Chapter

Embracing Technological Change in Higher Education

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Abstract

Access to information has never been easier, thanks to the rapid development of the internet and communication technologies, and the ubiquity of smartphones and other internet-enabled devices. In traditional classroom learning, teachers provide students with various sources of information that are known to be reliable. Nowadays, especially in a post-pandemic era, students increasingly rely on a host of resources available on the internet. Exposure to vast amounts of scattered information could adversely affect students' learning process. Meanwhile, pedagogical approaches, classroom learning practices, and student learning activities have evolved significantly to cope with contemporary challenges. This study reviews the current learning practices and the technological interventions in a rapidly evolving higher education landscape. In particular, the challenges when integrating technology into higher education are considered in detail and ways put forward for doing so in that context.

Keywords: change, attitudes, e-learning, higher education, online education

1. Introduction

The rapid development in information and communication technologies has significantly influenced the process of education in the past few years. An exponential increase in online education has been observed globally, which has significantly affected pedagogic approaches and learning behaviours [1]. Innovative technologies are being developed to improve the effectiveness of online learning processes. For instance, the Sandbox Collaborative, the innovation arm of Southern New Hampshire University, uses technology tools for twenty-first century collaboration, weaving audio-visual and IT systems into the fabric of this visionary incubator at the university, offering students an effective learning experience [2]. This facility is one of the examples reflecting the future of higher education that uses innovative technologies, including blockchain networks, virtual reality, artificial intelligence, and machine learning. Whilst huge investment in technology solutions is one of the major challenges for educational institutions, this can be addressed by increasing enrolments worldwide. Top institutions, such as MIT, have been allocating multi-million-dollar funds to pay for faculties to experiment with new teaching innovations [3]. Various innovative concepts are already being tested. For instance, students may subscribe for a course or modules of their choice, rather

than enrolling. Boise State institution is already implementing this concept through a Programme called 'passport to education', through subscription ($425 a month for 6 credit hours or $525 for 9 h on two bachelor-degree programmes), which is 30% cheaper than the traditional in-person university fee [4]. Southern New Hampshire University is testing an assessment system using artificial intelligence (AI) techniques [5], whilst Barnes & Noble Education is using an AI tool called 'bartleby write' that corrects grammar and checks for plagiarism [6].

There are various contributing factors that have led to the exponential growth in the online education. Firstly, internet access and smartphone ownership have increased significantly in the past few years, which has facilitated the remote learning process. In 2019, there were 5.1 billion unique mobile users, with a 67% global penetration rate, and 4.3 billion internet users, with a 57% global penetration rate [7], thus indicating that more than half of the world's population is connected to the internet. However, the digital divide is one of the major concerns that impact online education. Secondly, the recent COVID-19 pandemic has significantly affected the learning process due to the preventive strategies, such as school/college closures. Almost 99% of students were affected by the school closures due to the pandemic and it is estimated that over 100 million additional children will fall below the minimum proficiency level in reading as a result [8]. Online education was taken to be the most effective approach to address the issue of school closures owing to the pandemic, which led to a sudden increase in the number of students enrolling in online courses [9]. The sudden shift from the traditional classroom learning environment has left many wondering whether the adoption of online learning will continue to persist post-pandemic times, and how such a shift will impact students, teachers, and the worldwide education market. The size of the worldwide e-learning market, which stood at $18 billion in 2019, is expected to reach $390 billion by 2026 [10].

Despite the scope for online education being vast, the sudden shift towards it has led to serious complications in terms of delivering education in many parts of the world. Developed countries are far ahead of the developing and underdeveloped countries in terms of the internet access, the relevant infrastructure, high internet speeds, connectivity, and reliability. For example, 96% of the population of Norway has internet connection, whilst only 2% of those in Somalia have it. Moreover, it would take more than 30 h to download a 5GB video in Yemen, whilst it would take only 8 min to download the same one in Taiwan [11]. These factors, among others, are negatively affecting the adoption of e-learning in many countries. Considering these matters, this chapter provides an overview of the new technological developments in higher education, issues associated with the integration of technology into education, the attitudes of students and teachers towards the changes in the learning process, and the way forward.

2. Technological developments in higher education

Whilst technology adoption in education has been rising in the past few years, the COVID-19 pandemic has substantially accelerated it across K12 and higher education. The key trends now include developing cloud-based technologies for student relationship management (CRM applications), learning management systems (LMS), assessment management applications, and many other technologies that are efficient in managing the various operations of the institutions. The advances in the integration of technology with education and the new innovative solutions are discussed in the following subsections.

2.1 Video-based learning

Increased access to the internet has opened the door for remote learning, among which video-based learning is one of the first and most prominent approaches being used in education. For instance, YouTube, one of the most popular online video networks, has more than two billion users worldwide, with the American customer satisfaction index (ASCI) registering 75% [12]. Video is becoming a *de facto* medium in education. Students prefer to watch videos for better understanding, which can also lead to better knowledge retention, rather than reading long texts. Furthermore, there is a 27% Compound Annual Growth Rate (CAGR) in video streaming devices (tablets, smartphones, smart TVs, etc.), with it being projected that 66% of worldwide devices will be streaming 4K quality videos by 2023 [13]. Increasing internet speeds, with new technologies, such as 5G and high-speed broadband networks, is facilitating the wider adoption of video-based learning by streaming high-quality videos. Owing to these factors, educational institutions are increasingly likely to invest in creating educational videos that can be educational/topic-based videos, classroom-based videos, or technology-based videos, with screenshots and images along with a description. For instance, loom.com is a free tool, through the use of which educational videos can be created. Furthermore, video production and distribution can be cost-effective, as there are many tools for creating and editing videos. Importantly, they support anytime learning, whereby students can watch recorded videos as per their convenience. In addition, the flexibility to watch videos on multiple devices can enhance the learning process by supporting a convenient learning process.

2.2 Blockchain

Blockchain technology ensures that the transactions and data are not controlled by any organization, which helps in creating a decentralized environment as well as enabling safe and secure transactions. Each transaction is recorded in a public ledger in a verifiable and permanent way [14]. Blockchain is a technology being used for cryptocurrency; however, because of its security protocols and safety, it is being adopted in various areas of business. Various case studies and use cases have been developed for blockchain in higher education. Processes, such as sharing student data between institutions for a semester exchange, student transfers, or sharing students' academic data with recruiters, are a few instances where blockchain can be applied. This technology has been already applied by various institutions in different areas. For example, MIT has applied Blockchain to validate its certificates, whilst the University of Nicosia has used it for smart contracts and to accept cryptocurrency as a form of payment [15]. Many applications with different use cases are emerging, which can be student-centric solutions, such as automatic recognition of credits, or institution-centric ones, such as streamlining the process of diploma verification and virtual lifetime learning passport, whilst securing the issued certificates permanently. A recent study [16] has led to the development of a global higher education credit platform, named EduCTX, which constitutes a globally trusted, decentralized higher education credit, and grading system that can offer a globally unified viewpoint for students, higher education institutions, and other potential stakeholders. EduCTX prototype implementation delivered effective and secured management and control of ECTX tokens, representing the credits that students gained for completed courses. Regarding safety and security issues, blockchain technology can be considered an effective solution but the cost remains high, hence it is not feasible to be applied across all institutions.

2.3 Online assessment trends

Assessment methods, such as coursework, examinations, and viva are key to evaluating students' learning. Traditionally, the assessment was tasked to teachers, who allocated a particular grade based on their judgement and/or set marking criteria. Nowadays, with increasing reliance on online education, there is a growing need for new innovative technologies to assess students' learning. AI-based technologies and other semantic technologies, such as Natural Language Processing (NLP), have been identified as being effective solutions in this aspect. Machine learning (ML) techniques, involving trained algorithms, can help teachers in complex assessments as well as reducing the burdens of human marking, time, and cost.

Many studies focusing on the use of ML techniques for students' assessment, relied on the validity of the work while undermining the technical and pedagogic features in evaluating student works in science subjects, using approaches such as text recognition, classification, and scoring [17]. Disagreements related to vocabulary between human and ML scoring are possible when assessing students' works [18]. To address this, NLP techniques can be used in the assessment process. NLP algorithms have been found to be effective in assessing students' work, such as essays, marking closely the same as humans. Moreover, they can provide similar scores in both original languages and translated versions of essays, thus reflecting the applicability of assessment technologies across multiple languages. NLP techniques have been shown to provide consistency, scalability, and traceability in the form of an automated marking system. Furthermore, online exam invigilation proctoring techniques, such as audio/video/screen forms, automated AI invigilation, preventing HDMI cable extensions, avoiding background screen sharing, preventing unauthorized access, are a few of the new techniques being used in online exams and assessments aimed at avoiding cheating and/or copying. In addition, AI-based solutions, such as Expert Control System (ECS)-based tutoring platform and Agent-based Tutoring Systems (AbS) are proving to be effective in assessment for learning [19, 20].

2.4 Self-paced learning

Each student has a different set of learning-related abilities, strengths, and weaknesses. While students like a particular subject, they may dislike others and, as result, can be weak in these. To overcome this, self-paced learning, where students study at their own pace, with little influence from classroom lectures, can be one of the effective solutions. Technology plays an important role in driving self-paced learning. Many universities have launched online courses that give the students more control over their study, so they can study at their own pace. Blended learning, where significant elements of the learning environment, such as face-to-face online tools, are used in learning, can also support students' self-paced learning and enhance their engagement in learning [21]. Also, empirical findings have suggested that self-learning tools, with the support of relevant pedagogy and learning processes such as self-regulated learning can significantly improve students' learning and engagement [22]. In sum, online educational tools allow for self-paced learning and this can significantly improve students' engagement in learning and knowledge retention.

2.5 Artificial intelligence and machine learning

AI is already being implemented in various business sectors. The education sector has a range of areas in which AI can be of significant help in improving the

learning process. For instance, AI-based auto-invigilation can be used for administering online examinations. Using video, a remote invigilator can watch candidates during an exam, while audio invigilation can capture sound coming from candidates' backgrounds while taking the exam (recording any malpractices such as cheating). Moreover, facial recognition and biometrics can provide added security for verifying the candidates before accessing various online resources. However, using AI techniques in certain areas, including invigilation, is an issue that has been subject to debate with some arguing that it is unethical. Furthermore, data-driven analysis using AI and ML techniques can enhance decision-making capabilities in the education sector. For example, in learning analytics, historical school dropout data can be used to train ML algorithms to predict future dropouts based on numerous variables including dropout rates by class, level, gender, region (urban/rural), and college type. This can help institutions and governments in taking effective decisions aimed at reducing student attrition. The reliability of AI techniques has been proved to be effective in various studies [23]. For instance, a recent work [24] involved investigating the use of AI-based algorithms in the admissions process at a German university, where it was found that the decisions were more effective than those of humans. This is clear evidence that AI-based solutions can improve various operations in educational institutions.

2.6 Virtual reality

Virtual Reality (VR) enables students to become involved in active learning, rather than being passive in the learning process. VR now paved the ground for more advanced technologies such as Augmented Reality (AR) and Extended Reality (XR). These technologies/tools deliver a simulated environment to students that is similar, to some extent, to a real one which they can experience it in 3D-visual form. For instance, biology students can learn about the functioning of the heart through a simulated environment, where they can open the layers of organs and study the functioning of its inner parts, such as the atria, ventricles, arteries, and veins involved in pumping the blood. It has been ascertained that with VR techniques students can have a knowledge retention rate of 75% compared to 10% with reading and 5% from lectures [25]. A recent systematic review [26] on the impact of VR on students' performance has identified 24 relevant studies, out of which reported a positive impact of VR on performance, whilst seven revealed a negative one, and six registered no significant impact. Moreover, VR techniques can help in the acquisition of procedural and declarative knowledge as well as the development of skills, such as problem solving, communication, and collaboration [25]. VR technologies, being costly, are being used minimally; however, with new development making them cost-effective, they could become one of the major components of online education in the future. Nevertheless, some limitations have been identified in research relating to VR in higher education. In particular, most of the studies evaluating VR technologies have been focused on the usability of the VR application, rather than the impact of such technologies on learning outcomes [27].

2.7 Internet of Things (IoT)

Internet of Things (IoT) refers to the small objects connected to the internet that can communicate with each other. These objects can work without human intervention, thus enabling automation and control. IoT is being applied in various sectors, and it has immense scope in the education sector [28]. For instance, it can be used for tracking and monitoring a range of activities in school, such as monitoring school buses, providing automated lighting in classrooms, thereby reducing

electricity wastage and enhancing sustainability, monitoring students' health using devices, biometric attendance, student location tracking, and tracking students' academic progress. IoT could also dramatically change the ways universities work and enhance student learning in many disciplines and at any level. Furthermore, it could enhance learning outcomes by providing richer learning experiences, improved operational efficiency, and by gaining real-time, actionable, insight into student performance [29]. A few institutions have already been using applications exploiting IoT, and widescale implementation has yet to be achieved [30].

2.8 Chatbots

Chatbots are interactive applications that provide feedback or address the queries of the users, having been applied in almost every sector. It is very common these days to observe a pop-up on banking or retail websites, where a virtual avatar asks whether it can help with anything. Chatbots could be applied in many areas in higher education, such as personalized tutoring, personalized feedback, and query resolution. Institutions often receive thousands of queries regarding the admission process, fee structures, merit lists, college or exam schedules, syllabuses, etc. Chatbots in this context could be very helpful, as they can virtually assist users in real time, thereby enhancing their satisfaction. The scope of its application in higher education can be understood from a recent study [31] that developed three chatbots: (1) to support the delivery of a taught master's course simulation game; (2) to support the training and use of a newly introduced educational application; and (3) to improve the processing of helpdesk requests within a university department. Other studies [32, 33] have identified more possibilities for the use of chatbots in online education in the future for facilitating personalized and self-paced learning practices.

2.9 Open educational resources

Open Education Resources (OERs) constitute one of the foremost technology trends in higher education, which are cost-effective and accessible to both teachers and students. OER includes any learning material that can be freely accessed by students and teachers, thus being in the public domain, thereby making education accessible and affordable for all. UNESCO is the only international organization that sets out a framework for a dedicated OER Program. However, OERs exist for many years, and no major developments have been observed in this area. Social networking has become one of the important platforms for collaboration for learning, which is also an approach for improving open educational resources and forming online student communities for sharing knowledge.

3. Challenges to the integration of new and innovative technology solutions into higher education

Globalization and competition between institutions in the technology race are the two key factors contributing to the adoption of technology in higher education. However, there are various barriers to integrate technology into higher education provision. Preference for academic traditions, such as faculty/classroom-centred lectures, and mean many lecturers/professors, is reluctant to adopt technology-based alternative instructional methods. Limited support for faculty members in learning to use these technologies is another factor inhibiting their usage in higher education [34]. In particular, the lack of effective policies, inadequate

infrastructural facilities, and the absence of plans of action by institutions in developing and under-developed countries have been identified as obstacles to the implementation of new technologies [35]. Barriers can also be identified in specific to a technology being used in the higher education. For instance, regarding gamification technology, various inhibiting factors, including inflexibility of curricula, the negative effects of gaming, students' lack of readiness, lack of supporting materials, fixed class schedules, and limited budgets, have been identified as hindering its usage in classrooms [36]. Meeting the increasing expectations of the students is another challenge that has been identified in the context of integrating technology into higher education [35]. Children and young adults nowadays are particularly influenced by the technologies surrounding them. For instance, generation alpha, i.e., children born in 2010; the year in which iPad was launched, is used to the technologies that embrace IoT. Children of that generation are increasingly being brought up in smart homes with smart speakers, such as Amazon Alexa or Google Home, which are changing the way they access information. Furthermore, some students are creating their own apps in high schools, which clearly indicate the high levels of technology skills among the current generation of students. Hence, it is only to be expected that students will demand the same types of technology they experience in smart homes to be available in their classrooms and universities. This has led to it becoming mandatory for universities to upgrade to new technologies and smart devices that are redefining the ways of learning. However, meeting the rising expectations of students has become one of the major challenges for universities, with upgrading to integrate the new technologies in the learning process requiring a huge investment. Moreover, managing such technologies requires major changes to infrastructure, processes and policies, administrative systems, and pedagogic approaches [37–39]. Lack of funding, increasing operational costs, and lack of state/public support have been inhibiting the implementation of technology solutions in universities and colleges in the past few years [40]; however, few countries, such as Japan, have substantially increased funding for universities to address the above mentioned concerns [41].

With new innovative technologies being integrated into higher education, the risks to privacy and security have been growing. There is a need to draw a line regarding the number of students' private information that a university holds [35]. Unregulated processes and the use of innovative technologies, such as AI, may raise concerns of privacy and about the interests and influence of corporates in accessing the data due to invisible, biased, and inaccurate logic or data [42]. Furthermore, with the rapid increase in the amount of information being collected using AI technologies, such as students' learning behaviour, it is becoming increasingly complex to secure the data. In some cases, the less the information, the easier it is to protect, for when there is overload, the security of information held by the institutions may be at risk. Moreover, technology is also impacting the role of faculty in significant ways. Academics can use technology to prepare for classes, conduct research, and deliver instructions. A fundamental shift in faculty duties can be observed with the integration of technology. Faculty are observed as consultants and coaches rather than subject experts as students have multiple platforms for learning. Furthermore, the idea of the university such as accredited institutions with no campus, classrooms, or athletic teams to tie together the academic community has been changing with increasing opportunities for e-learning. With quick and unpredictable changes in technology, challenges in systematic planning of technological enhancement to educational programmes and catching up with new technologies are increasing, as a adequate number of resources are required for training faculty, updating operational changes, and managing them. Furthermore, technology has been transforming

business sectors, with more companies relying on automation, which has significantly been putting pressure on the jobs market. However, there are new opportunities emerging with the advances in technology, where human resources are required. Addressing this volatility has become a challenge for the universities to feed the ever-changing pipeline of opportunities, in preparing new courses that impart the right skills and knowledge for students to be employable. Technology may not reap its full potential and may not be effectively integrated into higher education, if the barriers to its adoption discussed in this section are not resolved satisfactorily by institutions.

4. Students and teachers' attitudes towards the change

The attitude of the students and teachers towards technology integration in higher education is an important aspect to be analysed. Understanding such attitude provides further insights into students' and teachers' behaviour and perception towards e-learning and allows better planning for future development and policies. Generation Z, the members who use modern technologies, especially mobile applications, is not particularly attracted to e-learning platforms, but rather, is more interested in the participation and collaboration in the creation of its content and interacts with each other in ways they are used to with other social media platforms such as Facebook, Instagram, and YouTube [43]. As students have unlimited access to information online, their attitudes towards e-learning have reflected a participatory approach in learning. This has resulted in the change of the role of instructors to that of a consultant or a coach. Hence, instructor knowledge of learning technologies and student understanding of computer systems, and technical infrastructure are important factors for ensuring the success of online learning [44]. With the introduction to technology from early childhood, students in higher education have learned to accept it as an integral part of their education, with many perceiving it as an essential resource for effective learning. However, the attitudes of students may not be the same in all disciplines and may differ from region to region, as there are various factors that influence its acceptance. Regarding this, a recent study [45] during the COVID-19 pandemic with 111 nursing students in the Philippines observed that, in spite of their having intermediate computer competency and a stable internet connection, the majority of them had negative or ambivalent attitudes towards e-learning. They reported e-learning as being impersonal, thus resulting in poor student-teacher interaction, whereas a study [46] in the UK on medical students' attitudes towards the Mental Health First Aid eLearning course found that the online course helped them to improve their knowledge and confidence to help someone in need, which thus resulted in positive responses to the approach. Another study [47] in Ghana, with 472 distance learning students of the University of Cape Coast, revealed that there are regional differences regarding students' perceived usefulness, self-efficacy, and attitudes towards e-learning. Hence, it can be concluded that there are various factors that might influence students' attitudes towards e-learning positively or negatively. Computer self-efficacy, social influence, level of enjoyment, system interactivity, computer anxiety, technical support, perceived usefulness, perceived ease of use, and behavioural intention to use are some of the factors that can influence the students' attitudes towards e-learning [48]. However, increasing reliance on the e-learning options due to the COVID-19 pandemic has led to the introduction of e-learning and other innovative technologies such as virtual learning, which have increased students' satisfaction levels and helped in developing positive attitudes towards e-learning [49].

Similar to students, teachers' attitudes towards technology may be influenced by a range of factors, which can be categorized as being at the teacher-level, school-level, and system-level [50]. As discussed previously, teachers may exhibit resistance to learn new technologies that require them to change their instructional and pedagogic strategies or they may experience a lack of support in terms of training to learn these technologies, which can lead to them developing negative attitudes about technology interventions in higher education. Teachers' attitudes can vary across different regions, with their acceptance and adoption of e-learning being dependent on their level of computer proficiency, the available resources, and students' readiness to engage in new technology [51]. The subject knowledge and experience may have no influence on the teachers' attitudes towards technology intervention. A recent study [52] investigated teachers' attitudes towards the use of Microsoft Teams in education, finding that the usability of the platform was negatively associated with their years of experience, and their general anxiety and power and control of the platform negatively affected the time they spent on the platform. Hence, it can be seen that, while those teachers who are provided with sufficient training and support may develop positive attitudes towards the use of new technology in higher education, others, with poor support and lower computer proficiency, can develop negative attitudes, and both of these dispositions can significantly influence the process of learning.

5. Conclusion: the way forward

It is undeniable that the future of learning will be significantly influenced by the technology revolution, with the traditional university-based learning models being replaced by online learning ones. Notably, the previous gradual shift towards online learning has been transformed into a much swifter transition due to the COVID-19 pandemic. Many institutions were unprepared for the change, but they had no option other than to engage with it. As a result, various challenges have emerged that have adversely affected the learning process for both teachers and students. Now, there is no turning back, so the challenges to adapting to new technology in higher education must be addressed if we are to move forward. Therefore, the future of higher education may need to deal with embracing the change by preparing the students and faculty for the rapid changes that may appear in the process of learning, administration, and management of resources. There is a pressing need for the development of new educational policies and standards for online education systems using different technology interventions, and restructure the accreditation and credit system in an online environment. A special focus has to be put on increasing the funding for deploying innovative technology solutions to meet the expectations of Generation Z students. At the same time, the safety, security, and privacy of the technology-enabled education systems have to be improved in order to ensure the reliability of the new technology interventions. Most importantly, the way forward is to make the most effective use of technology in education by collaboration between the universities, social organization, corporate institutions, and the states so as to enable access to education for all. This approach would enable streamlining the education according to the ever-changing pipeline of opportunities.

Conflict of interest

The authors declare no conflict of interest.

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