# Digital Transformation in Higher Education

## Trends, Emerging Practices, and Challenges

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# Acronyms and Abbreviations

| Abbreviation | Description |
|---|---|
| **AI** | Artificial Intelligence |
| **AR** | Augmented Reality |
| **BULB** | Boston University Learning Blocks |
| **BYOD** | Bring Your Own Device |
| **CLEVR** | Collaborative Learning Environments in Virtual Reality |
| **ExL** | Experiential Learning |
| **GSU** | Georgia State University |
| **HEI** | Higher Education Institution |
| **IoT** | Internet of Things |
| **IT** | Information Technology |
| **KPI** | Key Performance Indicator |
| **MOOC** | Massive Open Online Course |
| **NIST** | National Institute of Standards and Technology |
| **OER** | Open Educational Resources |
| **RFID** | Radio Frequency IDentification |
| **VR** | Virtual Reality |
| **XR** | Extended Reality |

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## Introduction

Higher Education Institutions (HEIs) around the globe differ in how they adopt new technologies and best practices. Some HEIs are early adopters and risk-takers, while others are more conservative in changing their processes and methods of service delivery. In this document, we provide an overview of the sector's main trends; emerging practices and technologies; and major challenges in higher education.

# Chapter 1. Trends and Challenges

This chapter provides an overview of the higher education sector's main economic, technological, and social trends.

## 1.1. Economic Trends

**Decrease in Funding.** The COVID-19 pandemic aggravated the already problematic economic crisis in higher education all over the world. This unanticipated disruption brought the public debate on the value of distance or online learning methods in higher education and the importance of specific adopted models, particularly in comparison to face-to-face learning. The latter has affected the level of enrollment in higher education resulting in a reduction of income without solid evidence of the effectiveness of impromptu distance learning (McKinsey, 2020).

**Change in Workforce Skills.** According to McKinsey (2020), the post-pandemic workforce must cope with the new digital era to survive the wave of change. The sudden shift to online services and course delivery coupled with the potential for long-term investments in these delivery systems will most likely create new demands for skills and staff in the higher education sector. Continuous experiences of disruptions and crises among teams, with a new emphasis on their work environment and well-being, increase awareness and demand for transformational and focused leadership styles designed to support the emerging needs of faculty and students.

**Funding Uncertainty.** For almost two years, local and national economies worldwide have been suffering because of the COVID-19 pandemic, leading to astronomical levels of unemployment, and widening socio-economic inequality. The higher education sector is not immune from the political and economic uncertainty of recovery. Several HEIs have instituted hiring freezes, furloughs, and budget cuts. Many have reduced their research activities and adopted a more flexible and data-driven planning approach, considering future economic realities (McKinsey, 2020).

## 1.2. Technological Trends

**Increased Adoption of Hybrid Learning Models.** Since the beginning of the pandemic, there was an immediate impact on the face-to-face traditional teaching methods. Most institutions have adopted hybrid teaching and learning options. Institutional adoption of blended or hybrid models for course delivery has accelerated

significantly over the past year. Learning models that allow flexible movement between distance and in-person experiences will help institutions minimize disruptions and ensure continuity of course delivery during future crises (Pelletier et al., 2021).

HEIs could take different measures in that regard:

- Use videoconferencing or forum tools remotely, but in real-time.
- Publish on the platforms recorded videos or podcasts, educational material, as well as answers to questions.
- Enable teachers to follow in real-time the work done by different groups on similar objects.
- In a hybrid way, combine physical assistance time and distance training time.

**Online Faculty Development.** As institutions implement distance and online education solutions, teachers must adopt new working methods and learn new tools. Teacher involvement and buy-in, capacity building, and support are essential to adopting and effectively using technology as an educational tool. Continued investments in faculty development, including remote capabilities for instructional design and technology support, will be needed to ensure faculty skills and literacy keep pace with ongoing technological advancements.

New e-learning solutions and learner-centered course design models will only be effective if teachers understand why and how to use them. The National Institute on Scientific Teaching and Macmillan Learning, for instance, have teamed up to offer an online short course on scientific teaching. In addition, many other campuses, such as Union College, Georgia Southwestern State University, and Oregon State, are developing online courseware about digital education and delivering a successful learning experience to students, specifically for their faculty (Pelletier et al., 2021).

**Accelerated Utilization of Learning Technologies.** Pelletier et al. (2021) found that many instructors and even institutions resisted adopting technological tools such as videoconferencing, team-based platforms, and virtual classrooms as a teaching method pre-pandemic. As the adoption of blended or hybrid learning models has accelerated, those same instructors and institutions have come to rely on those tools as essential ingredients in their work. With the discovery of new needs and uses of learning technologies, digital tools have become more pervasive and led to ongoing innovations and entirely new learning technologies (Grajek, 2020).

## 1.3. Social Trends

**Remote Learning and Remote Workforce.** The exponential changes in technology are putting pressure on the human resources of higher education institutions. So, planning the hiring of new staff, improving the skills of existing staff, and ensuring the development of personnel specialized in information technology are critical success

factors for the best and most reliable digital transformation. The situation became more complicated with COVID-19, whereby remote education has become a must and not a luxury.

According to Reuters (2020), in just one week, the number of users of the Microsoft Teams application rose from 32 million to 44 million, a 37.5 percent increase as more people had to work from the confines of their homes. This trend will likely continue post recovery from COVID-19. It is necessary to make all needed resources available to the higher education community from organizational, human, educational, and material resources to contribute to technology integration and student success. In terms of human resources, HEIs should significantly improve professional support to support teachers by using technologies and digital educational resources, specifically for animation, development, techno-pedagogical support, and promotion of resources (Pelletier et al., 2021).

**Mental Health Issues.** Pelletier et al. (2021) surveyed university students to determine the COVID-19 pandemic effect on mental health and found that 80% of respondents reported that the epidemic negatively impacted their mental well-being. Because of such findings, many debates have emerged among leaders in higher education about how teaching and learning must focus on the flexibility and social dimensions of education. Disturbance of an everyday social, political, and educational life has presented institutions with additional challenges to ensure the well-being and mental safety of students, faculty, and staff.

In many cases, students, faculty, and staff have experienced extended periods isolated from family, friends, and colleagues. The worsening economic and political conditions across many local communities have also contributed to heightened feelings of worry and stress. Consequently, as institutions shift towards remote experiences, they must explore transforming their student and employee support models to address the mental health challenges of their communities (Pelletier et al., 2021).

**Widening Digital Divide.** With remote education becoming a way of life in many countries, digital inequality has surfaced among students, faculty members, and countries. Those less technology-fortunate users will often find themselves at a disadvantage to cope with the inevitable change. These unfortunate individuals might even struggle to access essential devices and networks resulting in being deprived of top-quality education. Countries embarking on the digital education journey must first ensure a healthy learning ecosystem and the right of access to the Internet for everyone at affordable costs (Pelletier et al., 2021).

## 1.4. Major Challenges

Considering the case studies in the various researched countries, the different challenges that represent barriers to digital transformation in the higher education

Considering the case studies in the various researched countries, the different challenges that represent barriers to digital transformation in the higher education sector are presented in **Figure 1**:

- Change Management
- Cross Institutional Coordination and Integration
- Ongoing Investment Cost
- Misconception about Privacy
- Understanding the Benefits of Digitization


Figure 1. Digital Transformation Major Challenges

While reviewing the best practices and trends in higher education, it was evident that for digitalization to succeed, all systems and services must be integrated and operating seamlessly for a pleasant user experience. Applications such as the student information system, faculty information system, learning management system, and others must not exist in silos.

**Change Management.** Cultural and process changes that accompany digitalization are major challenges that higher institutions face while adopting digital transformation. Behavioral change comes at different levels: Staff members, students, and administration. The imposed change of new technologies usually is met with active, and often passive, resistance. With such opposition, institutions will most likely struggle with maintaining the flow of communication among stakeholders, administrators, and other departments.

This lack of communication will result in significant challenges. To ensure a smooth culture, process, and workforce shift, educational institutions should employ open communications with all related stakeholders, set clear objectives, and carefully plan the transfer's timing. Open communication may be coupled with implementing more agile and efficient management approaches that ensure the extensive engagement of the various stakeholders.

**Cross Institutional Coordination and Integration.** As important as digital transformation is in higher education, a lack of proper planning and understanding of current and existing applications could cause problems and even cause a reverse effect. Thorough strategizing and coordination among the various organizations and departments will help institutions avoid these issues. The significant points to consider are:

1. Although an offered solution might seem alluring on the surface, does it respond to the institution's needs?

2. Will the chosen solutions replace, duplicate, or integrate with existing solutions?

3. Are all application and data silos identified?
4. What key performance indicators (KPIs) must be adopted to measure the success of the implemented solutions?
5. What are the top priorities based on the institution's mission, vision, strategic goal (Impact Level), and immediate objectives (Outcome Level)?
6. How will digital transformation serve the above points?

**Ongoing Investment Cost.** Digital education made its way into many educational institutions that already had various digital services, systems, and infrastructure. But these might be limited capabilities to serve a fully digital higher education institution. Moreover, these systems were not designed to serve as an integrated solution, which means that many systems do not communicate nor work well with each other, thus resulting in application and data silos across the institution. In addition, different higher education institutions rely on outdated technical infrastructures that cannot be upgraded, making it difficult to integrate and host the new digital platform.

All these challenges lead to the reality that digital transformation comes with substantial capital and operating investments and the need to secure the funds necessary to procure and adopt this shift. Therefore, institutions usually must find the best funding sources for capital investments and ensure the operating budgets for perpetually maintaining and upgrading their current systems and infrastructure to enhance their compatibility and interoperability. Unfortunately, emerging technologies are usually expensive. So, with the financial limitations, they will most likely have, HEIs may find themselves unable to adopt the needed solutions. Thus, for a digital strategy to succeed, it is vital to ensure that HEIs have the required financial and human resources in the plan to secure a successful digital transformation.

**Misconceptions about Privacy.** With digitalization comes the fear of information security and data integrity exposure. Securing information technology assets is one of the biggest challenges facing higher education institutions. Maintaining and managing network and data security require time, money, and resources to monitor vulnerability and address weaknesses.

Nonetheless, recent technologies have provided high levels of security and privacy of information based on restricted and granted rights with a detailed audit trail of access logs and actions. Such measures must be implemented within a complete security strategy, such as the NIST Cybersecurity Framework, and adhere to all set guidelines to ensure the complete protection of the IT environment. In addition, HEIs should have independently established information technology and information security units with adequate staff, qualifications, and segregated job responsibilities.

**Understanding Benefits of Digitalization.** Unfortunately, digital transformation is sometimes assumed to be simply about introducing new applications and automating processes. Digital transformation is far beyond shifting from paper to digital format. It is an evolved and transformed way of thinking and operating. This lack of understanding usually limits the strategy and implementation plan by rendering them a simple

automation project. It is important to note that digital transformation in higher education, as in any other sector, has profound business benefits from improved student experience and insights to enhanced resource management and increased productivity and profits. Only by understanding these benefits will digital transformation become a driver to overcome the challenges.

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# Chapter 2. Emerging Technologies and Practices

Several key practices and emerging technologies could have an excellent potential for improving the quality and richness of higher education by enabling more innovative and engaging teaching methods and learning experiences. Several are emerging as the higher education sector continues to embrace digital transformation. The following is an overview of the most prevalent innovations and practices in the sector.

## 2.1. Artificial Intelligence

Artificial Intelligence (AI) can be used to address ongoing challenges in teaching and learning. It represents an opportunity to rethink the curriculum and associated educational programs to serve the new digital generation better. AI is getting deployed heavily in domains such as learning management systems, supervision, grading, assessment, student information systems, office productivity, library services, admissions, disability support, and mobile apps, to name a few.

In fact, in Germany, through a fund by the German Federal Ministry of Education and Research, AI Campus was created as a digital learning platform for the development of AI skills and competencies in German higher education, e.g., Goethe University, where this AI platform is as a support to AI-related fields. In New Zealand, AI was adopted to visualize the emotional scores to understand better the student's online emotions associated with activity and assessment; Mind Labs, a New Zealand-based personal training facility, conducted the study (UNESCO, 2019).

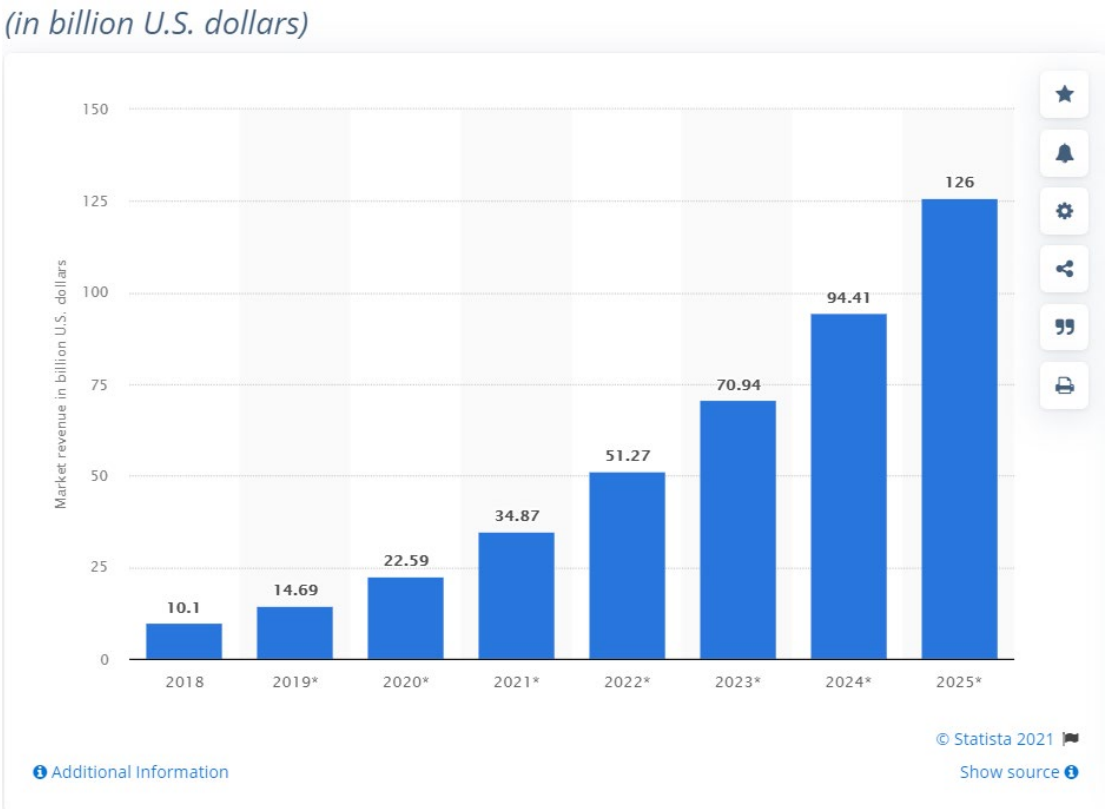


Figure 2. Artificial Intelligence Market Revenue Forecast 2018-2025 (Liu, 2020)

Nonetheless, AI remains a controversial topic. Perhaps the most sensational debate centered around the use of AI in education raised student privacy concerns. Some universities have faced lawsuits for using AI systems that collect biometric data to track and monitor academic progress and integrity without student consent. Another immediate problem higher education faces regarding AI is academic integrity, such as the use of cheap websites that offer paraphrasing tools to help students prevent plagiarism detection. In higher education, it may be necessary to fight fire with fire using AI systems to combat the use of other AI systems in a way that violates standards of academic integrity and intellectual property (Spilka, 2019).

AI may be used to assist in the filtering of prospective student applicants, based on preset criteria, during the admissions process. AI could offer more appropriate resources to students mastering certain subjects while providing supplemental study materials to students struggling with a particular topic. Researchers could also use AI to conduct literature reviews and network with peers in similar fields, establish connections across disciplines in separate silos, and collaborate with others to gain new insights and improve research quality. AI could help schedule classes and resources efficiently, optimize enrollment in course sections, and process registration requests.

## 2.2. Blockchain

The Blockchain, a revolutionary technology, is a public ledger that automatically records and verifies transactions of any type by using distributed ledger technology, which is the fundamental building block that powers Bitcoin, Ethereum, and other digital and cryptocurrencies. The Blockchain stores records in an immutable way – distributed ledgers that cannot change – and no one controls these records. Its technical capabilities have inspired several practical solutions to challenges in online education.

According to Kelly (2019), HEIs collaborate to create a trusted and shared infrastructure standard for issuing, storing, displaying, and verifying academic credentials and transcripts through blockchain. The blockchain's ability to manage, share, and protect digital content makes it ideal for helping researchers, faculty members, and other higher-ed principals create intellectual property, share it, and still control the way it is used while ensuring copyright and digital rights protection.

**Complete Learning History.** The blockchain cryptography-based recording approach ensures data accuracy and removes dangers like manipulation or deletion of study records. Because of the blockchain's decentralized architecture, distributed database, and communal maintenance, any HEI could record students' learning trajectories across geographies and time. These capabilities will increase platform efficiency while also lowering hardware costs. The blockchain-based learning record will comprehensively be documenting students' learning data that may be broadcasted over the network and downloaded by the student or a prospective employer. Employers can discover more about the students' learning status and validate their information using blockchain-based data.

**Reliable Certification of Learning Outcomes.** Despite the enormous popularity of online education platforms, students are dissatisfied after only a few courses because the learning outcomes are neither publicly acknowledged nor officially verified. However, blockchain technology provides a simple, effective solution for standardizing learning outcomes that can be easily verified even if lost. Based on this technology, it is possible to design the entire learning outcome certification system. With this system, students need not worry about losing their certificate, the institution can streamline the certificate preparation process, and employers spend less time and money on validating the learning outcomes of their prospective new hires.

**Decentralized Exchange of Educational Resources.** There are currently many online educational platforms offering various courses with extensive content. The courses are not shared on the platforms because of restrictions like educational methods, copyrights, and more. Blockchain technology makes it possible to share resources in online education through smart contracts. Based on these blockchain-based contracts, the online learning platform will efficiently and accurately complete the course's purchase, computation, and acceptance without any labor cost. Distributed storage and shared blockchain services enable students to acquire resources from different platforms by logging into a single node on the blockchain network.

## 2.3. INTERNET OF THINGS (IOT)

Higher education institutions can improve education quality, provide a better learning experience, and deliver improved efficiency by leveraging the Internet of Things (IoT). IoT helps higher education institutions analyze student information and performance, enhancing the learning journey with enhanced outcomes. Digital Campus is an example with IoT offering an essential platform for students to access information via corresponding locations to foster their learning experience. Universities will reduce operational costs within the digital campus, improve data security, and provide tools to researchers, academics, students, and staff. These benefits provide real value to the university's work and progress, student experience, and researchers.

Academics, researchers, and students are uniquely positioned to discover and develop IoT systems, devices, applications, and services. Nonetheless, IoT poses enormous challenges for higher education. For example, IoT technologies present new security and privacy issues that should be treated with fundamental priority to secure trust and authenticity of data and information. Learning and teaching quality and evaluation of students' work is another challenge. IoT educational applications should have tools and technologies for teachers, educators, and the scientific community to ensure the quality of research and address ethics issues within higher education (Aldowah, Rehman, Ghazal, & Umar, 2017).

The IoT infrastructure could be connected to the devices of researchers, students, faculty, and staff to better plan and use the educational spaces. Students can find out in advance if a study pod is available and work instead with their peers online. Researchers can find out if their lab is available in real-time or book a lab elsewhere. The security and protection staff on campus can monitor and observe an entire building because of enhanced sensors, RFIDs, cameras, and any other connected devices on the IoT for

better security and response. For building evacuations, systems can communicate in real-time with people in the building, giving them safety instructions and plans for evacuation.

By leveraging Bring Your Own Device (BYOD) policies, smart devices on IoT could collect information about students through learning devices, health trackers, and cameras. Within the learning management system, the university could set up a personalized learning solution for each student featuring a learning path, a study plan, and much more. HEIs must create educational spaces utilizing IoT and other future-learning technologies to change how they provide digital education and conduct research. The digitalized university life would include capabilities like:

- Both attendance modes, face-to-face and virtual
- Student and faculty check-ins
- Realtime presence through biometrics, IoT platforms, and RFID technologies
- Distance learning close monitoring
- Attendance coupled with predictive analytics to identify at-risk students

Finally, the IoT presents several ethical and legal challenges concerning biometric information privacy. In January 2021, a student attending Northwestern University in the United States sued the institution for violating an Illinois law on biometric information privacy. Northwestern was collecting data, including facial images, video and audio recordings, keystroke patterns, and eye movements, through an online proctoring software to prevent students from cheating during exams (EdScoop, 2021).

## 2.4. Extended Reality and Robotics

Thousands of companies around the globe are using AI, deep learning, robotics, augmented reality (AR), and virtual reality (VR) for automation and natural language processing applications (OECD, 2019). In 2018, more than 700 service robot manufacturers were targeting personal and professional users (OECD, 2019). XR technology is being deployed at HEIs as a strategic educational methodology for improved teaching and learning. MIT, for example, launched the *Collaborative Learning Environments in Virtual Reality* (CLEVR) project to develop VR simulations for classroom use. Healthcare, medicine, and nursing are other fields in higher education where XR technology is being applied, as in the case of Morgan State University (Pomerantz, 2020).

The Yale Blended Reality Project has dozens of sub-projects related to energy, electronics, medical training, and archaeological discovery (Yale University, 2020). Consequently, higher education institutions must keep up with these emerging technologies to ensure the employability of their graduates. XR facilitates digital Experiential Learning (ExL) is the process of learning through experience, which is more

narrowly defined as "learning through reflection on doing." XR technology is being deployed at HEIs as a strategic educational methodology for improved teaching and learning.

New, sophisticated facilities are being created to attract top-quality students and faculty. Forward-leaning technologies and the IoT could help HEIs build immersive educational spaces with virtual reality and enhanced reality so their students could benefit from a richer learning experience. At the same time, the faculty enjoy an enhanced teaching experience. Several learning scenarios could support this methodology. For example, AI-guided campus tours could be offered to prospective students during virtual open house events. Or, during a geology lab session, students could float into an active volcano's crater in Alaska and experience 3D information sent through live feeds, sensors, and other data. One step further, IoT and AI open the possibility of students in a classroom in Tunisia or their home interacting and sharing information with students, experts, and professors on other continents. This is an immense opportunity for learning that is worth exploring.

## 2.5. Blended and Hybrid Learning Models

Higher education institutions are using different approaches to delivering their course content to students. Higher education is rapidly diversifying, and the *Hybrid* and *Blended* models have been established and updated as the need arises. Both Hybrid and Blended models mix online and face-to-face learning. However, Hybrid Learning is an educational methodology whereby students decide and choose to participate online or in person. In contrast, the Blended Learning model combines online resources and activities with face-to-face education. Many institutions have developed their frameworks and used them as the basis for education sessions often held in virtual environments.

Because of the COVID-19 lockdowns, higher education has moved to complete online as technical interruptions and problems become very disruptive to the traditional learning experience. The pandemic has further forced higher education to adopt new hybrid models to cater to all social levels and new socio-economic trends requiring careful attendance. However, once the health risk issues are reduced with vaccination, the question for higher education institutions is whether to keep these hybrid models, abandon them and go back to more traditional models, or settle in a happy medium. Some may see a recent breakthrough in mixed education in the future, leading to an entirely online higher education career for students. Nevertheless, social studies have shown that face-to-face lessons are more appreciated by students, especially with what it brings from campus and social life. The opportunity for international higher education is to find the right balance to serve its teaching and learning mission (Pelletier et al., 2021).

## 2.6. Micro-Lectures

Micro-lectures are short, recorded video or audio lessons covering a specific topic. The trend with micro-lectures started in informal training and continuing education, but with

the COVID-19 disruptions, instructors and instructional designers have found creative ways to use micro-lectures to enable mobile and intermittently connected students to step through them at their own pace. Students will be responsible for ensuring the adequate leverage of this self-directed model of sub-modular learning to gain the required knowledge from these lessons. Micro-lectures offer the flexibility of integrating them quickly into the curricula.

## 2.7. Micro-Evaluations

Assessments and exams are instruments used for assessing the academic achievements of students. Online evaluations could be monitored, proctored, and invigilated. Micro-evaluations are the latest methods and techniques to evaluate the knowledge and skills of students. These are digital micro-assessments and micro-examinations administered frequently, e.g., dozens of times, throughout the academic term, and would take two to five minutes each to complete. Micro-evaluations could be quality assured through psychometric standards, like traditional assessments and exams. Combined with AI and XR, micro-evaluations may be used in healthcare education, clinical pharmacology, therapeutics in medical schools, and even in assessing surgical skills of trainees in virtual operating theatres in an experiential reality environment.

## 2.8. Chatbots

Universities across the United States are using AI-powered chatbots to boost enrollment and improve retention by fighting what is known as the Summer Melt (Gehlbach & Page, 2018). Rudra (2020) wrote that at the University of Oklahoma, the SoonerBot, an AI-powered chatbot launched in May 2018, was credited with securing the largest freshman class in the school's history in 2019. Georgia State University (GSU) saw solid results in reducing "summer melt" by 22 percent within the first semester of implementing an AI-powered chatbot, nicknamed "Pounce"; that number has since grown to more than 30 percent, which has led to hundreds of additional students enrolling each year at GSU (Renick & Page, 2020). AI-powered chatbots could also be used for tutoring students in various subject matters and providing help desk and technical support to users.

## 2.9. Quality Online Learning

With the advent of the COVID-19 pandemic, many educational institutions started developing portals and platforms for different educational resources and teaching strategies. The primary focus was helping faculty members pivot rapidly from traditional to online teaching based on finely selected materials. One of the most relevant related examples is the case of Indiana University's development of the 'Keep Teaching' portal. This portal provides templates that help students quickly find the information they need and reduce the faculty members' time spent building a site for each class. Templates and sites pages were dynamically updated and developed, enabling the staff to quickly

revise and redeploy needed information to meet the needs of faculty. The portal was a great success that dozens of colleges and universities across the United States and abroad reverted to the produced content and used it as a teaching reference (Indiana University, 2021).

In addition, the COVID-19 pandemic intensified the need for new pedagogical approaches for faculty to rethink content delivery, engagement activities, and authentic application and assessment. Western Sydney University launched an Online Engagement and Teaching Hub, which provided faculty members with different teaching strategies, recommended technologies based on evidence-learning theories, and showcases from peers in the university. Regardless of the instructor's physical location, the hub provided practical resources, the opportunity to connect with a community of practitioners, and a mechanism to enhance teaching practices.

Different institutions realized that online teaching is more than simply replicating the face-to-face experience via Zoom or Microsoft Teams. As such, HEIs must inevitably resort to quality assurance organizations, such as *Quality Matters*, and a pool of resources and validated quality assurance standards for the improvement and sustainability of online education. Quality assurance organizations will ensure that universities are prepared to teach online and that their courses meet stringent quality assurances and accreditation requirements.

## 2.10. Learning Analytics

As a subset of data analytics, learning analytics focuses on education data sets to make accurate, evidence-informed decisions to serve an increasingly diverse population of learners in higher education. Institutions continue to develop internal systems to collect effectively, host, and use currently available data to better understand the higher education sector stakeholders and provide the best educational experience for students. For example, the University of Wisconsin is harnessing educational data through graduates' studies and dynamic analyses to empower and improve decision-making and education quality. Such an approach will most likely impact teaching, learning, and policymaking positively, with a focus on quantitative and qualitative results. The university provides a program curriculum with the foundational knowledge and skills needed to navigate educational data mining successfully and generate the best and most accurate analytical results. It is evident that universities foster a mine of data more than they can analyze, and this is because of the lack of strategic data planning (Pelletier et al., 2021).

HEIs are establishing more complex data governance structures to support the challenges of more complex data infrastructure needs. Developing a *Data Strategy*, as proposed by Stony Brook University, helps bring common data objectives and tasks. The goal is to promote *Data Innovation*, enable data consumers to interpret data, take proactive, evidence-based measures, gain more organizational agility, and optimize data-driven outcomes. From another perspective, Colorado State University implemented the U-Behavior, a self-regulating teaching and learning method that guides students using science-of-learning strategies. This method is a first in the field to integrate instructions by providing students learning techniques via direct feedback in

visual individualized behavior charts, e.g., visual form learning analytics, and encouraging ongoing reflection on behaviors (Pelletier et al., 2021).

The future of learning analytics is promising, and institutions must continue to explore it while upgrading their infrastructures and technical capabilities to capture, analyze, and implement better data strategies and protocols. HEIs must strive to remain relevant and aware of best practices in this learning analytics area. In addition, higher education institutions should consider joining efforts with vendors utilizing data and learning analytics in their products to carefully ensure that institutional strategic goals are respected, and ethical standards are well observed.

Predictive modeling and analytics help identify at-risk students so that timely and appropriate interventions are done. Stakeholders across higher education institutions should receive learning analytics as an integral part of their skill development. More awareness and analysis training coupled with updated work procedures are a must-have for institutions to benefit from learning analytics to the maximum. Stakeholders across higher education institutions should receive learning analytics as an integral part of their skill development. More awareness and analysis training coupled with updated work procedures are a must-have for institutions to benefit from learning analytics to the maximum.

## 2.11. MOOC Platforms for Microcredentialing

Microcredentials, defined as degrees and certificates offered in shorter, more flexible schedules, have been gaining relevance with increased adoption recently, especially with the heavy reliance on online learning in recent years. The rapid changes in technology will require a quick update and alignment in the workforce's skills in higher education. Microcredentials provide flexible learning timespans and a subject-specific learning experience.

Credential Engine recently released a report highlighting the gained interest in microcredentials and alternative credentials even within university settings, notably on Massive Open Online Course (MOOC) platforms and via non-academic providers (Pelletier et al., 2021). More than 700,000 microcredentials are now available from different sources. The flexible nature of microcredentials -offered online, in person, or hybrid models - contributes to this growing trend. Japanese universities, for instance, started issuing digital certificates after the launch of a pilot *Digital Credential Technical Standards Dissemination Initiative* project that enables the sharing and reusing of digital badges in admissions and recurrent education among different institutions (Pelletier et al., 2021).

## 2.12. Open Educational Resources

In many countries, the adoption of free or low-cost learning resources, such as Open Educational Resources (OER), was already underway well before the COVID-19 pandemic. Boston University Learning Blocks (BULB) is an example of OER, built on an

open-source WordPress plugin that aids with creating an interactive platform for instructors by enabling the embedding of self-assessment questions directly into pages alongside the text, audio, and video content. Students can interact directly with the posted questions in their browsers and receive instant feedback while attending the lessons. Equally, in Australia, a collaboration among higher education institutions seeks to define and implement an overall concept for a sustainable model of OER and open educational practices to be implemented in all Australian universities. Aspects of the program include a national OER certification body, services for instructors developing OER, and enhancing the technical infrastructure for OER (eCampusOntario, 2021).

Based on different studies, on average, students spend around $600 per year on textbooks. OER will aid in cost savings and improve student outcomes (Pelletier et al., 2021). During the pandemic, the adoption of OER has led to increased student enrollment and increased credit hour production. The adoption of OER as a required course material did not grow in 2020, which shows that growth in awareness was not coupled with growth in adoption. Statistics show that 70% of faculties still retained textbooks as a course requirement, and 87% reported using the same textbooks as previous terms (Pelletier et al., 2021). A significant reason for this can be explained by the fact that some commercial vendors provide inclusive access for faculties of the same imprints in the alternative, lower-priced formats.

## 2.13. Smart Campus

The smart campus consists of two main components. First, the IT service delivery platform reuses end-to-end infrastructure to provide network connectivity, mobility, and security for all applications and services on campus. Second, it includes many Internet of Things (IoT) applications that work on a platform system to enable university professionals, enable teaching and learning activities, and enhance the student experience. IoT has a direct impact on educational technology, reforms in education, change management, experimental and practical changes, changes in campuses, changes in educational resources, among others.

The smart campus has the same characteristics as a small-scale smart city by utilizing Internet-connected devices to manage and control resources and optimize the user experience. Smart campuses are attractive to management because of their attributed cost-savings to students, faculty, researchers, and staff to improve university life in general. Smart campuses offer several advantages such as:

- enabling intelligent booking systems with real-time usage data for rooms and resources, such as laboratory time and library desk space;
- powering better digital workspaces and connecting lecture halls and auditoriums;
- monitoring environmental data across the facilities and buildings;
- improving campus security and protection services, thus giving students peace of mind; and
- supporting flexible and online learning options.

Refer to the **Internet of Things (IoT) Section** for more details.

## 2.14. UNIVERSITY 4.0

The Fourth Industrial Revolution (4IR) resulted in a shift from the mass production of goods and the provision of services toward customized products and services based on individual customer needs and requirements. The 4IR inspired Education 4.0, which is defined as a complementary phenomenon of digital inclusion in the daily lives of human beings whereby learners and machines are aligned to discover and innovate, with drastic changes in education and pedagogy coupled with integrating 4IR technologies into education. This futuristic vision of education relies on exploiting the power of digital technologies, customized data, and the opportunities offered by a connected ecosystem to promote lifelong learning. The educational revolution allows learners to be the architects of their learning, characterized by the personalization of learning with flexible, dynamic, and adaptive learning pathways (Gueye & Exposito, 2020). Finally, University 4.0 is based on the requirements of Education 4.0 with the added autonomous management of learning processes resulting from integrating the physical and digital worlds to improve and adapt the learning experience (Gueye & Exposito, 2020).

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# REFERENCES

Aldowah, H., Rehman, S.U., Ghazal, S., & Umar, I.N. (2017). *Internet of Things in Higher Education - A Study on Future Learning*. Journal of Physics: Conference Series. https://doi.org/10.1088/1742-6596/892/1/012017

eCampusOntario (2021). *Supporting Open Educational Resources in Ontario*. Retrieved from https://www.ecampusontario.ca/open-education-resources/.

EdScoop (2021, February 22). *Northwestern sued over biometrics privacy in test proctoring software*. Retrieved from https://edscoop.com/northwestern-university-biometrics-privacy/.

Gehlbach, H., & Page, L. (2018, September 11). Freezing 'summer melt' in its tracks: Increasing college enrollment with AI. Brookings. Retrieved from https://www.brookings.edu/blog/brown-center-chalkboard/2018/09/11/freezing-summer-melt-in-its-tracks-increasing-college-enrollment-with-ai/.

Grajek S. (2020, November). *Top IT Issues, 2021: Emerging from the Pandemic*. The 2020–2021 EDUCAUSE IT Issues Panel. Retrieved from https://er.educause.edu/articles/2020/11/top-it-issues-2021-emerging-from-the-pandemic.

Gueye, M.L., & Exposito, E. (2020). *University 4.0: The Industry 4.0 paradigm applied to Education*. Retrieved from https://www.researchgate.net/publication/344508737_University_40_The_Industry_40_paradigm_applied_to_Education.

Indiana University (2021). Keep Teaching: Classroom technology for hybrid instruction. Retrieved from https://keepteaching.iu.edu/.

Kelly, R. (2019). *Nine Universities to Collaborate on Digital Credentials Initiative*. Retrieved from https://campustechnology.com/Articles/2019/04/23/9-Universities-to-Collaborate-on-Digital-Credentials-Initiative.aspx.

Liu, S. (2020, December 7). *Artificial intelligence (AI) software market revenue worldwide from 2018 to 2025*. Retrieved from https://www.statista.com/statistics/607716/worldwide-artificial-intelligence-market-revenues/.

McKinsey (2020, October). *How COVID-19 has pushed companies over the technology tipping point – and transformed business forever*.

OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris. https://doi.org/10.1787/9789264311992-en

Pelletier, K., Brown, M., Brooks, D.C., McCormack, M., Reeves, J., Arbino, N., Bozkurt, A., Crawford, S., Czerniewicz, L., Gibson, R., Linder, K., Mason, J., & Mondelli, V. (2021). *2021 EDUCAUSE Horizon Report, Teaching and Learning Edition*. Boulder, CO, USA. EDUCAUSE.

Pomerantz, J. (2020, March). *Extending XR across Campus*. ECAR research report.

Renick, T., & Page, L. (2020, September 4). *What does it take for nudging to impact college students' success?* Ed Tech Dive. Retrieved from https://www.highereddive.com/news/what-does-it-take-for-nudging-to-impact-college-students-success/584727/.

Reuters (2020, March 19). *Remote work during coronavirus outbreak puts millions more on Microsoft Teams, Slack*. Retrieved from https://www.reuters.com/article/us-microsoft-tech-idUSKBN21629D.

Rudra, S. (2020, November 17). *In AI, Colleges See Cost-Effective Ways to Boost Enrollment*. EdTech Focus on Higher Education. Retrieved from https://edtechmagazine.com/higher/article/2020/11/ai-colleges-see-cost-effective-ways-boost-enrollment.

Spilka, D. (2019). *Artificial Intelligence and Big Data in Higher Education: Promising or Perilous?* Retrieved from https://www.smartdatacollective.com/artificial-intelligence-and-big-data-in-higher-education-promising-or-perilous/.

UNESCO (2019). *Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development*. Working Papers on Education Policy.

Yale University (2020). *Blended Reality Project Annual Report 2019-2020*. Yale University. Retrieved from https://blendedreality.yale.edu/publications/.