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EDUCAUSE Horizon Report | 2019 Higher Education Edition

EDUCAUSE Horizon Report
2019 Higher Education Edition

Bryan Alexander, Kevin Ashford-Rowe, Noreen Barajas-Murphy, Gregory Dobbin, Jessica Knott, Mark McCormack, Jeffery Pomerantz, Ryan Seilhamer, and Nicole Weber, *EDUCAUSE Horizon Report: 2019 Higher Education Edition* (Louisville, CO: EDUCAUSE, 2019).

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Table of Contents

> Click on a topic to jump to that page.

Executive Summary

For 17 years, the New Media Consortium convened panels of experts from higher education and posed three key questions for them to discuss: 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? The resulting Horizon Report series charts the five-year impact of innovative practices and technologies for higher education across the globe. This year, for the first time, EDUCAUSE led this conversation and guided the 98-person global panel to review recent literature and discuss their experiences and forecasts regarding technology adoption and educational change. With more than 17 years of research and publications, the Horizon Project can be regarded as education's longest-running exploration of emerging technology trends that support teaching, learning, and creative inquiry.

This report profiles six key trends, six significant challenges, and six developments in educational technology for higher education. These three sections of this report constitute a reference and technology planning guide for educators, higher education leaders, administrators, policymakers, and technologists.

The 2019 expert panel agreed on two long-term trends: rethinking how institutions work, and modularized and disaggregated degrees. These long-term trends indicate an expected evolution in the way higher education approaches its mission, as well as a trend toward increased student control over individual learning pathways. The mid-term trends, in contrast, are more pragmatic. Advancing cultures of innovation is a mid-term trend through which the panel predicts more industry collaborations through venture labs, incubators, and other business partnerships. Meanwhile, the focus on measuring learning remains a trend that will drive technology adoption. The panel believed that the expanse of data available today offers institutions new opportunities to assess, measure, and document learning. Redesigning learning spaces on campuses remains a short-term trend, and this year the panel expanded this trend from the physical to the virtual with a future focus on the design of learning environments in extended reality (XR). The panelists also agreed that blended learning design has yet to scale and remains as a short-term trend. This reemergence might be explained by challenges related to the teaching profession described in other sections of this report.

The panel was also asked to deliberate about the major obstacles to scaling and adopting technology solutions in higher education. They agreed that improving digital fluency, along with an increasing demand for digital learning experience and instructional design expertise, are solvable challenges. This year's panel concluded that both of these challenges are already being addressed at individual institutions through hiring practices and faculty development and that other institutions similarly have the ability to solve them. Difficult challenges—those that we understand but for which solutions remain elusive—are murky, yet panelists found room to be optimistic. The challenge of addressing the obstacles that stymie student success, for example, is evidenced in the panel's belief that the achievement gap might be addressed through efforts that include open educational resources, digital courseware platforms, and personalized learning pathways. The other difficult challenge in this year's report is the evolving roles of faculty with ed tech strategies. The experts identified advancing digital equity as a wicked challenge, one that is difficult even to define. Equally wicked, rethinking the practice of teaching is also considered a complex problem to define and is a challenge that evolved from a previous topic, rethinking the practice of teaching.

The panel also endeavored to forecast the technological developments they thought were drivers of innovation and change based on signals they identified in broad technology outlooks and promising examples of pilot projects or implementations in higher education The time to adoption for mobile learning and analytics technologies is estimated to be one year or less, acknowledging that the advances in these technologies and their promise to positively impact teaching and learning put them on the cusp of implementation across institution types. Mixed reality is expected to be increasingly adopted by higher education institutions within two to three years, making the most of the technologies where digital and physical objects can coexist. Artificial intelligence (AI) remains on the mid-term adoption horizon as programming, data, and networks driving AI mature. Virtual digital assistants and blockchain are expected to have widespread application in higher education within four to five years as the educational community seeks solutions that may be realized by these technologies.

In addition to forecasting the trends, challenges, and developments anticipated to impact higher education, this report includes a new section that reexamines

> The Horizon Project can be regarded as education's longest-running exploration of emerging technology trends that support teaching, learning, and creative inquiry.

previous panel forecasts. This section, called Fail or Scale, is intended to provide insight into what actually transpired in the field of higher education technology developments and their actual adoption or impact on teaching, learning, or creative inquiry. Previous panel members were asked to provide hindsight to a previous forecast with which they had experience. These essays are included to provide insight into how higher education has been impacted by technology developments from the recent past.

Perhaps one of the most unexpected outcomes of the community engagement around the Horizon Report in higher education is the overwhelming response to the call for exemplars—those projects that evidence the developments on the horizon that might inform or otherwise inspire other global initiatives in higher education. This year was no exception. EDUCAUSE reached out to the community for exemplars in the six development areas and, as in 2018, received inspiring projects from across the global postsecondary landscape. This report showcases only 18 of the more than 75 submissions, each of which was selected for inclusion in the report for innovation, scale, lessons learned, or as a project that otherwise stood apart as one that would inspire others in the field.

The four key sections of this report not only function as a reference and visionary technology-planning guide for educators, higher education leaders, administrators, policymakers, and technologists but also provide context and reflection around those forecasts that scaled and those that did not. It is our hope that the resources provided to complement each topic will help inform the choices that institutions are making about technology as well as insight into those initiatives that have failed-forward. For both cases, this report aspires to improve, support, or extend teaching, learning, and creative inquiry in higher education across the globe.

EDUCAUSE Horizon Report | 2019 Higher Education Edition at a Glance

Key Trends Accelerating Higher Education Technology Adoption

2019 2020 2021 2022 2023

Short-Term
Driving Ed Tech Adoption in Higher Education for the Next One to Two Years

Redesigning Learning Spaces
Blended Learning Designs

Mid-Term
Driving Ed Tech Adoption in Higher Education for the Next Three to Five Years

Advancing Cultures of Innovation
Growing Focus on Measuring Learning

Long-Term
Driving Ed Tech Adoption in Higher Education for Five or More Years

Rethinking How Institutions Work
Modularized and Disaggregated Degrees

Significant Challenges Impeding Higher Education Technology Adoption

Solvable
Those That We Understand and Know How to Solve

Improving Digital Fluency
Increasing Demand for Digital Learning Experience and Instructional Design Expertise

Difficult
Those That We Understand but for Which Solutions Are Elusive

The Evolving Roles of Faculty with Ed Tech Strategies
Achievement Gap

Wicked
Those That Are Complex to Even Define, Much Less Address

Advancing Digital Equity
Rethinking the Practice of Teaching

Important Developments in Technology for Higher Education

2019 2020 2021 2022 2023

Time-to-Adoption Horizon: One Year or Less

Mobile Learning
Analytics Technologies

Time-to-Adoption Horizon: Two to Three Years

Mixed Reality
Artificial Intelligence

Time-to-Adoption Horizon: Four to Five Years

Blockchain
Virtual Assistants

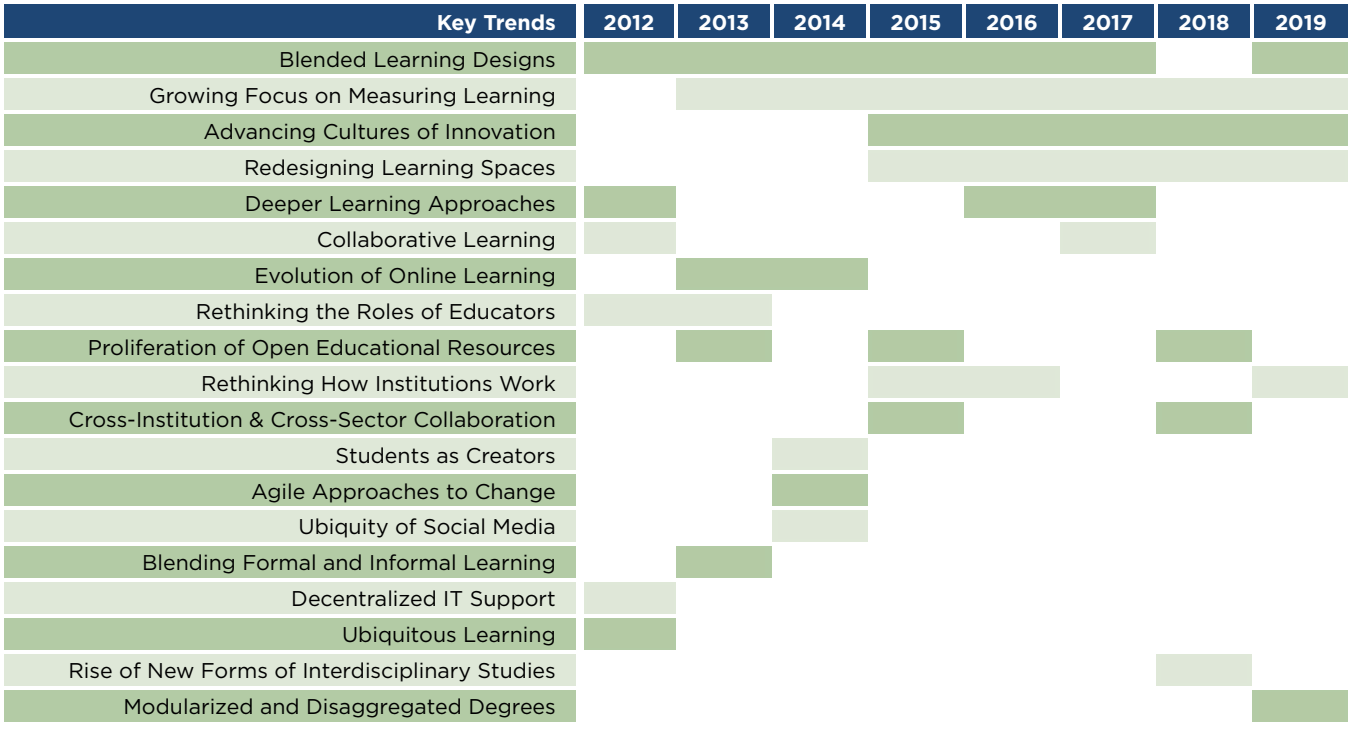
Key Trends Accelerating Technology Adoption in Higher Education

The *Horizon Report Higher Education Edition* has long played a role influencing or supporting strategic initiatives in higher education. This section of the report describes the trends expected to have a significant impact on the ways in which colleges and universities approach their core mission of teaching, learning, and creative inquiry. The six trends described in this portion of the report were selected by the expert panel after a robust series of conversations about broad trends in higher education, using recent publications to inform the dialogue. The trends are summarized in the following pages, with particular attention paid to the panel's discussion to capture the engagement among the diverse international group.

The topics in this year's trends section reflect a strong focus on meeting students' expectations of constant access to platforms, learning materials, and resources to learn anywhere and anytime. The panel expanded the definition of redesigning learning spaces from a trend accommodating more active learning in the physical classroom to one that includes attention to the learner experience in emerging learning spaces programmed into extended reality (XR). Similarly, expanding access and convenience was evidenced in a topic new to the report: modularized and disaggregated degrees. The panel anticipates more opportunities for individual learners to transcend traditional pathways by blending formal education with modularized online coursework that is credit bearing or otherwise accepted as valid in the workforce.

The trends in this year's report also demonstrate the panel's agreement that embracing innovation in higher education at the campus level will influence the ways in which institutions approach their core mission. Innovative approaches to new degree programs show that institutions are seeking to connect diverse disciplines while maximizing existing programs, as evidenced by the rise in interdisciplinary programs. Likewise, the emergence of incubators and entrepreneurial partnerships with colleges and universities provides students with the opportunity to embrace "failing forward" as campuses adopt a culture of experimentation.

The trends are sorted into three categories along a time continuum. Long-term trends typically have already been affecting decision-making and will continue to be important for more than five years; mid-term trends will likely continue to be a factor in decision-making for the next three to five years; and short-term trends are driving educational technology adoption now but will likely remain important for only one to two years, either becoming commonplace or evolving to create a new iteration of a previous trend.



Rethinking How Institutions Work

Summary

Institutions of higher education are actively developing new strategies to rethink how they fulfill their mission. Economic and political pressures have heightened scrutiny of the merit of a postsecondary education, especially in light of cost, access, and workforce readiness. Increasingly diverse student populations have added momentum to the attention paid to student success—attention that is frequently focused on low completion rates and high student loan debt. Not only are students more diverse, but a specific aspect of that diversity is the "new majority learner," who is older, is more likely to be balancing work and family with college, and has vastly different needs from those of a traditional-aged student navigating a residential college experience. Institutions of higher education are rethinking how to meet the academic and social needs of all students seeking credentials or degrees. This shift to student-centered learning requires faculty and academic advisors alike to act as guides and facilitators. Approaches to new degree programs, including the rise in new forms of interdisciplinary studies, indicate that institutions are seeking to provide students with experiences that connect disciplines while rethinking how to capitalize on existing resources.

Panel Perspectives

"Rethinking How Institutions Work" was primarily framed as a gradual evolution rather than a disruption of current practices, including increasing the use of both synchronous and asynchronous online learning. Participants identified and agreed on multidisciplinary approaches to learning. Panelists also discussed that higher education should move toward an approach that prioritizes "what workers need"—specifically, skills for jobs.

Higher education's **reputation and relevance** is a trend that is taking hold in higher education, influencing the IT strategy at **41%** of institutions.

—EDUCAUSE Trend Watch, 2019

"I think interdisciplinary approaches for innovation/entrepreneurship will lead higher education to become more daring in the interest of authentic learning. Those that fail with next gen student-centered programs will retreat to old modes…remember independent study?"

—Victoria Mondelli

"Ultimately I think the credit hour as unit of measurement needs to change, but that will take radical rethinking about the creation and administration of tests, which currently are resource-intensive and a very subjective affair."

—Deone Zell

Further Reading

Rethinking the Undergraduate Business Model

educau.se/rebusmod

This article explores four assumptions worth rethinking: students generally attend campus; when fees are paid, they are paid directly to the university; the default setting remains full-time study; and all the credits for a qualification usually come from the same provider.

Aligning the Strategic Campus Plan with the Institutional Mission in 2030: University Campuses as Complex Adaptive Assemblages

educau.se/scp2030

A forecast about how campuses might evolve between now and 2030, this study views the university as a "complex adaptive assemblage" and provides recommendations to form a cohesive idea of how the separate parts might come together to inform the future of higher education.

Renewal and Progress: Strengthening Higher Education Leadership in a Time of Rapid Change

educau.se/renprostr

The ability of higher education to flourish will require an expanded and more diverse pool of talented individuals who aspire to and are prepared for the college presidency.

Modularized and Disaggregated Degrees

Summary

Models of education have emerged that provide individual learners with options for education and training that transcend traditional pathways to degrees and other credentials. Opportunities for learners to blend their formal education with modularized online coursework, at an affordable cost, are establishing a learning continuum along which an evolving workforce can easily upskill. Badges and certificates provide prospective employers with evidence of skills gained through a wide range of educational opportunities and venues. While some contend that these competing models of education will destabilize or replace the traditional campus system, others believe modularization and the opportunity for learners to "build their own degree" will increase the odds for students to succeed by combining traditional and nontraditional degree paths. Institutions that develop partnerships with online course providers or otherwise create a variety of options for students to master content at their own pace are responding to the needs of learners who want more control over learning pathways when earning a certificate or a degree.

Panel Perspectives

This topic was suggested by a panelist in order to merge several topics from previous reports into a single topic. Melding elements of the topic Competing Models of Education with the topic Formal and Informal Learning, this trend focuses on learner options and the ability to "create one's own major." Panelists discussed the future of MOOCs, microcredentials, and badges as forms of modularized/disaggregated degree or certificate options that enable learners to have more control over their learning path.

Only **2%** of institutions have deployed **digital microcredentials** (including badging) institution-wide, but **29%** are expanding or planning their use.

—EDUCAUSE Strategic Technologies, 2019

"We have a research project at Leeds on unbundling, and we have now credit-based courses [open platforms]. I like the idea that I could study a master's by picking and choosing five or six modules from different institutions covering different areas."

—Catherine Wilkinson

"The call was coming from inside the house.' It's important to note that some of these alternatives occur within traditional institutions, as well as outside of them. The competition can be internal."

—Bryan Alexander

Further Reading

National Programme for Technology Enhanced Learning

educau.se/nptelol

This open platform is a joint initiative funded by the Government of India Ministry of Human Resource Development with support from Google to offer online courses and certification in various topics. Courses are free; learners a charged a fee to write an exam and get a certificate.

Unconventional Charles Sturt University Engineering Program Named One of the Best in the World

educau.se/csuengbst

Charles Sturt University Engineering delivers a highly student-centered and experiential education using an adaptive courseware platform and a competency-based approach. The CSU degree blends project- and problem-based learning with self-directed study via a network of online, on-demand learning topics for which students must demonstrate mastery.

The Unbundled University: Researching Emerging Models in an Unequal Landscape

educau.se/unbuni

This collaboration between the University of Leeds and the University of Cape Town examines the increasing disaggregation of curricula and services, the affordances of digital technologies, the growing marketization of the higher education sector itself, and the deep inequalities that characterize both the sector and the contexts in which they are located.

Advancing Cultures of Innovation

Summary

Though not yet common across institutions, full-scale incubators are nonetheless a trend in higher education as institutions seek innovative solutions that provide students with experiences that better prepare them for the workforce. This trend goes beyond innovations related to institutional operations, creating an opportunity for institutions seeking to establish a culture of innovation for their learners. These entrepreneurial campus partnerships provide students with the chance to learn skills beyond conventional disciplinary knowledge and focus on workforce preparedness, giving graduates an advantage when they enter the job market. Venture labs, incubators, and other forms of business partnerships encourage industry collaboration and enable student experiences to iterate beyond traditional education. Significantly, the opportunity to embrace "failing forward" as a construct of innovation nurtures a culture of experimentation. Faculty have the chance to incorporate dynamic experiences into their coursework, and students who enter the workforce with the exposure gained from the entrepreneurial mind-set are more prepared for rapidly evolving business sectors.

Panel Perspectives

The most commonly discussed theme among the panelists was "learning from failure," both for students and faculty. However, panelists also noted that the culture of higher education often does not accept "failure" for innovative activities, such as teaching initiatives. Another theme was partnerships with business organizations outside of higher education to spur implementation or to adopt business models to increase innovation.

Moving from transactional to **strategic vendor–institution relationships** is a trend that is taking hold in higher education, influencing the IT strategy at **41%** of institutions.

—EDUCAUSE Trend Watch, 2019

"Campuses have introduced innovation, creative, and venture labs to foster exploration, but in many cases, these remain outside of the curriculum. While these contribute to the overall entrepreneurial spirit on campus, few educators incorporate these approaches in their courses or academic programs. Going forward it will be interesting to follow up on whether there is a transfer (and to what degree) that permeates more deeply into the academic, curricular, and assessment domains."

—Maya Georgeiva

Further Reading

5 Amazing College Incubators

educau.se/startcuinc

This *Forbes* article reviews the top five campus-based incubators and makes the case that students who launch their projects at a university-located incubator are more likely to succeed as entrepreneurs.

The Contribution of Higher Education-Based Technology Start-Up Incubators to the Co-Production of Knowledge, Innovation and Growth: Experiences from the Edge

educau.se/sgstrinc

This *Industry and Higher Education* article outlines the challenges involved in attempting to evaluate the contribution of the higher education technology start-up incubator process and advocates for a theory-based evaluation methodology as a possible solution for effective evaluation.

Innovation Hubs and Incubators Drive Academic Research to Commercialization

educau.se/inhubinc

Users of innovation hubs want facilities that focus on entrepreneurship, creativity, and innovation; foster interdisciplinary collaboration and partnerships; offer responsive and flexible spaces; create a spirit of ground-up innovation; support commercialization of ideas/products; and connect to nearby universities.

Growing Focus on Measuring Learning

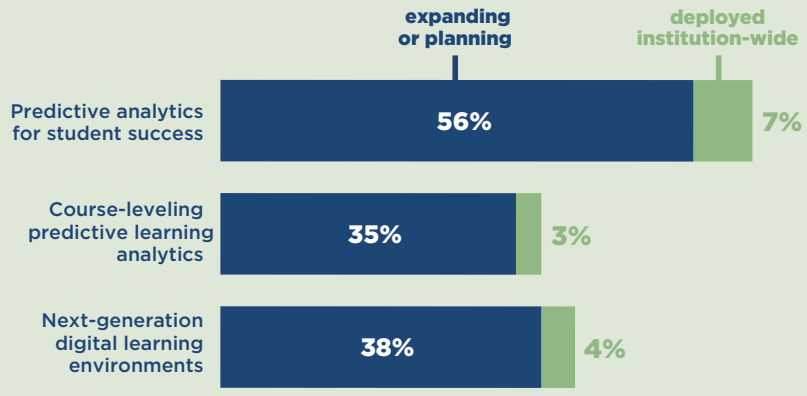
Summary

The methods and tools that institutions use to capture and measure academic readiness, learning progress, and other indicators of student success have matured as courseware products and platforms have gained widespread use. The expanse of data generated by increasingly integrated digital learning environments, together with emerging open standards for learning data, offers institutions new opportunities to assess, measure, and document learning. Although the quantity of data generated provides institutions with broad information to meet the needs of a diverse population of learners, leveraging rich data from across multiple platforms also creates challenges. Understanding how to use learning analytics to inform student progress may be elusive for campus leaders and faculty alike because the need to distinguish between different types of learner data is a relatively new skill. Further, the heightened need to interact with institutional research units and the expanded role of teaching and learning centers call for a rethinking of departmental collaboration. Preparing for a more data-centered approach to teaching, learning, and advising will require a strategy to upskill key institutional roles and develop a clear understanding of what is being measured across multiple platforms.

Panel Perspectives

Panelists discussed the need to separate engagement from assessment. For example, engagement with materials (as measured through clicks on web pages) is not necessarily translatable to assessments (what students have learned). As one panelist stated, "Looking at (or clicking on) something is not a proxy measure of learning."

Deployment status of particular technologies in higher education:



—EDUCAUSE Strategic Technologies, 2019

"I agree that data does not speak for itself. More analysts in IR offices, teaching and learning centers, and other units are needed to help administration and faculty understand the trends in student learning and respond to them thoughtfully."

—Victoria Mondelli

"Learner analytics serves as only a small portion of a bigger picture. Remember the blind men and the elephant story—by only looking at a small section, none could accurately describe the elephant."

—Yvette Drager

Further Reading

How Higher-Education Institutions Can Transform Themselves Using Advanced Analytics

educau.se/heitransaa

Many college and university leaders remain unsure how to incorporate analytics into their operations. This article outlines challenges and best practices, as well as how insights from data may spur significant changes in culture, policy, and processes.

Predictive Analytics: Nudging, Shoving, and Smacking Behaviors in Higher Education

educau.se/preanabeh

With predictive analytics, colleges and universities are able to "nudge" individuals toward making better decisions to enhance their probability of success.

Predictive Analytics in Higher Education: Five Guiding Practices for Ethical Use

educau.se/preanahe

It is crucial for institutions to use predictive analytics ethically because without ethical practices, student data could be used to curtail academic success rather than help ensure it.

Redesigning Learning Spaces

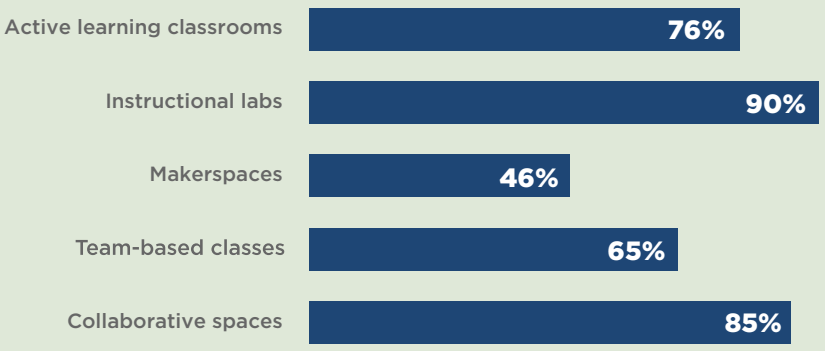
Summary

The transition to active learning classrooms and spaces in higher education has gained considerable momentum in recent years. Designing and evaluating spaces that facilitate active learning and collaboration require investments and strategic planning to renovate or construct classrooms, libraries, and common spaces where learning takes place. Although efforts often focus on the elements of redesigned learning spaces—such as wireless bandwidth, display screens, flexible furniture, varied writing surfaces, and abundant power—obtaining stakeholder buy-in and transforming pedagogical approaches are equally significant considerations. Faculty, students, instructional designers, IT staff, and facilities personnel are some of the key stakeholders in the redesign of academic spaces. Physical learning space design is considered a short-term trend, yet a commensurate focus on virtual learning spaces may be further out on the horizon. Many online platforms have bundled solutions to facilitate team-based learning and synchronous meeting spaces, yet emerging learning spaces programmed in extended reality (XR) have the potential to create more engaging and personal experiences for learners than any current developments in online course design.

Panel Perspectives

The most frequent discussion among panelists concerned faculty development and retraining faculty to adopt pedagogy for active learning classrooms (ALCs). Panelists also discussed how ALCs need to have a flexible design to incorporate different pedagogical approaches and low-tech approaches. Collaborative design processes were identified as the best approach to repurposing traditional classrooms for ALC use.

Technology-enhanced spaces that are provided by colleges and universities:



—CDS data as of March 8, 2019, for US institutions with Carnegie Classifications of AA, BA, MA, or DR.

"A distinction needs to be made between active learning classrooms (ALCs) and technology-enhanced active learning classrooms (TEALCs). The first requires flexibility in design, fixtures, and fittings, whilst the latter adds a layer of technology into the mix. Both can facilitate different ways of learning and teaching (including traditional lecturing!), but they are not one and the same thing."

—Damian McDonald

"We've been doing a good job of redesigning physical learning spaces. The challenge is to genuinely understand that the virtual campus is just that! A learning space and one, moreover, that will need to be appropriately invested in to ensure curriculum and instructional design excellence."

—Kevin Ashford-Rowe

Further Reading

Promoting Active Learning in Universities

educau.se/euaproacle

Active learning provides possibilities for both students and teachers to redefine learning in higher education and to move beyond comfort zones into collaborative learning and co-creation of knowledge.

Function Follows Form: How Two Colleges Redesigned the Classroom for Active Learning

educau.se/fff2colacle

Indiana University and the University of Central Florida are leveraging the expertise of facilities and information technology staff to support the redesign of classroom learning experiences.

Learning Space Rating System

educau.se/lsrs

The Learning Space Rating System (LSRS) project provides a set of measurable criteria to assess how well the design of classrooms supports and enables active learning.

Blended Learning Designs

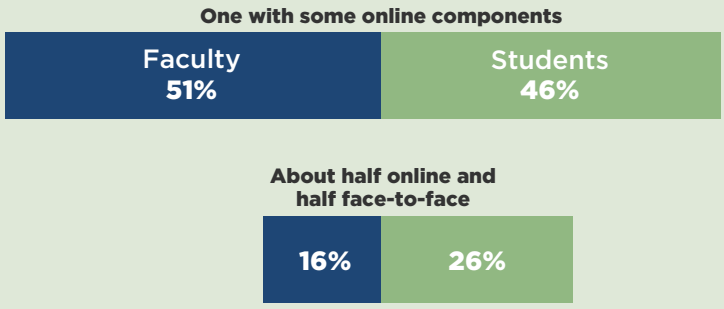
Summary

Blended learning designs have steadily increased as a favored course delivery model alongside fully online options. Previously defined by the proportions of face-to-face versus online coursework, blended learning is typified by the integration of those digital solutions most applicable for achieving the learning outcomes of the course. Media-rich digital learning platforms, personalized or adaptive courseware, and web conferencing tools capable of connecting students for synchronous distance activities are becoming common solutions for blended learning designs. Students report a preference for blended learning, citing flexibility, ease of access, and the integration of sophisticated multimedia. Although blended learning is becoming a common course design, the challenges of scaling this modality persist for some institutions. Supporting faculty to design learning experiences that take full advantage of digital platforms and to expand their pedagogical repertoire to include collaboration and student-centered learning design will support the growth of blended learning.

Panel Perspectives

A common theme among several panelists was that blended learning was a "foregone conclusion" and not necessarily a trend, since it is now an established component of higher education. However, panelists also discussed how increasing faculty's use of more complex or sophisticated blended approaches was a trend. For example, several panelists observed that increasing faculty professional development in blended learning to incorporate more innovative approaches was an important trend in order to refine uses of blended learning environments.

Type of **learning environment** in which faculty prefer to teach and students prefer to learn:



—2017 Faculty Study and 2017 Student Study

"The transition from face-to-face to a blended model for faculty can be daunting. As an administrator, this is a challenge for me in that moving to a blended model, for effective design, includes training and educating faculty, which takes time and resources. I do believe that this is a key topic for institutions, as student surveys indicate that students do like this model in many instances."

—Connie Johnson

"I would say that everyone here is likely to be a proponent of blended learning (done right), but there are still so many faculty who still believe 'chalk and talk' is the best and continue to only lecture, despite having a lots of tools that could help them enhance the learning process."

—Lisa Koster

Further Reading

Innovating with Purpose: The Blended Flow Toolkit for Designing Blended/Hybrid Courses

educau.se/bleflotkt

When faculty at Seattle University asked for additional support designing blended courses that successfully integrate online and classroom learning, instructional designers at the Center for Digital Learning & Innovation created an interactive Blended Flow Toolkit to assist with that request.

The Blended Learning Design Framework

educau.se/bldfrmwrk

Three design approaches to blended learning are provided in this framework for staff at City University London on how to approach the design for blended learning modules. Best practices are directly mapped to potential challenges, providing guidance for implementing the framework.

Development of an Institutional Framework to Guide Transitions into Enhanced Blended Learning in Higher Education

educau.se/enhbldlrn

This study assesses the response of one higher education institution to the changing digital landscape and its transition into enhanced blended learning.

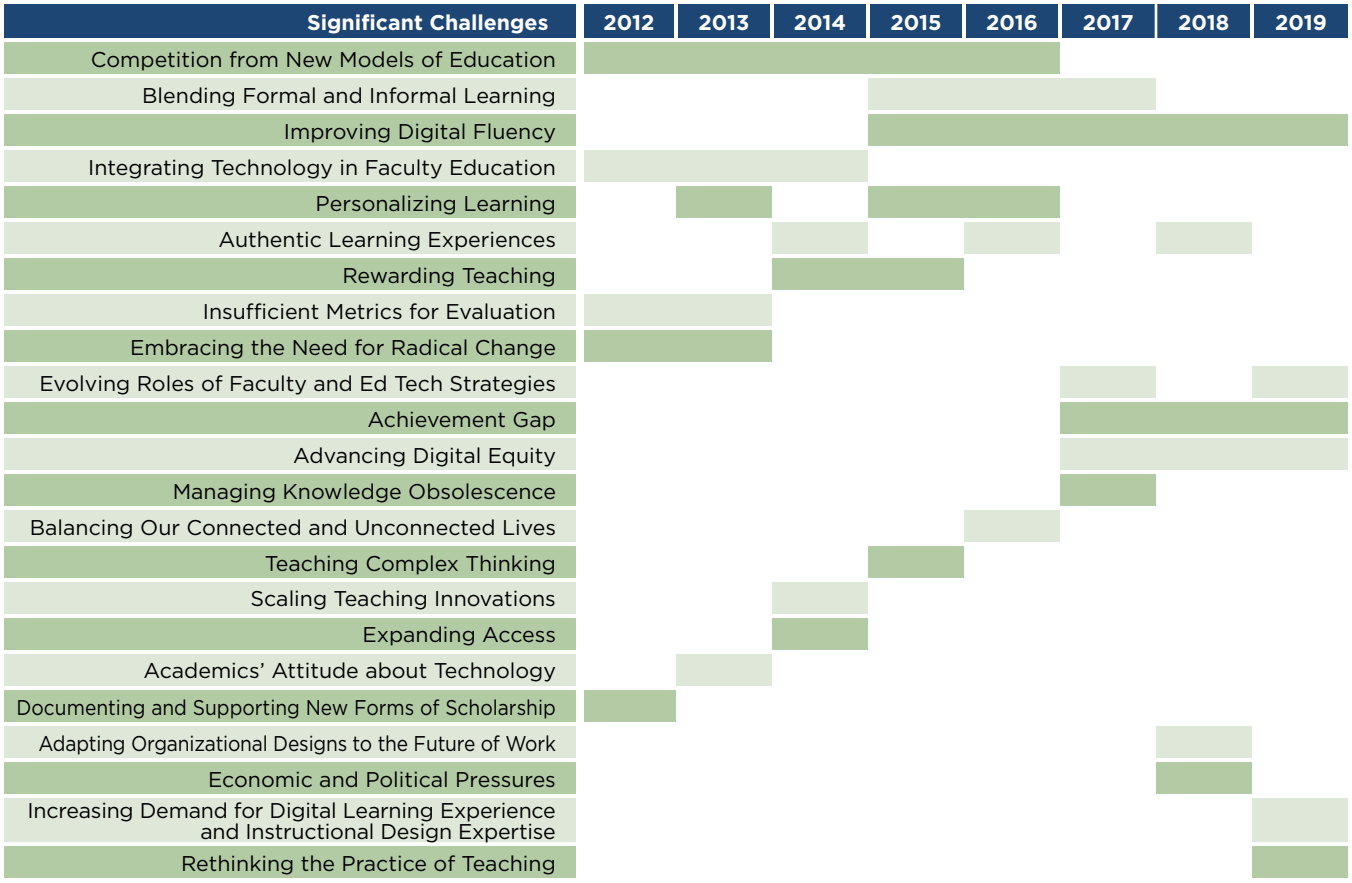
Significant Challenges Impeding Technology Adoption in Higher Education

Significant challenges are those that are expected to impede innovation, adoption, or scale. As in the trends section, the six challenges discussed here were selected by the expert panel after reviewing recent publications and exchanging dialogue. The challenges are recapped using the engagement among the international expert panel.

This year's trends reflect a focus on improving the teaching profession, and that theme is even more evident in the challenges. Two disparate topics related to faculty were highly voted by the panel, indicating the difficulty faced by institutions in supporting a changing teaching population. First, the challenge of equitably including faculty and adjuncts in the strategic planning for campus initiatives was evident in the difficulty institutions face in establishing buy-in at the early stages of planning or procurement. Also related to faculty is the changing practice of teaching and the complex barriers institutions must overcome when seeking to design faculty support that is not bound by location or time.

Digital fluency emerged in the report this year as an evolution of digital literacy from previous reports. The panel agreed that more nuanced skills of co-creation, in combination with the ability to leverage continuously evolving technologies, constitute competencies beyond what we once considered as literacy. This theme is included in the new topic related to instructional design expertise, as panelists agreed that the focus is moving away from training faculty to be digitally literate and toward a new emphasis on partnering with teams of specialized learning designers. Similarly, the challenge of digital fluency is apparent in the complex factors related to global digital equity. While equity of access is the central theme of this topic, panelist discussion associated with an individual user's ability to create content and collaborate in a distributed environment was considered an essential skill in the advancement of digital equity.

The significant challenges are organized into three difficulty-related categories based on expert panel assessment of the degree to which each could be solved at the institutional level. Solvable challenges are those that we both understand and know how to solve (though we seemingly lack the will); difficult challenges are generally well understood but for which solutions remain elusive; and wicked challenges, the most difficult, are complex even to define and thus require additional data and insights before solutions will even be possible.



Improving Digital Fluency

Summary

Digital fluency is the ability to leverage digital tools and platforms to communicate critically, design creatively, make informed decisions, and solve wicked problems while anticipating new ones. Merely maintaining the basic literacies by which students and instructors access and evaluate information is no longer sufficient to support the complex needs of a digitally mediated society. Learning solutions are designed and deployed using increasingly sophisticated technology, creating a need for learners to gain new skills to meaningfully engage with those tools. Digital fluency requires a rich understanding of the digital environment, enabling co-creation of content and the ability to adapt to new contexts. Institutions must not only support the uses of digital tools and resources by all members of the organization but also leverage their strategic technologies in ways that support critical thinking and complex problem solving.

Panel Perspectives

Among the panelists' responses, there was agreement that digital fluency was different from digital literacy and that this distinction should be emphasized. Additionally, panelists discussed how challenging it can be to measure digital fluency.

66% of students agree or strongly agree that the **technological skills** they develop in their courses now will adequately prepare them for their careers.

—2018 Student Study

"In developing digital literacy skills, students learn to use the tools of the future to solve ubiquitous problems related to whatever their future careers might be. This becomes a philosophical quest as much as skills development, emphasizing that users should not become slaves to the technology."

—Kevin Forgard

"Digital literacy relates to how people are negotiating pathways within their respective contexts. It is more than skills and competencies; it's about socially situated practice."

—Cheryl Brown

Further Reading

Digital Fluency: Preparing Students to Create Big, Bold Problems

educau.se/erdigflu

Digital fluency is viewed through the capacities of curiosity, communication, creation, data, and innovation.

Digital Competence and Digital Literacy in Higher Education Research: Systematic Review of Concept Use

educau.se/dicodili

This paper presents a systematic review of global research in which the concepts of digital competence and digital literacy are used in higher education research. It aims to establish an understanding of digital competence and digital literacy over time, disciplines, countries, method, and level of analysis.

Digital Literacy in Higher Education: A Report from the University of Rhode Island Winter Symposium

educau.se/uridlhe

This report documents the challenges and opportunities regarding the future of digital literacy on college campuses, outlines the research needed in this area, and recommends new approaches to professional development that may advance digital literacy in higher education.

Increasing Demand for Digital Learning Experience and Instructional Design Expertise

Summary

The growth of instructional design services and the increased use of dedicated course design teams are characteristic of nearly all institutional types. The shift to active learning and the measurement of course quality through rubrics like Quality Matters have resulted in a major shift in focus away from training faculty in the use of technology and toward a new emphasis on course development with teams of specialized learning designers. Knowledge of learning design includes design-thinking approaches to course content and engaging activities, as well as applying principles of universal design to develop content in multiple modalities to ensure access for all students. Demand is growing for instructional design expertise to assist faculty and other subject-matter experts in the development and implementation of adaptive learning platforms, competency-based learning pathways, the gamification of learning experiences, the integration of virtual or augmented reality, and other digital learning innovations. The demand for digitally rich learning environments and pedagogically sound learning experiences will continue to increase, and those institutions investing in learning designers and instructional designers will be better positioned to create rigorous, high-quality programming that serves the needs of all learners.

Panel Perspectives

Panelists discussed the essential role of faculty as part of a cross-functional team in the effort to design or redesign courses or programs. Trust between faculty and instructional designers was cited as a driver of success in these initiatives. Another theme in this discussion was panelists' suggestion that faculty should also be trained in instructional design.

42% of faculty rate their experiences with **individualized consultations for using technology in teaching** (course design, assignment development, assessment and evaluation, etc.) as good or excellent.

—2018 Student Study

"The pilot group of innovators who will deliver the exemplar set of courses is deliberately made up of teams including program directors, primary course convenors and their instructional design team, as well as university-level IT and learning and teaching leaders and student focus groups."

—Danielle Logan

"In one institution [that changed] tenureship for professors [to] include innovative use of technology and learner-centered approaches, the ability for designers to share that we can help faculty fulfil one requirement for their tenureship helps us immensely."

—Mohamad Ridwan

Further Reading

Building a Collaborative Instructor-Instructional Designer Relationship

educau.se/colinsdes

This article highlights the collaborative nature of the relationship between faculty members and designers while emphasizing the need for clear roles.

State of Instructional Design

educau.se/futinsdes

This report discusses the role, workflow, and experience of instructional designers, with attention to the opinions instructional designers have of their backgrounds, experiences, and roles.

Instructional Design: Demand Grows for a New Breed of Academic

educau.se/chronid

This trends report cites the growing demand in higher education for instructional designers who are technically adept, fluent in design, knowledgeable about pedagogy, and diplomatically skilled.

The Evolving Roles of Faculty with Ed Tech Strategies

Summary

At institutions of any type or size, involving faculty in the selection and implementation of educational technologies can be difficult. Whether an institution is implementing a new courseware platform for the purpose of personalizing learning or building a completely new program by applying a pedagogical approach such as competency-based learning, such efforts face a range of challenges. Identifying learning outcomes and engagement strategies before identifying educational technology solutions creates an advantage by establishing faculty buy-in at the earliest stages of a strategic initiative. The role of full-time faculty and adjuncts alike includes being key stakeholders in the adoption and scaling of digital solutions; as such, faculty need to be included in the evaluation, planning, and implementation of any teaching and learning initiative. Institutions that address the needs of all faculty through flexible strategic planning and multimodal faculty support are better situated to overcome the barriers to adoption that can impede scale.

Panel Perspectives

Panelists observed that in order for faculty to fully engage in educational technology, training and professional development should be provided to facilitate incorporation of technology. In addition, panelists agreed that adjunct faculty also need to be considered in professional development. One panelist noted that workshops that include both faculty and students could enable learning for both groups of stakeholders. Finally, panelists emphasized that frameworks for tech implementation and prioritizing tech that offers high ROI should be a guiding principle for institutional tech adoption for faculty use.

40% of faculty rate their experiences with **professional development around the integrated use of technology in teaching**, whether face-to-face or online (e.g., technology training opportunities, incentives, and professional advancement), as good or excellent.

—2017 Faculty Study

"[Professional development] is important, but often it's only for full-time faculty; if part-time/sessional instructors take part, it's on their own time. How do we support the part-time/sessional instructors who are paid by the teaching hour? Our school is trying to ensure that instructors are given paid PD opportunities, but it's still not enough."

—Lisa Koster

"Shouldn't this decision-making process [technology adoption] involve faculty at its heart? (And by the way, students too?) And if key faculty are involved in evaluation/selection, I think you've lowered at least a few of the barriers to entry."

—Jim Julius

Further Reading

The Faculty of the Future

educau.se/iheshavis

This article discusses how to professionalize all faculty through ensuring academic freedom, inclusion in shared governance, professional development, and a system of promotion and decision-making related to curriculum and students.

The Delphi Project on the Changing Faculty and Student Success

educau.se/uscdelphi

The Delphi Project provides tools and resources to help create new faculty models and better support faculty off the tenure track to enhance higher education institutions.

A Non-Tenure-Track Profession?

educau.se/ihetnrtrk

A report from the American Association of University Professors found that roughly three-quarters of all faculty positions are off the tenure track. This move away from tenured positions raises concerns about academic freedom and the ability of faculty to do their jobs well.

Achievement Gap

Summary

The growing focus on student success across institutional types indicates the importance of addressing the achievement gap in higher education. The ability to define and measure student success remains elusive; recent initiatives designed to increase course and program completion focus on digital solutions. The cost of college and course materials also contributes to the achievement gap. Open educational resource (OER) initiatives have proliferated in recent years, and OER materials are maturing beyond curated, openly available content to include sophisticated digital platforms authored with open content. Institutions are adopting adaptive courseware, personalized learning pathways, and digital tutoring solutions to provide students with immediate feedback and more access to content designed to help them master course material. Despite these options, degree completion in higher education is stymied by factors that go beyond these efforts, and closing the achievement gap continues to be a difficult challenge.

Panel Perspectives

Panelists identified factors that needed to be overcome to close the achievement gap. These included access to high-speed networks and to hardware beyond personal mobile phones. Some panelists noted that some students only have access to computers and internet access in public spaces or campus libraries. A few panelists also observed that these disparities were very apparent in community colleges. One panelist disagreed with the premise that a postsecondary degree is necessary for employment and argued that employers should rethink this requirement; this may contribute to the pressure individuals feel to attend college when they may be able to engage in rewarding careers without a degree.

15% of institutions have deployed **integrated student success planning and advising systems** institution-wide, and another **53%** are expanding or planning them.

—EDUCAUSE Strategic Technologies, 2019

"Hardware access is also wildly uneven: smartphones are by no means ubiquitous, even in wealthy nations; ditto for larger and more powerful devices."

—Bryan Alexander

"Bringing personalized learning solutions to the higher education system will require major system changes from colleges and universities around the world. We have no time to waste in unlocking student success. Students deserve the environment and support that will help them reach their full potential and earn their higher education certificate."

—Chun-Yen Chang

Further Reading

The Bologna Process Looks towards Its Third Decade: Enhancing Achievements and Responding to a Changing Context

educau.se/euabologna

As the Bologna Process looks towards its third decade, EUA has published a statement focusing on how to further the process's achievements and enhance its ability to respond to a changing higher education landscape.

How Personalized Learning Unlocks Student Success

educau.se/erpluss

Technology provides higher education with tools that can tailor the learning experience to the individual, help at-risk students master core skills, develop guided pathways that assess students' progress toward graduation, and suggest interventions if challenges arise along the way.

Optimizing Technology's Promise

educau.se/eropttecpro

How can we be proactive as we optimize the promise of technology to anticipate and meet the needs of the diversity of students, faculty, and staff today and in the future?

Advancing Digital Equity

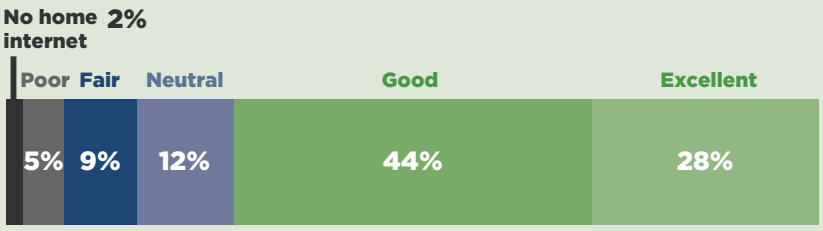
Summary

Digital equity refers to comparable access to technology, particularly to broadband connectivity sufficient to access unbiased, uncensored content and to enable full participation on the World Wide Web. Broadband access remains globally unequal across variables such as income, education, gender, age, ability status, and native language, as well as national, regional, and cultural dimensions. This complex fabric of factors has implications for access to education for instructors and students alike. UNESCO has created aspirational goals for global internet access, and the organization has released a second draft of its Internet Universality Indicators that includes a framework by which nations and international agencies can gather evidence of an open and accessible internet that advances digital equity and inclusion. Access to information and means of expression, as well as the ability to participate in governance, business, and commerce, are essential to the advancement of digital equity.

Panel Perspectives

Panelists primarily discussed the digital divide they've experienced when some students (particularly in rural areas) do not have access to broadband, high-speed internet. Panelists also said that public policies that favor privatization over government-funded infrastructure improvements will likely not lead to increased access and improved infrastructure due to businesses not prioritizing equity. One panelist stated that a combination of NGO and government strategies would be the best strategy to increase broadband infrastructure in underserved areas.

Students ratings of their **experiences with internet connection** at home/off-campus residence over the past 12 months:



—2018 Student Study

"It goes beyond just access and bandwidth to whose voices are dominant online and whose are excluded or invisible due to a range of complex issues. I am reminded of this frequently. For example, I have a Chinese PhD student, and I am constantly blown away by the literature she brings to discuss that I have never seen or heard about because it is published in spaces (and a language) I don't have access to."

—Cheryl Brown

"Communication on the internet will need to be open, and that is going to be a challenge for corporations and governments alike. The behavior of these actors will impact academia in a big way."

—Jason Smith

Further Reading

Digital Inclusion

educau.se/ihpbriefdi

This Mozilla brief is part of a series intended to provide more depth into Mozilla's thinking and actions on five key issues that comprise internet health, with the objectives of educating, guiding, and inspiring action.

UN Special Rapporteur Analyses AI's Impact on Human Rights

educau.se/unaiimphr

This post reviews the United Nations Special Rapporteur for the promotion and protection of the right to freedom of opinion and expression. The report provides an overview of the implications of artificial intelligence (AI) technologies for human rights and lays down a framework for a human rights–based approach to these new technologies.

Defining Internet Universality Indicators

educau.se/unescoiuiv2

UNESCO has developed a framework of Internet Universality Indicators to assist governments and other stakeholders in assessing their national internet environments and developing policies to advance these principles.

Rethinking the Practice of Teaching

Summary

Teaching practices in higher education are evolving, as student-centered approaches to instruction play a growing role in course design. The shifting nature of the instructor—from transmitter of knowledge to facilitator and curator—has accelerated the need for strategically planned faculty support and a reevaluation of the role of teaching and instruction. The redesign of courses and programs to take advantage of digital tools enables instructors to evaluate their teaching practices and use student-centered approaches to facilitate learning. Professional development supporting the use of digital tools has evolved into collaborations with instructional design teams and other professionals in the learning science field, accelerating the application of new teaching practices. Without sufficient access to sustained support and the tools and resources essential in the design of a student-centered environment, instructors are challenged to create these experiences on their own. Managing the changing practice of teaching requires that institutions intentionally design faculty support that is not bound by location or time.

Panel Perspectives

The panelists who offered in-depth responses argued that—similar to the challenge Evolving Roles of Faculty—support needs to be provided and perhaps included in assessment of tenure promotion.

In 2019, **understanding and advancing technology's role in optimizing the faculty experience** (as teachers, researchers, advisors, and more) just missed the Top 10 list, ranked at #11.

—EDUCAUSE 2019 Top 10 IT Issues

"This is one shift in the changing roles. I often think of the change to facilitator, coach, mentor, champion, assessment creator, and even curator!"

—Shannon McCarty

"I think this is intertwined heavily with the impact area of 'Improving the Teaching Profession,' as assisting educators in leveraging new tools and adopting new pedagogies (and even, at times, their teaching philosophy) requires support, rewards, and more inclusion in the tenure and promotion process (as well as reaching and meeting needs of non-tenure-track instructors)."

—Nicole Weber

Further Reading

Does Innovative Teaching Work? A New Effort Aims to Help Faculty Find Out

educau.se/esinnovte

Many professors try new teaching approaches or new digital tools in their classes, and Duke University and Carnegie Mellon University are releasing templates and best practices for getting expeditious IRB approval for classroom research.

Purposeful Faculty Development: A Q&A with W. Gardner Campbell

educau.se/ctprfcdev

In this interview, Gardner Campbell discusses why faculty development programs, even when they focus on operational, procedural, or technical details, can and should reflect higher education's fundamental values and principles, provide time and space for insight, and encourage deep thinking about higher purposes.

Climbing the Ladder of Empirical Education

educau.se/cliladee

In a series of posts, Michael Feldstein lays out the theory of change an instructor goes through in the process of trying new teaching strategies. As institutions make the transition from a philosophical commitment to student success toward an operational commitment, this theory of change is intended to accelerate that transition.

Important Developments in Educational Technology for Higher Education

The development section of the Horizon Report includes six technologies forecast to be important to teaching, learning, and creative inquiry in the future. These forecasts are arranged along three time horizons over which the developments are expected to achieve widespread adoption: developments expected to scale in one year or less; those forecast to take two to three years to achieve adoption; and those developments that are forecast to enter the mainstream of education within four to five years.

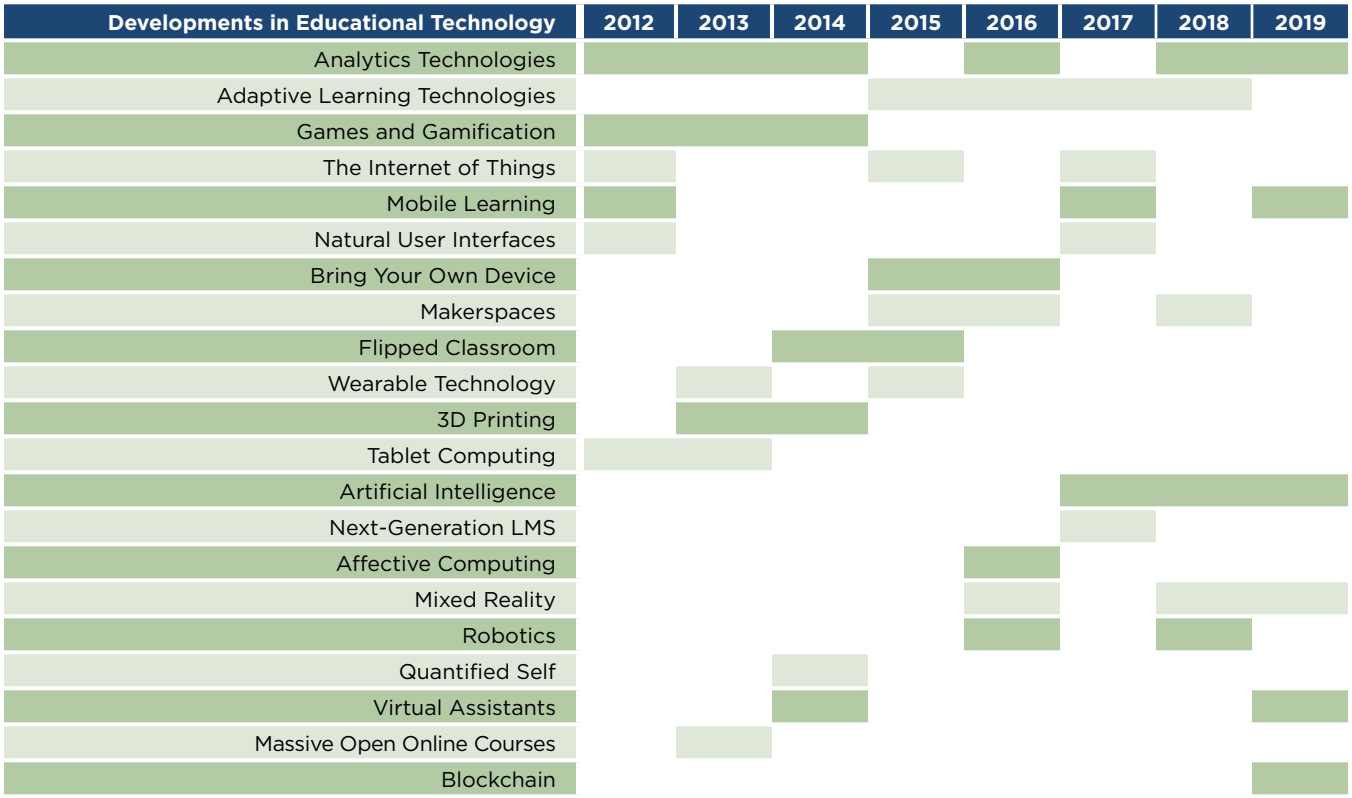
To prompt discussion about technology development forecasts, the panel considered summaries for a set of topics compiled from previous panel engagements. Topics were organized into seven categories of technologies: consumer technologies, digital strategies, enabling technologies, internet technologies, learning technologies, social media technologies, and visualization technologies. These topics and categories inform the framework around which the initial panel discussion is centered. A curated set of recent publications and news articles further directed the engagement among the panelists.

The panel was also prompted to proffer emerging technologies whose applications for higher education institutions may still be distant. An essential criterion for the inclusion of a new topic for the panelists to consider was its potential relevance to teaching, learning, and creative inquiry in higher education.

Significant to this section is that many of the technologies considered by the panel were not developed specifically for education, yet panelists generally agreed that some form of educational application was on the horizon. Panelists were similarly instructed to demote those developments from the topic list that they believed were either subsumed into another development or were otherwise no longer relevant.

Technologies might not get voted by the panel for several reasons. Frequently, the discussion indicates agreement that the development is already in widespread use in higher education; in other cases, the panel engagement around a topic concluded that a development is more than five years away from widespread adoption. Some technology developments, while intriguing, do not have enough credible project examples in higher education to substantiate them.

The technology developments selected by the 2019 Horizon Expert Panel have the potential to expand access and convenience, foster authentic learning, improve the teaching profession, spread digital fluency, leverage data, and spur further innovation. Each of the following essays 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.



Mobile Learning

The modern age of mobile learning sparked by the smartphone and tablet is now over a decade old, and students and teachers today rely on their mobile devices as a vital part of the entire learning experience. Mobile learning is no longer focused directly on apps but instead on connectivity and convenience, with the expectation that learning experiences will include mobile-friendly content, multidevice syncing, and anywhere/anytime access. As mobile devices become more powerful and affordable, and as ownership reaches ubiquity in many countries, the possibilities for engaging learning experiences are becoming limitless. The increased use of augmented reality (AR), virtual reality (VR), and mixed reality (MR) has enabled mobile learning to become more active and collaborative. Creating this quality mobile learning experience takes a lot of effort, however, and as a result remains in the early stages of adoption.

Overview

Mobile learning, also known as m-learning, has existed in some form for decades, starting with the advent of pocket and handheld computers in the 1980s. The modern era of mobile learning matured quickly as smartphones and tablets gained functionality comparable to that of a laptop or desktop computer. Driven by increased access to the internet and worldwide growth of smartphone ownership, cellular mobile devices are, for many, the primary way to interact with learning materials. Beyond the smartphone and tablet, mobile learning will expand to a wider variety of devices including smartwatches, headset displays that support AR/VR/MR, and Internet of Things (IoT) devices.

The capacity for mobile learning centers around the smartphone and to some extent the tablet. Early exploration of mobile learning began with the use of devices to enhance the learning experience through asynchronous activities, content creation, and being a flexible in-class tool for reference and exploration. The asynchronous experience centers around formative learning, such as polls, clickers, and informal feedback. The use of mobile devices has made content creation easier because smartphones and tablets include cameras to take photos and videos and a microphone to capture audio. This hardware, paired with powerful and intuitive mobile apps and increasingly available internet access, has created a revolution of content creation and sharing. With capabilities including Bluetooth, GPS, and NFC, mobile devices can create new interactive and personal experiences. Even the most basic smartphone can be paired with an inexpensive Google Cardboard to create an immersive experience. Powerful apps allow students to quickly reference content or explore a concept in a new way. For example, a student can peel back the layers of the human anatomy or view a 3D model of chemical elements with the touch of a finger.

A driving factor for mobile learning is the ownership of mobile devices, particularly the smartphone. In 2018, the Pew Research Center reported that 59% of adults globally own a smartphone, and research from the EDUCAUSE Center for Analysis and Research indicated that 95% of undergraduate students own smartphones. As mobile device ownership and usage have increased, mobile learning is no longer just focused on asynchronous interaction, content creation, and reference. More emphasis is emerging on content that is responsive instead of adaptive and on creating microlearning experiences that can sync across multiple devices and give learners the flexibility to learn on the device of their choice.

Relevance for Teaching, Learning, or Creative Inquiry

Mobile learning has evolved from an option for supplementing course content with stand-alone applications to a strategic consideration for course access and delivery. The flexibility, convenience, and sometimes the necessity of using a mobile device to access learning content have become drivers in higher education. According to a 2018 study in the United States, 79% of students access online courses through a mobile device, with the most popular feature being accessing course readings. This is further aided by the increasing mobile-friendliness of modern learning management systems (LMS) apps. The trend toward responsive design places a stronger focus on making course content available on all platforms, with mobile being a key consideration.

As the development and design of mobile content become more responsive, institutions have turned their focus toward supporting the integration of mobile design in course development and instructional design. Faculty development increasingly includes learning how to structure content for shorter times on task, selecting mobile-friendly file types and formats, better optimizing files, and communicating to students when content will not be available on a mobile device. These design principles foster a more universal experience for all users, regardless of platform or device. Popular quality assurance

instruments such as the Open SUNY Course Quality Review Rubric (OSCQR) and Quality Learning and Teaching (QLT) include mobile-platform readiness as an essential component of high-quality courses, especially online and blended courses, where these technologies can work together to enhance the learning experience.

Mobile learning frequently includes heightened interactivity with content and collaboration with other learners. College students in a research study in Beijing interacted with iBeacons during a visit to a science museum, and it was found that the mobile prompts guided them to interact more extensively with the exhibits and increased time on task. Instant messaging apps, wildly popular in students' personal lives, also show promise to support social interaction when compared to more traditional interactive tools like discussion boards. As devices have become more powerful, the affordances of mobile learning have grown dramatically in recent years, especially through AR and VR applications that allow learners to experience and experiment in a more authentic way than ever before. For instance, SkyMap allows people to connect astronomy concepts to the real world by holding their phone up to the sky.

According to Frost and Sullivan, 51 percent of employers require employees to use certain apps for their business, up from 27 percent in 2011. With mobile technology being more common than ever in the workspace, preparing students to use such devices is essential. For example, the University of Central Florida (UCF) offers a course called Mobile Journalism in which students learn how to use mobile technology to collect, create, and share news stories.

Mobile Learning in Practice

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

The GLOBE Zika Education and Prevention Project
educau.se/zikaed
Global Learning and Observation to Benefit the Environment (GLOBE) is an initiative for Zika-affected countries by crowdsourcing data on mosquitoes in a global mapping project. This project is supported by the US Department of State.

Gamified Learning Using Kahoot!
educau.se/glkahoot
This University of Memphis project uses an interactive gaming tool accessible from mobile devices to provide instantaneous feedback and class data to keep students motivated.

CloudClassRoom
educau.se/ccrtu
National Taiwan Normal University developed the CloudClassRoom (CCR) mobile platform to transform smartphone devices into powerful interactive tools for classroom learning. CCR enables students to respond to instructors' prompts, and answers are automatically aggregated and analyzed, providing the teacher with a rough picture of student learning progress just in time.

Further Reading

University of Central Florida 2018 Mobile Survey
educau.se/ucfmosu18
The UCF Mobile Survey has been conducted every other year since 2012 and is one of the largest comparison studies available for mobile technologies at a large higher education institution. The report surveys more than 4,000 students for device ownership, usage, and beliefs when using mobile technologies personally, in the classroom, and around campus.

Learning in Bursts: Microlearning with Social Media
educau.se/erlearnbrst
This study investigates the tools and pedagogical practices for effectively creating and delivering microlearning. Given the significant integration of smartphone technology and the influence of social media, the authors recommend using well-constructed assignments connected to course learning goals, created using social media platforms, with care taken for privacy.

Changing Mobile Learning Practices: A Multiyear Study 2012–2016
educau.se/erchgmoblea
Student surveys on device ownership and usage as well as student beliefs about the value of mobile devices for academic work are the focus of this multiyear study. The authors discuss mobile technology usage in higher education and highlight a need for better mobile integration in coursework and institutional strategy.

Analytics Technologies

Analytics technologies are a key element of student success initiatives across institutions and a driving force behind the collaborative, targeted strategic planning and decision-making of higher education leaders. Analytics technologies and capabilities will be an essential component of institutional thriving in the years ahead. Beyond static, descriptive analyses of student learning, grades, and behaviors, analytics capabilities comprise dynamic, connected, predictive, and personalized systems and data. Institutions and institutional leaders will need to develop these advanced analytics capabilities through innovative leadership, new computational technologies and systems, and a highly skilled workforce equipped for understanding and effectively sharing and using large and complex data resources. Analytics done well is a time- and resource-intensive endeavor for any institution, but if executed and maintained successfully, it can transform institutions and deeply enrich student and faculty educational experiences and success.

Overview

Our daily lives are shaped by inflows and outflows of data through our devices and our social and commercial interactions. These interactions are designed to better understand our behaviors, attitudes, and preferences and, in turn, help shape our future with personalized information. Data characterizing our social behaviors—the people we interact with, the places we go, the things we do—combine with others' data to form rich webs of analytic possibilities for civic leaders and corporations in better understanding groups and communities and making better policy, community design, or business investment decisions. Data describing our commercial preferences—our personal wardrobe styles, the TV shows we enjoy watching, the brand of fabric softener we purchase—serve as the guideposts for cultural, entertainment, and business leaders as they seek to divine tomorrow's trends and give shape to our future social, commercial, and political experiences.

More than just serving as drivers of economic or political gain, though, such trends in big data and analytics have had and will continue to have an impact in far more meaningful and important aspects of the individual human experience and in our global communities and environments. Environmental scientists have leveraged advanced data capabilities to monitor global weather patterns and temperature and sea-level trends, better positioning us to make smart decisions with our energy resources and make significant gains in environmental protection. International community development agencies, like the World Bank, have made skilled and systematic use of global economic, political, and crime data to target geographic regions where political and/or humanitarian intervention can help reduce human suffering and improve lives. Indeed, in these and many other ways, analytics capabilities may just help save us all, if we can also learn to tolerate the occasional fabric softener ad in our social media feed.

Whether data are used for business gain or for advancing global human thriving, the rise of data-driven human society has brought with it increased interest and investment in data- and analytics-based competencies, as well as in technologies and systems to help facilitate and improve our complex practices of collecting, analyzing, and interpreting data. In a study released last year ("The Quant Crunch: How the Demand for Data Science Skills Is Disrupting the Job Market"), IBM predicted that in the United States alone, the demand for data-related jobs will see a 28% increase by the year 2020. And in its "Future of Jobs Report 2018," the World Economic Forum identified "data analytics" as one of four major drivers of change in the global labor market. If the future is data driven, those data are (for the time being, at least) built and cultivated by human hands, technologies, and systems.

Relevance for Teaching, Learning, or Creative Inquiry

Institutions of higher education are not insulated from these data-analysis interests and investments. The innovative institutional leader of the future is one who understands the value of dynamic, integrated data systems and enriched analytics capabilities. Such a leader intentionally and strategically fosters an institutional culture that operates and makes decisions through engagement with these systems and capabilities, envisioning a future in which the student experience is highly personalized, more responsive, and, ultimately, significantly more positive and successful. And there is no shortage of institutional data to serve as the foundation of such an institutional culture—from student learning outcomes to student grades, faculty research, employee data, and satisfaction survey data, institutions are brimming with potential for powerful and transformative analytics.

As with the larger global workforce, the higher education workforce has also responded to this

analytics potential with increased investment in data and analytics through human resources as well as technological capabilities. According to EDUCAUSE's 2019 IT workforce report, higher education IT units reported that "business analyst" was one of the most commonly added new positions to their unit within the past year, while CIOs and managers rated "analyzing data to inform strategic decisions" the single most important skill to their own professional growth. Importantly, data-driven and analytics-driven investments and practices don't reside within one department or staff position within the institution but rather are best positioned as a highly collaborative endeavor. Involving multiple stakeholders across all units of the institution, from students and faculty to student affairs and IT to deans and provosts, increases a vested interest in engaging with and taking seriously the responsibilities required and educational potential offered through analytics.

The student experience and educational success should drive the why and how institutions invest in analytics capabilities. Problems relating to recruitment, advising, or teaching and learning can be addressed through resources and technologies that use data and analytics to identify student needs. At the root of institutional data are students with individual needs that vary for each along the path toward certificate or degree completion. Recruitment solutions, advising platforms, and course management systems, when leveraged well, can inform personalized learning pathways or timely interventions. Equally, institutions must wrestle with important questions around student data privacy and seek to implement policies and practices that ethically and securely protect student data. Security and privacy protections require a proactive diligence across the institution.

Analytics Technologies in Practice

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

A Crowdsourced Adaptive Platform for Recommendation of Learning Activities
educau.se/capstrat
University of Queensland's Student Strategy focuses on the development and dissemination of a crowdsourced adaptive platform called RiPPLE that recommends personalized learning resources to students.

Jefferson Competency Assessment Tool
educau.se/jeffcat
The Jefferson Competency Assessment Tool (JeffCAT) is a dashboard product developed in partnership with industry to monitor student performance, and to provide a holistic view of performance to students, faculty, and administration.

Student Relationship Engagement System
educau.se/sresio
The University of Sydney's Student Relationship Engagement System (SRES) is a complete platform that gives instructors full control of the data life cycle from a single web application, from capturing the right data to curating relevant sources, then analyzing and acting on the data, through to evaluating the impact of these personalized actions.

Further Reading

Institutions' Use of Data and Analytics for Student Success
educau.se/datass
While most institutions are currently gathering an abundance of data from multiple sources, it is now more critical for higher education professionals to make data-informed decisions.

Learning Analytics and Student Success – Assessing the Evidence
educau.se/jisclearnana
This Jisc briefing describes a growing number of studies using control groups that show that retention and other measures of student success can be positively influenced by using learning analytics to identify students at risk, combined with an effective intervention program.

Learning Analytics: Avoiding Failure
educau.se/erlearnana
The promise of learning analytics is that educational data can improve the quality and value of the learning experience in schools. In order not to fail, it is necessary to have a clear vision of what you want to achieve with learning analytics, a vision that closely aligns with institutional priorities.

Mixed Reality

At the intersection of the online and offline worlds is an emerging environment known as mixed reality (MR), where digital and physical objects coexist. This hybrid space integrates digital technologies into the physical world and creates virtual simulations of physical spaces, blurring the differentiation between worlds. Virtual reality immerses the user in a simulation, such as the experience of flying or being on Mars. Augmented reality layers information over physical spaces and objects, such as labels and other supplementary data over museum displays. Holographic devices are also being used to create mixed environments, as video displays project 3D images into a physical space: A hologram of Amy Winehouse, who died in 2011, will "go on tour" with a band in 2019, and she is not the first dead celebrity to do so. A key characteristic of MR is its interactivity, which confers significant potential for learning and assessment; learners can construct new understanding based on experiences with virtual objects that bring underlying data to life.

Overview

Mixed reality (MR) is an umbrella term for a range of technologies. Virtual reality (VR) is immersive—the user dons a headset and interacts with an entirely computer-generated environment. Augmented reality (AR) uses a headset or a smartphone to overlay images or other content onto the physical world. From AR, MR deploys overlays, but like VR, these are interactive and can be manipulated. Early MR researchers called this the "virtuality continuum," which spans the fully physical to the fully simulated.

The MR market is growing rapidly, projected to grow to $100-200 billion globally by 2022. MR in education is projected to grow to over $7 billion globally in that time frame. Meanwhile, the cost of VR and AR hardware is declining. A new Oculus or VIVE headset still costs several hundred dollars, but several less expensive options exist, such as Google Cardboard and others that are essentially glorified smartphone holders. A significant limitation of MR in education is that many current educational applications only allow for a small number of users. A few companies, such as ClassVR, have started developing applications that scale up easily for classrooms, including both inexpensive headsets and MR content that can be deployed at classroom scale.

Technology adoption in education often happens in distinct stages, and MR is no exception. Like many new technologies, MR first gained popularity with games. VR games such as Fallout and AR games such as Pokémon GO are well known. AR has also been enthusiastically adopted by museums, both to augment exhibits, as in the Skin and Bones exhibit at the Smithsonian National Museum of Natural History, and augment outdoor tours of cities, such as CHICAGO 00. MR often gets its start on campuses as an initiative. The University of Pennsylvania Libraries' PennImmersive and Yale University's Blended Reality: Applied Research Project are notable examples of campus units and faculty researchers joining forces to explore the potential of MR for research, teaching, and learning. Once the decision is made institutionally to deploy MR technology on campus, it is available to the most users if provided through the library or other campus space open to students. Often the technology is made available in a makerspace or media lab. The North Carolina State University Libraries loans equipment and provides spaces in which to use it. The Miami Beach Urban Studios at Florida International University and The Wilbur Powerhouse at Lehigh University go a step further—they are building-sized makerspace-like facilities, providing a range of technologies, including MR, to the campus and local communities.

Relevance for Teaching, Learning, or Creative Inquiry

MR technologies are well suited for experiential education. Through simulations and 360° video, VR can enable users to visit places they might otherwise not be able to access, such as art museums, archaeology sites, a refugee camp, or Mount Everest, as well as places that are entirely inaccessible, such as on board the *Titanic*, the Mesozoic, or Mars. VR enables users to do things that are impossible in the physical world, such as manipulate entire environments or navigate inside veins and arteries, or that are dangerous, such as training for firefighters. Through overlays, AR can enable users to interact with things that are invisible in the physical world, such as electromagnetic fields.

By dramatically expanding the range of tasks and activities with which a learner can gain experience, MR technology enables experiential learning where it may not have previously been possible. Reflection and self-assessment are also critical aspects of experiential learning but are not necessarily enabled by MR technology. In general, learning goals that can be effectively met using MR are those that benefit from repetition (such as developing clinical skills) or even from simple exposure (such as fear extinction).

For art education, MR enables students to create using materials they might not otherwise have access to. Where computer-aided design was once used in architecture and theater set design, now students can develop design sense using MR to visualize and analyze, model, and remodel entire environments. In fields such as urban planning, biology, and astronomy, students can develop scientific literacy, problem-solving skills, and content knowledge by interacting with simulated objects. For MR to be meaningfully integrated into teaching and learning, it must become familiar to the instructional designers and instructional technologists on campus so that they can help instructors integrate MR into their pedagogy.

Mixed Reality in Practice

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

Virtual Immersive Teaching and Learning (VITaL)
educau.se/vital
The Virtual Immersive Teaching and Learning (VITaL) initiative at San Diego State University provides a variety of virtual reality, augmented reality, and mixed reality immersive tools for use across the pedagogical spectrum.

Parsons Fashion Study Collection in Virtual Reality
educau.se/pfscvr
The XReality Center at The New School and the School of Fashion at Parsons School of Design partnered to create an immersive learning experience featuring a 1920s evening coat.

Virtual Field Trip to Iceland
educau.se/vftice
The Virtual Field Trip to Iceland is a scientific collaboration between New Zealand and Iceland, providing University of Canterbury students connections through geological landscape, hazard management, and geothermal power.

Further Reading

Learning in Three Dimensions: Report on the EDUCAUSE/HP Campus of the Future Project
educau.se/eduhpcotf
This ECAR research report identifies innovative uses of and hurdles in implementing XR technology, and which XR technologies are most effective for achieving various learning goals.

Augmented Reality in Education: A Meta-Review and Cross-Media Analysis
educau.se/sprngraimeta
This meta-analysis of research comparing AR versus non-AR applications identifies a list of positive and negative impacts of AR experiences on student learning, and factors that may cause them.

VR and AR: Pioneering Technologies for 21st-Century Learning
educau.se/vrpioneer
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.

Artificial Intelligence

Artificial intelligence (AI) uses computer systems to accomplish tasks and activities that have historically relied on human cognition. Advances in computer science are creating intelligent machines that functionally approximate human reasoning more than ever before. Harnessing big data, AI uses foundations of algorithmic machine learning to make predictions that allow for human-like task completion and decision-making. As the programming, data, and networks driving AI mature, so does the potential that industries such as education see in its application. However, as AI develops more human-like capability, ethical questions surrounding data use, inclusivity, algorithmic bias, and surveillance become increasingly important to consider. Despite ethical concerns, the higher education sector of AI applications related to teaching and learning is projected to grow significantly.

Overview

Artificial Intelligence made its debut in the Horizon Report in 2017 and has seen increasing news coverage since. From the excitement over self-driving cars to concerns about their safety and to discussions about the social justice aspects AI can bring and the challenges it provides, 2018 was a big news year, and 2019 looks no different. Applications such as Apple's iPhone facial recognition have become more mainstream, while concerns over facial recognition and biometrics used for airport security applications have raised concerns over safety and privacy.

A December 2018 *Guardian* article noted that most school-age children (65%) in 2018 will graduate into a job market comprised of jobs that don't yet exist. Further, a 2017 study in the United Kingdom found that high-tech industries are struggling to recruit and retain highly skilled talent. A 2017 report from the MIT Sloan Management Review found that 85% of industry leaders think AI will give their industries a competitive advantage, but only about 20% have done anything to prepare for this eventuality. While skepticism remains in regard to AI's application to educational contexts, and as fears abound that human instructors will be replaced with artificial intelligence apps or bots, these stories paint a picture of the need for students to have more opportunities to work with AI and gain experience in its use.

More educational AI applications are in practice, such as Watson Tutor embedded into student readings and the beta testing of the Canvas LMS smart reminders to nudge students toward more successful behaviors in online courses. AI seems to offer skills in AI itself as well. As skills in advanced analytics remain undersupplied in the workforce, platforms have begun to incorporate AI as a means of making complex analysis accessible across roles and organizations.

Relevance for Teaching, Learning, or Creative Inquiry

AI's ability to personalize experiences, reduce workloads, and assist with analysis of large and complex data sets recommends it to educational applications. However, concerns over equity, inclusion, and privacy temper enthusiasm for adoption. Despite such concerns, AI in the American education sector is expected to exceed a market value of $85 million by 2022, with a compound annual growth rate of nearly 48%, and the trend is similar globally. This rapid growth in adoption sees institutions of higher education partnering with industry to create AI-driven solutions for the purposes of reducing college costs and allowing students to personalize their learning experiences to best meet their needs.

One of the most frequently asked questions in the field of higher education is "how can we increase student engagement in learning?" From faculty members wanting to provide more engaging course experiences for their students to admissions officers looking to increase enrollments while maintaining those experiences, engagement is not a new topic but is a high-visibility puzzle. The *Chronicle of Higher Education* recently profiled Georgia State University's use of the AI tool AdmitHub as a means of connecting with prospective and incoming students, addressing concerns about enrollment, financial aid, and more. At the course level, startup Packback has been looking to solve the problem of what to do about online discussion forums by aiming to heighten critical thinking while allowing the learner to be curious as part of the learning process. Engagement is defined in a number of ways, but AI solutions are working to bring more human-like connection to those who seek it, whether in a discussion forum or on the other side of a support call.

Engagement is also foundational to student success and support initiatives. Student success and teaching initiatives increasingly aim to identify learning needs proactively, with the intention of helping students meet learning outcomes and complete certificate or degree programs on time. AI supports pedagogical approaches such as adaptive learning, using algorithms

to customize content to the predicted needs of individual students. Beyond course- and program-level pedagogical strategies, AI works with institutional data to help colleges and universities understand retention rates, intervention needs, and program performance. As institutional data mining grows in use and depth, analysis needs grow as well. Software like IBM's Watson leverage AI to provide tutoring opportunities that evolve as students' needs do.

Concerns about the cost and the ethical use of AI both help and hinder the adoption of the technology in higher education. While efficiencies and computing power are seen as affordances, concerns about surveillance, structural racism in programming algorithms, and whether machines will learn biases just as humans do contribute to skepticism about AI in higher education. Further, some faculty fear replacement, envisioning a future in which machines take the lead in classroom learning. Institutions, however, also serve as important grounds for research and development. While some institutions of higher education are exploring the affordances of AI and video for delivering high-quality learning content, others such as the University of Pittsburgh and the University of Washington are working with industry to supplement instruction by reverse-engineering incorrect answers to discover the source of confusion. Such initiatives could further work in adaptive learning, electronic tutoring, and more.

Artificial Intelligence in Practice

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

Student Data Science & Machine Learning Platform
educau.se/dsmlp
UCSD IT Services built a data science/machine learning cluster for undergraduate and graduate students using low-cost GPUs, allowing students unprecedented access to extremely high-speed computation.

IU Boost
educau.se/iuboost
IU Boost is a machine learning–driven model and a smartphone app whose primary function is to deliver a simple nudge: a push notification when a student hasn't submitted an assignment that has an approaching deadline.

Edulai
educau.se/edulai
The intelligent software Edulai is designed for university students and teachers to help monitor and measure the development of skills such as critical thinking, communication, collaboration, leadership, problem solving, and interculturalism.

Further Reading

How Artificial Intelligence and Virtual Reality Are Changing Higher Ed Instruction
educau.se/ediveaivrhe
Artificial intelligence and virtual reality have considerable potential to drive changes in how teaching and learning takes place in colleges and universities, as well as how student progress can be tracked. However, these tools carry risks such as bias that institutions need to understand and avoid.

How Artificial Intelligence Is Changing Teaching
educau.se/chronhowai
Artificial intelligence can serve as a time saver and digital engagement enhancer, but it also introduces potential ethical challenges in the realm of privacy and data use. The author discusses the balance between the affordances and challenges of AI use in teaching.

Artificial Intelligence Is Poised to Expand in Higher Education
educau.se/edtechaihe
This article discusses findings from a collaborative poll by Gallup and Northeastern University and encourages institutions of higher education to involve faculty in AI decision-making and governance.

Blockchain

Blockchain technology functions as a decentralized digital ledger and is currently used primarily to support the cryptocurrencies. The technology employs a distributed data structure in which the records in the ledger are replicated in multiple locations. Blockchain removes the role of a central authority over the ledger, creating a highly secure model whose integrity is built on the trust of all participants. The potential for the blockchain to disrupt and replace centralized systems has captured attention across sectors, including education, though broad adoption of blockchain in higher education remains at least several years out. Meanwhile, colleges and universities are investigating ways in which the technology could be used for areas including transcripts, smart contracts, and identity management. Advocates argue that blockchain has the potential to fundamentally change a wide range of industries that rely on intermediaries—such as banks—enabling a broad ecosystem solution instead, one that features decentralized verification and storage. In higher education, the legacy of blockchain might be what the technology inspired rather than the broad adoption of blockchain technology itself.

Overview

Blockchain has its roots in conceptual work done in the 1990s, and in 2008 that work saw its first major articulation as the technology that underlies the cryptocurrency Bitcoin. In simple terms, a blockchain is a distributed ledger. A conventional ledger is maintained by a single entity, which is responsible for the records and transactions recorded in that ledger. With blockchain, multiple copies of the ledger are maintained and shared by separate nodes, each of which has access to the full record of transactions. Each block—or set of transactions—includes a cryptographic signature and is linked to the previous block. All the distributed versions of the ledger are identical, and blocks can never be altered. The result is a secure, immutable record whose authority rests not on trust in any central entity but on the network of participants, all of whom verify the integrity of the chain.

By 2014, applications of the blockchain technology were being investigated for purposes other than cryptocurrencies. In October 2015, blockchain made the cover of *The Economist*, with the tagline "How the technology behind Bitcoin could change the world." Since then, various organizations have explored ways to use the technology for financial and banking transactions, medical records, supply-chain monitoring, insurance, music distribution, online voting, real estate, and smart contracts.

Most of the current thinking about blockchain in higher education concerns transcripts and records of achievement. The capabilities of digital tools have prompted alternatives to traditional transcripts that include much more detail and even artifacts about a student's learning. Blockchain could extend that model, creating a permanent, detailed record of formal and informal learning that allows individual users to control what is included in their learning record and who may access that information. A blockchain-based transcript could include information about courses and degrees, certifications, badges and other microcredentials, co-curricular activities, internships and employment, and other competencies and credentials. Such a record could follow students from one institution to another, serving as verifiable evidence of learning and enabling simpler transfer of credits across institutions. As one part of such a system, Blockcerts is an open standard for creating, issuing, viewing, and verifying blockchain-based records, including academic credentials, certifications, and professional development activities. Higher education might also use blockchain to track intellectual property or as a tool to support identity management. A blockchain can be public, allowing anyone to participate, or private, restricting participation to authorized entities.

Relevance for Teaching, Learning, or Creative Inquiry

The relationship between higher education and blockchain extends along at least two dimensions. Colleges and universities are developing uses of blockchain that can serve the administrative and educational functions of the institution. The University of Nicosia in Cypress issues academic certificates on a blockchain platform for students who participate in a course on digital currencies. Central New Mexico Community College has begun using blockchain to issue student-owned digital diplomas, allowing students to manage and share their verifiable credentials. Columbia University and IBM have established a partnership to develop blockchain technology through an incubator open to faculty and students at Columbia, as well as to the broader startup community. As early as 2015, MIT began using a blockchain-based tool to issue digital certificates and currently offers an online, self-paced course called Blockchain Technologies: Business Innovation and Application.

Meanwhile, blockchain is becoming a competency that fits into higher education curricula and research. A professor at New York University began offering a course on blockchain in 2014, and demand for the course has been growing ever since. A similar dynamic has appeared in courses at the University of California, Berkeley, Duke University, and Carnegie Mellon University, as well as a Coursera course from Princeton University. Blockchain is seen as a general technology, one that will likely influence many disciplines and business models. As a result, the demand for academic courses on blockchain comes not only from computer science students but also from those studying business and law, among others.

A growing number of colleges and universities are conducting research into blockchain and its potential applications, and institutional-level organizations are being launched to support this culture of investigation around blockchain. At The University of Texas, Texas Blockchain is a nonprofit organization run by students that is dedicated to "serving the local Austin blockchain communities by hosting events, incubating startups, and distributing resources." A similar organization, Blockchain at Berkeley, exists at the University of California, Berkeley, and supports blockchain efforts local to that community. One employment website, Crypto Jobs List, is wholly dedicated to opportunities in the blockchain industry.

As education increasingly becomes a lifelong activity, taking place not only in formal academic settings but in workplace training, courses from professional associations, workshops, and numerous other formal and informal models, blockchain could provide the means for individual students to maintain an accurate record of their knowledge and skills. This could be invaluable, particularly for students who transfer among several institutions or those who want to transition, for example, from military service into higher education and the civilian workplace. Blockchain can also support the growing list of ways that learning and skill acquisition are recognized, such as badges, stackable credentials, MOOC certificates, and industry certifications.

Blockchain in Practice

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

FlexchainEdu
educau.se/flexch
FlexchainEdu uses a blockchain-based system that has the potential to transform the way higher education organizes, stores, and validates student data, as well as provide credentials that are student-owned and universally respected by an evolving employment marketplace.

Woolf: Building a Borderless University
educau.se/woolf
Woolf is a two-sided marketplace—a regulated network for accredited teaching between students and teachers. Woolf will allow students anywhere in the world to study with academics anywhere in the world for accredited degrees.

EdRec: Next Gen by Design
educau.se/edrecngd
A winner of the Reimagining the Higher Education Ecosystem Challenge, EdRec: Next Gen by Design is a collaboration between BrightHive, Concentric Sky, and DXtera Institute. The Annex document outlines their winning proposal for a student-centered future powered by sovereign records that will open a combination of microcredentials, competency frameworks, and learning pathways to propel students towards careers.

Further Reading

Will Blockchains Revolutionize Education?
educau.se/erblckchnedu
Blockchains hold considerable promise for education by offering a new method to manage credentials and other evidence of competency and by supporting open badging systems. Cost is a concern, however, and the reliability of a blockchain says nothing about the value or enforceability of the records within. Standards will also be an important part of developing an interoperable blockchain ecosystem.

5 Ways Blockchain Is Revolutionizing Higher Education
educau.se/foblockchn
The culture and history of higher education make it an excellent fit for some of the opportunities that blockchain offers. Those include student records, a platform for distributed partnerships, protection of digital assets, a subject of academic focus, and innovation in learning.

The Blockchain for Education: An Introduction
educau.se/hackedubc
Understanding how blockchain could influence higher education requires at least a basic understanding of the history of blockchain and how it technically functions. An awareness of who is supporting blockchain efforts in education can also help make sense of which of the many visions of a blockchain-enabled future is likely to be realized.

Virtual Assistants

In the 1987 Knowledge Navigator and 1988 Future Shock videos, Apple envisioned a future where users of various ages and abilities naturally interfaced with a device screen by speaking commands, asking questions or using gestures to learn, work, and stay connected to others in the virtual environment. Advancements in voice recognition and natural user interfaces have made these interactions a reality. Since the topic of virtual assistants last made an appearance in the 2014 Horizon Report, AI-augmented machine learning has dramatically increased the accuracy of both automatic speech recognition (ASR) and related natural language processing (NLP), the underpinnings of virtual assistants like Siri, Alexa, Bixby, or Google Assistant. Virtual assistants are commonly available on most smartphones, tablets, and computers, and a new range of independent passive listening smart speakers like the Amazon Alexa and Google Assistant speakers have rapidly become popular home affordances. These devices understand voice commands to perform simple tasks around the home and, with location services activated and added "skills" enabled, can go beyond a simple search tool to provide more complex and competent virtual assistance. While the convenience of these devices has wide appeal, the "always listening" aspect of the interface has some concerned about privacy and security.

Overview

Virtual assistants are becoming a familiar alternative for users to conversationally interact with their mobile devices and an increasingly affordable option for a voice-activated home assistant. Speech recognition entered the consumer market in earnest in the late 1990s with Dragon Dictate, software for voice dictation and a range of spoken commands to perform basic system and software functions. Over 25 years later, the Dragon Nuance engine continues to function as a speech-to-text solution, yet the product has evolved with the development of AI technology and now functions on par with more recent virtual assistants. By 2011, when Siri was introduced, voice recognition set the Apple iOS apart from other smartphones. Despite the frustrating inaccuracy of Siri's interpretations and responses, voice-control systems proliferated, including Google Now, Cortana, and Alexa, all of whose functionality relies on passive listening for a trigger word to wake and respond.

Virtual assistants have become more reliable through deep neural learning, resulting in an increase in the accuracy of natural language processing (NLP) and automated speech recognition (ASR). NLP helps virtual assistants with the meaning of words, while ASR more accurately interprets sounds, resulting in a more satisfying experience. In turn, virtual assistants can perform increasingly complex tasks. In a recent Pew Research poll, nearly half of US adults polled reported using a digital assistant on their smartphone, and 55% indicated that hands-free use of their device was a "major reason" for relying on the digital virtual assistant. In January 2019, NPR and Edison Research reported that 21% of Americans had added a virtual assistant to their suite of home technology over the past two years. Of those who reported having children in the home, 43% admitted the purchase was driven in part by a desire to reduce screen time; by the time these users enter university, conversing with a digital assistant is likely to be familiar and intuitive.

Although virtual assistant devices remain a relatively new technology, their usefulness and convenience are valued by many. The surge of consumer sales of virtual assistant speaker devices like the Amazon Echo Dot combined with the commercial expansion of the Internet of Things (IoT) is projected to provide these devices with smart home capabilities in the near future.

Passive listening—the always-listening function of a smart speaker—crosses personal boundaries for some and raises questions about security and privacy. The convenience of conversational interaction versus the privacy risks of sending data to the cloud to be interpreted is an important consideration for users of virtual assistants. Despite anonymization and encryption assurances from developers, data breaches remain a risk. Audio-centric advances in AI may soon be able to scan for more than a trigger word or phrase to activate the assistant. Acoustic scene recognition and audio event detection by application and device type will create a more nuanced relationship between consumer items and the privacy and security of data they collect.

Relevance for Teaching, Learning, or Creative Inquiry

Virtual assistants are already capable of meeting basic student needs related to campus information and support services. Chatbots that provide students with 24-hour support like the AgentBot developed for Siglo 21 University in Argentina were adapted from a customer service solution to provide academic student support. Amazon Echo Dots are being piloted at several US universities to provide students with

information ranging from academic advisory services to help with financial aid. Northeastern University developed the Husky Helper virtual assistant to respond to the top 20 questions that students had asked of the call center over the previous three years. Husky Helper will use AI and machine learning to identify and learn other common student needs.

As the capability of interacting through natural conversation increases, educational uses for learners of all languages multiply. Virtual assistants are expected to be used for research, tutoring, writing, and editing. Similarly, virtual tutors and virtual facilitators will soon be able to generate customizable and conversational learning experiences currently found in a variety of adaptive learning platforms. Investments in the education sector of AI demonstrate the potential for robust growth for virtual assistant solutions for learners.

Device capabilities are globally uneven. Context awareness in languages other than English is currently relatively narrow. Siri, Alexa, and some other assistants allow users to choose accents, yet natural conversation in a variety of languages and dialects is conspicuously absent. The majority of digital assistants speak to us in female voices, creating an environment where women are deferential and at our service. While a few virtual assistants have male voice options, the need for a more gender equal or neutral future of AI development has been identified by groups including EqualAI, an organization seeking to prevent gender bias by establishing AI development standards. Solutions for this lack of diversity may also be realized through machine learning and NLP, while near-term advances in voice engine optimization (VEO) have the potential to contribute to broader diversity. Just as search engine optimization (SEO) has dominated the consumer sector to optimize web search results, VEO may presage the future of virtual assistants in higher education through the growth of broad language options and less bias.

Virtual Assistants in Practice

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

Alexa@SLU
educau.se/alexaslu
The AskSLU skill developed for the Saint Louis University EchoDot pilot delivers answers to over 130 campus-specific questions aimed at getting students answers to common questions so they can focus their time on deeper engagement with their studies and enhance productivity.

Voice-Activated Apps for University of Colorado Denver and Anschutz
educau.se/chbhe
VoxScholar apps foster academic success by focusing on academic performance or evidence-based teaching advice. VoxScholar apps are available to students and faculty at the University of Colorado Denver and the Anschutz Medical Campus. Both can get just-in-time tips on study skills, faculty development, and a custom lab tutor through Google Assistant. The apps respond intelligently to coach learners and faculty to meet their learning goals.

LibChat @ VicUni
educau.se/libchat
Victoria University Library introduced a live chat service (LibChat) to provide an alternative information service in an online world. The library chat service helps students develop the skills and capabilities required to succeed in blended learning environments and provides staff with strong digital information skills, analytical proficiency, and computer literacy.

Further Reading

How an Artificially Intelligent Virtual Assistant Helps Students Navigate the Road to College
educau.se/aivahelpstu
To decrease "summer melt," this study leveraged conversational AI to support would-be Georgia State University freshmen with the transition to college through personalized text message–based outreach over the summer.

A Game of Virtual Digital Assistants: The Complex Future of Voice Search and AI
educau.se/ligamevda
The landscape of virtual digital assistants includes several major players, including Amazon's Alexa, Google Assistant, Apple's Siri, and Microsoft's Cortana. This blog predicts that even as the market for digital assistants matures, no single tool will dominate and that services that come to rely on digital assistants will need to work with multiple platforms.

The Benefits of Artificial Intelligence in Higher Education: Virtual Learning Assistants Solve Costly Needs
educau.se/benaihe
Unlike some general-purpose AI solutions, Cognii is a virtual learning assistant (VLA), designed specifically to improve education. Cognii uses AI, natural language processing, machine learning, and other tools to assess essay answers in online education, providing students the kind of feedback and support that previously was only available through human interaction.

Fail or Scale

EDUCAUSE is committed to producing a more reflective report that both forecasts horizons in higher education technology and contextualizes previous forecasts. This year, we introduce a new section of the report called Fail or Scale. This section of the report looks back to previous forecasts, specifically in the technology developments section, from four years prior or beyond. To provide insight, we sought the expertise and experience of expert panelists who were part of the panel at that time or otherwise had a depth of experience with the history, adoption, or scale of the technology development topic. Each essay includes a description of the technology the author chose to reflect upon, a review of the year it was forecast in a report, and the impact horizon within which it was predicted to have wide adoption.

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Adaptive Learning: Understanding Its Progress and Potential

Nicole Weber

As we look forward to new developments, trends, and challenges in this year's Horizon Report, it is important to look back on the forecasts of the past to see if they, indeed, came to fruition as predicted. One of the most interesting developments over the past few years has been adaptive learning.

What Happened with Adaptive Learning?

According to the *2018 Horizon Report: Higher Education Edition*, "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." From a student perspective, these technologies adapt to what they need by providing real-time feedback and learning paths to help them advance—no matter the level at which they begin. Because adaptive learning can leverage machine learning and artificial intelligence, instructors no longer need to pick through mountains of content around every single area of potential remediation in their courses. Adaptive learning can help faculty balance their workload by offloading content dispersion to dynamic means of consumption, saving their time for interacting with their students and getting them to dig deeper and apply concepts.

Adaptive learning has been a staple in the Horizon Report since 2015, when it first appeared as an important development in technology for higher education with a time-to-adoption horizon of four to five years. In 2016, it was combined with learning analytics (Learning Analytics and Adaptive Learning), and the time to adoption decreased significantly to one year or less. In 2017, time-to-adoption remained at one year or less, but in 2018 it increased to two to three years and was touted as having the potential to empower active learning, support at-risk student populations, and assess factors affecting completion and student success while providing a solution to one of higher education's most difficult challenges: the "iron triangle" of cost, access, and quality. This year, however, adaptive learning failed to make the list of developments.

If estimates from the 2016–17 Horizon Reports had been accurate, we would be seeing adaptive learning more broadly adopted on campuses across the world. However, in 2018 the time to adoption actually took a step backward, increasing to two to three years, putting broader adoption between 2020 and 2021. Based on my own research and the work we are currently doing on my campus to implement adaptive technologies, I believe that the 2018 Horizon Report forecasting is more probable than earlier estimates. It is clear from attending various conferences that some institutions are waiting and watching while early adopters pilot, implement, and share what they have learned. Aligned with this observation, the EDUCAUSE Center for Analysis and Research (ECAR) found adaptive learning to be of limited impact at this time, with half of their institutional survey respondents reporting that they were watching to see if adaptive learning would fit into their strategy. Perhaps this technology has neither failed nor scaled, but rather it has thus far failed to scale to its potential.

To explore this a bit more, the first question we should ask ourselves is how we know adaptive learning is not an outright fail. Even though many may be waiting to see empirical evidence, institutions are exploring adaptive learning technologies for meeting challenges associated with high-DFW gateway courses and enabling learner agency. Adaptive learning also continues to appear in key publications—such as the 2019 Key Issues in Teaching and Learning—likely for having the potential to contribute to academic transformation by being part of breakthrough teaching models that increase student completion and success.

With so much potential, why has adaptive learning not scaled quickly? One of the largest challenges is the investment (e.g., time, money, resources, and vision) needed to implement and scale these courseware products.

But can adaptive learning be scaled to its potential? While challenges remain, some institutions are seeing promising results. The University of Central Florida (UCF) is working to drive down costs for students through a multifaceted partnership model with Cengage and Realizeit. In addition, their business curriculum has been redesigned from a large-scale lecture-capture model to one that focuses on leveraging blended, active, and adaptive learning. Multiple sections of 200 students each meet five

times per term for active learning sessions that focus on small-group work facilitated by faculty; outside class they take part in interactive, adaptive personalized learning. This is a concrete example of a breakthrough teaching model of the future, even though it has met some resistance.

What Can Higher Education Learn?

We could say that what happens in the Horizon Report Expert Panelist Discussions stays in the Horizon Report Expert Panelist Discussions. However, I am sure my wonderful colleagues would not mind my sharing a very high-level view of our conversations related to adaptive learning regarding its impact and the challenges that can guide further exploration.

Overall, the expert panelists believed in the potential impact of adaptive learning. We discussed its ability to facilitate scale (e.g., teaching more students in a better way at a lower cost) and improve performance and persistence for *all* students through personalized content delivery that meets the student where they are based on their needs. Additionally, it allows the instructor to use time typically spent relaying content for deeper learning activities instead (e.g., collaboration around and application of course concepts), which aligns with other areas in this Horizon Report (e.g., Rethinking the Practice of Teaching, Blended Learning Designs, and the Evolving Roles of Faculty with Ed Tech Strategies).

While a positive potential impact was perceived, panelists also discussed a number of challenges related to adaptive learning. Technology tools were felt to be in their infancy, creating a large investment from the institution of time, money, and resources. Products must become easier to support and use while lowering costs. Instructors and institutions will continue to be hesitant to adopt complex solutions if they are required to pay high licensing fees or pass along additional costs to their students. Some panelists felt that adaptive learning could find barriers in its potential to disrupt higher education's traditional time-based administration. If better, shorter learning experiences could be created or new models (e.g., bundling a remedial course with the next in its sequence) leveraged, why would an institution remain committed to the traditional 15-week semester? However, this is a much larger issue, with culture and legacy playing roles both at the institutional level and beyond.

With this, maybe we get at one of our original questions regarding why, even with all its potential, adaptive learning failed to make the 2019 Horizon Report. We could chalk it up to the panel not being convinced that adaptive learning technologies are a near-term development (which was the date-range it was placed in for us to vote on) or, maybe it was perceived to have been on the list for a number of years without making a lot of progress and at risk of becoming stale. We may never know for sure, but my best guess is that we need to hone in on relevancy (e.g., using adaptive learning to redesign curriculum) that focuses on creating rich learning experiences aimed at student success and how we can bring these platforms to our campuses in cost-effective ways.

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Augmented and Mixed Reality: The Why, When, and How of Situating Learning in Authentic Contexts

Kevin Ashford-Rowe

In 2016, the Horizon Expert Panel determined that augmented reality and virtual reality were two to three years from widespread adoption. By 2018, the notion of mixed reality was, at four to five years from adoption, even further out. Whether described as augmented reality, virtual reality, or mixed reality, the notion of using digital technology to create a virtual or physical/virtual hybrid environment, through which a student might navigate, has been emerging through higher education (and many other sectors of education) for a number of years. This is the conundrum, however: Why does such an approach to enhancing the students' learning experience remain so elusive in terms of mainstream adoption?

What Happened with Augmented and Mixed Reality?

Educational expectations for mixed reality (i.e., augmented and virtual reality) persist, and I believe this is not just because of the technologies per se but more because of the teaching opportunities that they provide to instructors and the designers of the student learning experience. In fact, one could argue that augmenting reality is as old as the hills and that humans have been doing so, in one form or another, for millennia. During the Expert Panel phase of the development of this report, panelists discussed the notion of augmenting reality and creating a mixed reality in terms of delivering a blended virtual and physical hybrid environment through which a student might navigate. I shared my belief that mixed reality plays into a deep and longstanding capability of the human mind to aggregate the physical and the imagined. In this regard, I don't think that augmenting or mixing reality is actually a new concept.

I believe that our first Australians, in creating the concept of the Dreaming or Dreamtime many thousands of years ago, were already augmenting or mixing reality. The Dreaming or Dreamtime is a complex and deeply layered concept that in the simplest of terms attributes a virtual (or unseen) layer to the natural physical landscape, thus augmenting reality to support a range of culturally and historically important knowledge. To me, this is augmented or mixed reality—but of course, the first Australians just didn't have access to digital technology and instead had to harness the power of the human imagination.

If you add into these technologies and approaches what has become known as "extended reality" and "hyper reality," what you find is a common approach to using technology to enhance the educational experience that, in many respects and in one form or another, is underpinned by the educational principle of situating learning in authentic contexts. This is very interesting, particularly in that the 2018 Horizon Report, within the section that describes "significant challenges impeding technology implementation in Higher Education" listed authentic learning experiences as being a "solvable challenge." It would seem that while authentic learning might be solvable, it may yet be that perceptions of cost or technical complexity preclude it from being considered as a scalable approach.

Of course, there could be a myriad of reasons to explain why this is so. These reasons could include the costs of implementing such approaches at scale across the enterprise or, perhaps, the lack of expertise and expert knowledge in the ways in which learning might be best designed to benefit from them. In his February 2018 article "3 Reasons Augmented Reality Hasn't Achieved Widespread Adoption," AJ Agrawal, argues that—in this order—it is due to a combination of ergonomics, basic utility, and corrective lenses. In short, no matter the benefits, "no one wants to wear a pair of goggles on their head during daily routine" (ergonomics); "even the most mind-blowing AR glasses won't matter until they look 'normal' enough for everyday wear" (basic utility); and, given that three-quarters of the US population need corrective lenses, "it goes without saying that smart glasses need this option [corrective lenses]." He also points out an important distinction that should be made between VR and AR—AR possesses a natural advantage in that the information being displayed is integrated with what is in front of the user.

But, what is interesting is that, irrespective of the reasons, those considered expert for the purposes of the Horizon Report are not yet sufficiently confident that virtual reality, augmented reality, or mixed reality has entered mainstream usage in higher education.

This deeper appreciation of why—and when—a particular technology approach might be used leads in turn to an important principle, which is often missing in our considerations of when and why we might adopt one digital or technology approach over another. That principle is that it is not so much the technology that we use but, more importantly, understanding and being able to describe the reason(s) why we would use it. What is it, from an educational perspective, that we are hoping to gain? Will it make it easier for a student to understand an important but complex theoretical concept? Will it more quickly build their competence in following an important process or procedure? Might it even enable them to combine both ideas by allowing them to demonstrate their understanding of key concepts in solving difficult challenges and problems—an approach more in keeping with the types of complex challenges that they'll likely be expected to resolve in the workplace? For me, understanding and answering these questions enables us to make the best case for utilizing mixed reality in learning design.

What Can Higher Education Learn?

I would like to explore this idea a little further, with particular consideration of authentic learning, an approach to learning assessment that emphasizes the value of situating the learning experience. This approach also requires that the design and development of approaches to learning and assessment be closely related to the workplace. If making a learning experience "more realistic" for learners better prepares them to succeed beyond graduation, the extent of the authenticity of the learning experience could itself be important (i.e., how authentic is it?). If that is the case, particularly when digitally augmenting or mixing reality, then there follows a requirement to be able to identify the design components that determine authenticity and that, once identified, might be tweaked to ensure a higher degree of fidelity or authenticity in the learning experience.

A number of universities and higher education disciplines—very often within health, medicine, and business—are already delivering authentic learning experiences using such technological approaches to deliver at scale. Noteworthy here is the University of the Sunshine Coast (Australia) and its Cave2, a 320-degree panorama that provides a highly immersive 2D and 3D virtual reality learning environment. In addition, Australian Catholic University (my former employer) has worked collaboratively with its School of Behavioural and Health Sciences in the use of HoloLens to explore applications to enhance teaching practice. The university has also supported the discipline of Exercise Science (also in the School of Behavioural and Health Sciences) in developing a proposal for a Perception-Action Rehabilitation Clinic—based on virtual reality—for sport and health aging.

All of this is against an international backdrop that sees colleges and universities increasingly challenged to better prepare and equip students with the skills and capabilities that will enable them to succeed in both the current and disrupted future workplaces. It is in meeting this challenge that many institutions, both in Australia and around much of the industrial world, are looking to authentic learning experiences as one means to enhance their future graduates' capability to enter the labor market as "work ready."

Despite previous forecasts for mixed reality's scale in higher education, a closer review of trends or approaches that support the creation of increasingly augmented, mixed, hyper, blended, or virtual environments makes apparent that it is not just the technology that needs to be engaged with but also the educational (or learning) outcomes that it is seeking to achieve. Once this has been understood, the ways in which that digital solution can enhance the student learning experience can be better described. Ideally, those within an institution tasked with supporting the uptake and usage of educational technology to enhance learning might work closely with those who teach to achieve a common lexicon around educational enhancement. This will enable both groups to better understand and communicate their particular perspectives. If the use of a digital technology is going to be adopted, then it is important that the particular learning outcome has been defined and the range of approaches that might best enable it to be achieved have been considered. It is at this point that the educational advantages of a range of technology approaches should be considered and the one that best supports achieving this outcome is selected.

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Gaming and Gamification: High Hopes and Campus Realities

Bryan Alexander

For three years, the Horizon Report forecast that games and gamification would become a significant force in educational technology. From 2012 to 2014, the reports positioned this development in the "Two to Three Year" time-to-adoption horizon. The reports saw digital gaming as growing in importance as a tool for learning, as a subject of class study and research scrutiny, and as an area where academics would produce content. The reports also viewed gamification as rising, as faculty and staff members would introduce to the learning experience structures and techniques drawn from the gaming world. Each of the Horizon Reports drew on a similar mixture of factors: the enormous growth of the gaming industry; the development of scholarship on teaching with games; and awareness that traditional-age students were immersed in computer games.

What Happened with Games and Gamification?

However, games and gamification fell off of Horizon from 2015 on. The topic never appeared again, not even as a trend seen as likely to manifest in a more distant future. Because games and gamification didn't appear as a short-term trend in subsequent reports, nor was the topic discussed as a given, we can deduce that the Horizon collective opinion found gaming to have fallen by the wayside.

Such an assessment seems to map onto the reality of higher education and technology since 2015 (or 2012, for that matter). There was a burst of excitement for a decade starting in 2003, with the publication that year of James Paul Gee's *What Video Games Have to Teach Us About Learning and Literacy*. Gee argued that computer games were essentially pedagogical tools, as players learned how to use them, utilizing many pedagogical techniques, from Vygotsky's zone of proximal development to carefully calibrated scaffolding. Other articles, books, and presentations followed. In response, campuses explored gaming in a variety of ways, from teaching commercial computer games in classes to institutional teams producing games. Gamification followed next, inspired in part by Jane McGonigal's widely watched 2010 TED Talk ("Gaming Can Make a Better World") and her 2011 book *Reality Is Broken: Why Games Make Us Better and How They Can Change the World*. McGonigal and others argued that since games (both digital and analog, but especially computer based) were successful in modifying user behaviors, game techniques could be deployed beyond games in order to encourage people to lead better lives. Educators then applied this insight to gamify classes, using points, levels, characters, quests, and so on to encourage student learning.

After a decade of energetic creative ferment, the excitement seems to have faded. There have been fewer presentations on games or gamification at major conferences. While some colleges and universities have game design programs, none has expanded beyond that narrow, often preprofessional specialty. Games seem to have become a niche rich-media tool, used in a handful of classes in a small number of departments. Having students learn computer science principles through Minecraft is pedagogically fascinating, for example, but constitutes a very slight impact on an entire academic institution.

We can identify a series of reasons for this expansion and contraction of interest. To begin with, the 2008 financial crash commenced a round of budget cuts across much of American higher education. State funding challenges, anxiety over tuition, and reduced enrollment maintained pressure on campus budgets. As Casey Green observed in his 2018 Campus Computing Survey, academic computing budgets all too often remain below where they stood a decade ago, while those departments are tasked with supporting continually escalating service. Those units are less likely to have the resources to support gaming—a very new, unproven, and experimental technology for learning—when they have so many other competing demands to satisfy.

Campus IT is also less likely to devote scant resources to a technology that shows few signs of scaling up toward enterprise levels. On the consumption side (students playing games), whereas commercial gaming easily handles tens of millions of simultaneous players, educational gaming has always been aimed at very small populations. For example, Peacemaker, a game that simulates of Israeli-Palestinian politics, is a fine choice for a political science or history class on the topic but is ill suited for the rest of the curriculum. Faculty members must investigate games for each of their classes, test them out, and then, if appropriate, implement them individually. This is rendered more

difficult when instructors lack knowledge of the vast, complex, rapidly developing, and at times forbidding gaming industry.

On the production side, it is difficult to select a game-authoring tool that can produce academic content at scale with basic training. There is no enterprise-level program that lets faculty or campus teams create playable and appropriate games. Apps such as GameMaker let users produce platform and maze games, which require a great deal of imagination to fit into postsecondary learning. Text-adventure programs such as Inform and Twine are superb software, but their results occupy a vanishingly small niche within the broader gaming world and lack the graphic excitement most associated with gaming. Instead, to produce a game requires significant investment in personnel, time, and technology, and that process typically yields a result that addresses only a sliver of the undergraduate curriculum, as with the Arden Shakespeare game, the production values of which included a quarter-million-dollar grant. The cost/benefit of game production does not appeal, especially in the post-2008 budgetary environment.

What Can Higher Education Learn?

We can derive several lessons from this history, starting with the importance of combining a technology that scales with faculty engagement. A new technology—especially one that requires significant research and training—needs to be able to work across the curriculum and in sufficient numbers to merit institutional investment. Faculty members can carry such a technology forward to some extent, but only if they are knowledgeable and engaged with it and if they can sufficiently support the hardware or software. Otherwise the technology will only appear at best in a small segment of a college or university.

We can also recognize connections between broader social developments and campus technology. Gamification appeared at first to be a beneficial strategy for improving civic life, encouraging people to participate politically and to enhance their health. Yet it soon elicited criticism in its workplace instances for being an ethically dubious form of manipulation that does not respect human complexity or constitute good gaming. Rising anxiety about institutions including governments and the media rendered gamification suspect. Further, growing ethical concern about technology companies' use of user data further hampered game systems that track user behavior. Campus populations were not immune to these criticisms and suspicions; in fact, some academics led the anti–Silicon Valley charge. In other words, gamification's potential may be a casualty of the "techlash."

There is also the sense of a technology being seen as a good fit for education. Despite their demonstrated pedagogical capacity, commercial games may just be too distant from the classroom experience, while published educational games may simply be too few in number. Whereas some faculty members find games fascinating and productive for their teaching, they are so far a small minority of the professoriate. For the supermajority, computer games are too far removed from their classes and pedagogy. Indeed, some academics consider games to be childish, better suited to primary school. Other forms of rich media may be closer and easier to adapt to academic needs, such as video, videoconferencing, and virtual reality.

So much for the consumption side. Related problems occur on the production side as well. Creating games is often difficult, since the costs of ambitious and media-rich ones can run very high. Creating less-expensive games, such as text-based interactive fiction or smaller platform games, is self-evidently less of a resource strain, but this strategy runs into the problem of scale. Unless a campus IT unit devotes itself to becoming a game production studio, publishing a range of interactive media across the curriculum, it will only be able to produce a handful, reducing the effort's impact on the institution as a whole. Production runs into problems of scale and impact.

Bryan Alexander is an internationally known futurist, researcher, writer, speaker, consultant, and teacher, working in the future of education. Some of the technological areas he focuses on include social media, digital storytelling, mobile devices, gaming, pedagogy, scholarly communication, and forecasting. In the past, he has worked in a used bookstore, been an English professor, and helped build a national nonprofit organization for technology in liberal education. He completed an English language and literature Ph.D. at the University of Michigan in 1997, with a dissertation on doppelgangers in Romantic-era fiction and poetry. Currently, he runs a consulting firm, Bryan Alexander Consulting, and is a senior fellow at Georgetown University. Alexander is the author of *Academia Next* (Johns Hopkins University Press, forthcoming 2019), *Gearing Up for Learning Beyond K–12*, and *The New Digital Storytelling* (second edition).

Methodology

The Horizon Report process begins with the selection of a balanced and representative expert panel to assure a diverse, global perspective. The most-engaged members of the previous panel are asked to return, and nominations are opened to identify new panelists. We seek those with experience piloting or implementing emerging educational technology, those who have presented or published in the field, and those who have held advisory roles on a campus or in their sector. We also seek to include developers, vendors, and entrepreneurs whose insight would advance the panel's work. The panel is a balance of global and US members, with attention to multiple regions within the United States. Additionally, we seek a balance in gender, as well as in panelists who are members of EDUCAUSE and panelists who are outside our membership.

The goal of the expert panel is to forecast the broad technology developments they believe will drive innovation and change in higher education over three time-to-adoption horizons. The panel also identifies trends in higher education that are accelerating technology adoption across three time horizons. Finally, the panel selects challenges that impede innovation and adoption and groups those challenges based on the difficulty of solving them. These three components of the panel's work result in the topics included in the annual report.

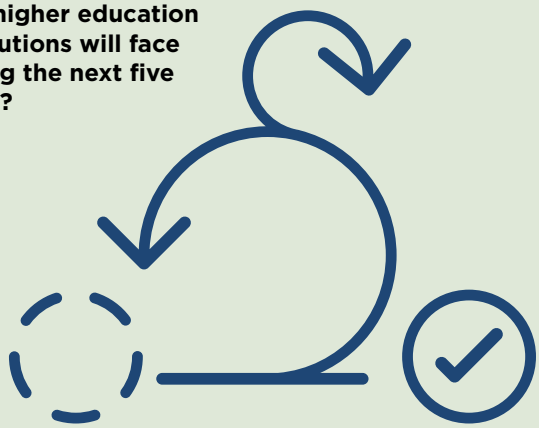
The goal of the expert panel is to forecast the broad technology developments they believe will drive innovation and change in higher education over three time-to-adoption horizons.

Selecting the topics in the report is achieved through a modified Delphi process. The work begins with a review of the literature—press clippings, research reports, essays, and blogs—that pertains to emerging technology. The expert panel is provided with an extensive set of background materials and is asked to respond to them, identify those that seem especially worthwhile, and add to the set. The group discusses existing applications of emerging technology and brainstorms new ones. A key criterion for the inclusion of a topic in this edition is its potential relevance to teaching, learning, and creative inquiry in higher

The Method

Following the review of the literature, the panel engages in the central focus of the research—the research questions that are at the core of the EDUCAUSE Horizon Project. These questions were designed to elicit a comprehensive listing of interesting technologies, trends, and challenges from the panel of experts:

1. **Which of the important developments in technology cataloged in the Horizon Project listing will be most important to teaching, learning, or creative inquiry in higher education within the next five years?**
   a. 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?
   b. What technologies that have a solid user base in consumer, entertainment, or other industries should higher education institutions be actively looking for ways to adopt?
   c. What are the key technologies you see developing to the point that learning-focused institutions should begin to take notice during the next four to five years?
2. **What trends do you expect to have a significant impact on the ways in which higher education institutions approach the missions of teaching, learning, and creative inquiry?**
3. **What do you see as the significant challenges related to teaching, learning, or creative inquiry that higher education institutions will face during the next five years?**



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

education. A carefully curated set of articles from the EDUCAUSE library and other relevant publications ensures that background resources stay current as the project progresses. These resources inform the thinking of the participants throughout the process.

One of the expert panel's most important tasks is to answer these questions as systematically and broadly as possible to ensure that the range of relevant topics is considered. Once this work is done, the panel moves to a consensus-building process based on an iterative Delphi-based methodology.

In the first step of this approach, the responses to the research questions are systematically ranked and placed into adoption horizons by each panelist using a multi-vote system that allows members to weight their selections. Panelists are also asked to identify the time frame during which they believe the technology would enter mainstream use—defined for the purpose of the project as about 20 percent of institutions adopting it within the period discussed. (This figure is based on the research of Geoffrey A. Moore and refers to the critical mass of adoptions needed for a technology to have a chance of entering broad use.) These rankings are compiled into a collective set of responses, and inevitably, the ones around which there is the most agreement are quickly identified.

From the comprehensive list of trends, challenges, and technologies originally considered, the twelve that emerge at the top of each group from the initial ranking process—four per adoption horizon—are further researched and expanded. Once these interim results are identified, the panelists, working with both EDUCAUSE staff and practitioners in the field, explore the ways in which these twelve important technologies might be used for teaching, learning, and creative inquiry in higher education. A significant amount of time is spent researching real and potential applications for each of the areas that would be of interest to practitioners.

For every edition, when that work is done, the thirty-six topics are then ranked yet again. The six trends, six challenges, and six important developments in educational technology that emerge are those detailed in the EDUCAUSE Horizon Report.

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