A short survey on the role of technology in transforming education

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Abstract

Education is the key to the quality of human life in the future and providing quality education is the main aim of institutions. However, recently, the coronavirus pandemic (COVID-19) has transformed the mode of delivery of education in the world everywhere. Educational institutes are choosing to stay under a lockdown or have been forced to shift to virtual education. In such times, technologies such as Artificial Intelligence, Internet of Things, Cloud Computing, X-Reality systems could play a major role in enabling education. This is a short survey paper which explores the role that technology plays in education and also showcases that a more humane attitude is needed to a technology-based world. In the end, a few challenges related to each technology have been presented, winding up with discussion and conclusion.

Keywords
technology, education, AI, cloud computing, adaptive learning

1. Introduction
In future, education will become one of the key factors to determine the quality of human life. In the same lines, United Nation's 2030 Agenda for Sustainable Development is to provide good quality teaching services. It aims to safeguard holistic and unbiased quality of educational services and create learning possibilities for life long (Burbules et al. 2020). Interestingly, the new digital technologies have transformed education in several learning contexts formally as well as informally. Information technology (IT) has facilitated educational reform, which has also been stimulating sharing knowledge in society. Considering the coronavirus pandemic (COVID0-19), it has become all the more crucial to make structural changes at the fundamental level through technology to see a substantial rise in educational productivity (He, 2011). However, it is not enough to define technology within the context of education merely by using desktops in classroom settings. The era of Artificial Intelligence (AI), Big Data, Cloud Computing and Internet of Things (IoT) have altered the approaches to in every aspect of life. Therefore, schools, colleges, universities also need to upgrade by undergoing a change in terms of adopting technologies. The so-called information age offers a lot of opportunities to bring about technological reforms needed in education, with the educational bodies becoming hubs of cooperative and self-directed education as students and teams work with recent technologies to solve real time issues that come along with the leadership of a teacher (Lemke, 1998). Despite all of the hype around technology being transformational, the educational institutions have displayed alterations over the last few decades compared to the other aspects of society (Selwyn, 2012). In this paper, the aim is to highlight some of the technologies mentioned above that have digitized the teaching and learning approaches in education. The advantages and disadvantages of incorporating these technologies will also be presented. Lastly, the findings will be discussed, ending the paper with conclusion.

2. Literature Review
2.1 Education – integrating it with technology
Since the advent of technology, education worldwide has shifted its focus more on the importance of developing "21st century skills" within students (E. Care, 2017). There has been a rise in the demand of technology related skills in the workforce industry, which span from mundane tasks to tasks that need complex, high-level competencies. This transition from routine and manual tasks to strategic, creative, problem-solving and analytical skills has impacted what students need to learn in schools (OECD, 2015). These competencies are also crucial in other aspects of life such as

involvement in government affairs, acknowledgment of history, arts and literature, and social conversations in everyday life (Eurydice, 2002). Therefore, modern innovative technologies have altered almost every aspect of our everyday lives, including the field of education. Technology provokes a hiatus in the usual thought patterns, which encourages introspection. This leads to a new understanding of how teaching and learning progresses. Educational technology, when used effectually, has positive impacts on teaching and learning. Moreover, as coronavirus 2019 (COVID-19) has impacted almost all countries, it has transformed the delivery mode of education in world everywhere. It has become a need of the hour to reflect on how new technologies can help to deal with problems related to this viral pandemic (Javaid, 2020). To face and resolve the challenges due to the outbreak of COVID-19, the educational institutes have become more efficient by focusing on the delivering quality services making use of technology (Qasem et al. 2020).

2.2 The role of technology in the context of learning and teaching

An important goal in education is to help students' understand how technologies work and the impacts they have on their learning performance. This includes developing an understanding of algorithms, AI, and intelligent systems. These assumptions carry implicit biases and unforeseen impacts that influence different groups (O'Brien, 2019). During the initial years of 2000s, the incorporation of technology in the field of education started with online schools to provide virtual "off-school" services (Watson et al. 2008). However, since then the media of education has transformed, and the schools are taking more time to adapt to the new systems. Using the modes of online and blended learning, students and faculties interact asynchronously and synchronously with the help of technology. However, the structure of traditional practices of classroom lectures, quizzes, etc. still remain the same in the form of a virtual forum. It has been observed that teaching online has given teachers innovative ideas for transforming and revitalizing traditional teaching methods. For instance, MOOCs have been successful in breaking the traditional models of teaching and learning. The usage of virtualization technologies has enabled the creation of a sensory based learning climate that provides a unique space within the context of learning.

Another example of technology-based learning that is available all the time, independent of location is called ubiquitous learning (Burbules, 2009). The environment in terms of learning spans here both spatially and temporally. Here, the technologies related to blended, online, visualization, and augmented reality play a key role in providing a distributed learning experience which can be made accessible in different locations. In terms of innovation, intelligent tutoring "adaptive instruction" offers a lot of potential to the learner as he/ she interacts with an online instructional program. This tool collects data about the learner's responses and builds analytical models based on the trends of answers, extracting conceptual errors the individual makes. Thereafter, it provides a customized tutorial or intervention to assist the learner with that error. This requires knowledge about the learner feedbacks, and using AI-driven models, the underlying learning difficulties can be identified that those patterns indicate (Gejendhiran, 2020). Therefore, technologies have shifted the focus in terms of the when, where, how, what, and why of learning. Technologies have fundamentally changed the places and times of learning, the learning methods, the content, and the motivations behind learning. Along with learning context, rethinking also needs to happen around the teaching strategies. It is required that teachers create a pedagogy that enables them to teach the students more effectively. Teachers need to redefine their strategies in alignment to online, blended, flipped, and ubiquitous learning contexts. Using adaptive instruction, teacher can incorporate technology and take help of data scientists to develop learning environments that find learner difficulties and develop necessary teacher interventions that can solve the issues. In the next sections, a few prevalent technologies today and their role will be discussed within the context of education.

3. Recent Technologies

3.1 Artificial Intelligence (AI)

Using algorithms in AI has helped to individualize learning experience of students. The AI model can be trained based on a particular learner's interaction with knowledge which can be further analyzed and used to compute the needs of an individual or the whole class. In recent times, it has been found that AI systems in disruptive education already has tapped the potential of personalized tutoring and moderate discussions (Carnegie LearningMATHia, 2020). For example, educational psychologists and computer scientists collaborate together to develop algorithms by monitoring learning activities of high and low performers in the early stages. They can use theories of cognition and metacognition to accurately sort out students who will perform poorly in a course (Bernacki, 2019). Therefore, these algorithms provide adaptive support to develop students' cognitive strategy and monitor their learning progress (Bernacki, 2020). AI can also be used to provide students with a course guidance and real time feedback (Khumrin, 2017). Interestingly AI systems also incorporates individualized scaffolding which includes diagnosis, support, and then fading of that support dynamically, at scales not feasible with interventions for teachers (Van de Pol et al. 2010).

3.2 XR (AR, VR, MR)

X-Reality (XR) systems mix the online and offline worlds to incorporate virtual, augmented, mixed reality systems and haptic systems (Mann et al. 2018; Tilhou et al. 2020). To experience Virtual Reality (VR) the user wears a headset that produces images and sounds which are similar to a real or imaginary world. It is different from Augmented reality (AR) in the sense that using a headset, glasses, or device (e.g. phone or tablet), the user can see a live view of the real world when the elements are integrated, using media files such as video, images, sound or GPS data. That is, AR acts as an overlay of digital media on the offline world. When offline and online worlds mix and physical and digital objects co-exist and communicate in real time, it forms Mixed Reality (MR). An interesting example would be while a user is seeing an image, the use can reach out and communicate with the digital overlay. Every learners' cognitive processes are applicable in XR contexts. Using this technology, learners can evaluate their physiological feedback and responses when they are experiencing the virtual features of the environment using XR technology to enhance learning productivity (Crompton et al. 2020).

3.3 Cloud Computing

Conventional classroom teaching model requires ample time to be spent on both teaching and classroom management. It becomes hectic to mentor and monitor the student related academic activities. Teachers and the management of the educational institute face challenges to monitor the student performance closely. In order to leverage optimum utilization of the class hours, a unique system which will reduce the time of administrative tasks of teachers and to increase the time of teaching and interaction with students (Selwyn, 2012). Cloud computing enables suitable, resource sharing, permeating, on-demand access which can be easily provided using different types of service provider interactions (Zissis and Lekkas, 2012). It plays a crucial role in education as it can lower the huge amounts of IT costs that the institutions need to invest in infrastructure. It also provides a convenient platform for educators to enhance their teaching methods and students learning. Following an experiential education approach, students get motivated by using unique gaming techniques or collaborative e-learning platforms. It also saves the energy output. Using the different cloud deployment models, the same infrastructure can be leverage by different universities for the academic purposes. One of the most important benefit is feasibility of collaborative learning virtually, which makes it convenient for teachers and students, looking to shift to computer-based technologies to improve the learning styles (Thorsteinsson nd Niculescu, 2010). It has facilitated the use of virtual collaborative learning tools in the field of education categorized such as synchronized tools, Learning Management System (LMS) tools, and social networking tools (Al-Samarraie and Saeed, 2018).

3.4 Adaptive learning technologies

Using these technologies, it is possible to examine a student's class participation or activities in real time. Using this feedback, the students can thereafter alter their learning approaches, the timeline of studying the course content, and to match the preferences of the learner (Avella et al. 2016). Therefore, distinguished by interactive features, adaptive learning technologies can be personalized. One of the most popular examples of adaptive learning technology includes Khan Academy (2020). Adaptive learning platforms also include intelligent tutoring systems such as MATHia (Carnegie LearningMATHia, 2020). Researchers develop these learning platforms by taking help of experts and novice math enthusiasts in cognitive task analysis (Aleven et al. 2016) to examine their math ability in solving questions. They track math-solvers' perceptions as they carry out math exercises and participate in different processes such as scrutinizing their past tacit knowledge and response accuracy. Thereafter, the psychologists and software developers incorporate these results as references to communicate and enhance the technology's ability to identify learner fallacies and provide real time feedback that enhances learning efficiency (Koedinger et al. 2012). Past research has shown that the platforms built using this approach has matched the tasks of tutors, at more viable scales (VanLehn, 2011).

3.5 Internet of Things (IoT)

An increase in the usage of IoT is seen in the education sector. The IoT is serving governments indirectly by providing a variety of solutions like online platforms that have a massive reach than regular schools. In his own work, Singhal found that the IoT improved foreign language learning in the United States. IoT provides a feasible solution by facilitating better online experience and improving knowledge sharing for R&D (Kortuem et al. 2012; Shenkoya, 2020). Using the Internet of Things (IoT) technology, the connectivity between devices has augmented data tracking and analytics. It has vastly improved the channels of communication between different stakeholders of schools, colleges and universities, students and teachers. The teachers can create a more flexible and connected learning environment virtually, which makes it convenient for students to learn at their own pace, from the comfort of their own locations when needed. Predictive analytics gives insights into the performance of students in the classroom (Gejendhiram, 2020). Therefore, it has become possible to even track down the students who are "at-risk" in terms of their performance in the very early stages of the courses itself. IoT has opened up a whole new gambit of opportunities and possibilities in higher education. Now it depends on the creativity of the individuals as to how they want to take advantage of it.

3.6 Mobile computing

Mobiles are considered as basic entities needed in everyday lives (Zydney and Warner 2016). These handheld devices have made searching information ubiquitous i.e., anywhere, anytime, independent of a person's location (Babu et al. 2014). Technological advances in these handheld devices have created new avenues for learning (m-learning), which is considered as an integral process in education making learning accessible and a feasible solution for educational institutions. The process of learning happens through cloud services, making information avaiable on mobile devices (Ozdamli and Uzunboylu 2014). The authors in their seminal work (Alghabban et al. 2017) developed a cloud-based m-learning platform allowing students to interact using their preferred learning styles. This mode of learning enhanced the learning capabilities of students by 30% customizing the features based on different learning goals. Using such platforms, they were introduced to mobile learning environments to mitigate the limitations of mobile (Gayathri and Srinivas 2014). Mobile cloud computing is defined as "an integration of cloud computing technology with mobile devices to make the mobile devices resource-full in terms of computational power, memory, storage, energy, and context awareness" [39]. M-learning technology customized the learning processes of individuals (Khan et al. 2014; Papavasiliou et al. 2014). Therefore, mobile technologies have developed new learning opportunities that educational institutions can leverage to improvise different modes of learning. Recently, due to COVID-19 pandemic several HEIs have started incorporating m-learning technologies as parts of their teaching pedagogies.

2. Challenges

There is a need to identify challenges, limitations, and boundaries of integrating the above-mentioned technologies in the field of education as well. For example, AI is slowly becoming a part of everyday human life, therefore, it is important to tone up the laws, protocols and standards, and public policies related to AI technology. This will enable AI to function within a broader structure of human intelligence, different educational purposes, human norms and values (Burbules et al. 2002). Despite the advantages X-Reality (XR) systems offer, they are still not perfect from a technological, organizational and psychological point of view. Due to the game nature of VR, it is often not taken seriously as a learning platform by students. So they might not fully engage their mind to acquire new knowledge and critical thinking. VR technology require exhaustive graphics capabilities which cannot be achieved using standard computer equipment. Therefore, it would take a lot of monetary investment as well as efforts to achieve smooth implementation worth immersion and interaction. Interestingly, these are not suitable for individuals coming from different genders, cultures, religions, ethnic groups and geographies, which limit the successful distribution and adoption of even already proved implementations (Velev and Zlateva, 2017).

With respect to IoT, as it is relatively new technology trend, there is still lack of trust in the usage of this technology. Due to the enormous size of data (Big Data), protecting it, i.e. data security has become a top concern (Sha et al. 2020). The IoT architecture has resource limitations. It is tough to develop a robust security system for it. Due to these limitations, the algorithms have to be limited as well (Tavana et al. 2020). For a successful and secure implementation of IoT and communication protocols, they should be lightweight and energy-efficient irrespective of the complicated processing and improved energy harvesting techniques. A big challenge when considering cloud based IoT solutions, due to the extensive heterogeneity of available devices, operating systems, platforms, services, and applications. One cannot overlook heterogeneity related to cloud platform as well. Due to the different deployment models in cloud, there is an overlap in ownership of infrastructure for cloud services, which might create issues when multiple users make use of cloud platforms without proper merging and customization of resources according to each provider (Marjani et al. 2017). Moreover, data privacy is of utmost importance, which poses a major challenge preventing institutions from incorporating cloud technology. The customers develop trust when the models cover application development with security and privacy protection, along with implicit authentication techniques (Olszewski and H. Crompton, 2020).

3. Discussion and conclusion

Technologies have transformed the *when, where, how, what*, and *why* of teaching and learning in education. Technologies now days are fundamentally modifying the places and times of learning, the learning methods, and the teaching material, etc. Technologies possess immense potential and the educational bodies need to leverage this opportunity and adapt with it has become the need of the hour during these challenging times of COVID-19. At the same time, a shift in the thought process is required in terms of not only what these technologies do *for* us, but what they do *to* us. Whether new technologies in the context of education level up quality of life in future—or present new challenges and difficulties, only time will tell. It might happen that there will be some elements of both, for which all of us need to be prepared.

It is also important to consider students' perceptions, cognitions, affective and physiological responses when systems are designed by the developers, and instructors. Those who encourage effective learning using technology should also engage in research on the use of emerging technologies. Likewise, educational stakeholders should study technology integration frameworks and educational eco-systems to support the use of technology (Sandoval et al. 2016) and epistemic cognition (Bernacki, 2018) as they incorporate technologies for learning and teaching. Finally, scholarly research and practical progress will require that researchers track data produced when students learn to more precisely predict the psychology of learning with the usage of emerging technologies in the educational contexts. To summarize, a more humane attitude is needed to a technology-based world.

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