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EDUCATION 4.0: BREAKTHROUGH INNOVATIONS

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ABSTRACT
Education is the backbone of human civilisation. It decides what will be the future of our societies. It changes from time to time. Education 4.0 is the most recent era in which innovations and technologies have been revolutionizing the whole sector. These inventions altered the landscape of the previous educational system and started an unprecedented phase with digitalisation and cyber-physical innovations. Artificial intelligence, virtual reality, augmented reality, cloud computing, 5G networks, the internet of things, robots, 3D, and game-based learning are all part of Education 4.0. These innovations have the potential to meet the needs of 21st century skills such as critical thinking, creativity, scientific temper, multilingualism, problem-solving, ethics, social responsibility, and digital literacy. This paper highlights education 4.0 and different disruptive innovations due to the fourth industrial revolution and their educational implications.

Keywords: *Education 4.0, Industrialization, Artificial Intelligence, Virtual Intelligence, Augmented Reality, 3D, 5G, Cloud Computing, Internet of Things*

INTRODUCTION

It is the age of science and technology, where everything is advancing, and the role of education is becoming increasingly crucial. Several technological advancements like cloud computing, artificial intelligence, extensive information and research, smart robots and machines, distributed and portable computing systems, 5G networks, the internet of things, virtual reality, smart spaces, 3D printing technologies, quantum computing, and augmented reality are now being incorporated into education. These technological advancements and integrations with education have been significantly changing the paradigm of our education system from the first industrial revolution, which was started in the 18th century. We are now in education 4.0, which started parallel with the fourth industrial revolution. It diversifies education and addresses the needs of the 21st century, such as critical

thinking, divergent thinking, communication, collaboration, creativity, innovation, information literacy, media literacy, ICT (Information, Communications, and Technology) literacy, flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, leadership and responsibility, and problem-solving among the stakeholder of education (CBSE, 2020; AACTE, 2010).

A PATHWAY TOWARDS EDUCATION 4.0

Technology-driven Education 4.0 is a tough period in education. Technological I ntegration is strengthening education, although it took a long time. The early industrialization employed stem and water to mechanise the produce (Miranda et al., 2021; Mudgil, 2021; Keser & Semerci, 2019; Sharma, 2019; Peters, 2017). During these centuries, essentialist and behaviourist education was founded on the three Rs: receiving by listening to teachers, responding by taking notes, studying books, and performing worksheets, and regurgitating by taking the same examinations as the cohort (Gerstein, 2014; Keats & Schmidt). The teacher presented class notes, handouts, textbooks, and films in a stand-up performance in Teacher-centered, rote-memorization education. Education 1.0 refers to these centuries (Miranda et al., 2021; Sharma, 2019; Gerstein, 2014).

The second industrial revolution used electric power to mass produce after the first (Mudgil, 2021; Keser & Semerci, 2019; Sharma, 2019; Peters, 2017). Education 2.0 emphasises communicating, contributing, and collaborating. Education 2.0 is humanistic and progressive, emphasising the human element in learning (Gerstein, 2014). Project-based learning, inquiry learning, cooperative learning, global learning projects, podcasts, social bookmarking, Skype, wikis, blogs, and other social networking in the classroom were included. Teaching is more andragogical and constructivist, with active, immersive, real, relevant, and socially networked learning experiences embedded into the class or course structure (Sharma, 2019; Gerstein, 2014; Keats & Schmidt, 2007; Hiemstra & Sisco, 1990 as cited in Gerstein, 2014). Education 2.0 is more flexible, promotes lifelong learning, eliminates geographical obstacles, and merges education and work (Yamamoto & Karaman, 2011). After the second industrial revolution, electronics and computer technology were employed to automate production, launching the third industrial revolution, or electronic age (Miranda et al., 2021; Mudgil, 2021; Keser & Semerci, 2019; Sharma, 2019; Peters, 2017). This notion underpins education 3.0, a personalised, self-determined education. A different group of three Cs—connectors, creators, and constructivists—is in the focus (Gerstein, 2014). Here, learners create shared knowledge assets and profit from social networking. Education 3.0 is connectivist and heutagogical (Gerstein, 2014). Teachers, learners, networks, linkages, media, resources, and tools constitute a unique organism that may suit the requirements of learners, educators, and society. Education 3.0 recognises that each instructor and student's journey is unique, personalised, and self-determined (Sharma, 2019; Gerstein, 2014). Finally, t he fourth industrialization that led to Education 4.0.

EDUCATION 4.0

Education 4.0 combines human energy, intelligence, and innovations (Fisk,2017). It took shape during the fourth industrial revolution, which was seen in the twenty-first century. Today we are in the twenty-first century, which means we are in education 4.0. Where critical thinking, creative thinking, divergent thinking, analytical thinking, reasoning, collaboration, communication, innovation, research, information literacy, technology literacy, information and communication literacy, soft skills, social skills, flexibility, leadership, scientific literacy, financial literacy, civic literacy, entrepreneurialism, global awareness, management, judgement,

environmental understanding, scientific reasoning and health and wellness literacy, emotional intelligence, coordination and cooperation are the principal needs of education (The World Economic Forum, 2022; CBSE, 2020; NEP,2020; World Economic Forum, 2016; AACTE, 2010). To accomplish this, we are combining twenty-first-century innovations with education, such as cloud computing, artificial intelligence, extensive information and research, smart robots and machines, distributed and portable computing systems, 5G networks, the internet of things, virtual reality, smart spaces, 3D printing technologies, quantum computing, and augmented reality (Mudgil, 2021; Himmetoglu et al., 2020; Moid, 2020; NEP 2020; 2022, Halili, 2019). This integration makes education more comprehensive, ever-ready, self-paced, and inclusive and introduces blended learning, flipped classrooms, project-based learning, remote learning, open educational resources, Massive Open Online Courses (MOOCs), learning how to learn, sustainability, cloud computing, blockchain, artificial intelligence, augmented reality, virtual reality, multidisciplinary education, practical methods of learning, and adaptive learning content (Himmetoglu et al., 2020). Education 4.0 enables education to create change (Sharma, 2019), bringing a rebellious shift in each sphere of education. It redesigned the curriculum, redefined the role and functions of all the education stakeholders, and changed our education system's infrastructure pedagogy and evaluation pattern through its disruptive innovations (Kumar et al., 2020).

DISRUPTIVE INNOVATIONS IN EDUCATION

Education 4.0 yields some breakthrough innovations that significantly change the topography of education in the global education landscape. It is preparing a one-of-a-kind educational foundation using a cyber-physical system, a combination of hardware, software, and biology, as well as advanced communication and connectivity.

The followings are the breakthrough innovations that have revolutionized the education world:

ARTIFICIAL INTELLIGENCE

Artificial intelligence is an emerging innovative, and derivative field of education. All areas—academic, institutional, administrative, assessment, evaluation, and tutoring—are affected. Analysis, decision-making, deep learning, and machine learning become more efficient (Cope et al., 2020; Verma, 2018). AI in schooling revolutionised the system. It transformed education's goals, instructional methods, discipline, teachers' and students' roles, curriculum, teaching-learning materials, school management, and administration (Kengam, 2020; Verma, 2018; Nye,2014). It makes education accessible to all social groups, specially-abled children, linguistic groups, age groups, and ethnicities (Kengam, 2020; Pedró et al., 2019). In the future, artificial intelligence will make admittance to assessment easier, more effective, faster, and cheaper. Using synchronous and asynchronous computers, it promotes collaborative learning and personalization (Gocen & Aydemir, 2020; Kengam, 2020; Pedró et al., 2019; JandaNikos et al., 2001).

Students' smartphone addiction is the largest challenge for the teaching-learning community. Artificial intelligence capitalizes on this. It helps us teach and learn by reading mood and understanding levels using facial and gesture recognition technologies (Kengam, 2020; Pedró et al., 2019). The chatbot is an example of artificial intelligence, that offers an interactive and convenient way to access information, support, and improve students' learning experiences.

CLOUD COMPUTING

Cloud computing is another boon of the twenty-first century that enables anywhere, anytime education and enhances the effectiveness of education (Kumar et al., 2017; Waga et al., 2014). It is a ubiquitous, convenient, on-demand network where students, teachers, and other stakeholders can create their own "Cloud-Based Personalised Learning Environment" or use m-learning to access Open educational resources from the cloud. It centralises resources and allows multiple people to access them through multiple devices. It offers students simple and creative learning experiences with personalization. It provides numerous advantages, including personalised learning, reduced course fees, increased accessibility, improved management and administration efficiency, improved educational quality, reduction of required infrastructure, standardised content, increased collaboration, and scalable learning (Kumar et al., 2017; Saini et al., 2017; Bouyer & Arasteh, 2014; Waga et al., 2014; Rao & Challa, 2013). Different virtual universities, distance universities, and educational technology companies are emerging in the current global scenario and expanding the scope of education with the help of cloud computing (Bouyer & Arasteh, 2014). IBM Cloud, Microsoft cloud, Google cloud, and Dropbox are some of the clouds. Learning Management System and Google classroom are two examples of cloud computing being used in education to improve educational outcomes.

ROBOTICS

The robotics is one more marvellous creation of human intelligence. It is a three-dimensional physical object that moves in space and time. Also, it can emulate human/animal behaviour. It assists students in promoting twenty-first-century skills such as problem-solving, critical thinking, teamwork, higher-order learning, and computational thinking skills, as well as reflecting on their learning. It also assists students in developing skills that are difficult to learn in traditional classes but are critical in scientific and engineering practices (Gura, 2012; Chambers et al., 2007). It can potentially improve academic skills such as scientific process comprehension, scientific concept development, and improvement of achievement scores (Barker & Ansorge, 2007; Williams et al.,2007; Highfield, 2010). Robotics is supplementing and supporting teaching-learning activities in 21st-century classrooms, challenging students' creativity while improving cognitive skills and motivating them to be active learners. Robots are playing an increasingly important role in education, and it simplifies the role of the teacher. The apt example of it: a Nao model as part of a European research project called L2TOR, with the goal of teaching young children a second language. The robot acted as a tutor, giving students the individual attention they needed to learn a new language at their own pace.

THE INTERNET OF THINGS

The internet of things is another twenty-first-century innovation with artificial intelligence, connectivity, sensor, and smart devices. It increased the assortment of activities, increased student participation and collaboration, and raised the level of academic processes. It has broad implications for online education, computer science education, research and industry, scalable manufacturing, low cost, and the long term. It facilitates the teacher in teaching and managing the class, as well as improving students' academic achievement. Gamification and a smart classroom are pivotal needs of this era. The advent of the internet of things has made it more effective and productive. Wearable technology is another aspect of modern life that will be made more convenient by the internet of things. Attendance monitoring systems in education will be simpler and more

accurate, allowing teachers to manage better and administer classes. It personalises education through feedback, which is the other side of Education 4.0. It improves educational facilities by utilising the internet of things (Ali & Nihad, 2021; Remya, 2021). Another internet of things facilitation is the smartbook. It lowers the cost and labour of education by automating processes outside of the traditional educational process. It personalises education, fosters global networking, improves smart QR code usage, simplifies data collection and analysis, fosters group work collaboration, improves campus safety, improves learning experiences and outcomes, and facilitates efficient institutional management (Thiyagu, 2017). Smart boards, smart ebooks, and educational apps like ClassDojo that allows parents to see student schoolwork via photos and videos. Class Dojo is used in 95% of all K-8 schools in the U.S. and 180 countries and messages can be translated into 35 languages automatically.

3D PRINTING

Another human innovation that improves the teaching-learning process is 3D printing. It is an effective teaching tool for teachers and a useful learning tool for students. It enables the learner to grasp any concept or idea quickly. It is a tool that allows us to give our digital data a physical appearance (Pai et al., 2018). It can potentially create an immersive and dynamic learning environment for everyone in the teaching-learning process. Also, it facilitates personalised learning for the visual learner. It develops curiosity among students and is used to teach design, and creativity skills, produce artefacts that aid learning and create assistive technologies. 3D printing offers a way for students to truly connect to the subject matter by physically manipulating ready-printed teaching aids or by designing tools themselves. One of the appropriate examples is THE MAKERBOT REPLICATOR+ that helps students for concept forming and designing their own concept.

AUGMENTED REALITY

Augmented reality is another innovation in education 4.0 that combines ubiquitous computing, tangible computing, and social computing. It provides unique affordances by combining physical and virtual worlds and continuous and implicit user control of the point of view and interactivity. It has three characteristics: it combines the real and virtual worlds, interacts with the user in real-time, and is registered in a 3D space. It allows students and teachers to see the real world while supplementing reality without completely immersing them in a synthetic environment (Kesim & Ozarslan, 2012). Augmented reality is a cutting-edge innovation that facilitates learning, increases student motivation and curiosity, increases student achievement, increases student participation and cooperation in learning, develops positive attitudes, reduces cognitive load among students, and ensures learning is enjoyable (Sirakaya & Sirakaya, 2018). For instance, ‘Elements 4D’ and ‘Anatomy 4D’ apps cover topics in chemistry and anatomy. ‘Arloon Plants’, ‘Arloon Mental Math’, and ‘Arloon Geometry’ focus on botany, arithmetic, and geometry.

VIRTUAL REALITY

Virtual reality is an immersive, hands-on innovation in education 4.0 that is changing the landscape of education. It creates opportunities for learning in a real-world setting. It promotes immersion, interaction, and participation (Pinho, 2004). It facilitates students’ metaphysical comprehension and assimilation. It provides

three-dimensional computer environments with advanced forms of interaction that can motivate students to learn. Using the objective and the real environment makes learning more interesting and fun, increases motivation and attention, and reduces costs (Piovesan et al., 2012). The use of virtual reality in education simplifies teaching and learning for both teachers and students. It increases student engagement, allows constructive learning through meaningful experiences, provides authentic experiences, allows for new perspectives and empathy, allows creativity, and allows the visualisation of difficult models (Hu Au & Lee, 2017). Visual simulations to train the soldiers for battle field, games to create smart and quick moves-VR boxing and exploring plants/universe are some key functions of VR technologies.

5G NETWORK

Communication is the foundation of our teaching-learning process. It may not be carried out without communication, so communication speed is a major factor in the frequency of teaching and learning. The evolution of the five-generation network increased the efficiency and proficiency of education 4.0. It enables other disruptive innovations such as segmented reality, virtual reality, the internet of things, cloud computing, and the robot of education 4.0. The five-generation network contributes to inclusive education. It boosts the effectiveness of distance, remote, blended, digital, and intelligent immersive learning. It makes learning more flexible and assists students with special needs.

DIGITAL GAMES

Gamification is a 21st-century teaching method reflected in Education 4.0. in this digital age, digital games are the medium of entrainment. It improves the effectiveness and student-centeredness of the teaching-learning process, motivates students, provides practical experiences, improves decision-making and problem-solving skills, as well as critical thinking, cognitive, spital, and motor capacities among students, promotes positive competitiveness, develops knowledge acquisition capacities, improves student self-efficiency, prepares cooperative and collaborative learning environments, improves ICT skills, fosters student self-reliance, autonomy, and development (Zainon et al., 2013; Felicia, 2009). One of the best examples applied in teaching and training is the use of Kahoot for gamification of any educational content.

CONCLUSION

Education 4.0 is a disruptive era of innovation and technology. It is an era of automation and cyber-physical systems. It changed the landscape of global education and convinced the teaching fraternity to rethink our aims, objectives, method of teaching, curriculum, the role of teachers, the role of students, discipline, and the medium of instruction. There are many breakthrough innovations invented in education 4.0 and they will keep on adding. It makes the teaching-learning process effective, innovative, and productive, as well as fulfilling the need and expectations of the 21st century. In nutshell, teaching and learning through these innovations are boons for both teachers and students in terms of efficient pursuit of education.

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