain Doherty, and Chaoyan Dong, *Ulster Med Journal*, September 12, 2017) When it comes to adaptive learning in higher education, much of the attention has concentrated on traditional undergraduate and graduate programs. This article explores ways in which these technologies can provide more personalized learning for students pursuing medical degrees.

Personalized Education Using Adaptive Learning Technology: One Size Doesn't Have to Fit All
educau.se/ltact
(Paul Smith, *Learning and Teaching in Action*, 2016) Amid all the discussions, hypotheses, and debates about adaptive learning technologies, this paper investigates how personalized training using adaptive learning software impacts student learning. It found that "this student-centered teaching method can lead to significant educational gains."

The Role of Adaptive Learning in Education
educau.se/roleadap
(Ravindra Savaram, Ed Tech Review, September 11, 2017) This article provides a concise overview of the growth of adaptive learning technologies in higher education and highlights current trends. It includes recommendations for institutions to adopt when incorporating adaptive learning technologies.

Artificial Intelligence

Time-to-Adoption Horizon: Two to Three Years

In the field of artificial intelligence (AI), advancements in computer science are being leveraged to create intelligent machines that accomplish tasks and make decisions in ways that closely resemble those of humans. To achieve this, AI draws inferences based on machine learning, which informs a computer's capacity to make decisions and predictions through exposure to massive data sets, and natural language processing. This helps humans interact with machines in ways similar to how they interact with other humans. These capabilities are driving a host of developments in industries such as health care, financial services, and education. As the underlying technologies continue to develop within the education sector, AI has the potential to enhance online learning, adaptive learning software, and research processes in ways that more intuitively respond to and engage with students while also relieving instructors of tedious tasks. Some reports forecast a 43 percent market growth for AI technologies in the education sector by 2022.[226]

Overview

Since being featured in last year's *Horizon Report: 2017 Higher Education*, AI has continued to make headlines in a variety of sectors, from Tesla's self-driving cars[227] to Apple's newest facial-recognition software debuted in the iPhone X.[228] Education leaders have had a wide range of reactions to AI's impacts on teaching and learning strategies, with sentiments ranging from optimism about its potential to transform and democratize education[229] to skepticism because of its role in automating teaching and reducing jobs.[230] Further, a recent Northeastern University and Gallup study revealed that although only 22 percent of those with a postsecondary degree believed that their studies prepared them to work with AI systems, 77 percent of respondents think AI will positively impact their lives.[231]

As AI continues to develop across sectors, students who become knowledgeable about AI and gain more experience working with it could have a competitive edge in the workforce. India and China have made notable commitments to advancing and integrating AI into education. New Delhi's Bennett University, in partnership with several U.K. institutions, received a grant to begin large-scale adoption, training, and skilling in AI across 25 postsecondary institutions.[232] In China, the previous head of the country's Google operations is working with the government on a five-year plan to develop a two-step process for increasing AI knowledge transfer. The plan starts by upskilling educators in AI techniques such as machine learning; those educators will then leverage their new expertise to inform students about AI and share best practices across the country.[233]

While notable examples of AI are being implemented in the classroom, administrative tasks are also using it to streamline their processes. Institutions are improving teacher evaluations using AI-enabled chatbots to record, organize, and provide detailed feedback from students.[234] Georgia State was recognized for creating Pounce, a chatbot that helps incoming students navigate the complex application process, presenting a personalized checklist for completing financial aid and enrolling in courses.[235] AI is advancing areas other than teaching and learning as well, including campus safety and management. The University of Texas at Austin (UT), for example, is using AI systems to track, label, and analyze traffic patterns in efforts to increase safety measures for pedestrians and alleviate high traffic burdens.[236] UT is also using data to develop self-adjusting irrigation systems to reduce water consumption and significantly cut costs.[237]

Relevance for Teaching, Learning, or Creative Inquiry

AI is a useful tool for implementing today's leading pedagogical trends, such as personalized learning, while also encompassing a variety of technology-based solutions, such as machine learning and open educational resources. Carnegie Learning and OpenStax have partnered to create an affordable learning solution for developmental math students. By leveraging Carnegie's Mika, an online math course enabled by machine learning and AI, and OpenStax's free online textbooks, the joint effort aims to increase math scores through personalized tutoring and real-time feedback while also reducing costs to postsecondary students.[238] To better expose students to real-world uses of AI, universities are partnering with corporations to research and identify use cases for the technology. The University of Technology Sydney recently announced an ongoing project with a major bank's insurance practice aimed at increasing customer satisfaction. The resulting OnePath

system leverages years of data from behavior modeling, text mining, and natural language processing to understand and distinguish the most relevant policy questions.[239]

AI is also changing how students and teachers interact with learning materials. The University of Michigan announced that students enrolled in statistics courses would be using the newly developed M-Write, which uses machine-learning algorithms to help improve and streamline the writing process. By using automated text analysis techniques that can match vocabulary and topics, the system helps students identify weakness in their analysis, speeds up the grading process, and alerts educators about which students need additional assistance.[240] As another example, by using learning analytics, online learning can adapt to automatically fit students' needs and provide interventions to deliver "just-right, just-in-time learning." Oregon State University piloted adaptive courseware in eight high-enrollment courses to deliver personalized content to students who might not otherwise receive individual attention. The university's goal is to increase retention rates in these classes by proactively helping students succeed.[241]

Even as AI is increasingly used to help students and institutions make informed decisions, a body of literature has emerged that cautions against relying strictly on AI systems. For example, in terms of admissions, education leaders are concerned about the "gray area" in AI decisions—that is, AI systems cannot determine which college is best for every student because such decisions are not wholly fact-based, and relying on AI in all such situations could diminish diversity in institutions.[242] However, AI is proving useful for completing time-consuming, tedious tasks, freeing instructors to focus on creating engaging learning experiences. A professor from Shenzhen University and Huazhong University of Science & Technology developed an AI-based framework for creating realistic textures that could further improve virtual worlds. By developing a process to automate these textures at a large scale, researchers can devote more time and resources to improving video game design, virtual reality, and animation.[243]

Artificial Intelligence in Practice

The following links provide examples of artificial intelligence in use that have direct implications for higher education.

Applying Machine Learning to Scale Up Microcredentials
educau.se/dbadgeai
Penn State University Libraries married the areas of information literacy and competency-based education to create information literacy digital badges. They are piloting artificial intelligence to evaluate student work submitted for the badge, which provides real-time feedback for student responses.

CSUN AI Innovation Collection
educau.se/aiexp
California State University, Northridge held a yearlong faculty exploration program to explore AI and held a student competition to find new and interesting applications for AI. They also created an AI-powered chatbot, with the goal of helping students, faculty, and staff get 24/7 help to the most common questions anytime, anywhere.

Developing Virtual Patients for Medical Education
educau.se/vrmed
Virtual patients are avatar representations of human standardized patients controlled by AI so students can carry on a conversation using natural language. The system, from The Ohio State University, provides immediate feedback on student performance, allowing students to rehearse professional behaviors and interviewing skills prior to working with real patients.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about artificial intelligence.

7 Roles for Artificial Intelligence in Education
educau.se/roleaied
(Matthew Lynch, *Tech Edvocate*, May 5, 2018) This article outlines a variety of ways in which AI continues to be integrated into teaching and learning practices to increase student success.

Artificial intelligence (AI) Makes Learner-Centered Learning Successful
educau.se/aisucc
(Open Access Government, June 1, 2018) Two professors from Chemnitz University of Technology outline how AI-enabled learning solutions can provide learner-centered education to students through real-time assessments.

Next Gen Robotics, Artificial Intelligence, and Education Informatization: The Future Is at TechCrunch Hangzhou
educau.se/robai
(*Technode*, June 26, 2018) Five technology leaders in China discuss their experiences with AI, along with the trends moving AI forward and the ways in which the education sector can integrate it into existing online learning.

Mixed Reality

Time-to-Adoption Horizon: Four to Five Years

At the intersection of virtual and physical realities is an emerging environment known as mixed reality (MR), where digital and physical objects coexist. This hybrid space integrates virtual technologies into the real world so that viewers often cannot distinguish where one world begins and the other ends. MR's virtual aspect comes from the use of devices equipped with 3D viewing technologies that seamlessly layer digital objects onto the real world. Another major MR component is the integration of augmented reality (AR), which layers information over 3D space. A key AR characteristic is its ability to respond to user input, which offers significant potential for learning and assessment; learners can construct new understanding based on interactions with virtual objects that bring underlying data to life. Holographic devices are also being used to create MR environments, as their video displays project 3D images into a physical space.

Overview

The market for MR applications is growing exponentially and is expected to double in the next five years.[244] As equipment becomes more affordable and schools have greater access to technology, the interest in using virtual reality (VR) and MR as educational tools is growing. In a recent survey of faculty, 81 percent of respondents said that VR, AR, and MR will be key educational technologies over the next decade.[245] These new technologies comprise real and virtual combined environments and human-machine interactions generated by computer technology and wearables.

The affordability of MR has encouraged widespread adoption in postsecondary education, with features including voice activation and collaborative virtual experiences. Learners are becoming immersed in curricula that span medicine, science, art, history, and teacher training and are experiencing scenarios and objects that would not be possible in traditional classrooms. Effectively integrating these technologies into the curriculum requires careful planning and numerous resources; in addition to adopting and incorporating the technology itself, institutions must consider related efforts, including faculty development, instructional design, learning space integration, infrastructure assessments, and governance, policy, ethics, and access equity.[246] For example, because VR places greater demands on campus wireless networks, infrastructure upgrades might be necessary. Educators from University College London believe that MR has considerable potential with regard to an institution's academics, innovation efforts, and community impact. The educators assert that MR can serve to better integrate research and education through active participation in research and inquiry and that it can support interdisciplinary ties to students' academic work.

VR is already being employed by some institutions as a recruitment tool. If prospective students and their families cannot afford to attend an on-campus tour, for example, they can get a sense of an institution's layout and surroundings through VR. Such technologies let institutions reach a broader audience without having to hire additional admissions staff. The technologies also let institutions communicate their innovative approach in a way that resonates with young people. For members of Generation Z—the first college-aged cohort to grow up entirely in the internet era—this fresh approach to traditional recruiting speaks to their personal experiences.[247]

Relevance for Teaching, Learning, or Creative Inquiry

Some professors who have studied and developed MR believe these technologies are slowly but surely asserting themselves into the higher education classroom. They cite the highly stimulating, interactive nature of the VR experiences and how the brain's response to them is similar to that of an actual event. Yet the technologies' applications for more abstract learning, such as theoretical concepts, will require more consideration from educators than simply bringing students into VR to explore a physical space.[248]

MR technologies offer students new opportunities to assume roles of co-creators by creating MR environments as a part of their coursework, often with authentic or real-world application. At the University of Illinois, students are the ones designing virtual experiences—in this case, to help members of the prison population adjust to life after incarceration. While the average person might think nothing of stopping by a local café for coffee, such routine tasks can be daunting for someone who has spent years

behind bars. The project's goal is to help former inmates better assimilate into society and thereby reduce recidivism.[249] At the European School of Management and Technology in Berlin, students in the Leading Digital Transformation executive education program are using VR to solve company problems or discover new business opportunities. For example, a course alumnus who works for an engineering equipment maker has gone on to use VR to help engineers pinpoint problems in faulty machines, which has sped up repairs while reducing downtime and maintenance costs.[250]

Possibilities for MR applications in research are also promising. At Imperial College London, researchers have shown how surgeons can use Microsoft HoloLens headsets to see through the limbs of patients while conducting reconstructive surgery. The Imperial team overlaid images of CT scans—which include the position of bones and key blood vessels—onto each patient's leg, offering surgeons a first-of-its-kind inside view during an operation.[251]

Mixed Reality in Practice

The following links provide examples of mixed reality in use that have direct implications for higher education settings.

Improving Patient Safety Using VR to Train and Assess Emergency Personnel
educau.se/dissim
Ohio State has designed a virtual reality simulation to train and assess medical students, residents, fellows, paramedics, and others responding to a mass casualty incident.

Maritime Simulation Training
educau.se/maritime
South Metropolitan TAFE is a Technical and Further Education institution based in Fremantle, Western Australia. The maritime simulation center in Fremantle enables the TAFE to work with the Fremantle Port Authority to enable the roughly 300–400 maritime students to experience all facets of ship operations via simulation experience.

XR for Historical Reconstructions
educau.se/bates
Bates College faculty in the humanities incorporate 3D modeling in their courses for the digital reconstruction of historical structures, such as ancient mosques and Roman theatres. VR tools are used to provide students with the opportunity to immerse themselves in their reconstructions, offering unique perspectives on how these structures may have impacted the lived experiences of the people who resided in these ancient cities.

For Further Reading

The following resources are recommended for those who wish to learn more about MR in higher education.

Augmented Reality: Application in Higher Education
educau.se/arhe
(Danny Munnerley, Matt Bacon, Robert N. Fitzgerald, and James Steele, Australian Government Office for Learning and Teaching, Dec. 2014) Researchers from Australian National University, the University of Canberra, and Macquarie University believe that AR has particular value for higher education in the areas of learner mobility and flexibility. Their ARstudio project explored the uses of AR in higher education over the course of two years, with a specific focus on tools for mapping its uptake and evaluating its effectiveness.

Virtual Reality: A Tool for Preservice Teachers to Put Theory into Practice
educau.se/vrsim
(Charles Anazalone, Department of Learning and Instruction, June 29, 2017) The University at Buffalo Neurocognition Science Laboratory is working on a multifaceted project to investigate, compare, and characterize interactive VR-based preservice teacher clinical teaching environments with those of real-life teaching environments. The project incorporates elements of MR, instructional design and technologies, artificial intelligence, and learning analytics.

VR and AR: Pioneering Technologies for 21st-Century Learning
educau.se/vrpioneer
(Maya Georgieva and Emory Craig, *EDUCAUSE Review*, May 17, 2018) This series of Transforming Higher Ed blog posts provides an in-depth exploration of VR and AR and their impacts on higher education. Authored by MR experts and educators Maya Georgieva and Emory Craig of Digital Bodies, the series includes topics such as immersive storytelling and journalism, STEM education, learning space design, and ethical challenges.

Robotics

Time-to-Adoption Horizon: Four to Five Years

Robotics refers to the design and application of robots, automated machines that accomplish a range of tasks. The first robots were integrated into factory assembly lines to streamline and increase the productivity of manufacturing, most notably for cars. Today, the integration of robots into mining, the military, and transportation has helped improved operations for industries by taking over tasks that are unsafe or tedious for humans. The global robot population is expected to double to four million by 2020, a shift that is expected to reshape business models and economies throughout the world.[252] There is a substantial debate on how workers will be affected by the global economy's growing dependence on robots, especially now that robots are more autonomous and cheaper than ever. In higher education, robotics programs are focusing on solving broader and emergent societal problems, including advancing high-level surgical medicine, mitigating significant workforce imbalances, personalizing learning at scale, and expanding access to on-site experiences previously limited by disabilities or geographic constraints.

Overview

The integration of robotics into everyday life, whether on campuses, in offices, or at home, is a development filled with both promise and legitimate concerns. As an indication of the potential of robotics, institutions such as Carnegie Mellon and Stanford have played key roles in the development of self-driving cars, along with a bevy of automakers and other technology companies.[253] On the flip side, however, workers remain concerned about losing jobs to ultra-efficient robotic automation, despite some evidence to the contrary (specifically, that at the present time aggregate productivity has not risen sharply, and various jobs do not appear to be harder to obtain than in the past[254]). However, some professions formerly assumed to be safe may face an uncertain future.[255] With claims that the related technology of artificial intelligence (AI) may make half of today's jobs obsolete within 20 years, at least some level of concern seems warranted.[256]

Yet the field of robotics is also supporting humans, from both personal and professional perspectives, as many new applications of automated technologies are humanistic in their aspirations.[257] In the world of medical technology, surgeons will have a helping hand during complicated procedures, thanks to the assistance of robots.[258] At the 2018 Winter Olympics in Seoul, South Korea, robots designed to help with facilities maintenance provided cleaning and painting services.[259] Additionally, nations that lack workforce numbers to adequately support aging populations are using robotics powered by AI. Japan, for example, is experimenting with the kinder, gentler side of robots by programming them for caregiving roles in nursing homes.[260]

In higher education, such technologies are positively impacting student services and applicant access to the campus as well. Some universities are using drones to give applicants a bird's-eye view of campus, which accommodates people unable to travel for in-person tours. Such video tours are swiftly becoming a powerful recruitment tool.[261] And telepresence technology, which is already used in both the private sector and in medicine, may help bridge the social gap for distance learning students whose educational options would otherwise be limited by geographic constraints.[262]

Relevance for Teaching, Learning, or Creative Inquiry

Higher education faces a significant challenge: preparing students for success in the next generation workforce.[263] Nearly 9 in 10 jobs lost since 2000—including many jobs that require college degrees—were lost due to advancements in automation.[264] To address this, institutions of education must reevaluate teaching methods and the curricula they offer. Some of the necessary changes will require higher education to invest in facilities and programs that prepare students to work directly with robotics technologies and even invent new ones. Institutions such as the University of Michigan, which is situated in a historical manufacturing region, have risen to the occasion by expanding their campuses with dedicated robotics facilities.[265] Scheduled to open in 2020, Michigan's 140,000-square-foot robotics facility will include a fly zone for autonomous aerial vehicles, an outdoor obstacle course for walking robots, a high-bay garage space for self-driving cars, and space for rehabilitation and mobility robots involving prosthetics and exoskeletons.[266]

A growing number of robotics partnerships are focused on developing novel solutions to societal issues. For

example, the MIT Media Lab spinout Orio has responded to the high-density housing explosion in urban centers by developing smart robotic furniture that transforms into a bedroom, a working or storage area, or a large closet—or simply slides back against the wall—to optimize space in small apartments or classrooms.[267] Sony and Carnegie Mellon are collaborating on the development of robots for food preparation, which may help address a number of health issues linked to poor nutrition.[268] Researchers at Singapore's Nanyang Technological University are developing solutions that make ready-to-assemble furniture less burdensome for consumers.[269] Institutions are increasingly harnessing robotics and automation in service of higher education's mission to send graduates into the workforce who are prepared to use these technologies to tackle larger-scale problems.[270]

Robotics offers new possibilities for integration into existing curricula and contributing to student success. With respect to makerspaces, the DeArmond Makerspace at the University of Oregon partners with the Department of Computer Science to support projects involving the building of planetary rovers for the A-Rocket-Launch-for-International-Student-Satellites (ARLISS) competition.[271] Robotics also offers almost unlimited opportunities for exploration and discovery, such as a project at the Robotic Lab in the Department of Biological Physics at Eötvös University in Budapest in which a flock of drones self-organized into a coherent swarm, much like starlings.[272]

Robotics in Practice

The following links provide examples of robotics and robotics programs that have direct implications for higher education.

Insect-Sized Robots
educau.se/robofly
A team of engineers at the University of Washington has created a robot that weighs about the same as a toothpick. Too small for a propeller, this robot achieves liftoff by flapping its wings. Once equipped with more-advanced sensor systems, robots such as this could be used to detect methane leaks.

MIT Distributed Robotics Lab
educau.se/bldrobot
Under the direction of Professor Daniela Rus, this MIT lab has pursued her vision of "pervasive robotics integrated into the fabric of everyday life, helping everyone with physical work and cognitive tasks." The lab has worked on projects such as drones to assist with the navigation of self-driving cars and pill-sized robots that can work internally to treat human wounds.

Virginia Drones Project
educau.se/jmudrone
In an undergraduate course on drones, students from James Madison University and Old Dominion University partner with state and national organizations to use unmanned systems to investigate a range of ecological issues.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about robotics technologies.

The AI Invasion Is Coming to Africa (and It's a Good Thing)
educau.se/aiinva
(Lexi Novitske, *Stanford Social Innovation Review*, February 12, 2018) Across the African continent, from Ghana to Zimbabwe, AI and robotics have the potential to bring positive changes in sectors such as health care and finance while bridging the gap between physical infrastructure inadequacies and consumer demands and freeing up time for skilled labor and increased labor productivity. Yet governments, investors, and NGOs must train workers for complex tasks and reform laws and education to meet the demands of tomorrow's economy.

Skill Shift: Automation and the Future of the Workforce
educau.se/skilaut
(Jacques Bughin et al., McKinsey Global Institute, May 2018) The adoption of automation will raise the demand for certain skills while lowering the demand for others. This briefing quantifies time spent on 25 core workplace skills today and in the future for five European countries and the United States.

Why a Robot-Filled Education Future May Not Be as Scary as You Think
educau.se/robfill
(Michelle R. Weise, EdSurge, June 21, 2017) In this article, a researcher from Southern New Hampshire University explores how higher education can get beyond its fears, pessimism, and anxiety about the increasing role technology may play in K–20 education.

Methodology

The process used to research and create the *NMC Horizon Report: 2018 Higher Education Edition* is rooted in the methods used across all the research conducted during the NMC Horizon Project. The Horizon Report is informed by both primary and secondary research. Dozens of meaningful trends, challenges, and important developments in technology are examined for possible inclusion in the report for each edition before the expert panel selects the 18 topics profiled here.

Every report draws on the expertise of an international panel of individuals who first consider a broad set of trends, challenges, and developments in technology and then explore each of them in progressively more detail, reducing the set until the final listing of topics is selected. This process took place online and was intended to be a completely transparent window that provided a real-time view of the work as it happened.

This year, the panel was composed of 71 education and technology experts from 19 countries on 6 continents; their names and affiliations are listed at the end of this report. Despite their diversity of backgrounds and experience, they share a consensus view that each of the profiled topics will have a significant impact on the practice of higher education around the globe over the next five years.

The procedure for selecting the topics in the report is based on a modified Delphi process refined over more than 16 years of producing the Horizon Report series. The panel represents a wide range of backgrounds, yet each member brings a relevant expertise. Over the years of the NMC Horizon Project research, more than 2,500 internationally recognized practitioners and experts have participated on the panels; in any given year, a third of panel members are new, ensuring a flow of fresh perspectives.

Once the panel for a particular edition was constituted, their work began with a systematic review of the literature—press clippings, reports, essays, and other materials—that pertains to technology developments, trends and challenges, current research and reports, and more. Panelists were provided with an extensive set of background materials when the project began and were asked to comment on them, identify those that seemed especially worthwhile, and add to the set.

Following the review of the literature, the expert panel engaged in the central focus of the process—the research questions that are at the core of the NMC Horizon Project. The group discussed existing applications and manifestations of trends, challenges, and technology developments and also brainstormed new ones. A key criterion for the inclusion of a topic in this edition was its potential relevance to teaching, learning, and creative inquiry in higher education.

These research questions were designed to elicit a comprehensive list of interesting technology developments, challenges, and trends from the panel:

1 Which of the important developments in educational technology catalogued in the NMC Horizon Project Listing will be most important to teaching, learning, or creative inquiry for higher education within the next five years?

2 What important developments in educational technology are missing from our list? Consider these related questions:

- **What would you list among the established developments in technology that some institutions are using today that arguably *all* higher education institutions should be using broadly to support or enhance teaching, learning, or creative inquiry?**
- **What technologies that have a solid user base in consumer, entertainment, or other industries should higher education institutions be actively looking for ways to apply?**
- **What are the developments in technology you see advancing to the point that higher education institutions should begin to take notice during the next four to five years?**

3 What key trends do you expect to accelerate educational technology uptake in higher education?

4 What do you see as the significant challenges impeding educational technology uptake in higher education during the next five years?

In the first step of this approach, the responses to the research questions were systematically ranked and placed into adoption horizons by each expert panel member using a multi-vote system that allowed members to weight and categorize their selections. These were compiled into a collective ranking, and the ones around which there was the most agreement were advanced.

From the comprehensive list of trends, challenges, and developments in technology originally considered for any report, the dozen that emerge at the top of the initial ranking process in each area were further researched and expanded. Once these interim results were identified, the group explored the ways in which these topics impacted teaching and learning in colleges and universities. A significant amount of time was spent researching real and potential applications for each of the topics that would be of interest to practitioners. The semifinalist topics of the interim results were then ranked yet again. The final topics selected by the expert panel are those detailed here in the *NMC Horizon Report: 2018 Higher Education Edition*.

The 2018 Higher Education Expert Panel

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Endnotes

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