REVIEW ARTICLE

Education 5.0: Evolution of Promising Digital Technologies – A Comprehensive Review

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ABSTRACT: Education is the manifestation of perfection already in man. Akin to industrial revolution, education has evolved from Education 1.0, which was primal, to the most modern present-day system of Education 5.0. Artificial Intelligence and allied emerging technologies played a vital role for more than 20 years during the stretch of Education 4.0. With the advent of prominent digital technologies such as Generative AI there is a quick transition from Education 4.0 to Education 5.0. The Generative AI represents a monumental technological leap in machine learning to supplement human creativity and innovation. It will profoundly reshape the learning eco-system and the way how content is created and used virtually across the educational domain. The quick production of text, codes, images, audio and videos has the potential to augment the educational process and greatly enlarge human capabilities by democratizing access to all on an unparalleled scale. By embracing the promising Generative AI tools with a balanced mindset, we can work to maximize its benefits while minimizing the associated risks/limitations. The possible initiatives to audit, check and refurbish algorithms, to implement through responsible regulations and facilitate a fair access to all the users, play a vital role in popularizing Generative AI models in wide-ranging educational tasks. In the long-run, Generative AI, if developed and deployed responsibly, can become a constructive set of tools that propels creativity, discovery, problem solving, facilitate personalization, and enhance human progress in future.

KEYWORDS: Artificial Intelligence, Education 5.0, Generative AI, Personalized Education.

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INTRODUCTION

Education can be understood completely from four important views and perspectives. The ***Spiritual View*** describes that 'Education is the manifestation of perfection already in man' as stated by *Swami Vivekananda*. Though every individual has a brain, which is the central point of enquiry, thought-process and learning, education helps to manifest the state of perfection already in human. *Swami Vivekananda* emphasized that "*we want that education by which character is formed, strength of mind is increased, the intellect is expanded, and by which one can stand on one's own feet*". The ***Process View*** states that 'Education is the process of teaching in a School, College or University to make the students learn. Hence it involves the systematic procedure of educating students, especially using a formal, online / virtual, and blended system of education in School, College or University. Innovation in education is more process-centric one. The ***Learner's View*** illustrates that 'Education is a composite multi-stage process of building character through acquiring knowledge, skills, ethics and wisdom for a successful career in order to lead a happy human life'. Finally, the ***Holistic View*** portrays that 'Education shall be total and inclusive in nature to develop a wholesome personality for an individual and societal transformation, eventually leading to harmony, peace and prosperity in human life' [1].

Hence the real purpose of education is to impart knowledge, shape character, instill confidence, inculcate ethos and universal human values, and enable the learner to lead a peaceful life with an essence of life-long learning skills and contribution to the society. Thus the broad objectives of education are [1]:

- To build ethos or shape character,
- To develop self-confidence,
- To acquire knowledge,
- To learn skills for career development,

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- To serve the society and contribute to nation building,
- To learn to be a good human being, and
- To lead life in a peaceful way with harmony and happiness.

So Education is the continuous pursuit for knowledge, skills and attitude. Education is the key to nation building and nations are built in educational institutions. Education and its outcome is the prime-mover of nation's economy, health, peace and wealth. Education is the life-line for individuals, civilizations, communities and societies to evolve, prosper and develop humanity.

Education has evolved over a very long period of time. Education in its original form, i.e. '***Education 0***' describes Education as the learning process, which originally involved the Guru and Shishya, known as ***Gurukul system*** from time immemorial, wherein the Guru had profound knowledge and devoted to impart highest quality education to the disciples and train them to bring out the best talents hidden in them. The Shishyas used to be highly obedient and enjoy learning to equip with life skills. So the learning used to happen by curiosity, practice, dedication and demonstration. The Gurukul system of education happened in the teacher's house or a monastery. Education was free, and students used to pay "Gurudakshina", a voluntary contribution after the completion of their studies. The Gurudakshina was a mark of respect by the Shishyas towards their Guru. It was the way in which the students acknowledged, thanked and respected their Guru, whom they considered to be their spiritual guide.

The best example for Gurukul system was the training by Dronacharya to his disciples (Figure 1a). This good old Gurukul system of education with the Shishyas showing sacrosanct respect to the Guru and largely centered around the Guru-Shishyas, has been transformed into the present-day ***Modern education*** system, wherein the Student enters the Education system (Institution) to learn and get transformed into a Graduate with desired attributes. The Educational process though consists of an important key element, the Teacher(s), but the system (Figure 1b) is largely dominated by the Institutions, Policy makers, Corporates, Parents and others.

Similar to industrial revolution, which has evolved from Industry 1.0 over the time to Industry 5.0, education has evolved over a very long period from Education 1.0, which was primal, to the most modern present-day Education 5.0, as depicted in Table 1.

Fig. 1a Gurukul system of education

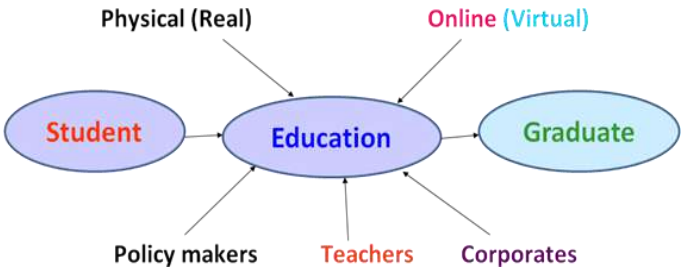

Fig. 1b Modern education eco-system [1]

1. EDUCATION 1.0

The history of education extends far back to the first written records recovered from ancient civilizations. Education 1.0 deals with the education in ancient India that existed before 1900, wherein education was mainly imparted through the Vedic and Buddhist education systems. Sanskrit was the predominant language used to impart the Vedic education system. Pali was the language used in the Buddhist education system. The main aim of education in ancient India was to develop a person's character, master the art of self-control, bring about social awareness, and preserve and take forward ancient culture. The Buddhist and Vedic systems had different subjects. In the Vedic system of study, students were taught the four Vedas: Rig Veda, Yajur Veda, Sama Veda, and Atharva Veda. Students were also taught the six Vedangas: Ritualistic knowledge, Metrics, Exegetics, Grammar and phonetics, Astronomy, Upanishads, and more [2].

Table 1 Industrial Revolution and Educational Evolution

Industrial Revolution		**Educational Evolution**	
Period	**Industry 5.0**	**Period**	**Education 5.0**
2020 onwards	Intelligent Automation, Machine Learning, Deep Reinforced Learning, Metaverse, 4D Printing, CleanTech, GenAI	2023 onwards	Intelligent Learning, Immersive Learning, Personalised Learning, Intelligent Tutoring, Metaverse, GenAI,
Period	**Industry 4.0**	**Period**	**Education 4.0**
2000-2020	AI, Blockchain, Cybersecurity, Cloud Computing, AR, VR, Automation & Robotics, IoT, 3D Printing	2000-2022	AI, Blockchain, Cybersecurity, Cloud Computing, AR, VR, Automation & Robotics, ICT, IoT, Online Education, *ATL, BDL. DST, EBL, FLT, HBL, PBL*
Period	**Industry 3.0**	**Period**	**Education 3.0**
1950-2000	Computer, Electronics, IT, Internet, ICT	1980-2000	Computer and IT based Education, Computer-based Teaching
Period	**Industry 2.0**	**Period**	**Education 2.0**
1850-1950	Electrical Energy, Mass Production	1900-1980	Formal System of School Education
Period	**Industry 1.0**	**Period**	**Education 1.0**
1750-1850	Steam Engines, Mechanization	Prior to 1900	Vedic Education, Gurukul Education

Note: *ATL: Activity-based Learning; BDL: Blended Learning; DST: Design Thinking; EBL: Experiential Learning; FLT: Flipped Teaching; HBL: Hybrid Learning; PBL: Project-based Learning

In ancient India, Vedic education was imparted orally rather than in written form. Education was a process that involved three steps; the first was Shravana (hearing), deals with the acquisition of knowledge by listening to the shrutis. The second was Manana (reflection), wherein the students think, analyze, and make inferences. The third was Nididhyasana, in which the students apply the knowledge in real life. During the Vedic period from about 1500 BC to 600 BC, most education was based on the Vedas (hymns, formulae, and incantations, recited or chanted by priests). The main aim of education, according to the Vedas, is liberation. Vedic education included proper pronunciation and recitation of the Veda, the rules of sacrifice, grammar and derivation, composition, understanding of the secrets of nature, reasoning, including logic, science and skills necessary for an occupation. Some medical knowledge also existed and was taught. There was a mention in the Veda of herbal medicines for various conditions or diseases, including fever, cough, baldness, snake bite, and others [2].

The formal education in the middle and later middle ages (500 to 1900 AD) started in schools. The word school applies to a variety of educational organizations including town, church, and monastery schools. During this period, instruction for students in such schools ranged from the basics of literacy (alphabet, syllables, simple prayers and proverbs) to more advanced instruction in the Latin language. Occasionally, those schools might also have taught rudimentary arithmetic or letter writing and other skills useful in business. Often

instruction at various levels took place in the same school-room [2].

The teacher imparted knowledge of Astrology, History, Literature, Medicine, Philosophy, Religion, Scriptures, Statecraft, and Warfare. The corpus of Sanskrit encompasses a rich tradition of poetry and drama as well as technical, scientific, philosophical and religious texts. Education 1.0 was the system that extended upto 1900, where people used to learn alphabets on sand, draw sculptures on stones, and only few Elite were trained to be Scribes to write documents using special papers and inks [2].

2. EDUCATION 2.0

Education 2.0 describes the formal system of education after 1900 and up to 1980, where children used to attend schools and used slates for writing in primary schools. The teachers used to teach mostly in Sanskrit and local languages. Morning prayers, the practice of yoga, asanas, meditation, and rehearsal were most common in nature. Writing on paper was only for the upper classes. Education was widespread for elite people. The subjects taught included reading, writing, arithmetic, astronomy, metaphysics, ethics, law, medical science, religion, and theology. The education system, with its western style and content, was introduced by the British, who advocated for the teaching of English in schools and the formation of a class of Anglicized Indian interpreters [2]. Thus many of our Indians learned English, and several freedom fighters were formally educated; some of them even visited England prior to 1900 to get educated in law to become barristers. The best example was the father of our nation, Mahatma Gandhiji.

For Mahatma Gandhiji, education was incomplete without an element of learning. For him, a person was made of three constituents, namely the Body, the Mind, and the Spirit. Gandhiji opined that the education system gave primacy to the mind and kept the body and spirit somewhere at the backburner. Gandhiji believed that schools, colleges, universities, and the education system should be intricately tied with all the three components through the ideas of innovation and social service. Serving the communities and serving the underprivileged sections of society should be an integral part of learning from the early stages of schooling. Such ideas and practices will lead to educating the mind and the spirit and will also generate a sense of active citizenship, empathy, and inclusion amongst children. The idea of active citizenship was also related to understanding one's rights, duties, and obligations as a member of the community [1].

Since our country's independence in 1947, the Indian government has sponsored a variety of programmes to address the problems of illiteracy in both rural and urban India. Maulana Abul Kalam Azad, India's first Minister of Education, envisaged a strong focus on education throughout the country with a uniform educational system. The Central Government under the visionary leadership of the first Prime Minister of India Shri Jawaharlal Nehru established the Secondary Education Commission (1952–1953), the University Grants Commission (1956), and the Kothari Commission (1964–66) to develop proposals to modernize India's education system. The Government of Nehru adopted a resolution on scientific policy and sponsored the establishment and development of high-quality scientific and technological educational institutions, such as the Indian Institutes of Technology. In 1961, the Union Government formed the National Council of Educational Research and Training (NCERT) as an autonomous organization that would advise both the Union and State Governments on formulating and implementing education policies [3].

The Government of India formulated the National Policy on Education (NPE) to promote and regulate education in India. The policy covers everything from elementary education to higher education in both rural and urban India. The first NPE was promulgated by the Government of India by Prime Minister Smt. Indira Gandhi in 1968, the second by Prime Minister Shri Rajiv Gandhi in 1986, and the third by the present Prime Minister Shri Narendra Modi in 2020 [3].

3. EDUCATION 3.0

The advent of computers and their usage from 1980 onwards scripted Education 3.0, wherein prior to 1980, people were not aware of or accustomed to the concept of information technology. It is pertinent to mention that Shri Rajiv Gandhi's Government first introduced

computers and IT in India in 1985. Today, the information is a mouse click away from us; and social media, messengers, supercomputers, and computing technology would have been a dream if Rajiv had not been firm on his decision to bring computing technology to India [4].

Embracing information technology has changed the fortunes of our country. Today, when India stands tall as one of the driving forces that run the world of computers, many would wonder how deep and enriched the history of computers in India is. No doubt, the indigenous development of computer components began way back in 1971, but the pace of using computers accelerated after Rajiv Gandhi became the Prime Minister of India in late 1984. Hence he is called the 'Pioneer of Digital India' or the 'Computer Man of India'. It was during his tenure that the seed of the IT and telecom revolution was sown in India. His brainchild 'IT and Communication' policy has resulted in computers that became a household name when he slashed the prices of the systems. At the time when having a basic telephone was considered as luxury, such a policy had put India on the cellular network [4].

During his tenure, Rajiv introduced some revolutionary policies that transformed India's image on the global stage. His far-sighted initiatives paved the way for India to become the IT superpower and made it the top preferred destination for offshore software development. It was his farsighted initiatives to drive India towards modernization and his motivation to pull the masses out of poverty, which gave them a dream that laid the foundation for India to become an IT superpower. Digital India initiative was first started with the launch of the National Informatics Centre. The 1984 policy, providing the provision for software exports through satellite links has led to 'The Long Revolution: The Birth and Growth of India's IT Industry'. It had the provision for exports via satellite, which attracted American firms like Texas Instruments and others that opened up a new gateway for software exports from India. A number of policy initiatives, including the liberalization of policies for the computer and electronics sectors, rural digital telephone exchange, software technology parks, and the computerization of railways, were set in motion during late 1980s [4].

In 1986, the Central Government introduced a new National Policy on Education (NPE). The new policy called for "special emphasis to remove disparities and equalize educational opportunity," especially for Indian women, backward classes, and minorities. To achieve such social integration, the policy called for expanding scholarships, adult education, recruiting more teachers from various communities, incentives for poor families to send their children to school regularly, the development of new institutions, and providing housing and services. The NPE called for a "Child-centered Approach" in primary education and launched "Operation Blackboard" to improve Primary Schools nation-wide. The policy expanded the open-university system with the Indira Gandhi National Open University, which was established in 1986. The policy also called for the creation of the "Rural University" model, based on the philosophy of Mahatma Gandhiji, to promote economic and social development at the grassroots level in rural India [3].

From 1984 onwards, several State Governments permitted private players to start schools and colleges that led to easy access to education for many aspirants. In order to regulate and maintain the standards of technical education, the Central Government has set up the All India Council for Technical Education (AICTE) in accordance with the provisions of the AICTE Act 1987. The objectives of AICTE are Promotion of Quality in Technical Education, Planning and Coordinated Development of Technical Education System, and Regulations and Maintenance of norms and standards.

During 1990-2000s India has one of the largest and most diverse education systems in the world. Privatization, widespread expansion, increased autonomy, and the introduction of programmes in new and emerging areas have improved access to higher education. At the same time, it has also led to widespread concern about the quality and relevance of higher education. To address these concerns, the 1986 National Policy on Education was modified in 1992 by the then Prime Minister Shri P.V. Narasimha Rao Government, which spelled out strategic plans for the policies and advocated the establishment of an independent National Accreditation Agency. Consequently, the National Assessment and Accreditation Council (NAAC) was established in 1994 as an

autonomous institution of the University Grants Commission (UGC). The mandate of NAAC, as reflected in its vision statement, is to make quality assurance an integral part of the functioning of Higher Education Institutions (HEIs). Similarly the National Board of Accreditation (NBA) was established by AICTE in 1994 to assess and accredit engineering and technology programmes.

In 2005, the former Prime Minister Shri Manmohan Singh adopted a new policy based on the "Common Minimum Programme" of his United Progressive Alliance (UPA) government. The Programme of Action (PoA) 1992, under the National Policy on Education (NPE), 1986 envisaged the conduct of a common entrance examination on an all-India basis for admission to professional and technical programmes in the country. For admission to Engineering and Architecture/Planning programmes, Government of India vide its resolution dated 18.10.2001, has laid down a Three-Exam Scheme (JEE and AIEEE at the National Level and the State Level Engineering Entrance Examinations (SLEEE) for State Level Institutions, with an option to join AIEEE). This takes care of admission standards in these programmes and helps in the maintenance of professional standards. This also solves problems of overlap and reduces the physical, mental, and financial burden on students and their parents due to the multiplicity of entrance examinations. On the whole, Education 3.0 has seen a tremendous transition in Schools, Colleges and Universities with an extensive usage of computers, information technology tools, OHPs, LCDs for better teaching and storage of teaching-learning materials on Floppy, CDRom, Hard-disks, etc.

4. EDUCATION 4.0

Education 4.0 describes the evolution of education over a period of two decades from 2000 to 2020. It is more aptly described as evolution of Information and Communication Technology (ICT) in education that deals with an extensive use of information and communication technology to support, enhance, and optimize the delivery of information. The world-wide research has shown that ICT can lead to an improved student involvement, learning and better teaching-learning methods. Education 4.0 marks the beginning of 21st Century Education. The challenges in 21st Century Education are:

- How to equip students with the 21st century knowledge, skills and attitudes?
- How to teach a large class with the aid of technology?
- How to improve student engagement and reduce students' reluctance?
- How to improve faculty involvement and upgradation through continuous learning?
- How to allow continuous improvement in curricula, incorporation of better Open Educational Resources (MOOCs) for more effective teaching?
- How to ensure examination reforms and e-system to reinforce teaching and learning?
- How to ensure proper implementation of Outcome Based Education (OBE)?
- How to ensure life-long learning?

Education 4.0 with the use of Revised Bloom's Taxonomy of educational learning objectives has led to a greater focus on Outcome Based Education (OBE). Engineering education is an outcome based one and the outcome is the combination of Knowledge, Skill and Attitude gained by the Student / Graduate. It also refers to the attributes of Engineering Graduate(s). The outcomes shall be largely accomplished through the Teaching-Learning process. In order to assess the outcome of engineering/technology programmes, the National Board of Accreditation played a vital role. NBA became an independent autonomous body in 2010 and became the permanent signatory of Washington Accord in 2014, and subsequently accredited several UG engineering/technology programmes in Tier-I and Tier-II modes by defining 12 Programme Outcomes, which are specific, measurable and achievable.

Education 4.0 witnessed the use of ICT tools such as smart-boards, smart-projectors and interactive projectors, multi-media tools for delivery of wide-range of lectures. It also encouraged the creation of educational technology and learning materials such as videos, CBTs, digital web content, YouTube videos, etc. In order to provide access to quality educational materials, the Ministry of Human Resource Development, Government of India has launched the National Programme on Technology Enhanced Learning (NPTEL) in

2003, which is an Indian e-learning platform for university-level Science, Technology, Engineering, and Mathematics (STEM) subjects. It is jointly developed by Indian Institutes of Technology (IITs) and the Indian Institute of Science. The initiative is funded by the central Ministry of Education. The project's central idea is to put recorded lectures taught by its member institutes online for open access. It operates an educational YouTube channel covering engineering, basic sciences, and some humanities and social science subjects.

NPTEL is coordinated by seven IITs: IIT-Bombay, IIT-Delhi, IIT-Kanpur, IIT-Kharagpur, IIT-Madras, IIT-Guwahati and IIT-Roorkee in conjunction with the Indian Institute of Science (IISc). In March 2014, Swayam started offering NPTEL courses along with in-centre and proctored certification examinations. Course credits can also be transferred to the students of other higher education institutions or through the Academic Bank of Credits under the UGC guidelines. It is the largest e-repository in the world of courses in engineering, basic sciences and selected humanities and management subjects. The initiative runs through MOOCs model so that students outside IIT system can also participate in learning the quality content and get certified provided they meet the passing criteria in the exams conducted at the end of the NPTEL courses.

So ICT in education with integrating technology to the curriculum has a significant and positive impact on students' learning and achievements. There are reports to indicate that results have shown that the students who are continuously exposed to technology through education have better knowledge, presentation skills, innovative capabilities, and are ready to put more efforts to continuous learning as compared to their counterparts.

4.1 Role of ICT in Education

ICT plays a vital role in education and exhibit the following features [5]:

- It helps the students to be global learners and hence compete internationally by being part of a global workforce and facilitate social mobility.
- It facilitates more students to access Massive Open Online Courses (MOOCs) from Coursera, edx, Khan Academy, NPTEL (Swayam), etc.
- ICT helps the Teachers to motivate students and enhance interest in learning.
- Students can learn at their own pace without stress and exam fear.
- It helps to train the faculty members, make them learn continuously and thus enable them to teach on par with global standards.
- It helps to improve teaching skill, methodology, leading to innovative teaching.
- It enhances learning experiences by providing new sets of skills to work with emerging technologies.
- ICT plays an important role in student assessment and evaluation. Using ICT tools the faculty members shall prepare a wide range of question papers, assignments and self-works, and post to the students to practice at their own pace.
- It helps the teachers to easily design question papers with wide-ranging learning objectives using Bloom's Taxonomy of Action Verbs.
- It helps to follow different assessment, duration and weightage, and relative grading based upon the students' capability and performance.
- It helps for CO-PO mapping, CO and PO attainment calculation.
- It helps Teacher to pass information to students within a very little time.
- It helps in saving time and minimizing costs associated with delivery of information by automating regular tasks.
- It facilitates improving the administration of institutions to enhance the quality and effectiveness of service delivery.
- It will be useful for NAAC, NBA and ABET accreditations.

4.2 Need for ICT in Education

In view of the large expansion and extensive globalization of education, there is a great need for ICT in education as depicted in Figure 2. ICT is essential to deal with a wide range of data such as Textual data, Numeric data, Graphics data, Photographs, Audio data, Video data, etc. ICT has a great potential for learning, teaching, skill formation and life-long learning as it has

easy access, higher efficiency, and wider linkages as shown in Figure 3 [6].

4.3 Benefits of ICT in Education

ICT has several benefits for education, covering a wide range of aspects as highlighted below:

- It makes education more effective and responsive as depicted in Figure 4b
- It helps in setting up of Virtual Schools / Colleges / Universities
- It facilitates the conduct of Virtual Classrooms / Labs
- It helps Dual Shift Systems and offer Flexibility in Learning Schedules
- It assists Multi-grade Schools / Colleges / Universities
- It caters to all Urban, Semi-urban or Rural Schools and Institutions uniformly
- It fosters inquiry in terms of Designing and Creating, Visualization
- It motivates and engage learners through tutored learning
- It adds life to concepts and processes through simulation, visualization
- It brings the whole world into classroom, allow application of information
- It provides easy access to the entire world of information
- It offers collaborative opportunities and communication
- It promotes 4Cs, namely Critical thinking, Collaboration, Communication and Coding.
- It greatly helps for Policy Planning, Administration and Management of Institutions and Systems in terms of:
  - *Administration*: Admissions, Student flow, Personnel management, Faculty development, creation and maintenance of Infrastructural facilities.
  - *System*: Outcome mapping, Personnel payroll, MIS, Communication, Information management, Quality loop.
  - Management of Policy Planning, Coordination and Execution
  - Implementation and assessment of policy procedures and accomplishment of Targets, and Review.
  - Regular dissemination of Vision, Mission and Goals.
  - Storage and analysis of data and information.
  - Tracking improvements, procedures, systems and outcomes.

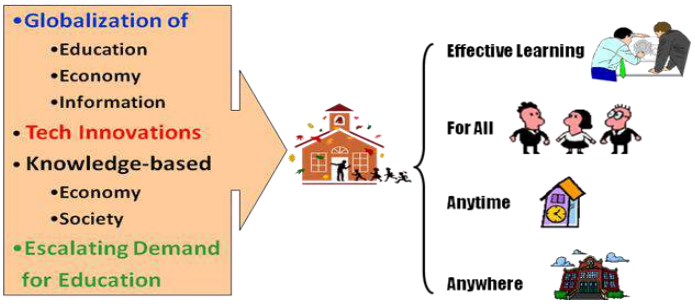

Fig. 2 Need for ICT in Education [6]

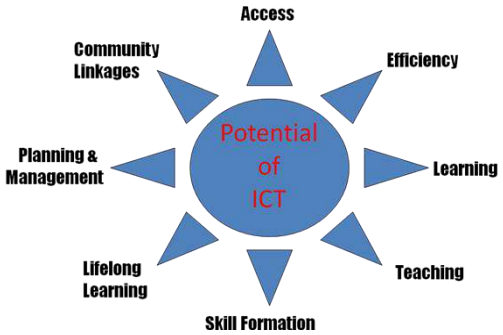

Fig. 3 Potential of ICT in Education [6]

Fig. 4a Education 3.0 was loaded with books

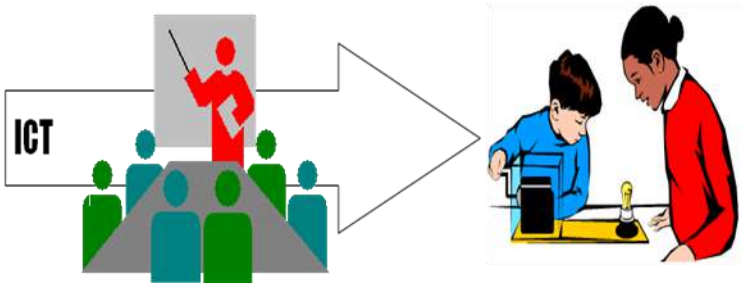

Fig. 4b Education 4.0 makes learning responsive

4.4 Software/Hardware and Devices required for ICT in Education

The following software and hardware are needed for implementation of ICT in education:

- Online digital repositories for e-lectures, course materials, and digital library.
- Online/ cloud based academic management systems.
- Remote devices for access of course materials.
- Smart phones, Handheld Computers, Tablet Computers, Audio players, Camera/Projectors.

The onset of Covid-19 pandemic in early 2020 has greatly affected the quality of education and revolutionized the entire method of teaching, learning, assessment, and examination system in India and everywhere. For nearly two years there was an almost absence of face-to-face teaching, there are no proper practical classes or hands-on practice or project work either in the laboratory or at home. Everything has turned out to be online, virtual, simulation, etc. Most of the teachers in schools and colleges taught students from home remotely using online tools, and similarly the students used some ICT devices and tried to learn online from home. The role of online tools and ICT techniques to enhance the involvement of learners and teachers is very well described and documented [1].

The book highlights the need of ICT Tools and Techniques for a wide-range of learners to learn at their own pace. It also deals in detail about the need for Creativity and Innovation in Engineering Education, Three Dimensions of Teaching, Circle of Learning, Bloom's taxonomy of educational objectives for Outcome based education, Frames of Mind, Gardner's Theory of Multiple Intelligences, Simple Tests to identify Frames of Mind and Multiple Intelligences, Innovation in Global and Indian Education, TQM and ICT Tools to improve Quality in Education, Achieving Academic Excellence – Online Flipped Teaching, Creative Problem Solving, Design Thinking [1].

4.5 ICT Tools

There is a wide-range of ICT Tools as shown in Figure 5. The three important areas in education are Preparation, Teaching-Learning Management Systems (TLMS) and Assessment. Accordingly the ICT tools can be broadly classified into Preparation Tools, Teaching-Learning Management Systems (TLMS) Tools and Assessment Tools, depending upon their purpose and usage. Hence the learners, teachers, resource persons and expert speakers shall make use of this wide variety of tools for preparation, TLMS and eventually for assessment in education. Table 2 highlights the list of ICT Tools applicable on a location and at a distance.

Table 2 ICT Tools Applicable on a Location and at a Distance

ICT Tools on Location (Site)	ICT Tools at a Distance
Digital notepads, White boards	Community Radio
Digital books, E-books	TV broadcasts
Films and Videos	Web pages, Webcast
Slides, Scanners	Internet, Intranet
Audiotapes, CDs	Satellite communication
Computer projection	Videoconferencing
Smart boards, Smart Projectors	Digital webpages
Interactive Laboratories	Virtual Laboratories

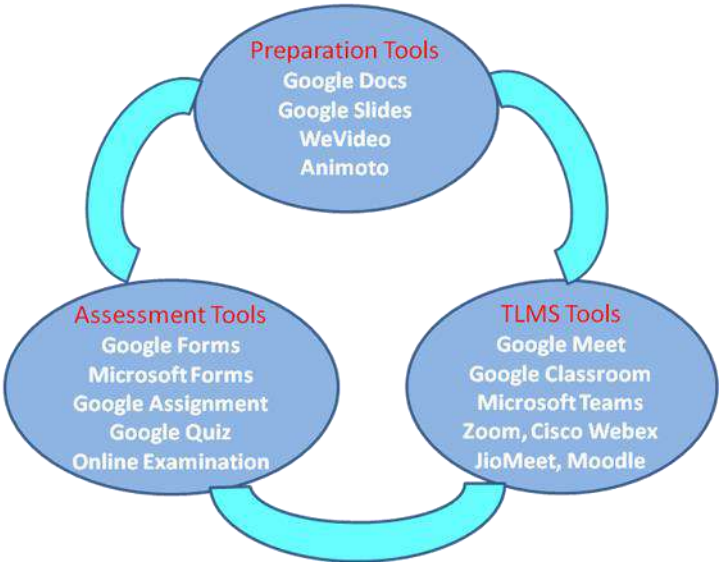

Fig.5 ICT Tools for Education [5]

The popular ICT Tools and Systems being used for Online Education include [5]:

- Microsoft Office 365 Education
- G Suite for Education
- TCSiON Education
- Webinarjam
- Zoom Edu
- Cisco Webex
- Zoho Meeting
- Microsoft Skype

The Microsoft Office 365 Education is a subscription package that brings together a variety of Microsoft apps and services like Word, Excel, Outlook, PowerPoint, Teams, OneNote, Exchange, One Drive, etc. It is designed for education, business and families.

Google Suite (G-Suite) for Education is a collaboration tool with a bundle of learning and teaching apps offered by Google. It was initially known as Google Apps for Education. The most notable G Suite apps are Google Classroom, Google Meet, Gmail, Assignments, Jamboard, etc. Google Meet is a part of G-Suite (paid) but free accounts can also use it for video meetings with upto 100 participants. It is a new version of Google Hangout and is more user-friendly. Google Meet is commonly used for Online Teaching and Learning. It is a video conferencing tool available on website and also as a mobile app (for both iPhone and Android) that can be used for video as well as audio meetings. You can either join a meeting with a url or code or start your own meeting.

Google Classroom being part of G-Suite is an online platform for online learning. It enables creating assignments, submission of assignments, grading of assignments and getting grades into results. Google Classroom integrates Gmail, Google Drive and Docs, which facilitate attachment of files and notifications. It works both on Computer and Mobile Phone devices.

4.6 ICT Techniques for Education

ICT Techniques will be of great use to the teachers to actively involve the wide range of learners in their own areas of liking. Employing any one or more of the following techniques will generate interest in the students and involve them in the learning process. Different techniques can be employed for different levels of students according to their interest and liking [5].

There are several ICT Techniques. The popular ones that lead to innovation in education are:

- Blended Learning
- Creative Learning and Problem Solving
- Design Thinking
- Experiential Learning
- Flipped Teaching
- Project-Based Learning
- Self-Learning
- Spoken Tutorials
- AR based and VR based Learning

4.7 Use of AR and VR in Education

When the Covid-19 pandemic caused distress and devastation in the education sector and stopped children from attending school due to lockdown, Basavaraj Sungari's novel initiative did just the opposite. It was in the morning on one fine day in July 2020 that Basavaraj Sungari, a Government School Science Teacher from Belagavi, Karnataka, was learning about Augmented Reality (AR)-based experiments for the students of Model Higher Primary School in Belagavi. Basavaraj used augmented reality to teach his students, which made his online science lessons interactive and interesting [7].

Basavaraj created videos for his students during the extended lockdown period. An avid user of new-age technological tools, he has created 3D content using mobile and desktop applications. He has also been using some editing tools to create videos to explain Physics, Chemistry, and Biology concepts to students in local language for better understanding. He is using Arloopa (Figure 6), a mobile app that helps artists embed their videos with images or videos using Augmented Reality (AR) and Virtual Reality (VR) technology [8].

Basavaraj effectively used AR and VR tools to teach his students. He mixed AR with VR to teach children how to unlock their imaginations during lockdown. His two videos regarding wildlife (Figure 7) and the solar system went viral among his students. The pandemic affected everyone, but Sungari believed children's mind could never get locked down. So he arranged different activities to keep them engaged and gave them as much as he could. He kept himself updated in the new high-tech world [9].

Fig. 6 Students learning science through Arloopa app, an AR application [8]

The fotonVR offers VR solutions in education and provides innovative ICT tools for education. The VR provides 3D and 360^0 based education for science and technology. The beauty of VR for higher education and science education is that there is no longer a dependency on books and reading for hours. If students are interested to know how Mars (Figure 8a) looks like, they need not to look through Google Images or YouTube videos of satellite images; they simply need to strap a pair of VR headsets so that they will find themselves on Mars! They will be able to walk on the planet from the room! VR also facilitates students visualize human body and study the functions of important organs (Figure 8b). So students do not just hear and see…but they do it in VR [10, 11].

Fig. 7 Students learning science using AR application [9]

Fig.8a Student uses VR to visualize planets [10]

Fig.8b Student uses VR to visualize Human body [11]

4.8 Use of Artificial Intelligence in Education

One of the 17 Sustainable Development Goals (SDGs) of the 2030 UN Agenda for Sustainable Development is SDG 4, which aims to ensure inclusive and equitable quality education and promote life-long learning opportunities for all. While Artificial Intelligence (AI) is not specifically mentioned in the 2030 Agenda, UNESCO and many other stakeholders have acknowledged that AI and AI-powered solutions have the potential to act as enablers towards accomplishment of many SDGs, including SDG 4. This carries a positive proposition for India, where the responsible and human-centered application of suitable AI systems through system-driven policy and engagement with all stakeholders could lead to long-term desired equality, equity and inclusion in education with improved learning outcomes [12].

During Covid-19 pandemic, the key role that technology played in mitigating learning losses was a clear testimony on how we were dependent on the technology. AI and related software tools played a pivotal role to sustain India's continuity of educational activities. The National Education Policy of 2020 prioritizes the integration of AI in education. Since then India has made considerable strides in its education system and strong indicators point to the country's notable efforts to enhance learning efficiency and effectiveness by using AI-powered technology [12].

UNESCO's 2021 recommendation on the ethics of AI made it clear that AI has indeed the potential to radically reduce inequalities, promote diversity and benefit humanity as a whole, provided national and international policies as well as regulatory frameworks ensure that human-centered technologies benefit the greater interest of the people. With this state of the Education Report focusing on AI in Education, UNESCO wants to offer a glimpse of the varied dimensions and challenges regarding the current and future use of AI in the Indian educational setting [12].

In line with UNESCO's 2021 recommendation Intel has played a vital role to 'create technology that improves the life of every person on the planet.' Making technology inclusive and expanding digital readiness is a key component of Intel's goals. Increased digitalization requires investments in building the digital capacities of people, specifically in emerging technologies like AI. Digital readiness encompasses skills, trust and responsible use of technology for broader socio-economic benefits. The Intel® Digital Readiness Program portfolio was rolled out globally in collaboration with governments, academia, civil society and industry partners and it is expanded to 27 countries that impacted over 3 million people as on date. Intel is committed to collaborating with governments in 30 countries, enabling digital access to 30000 institutions and skilling 30 million people for current and future jobs. Intel® Digital Readiness Programs in India include Intel's shared value and shared responsibility programs that aim to demystify and democratize AI for broader, diverse, technical and non-technical audiences, irrespective of their location, gender and ethnicity. The program portfolio consists of five key programs as shown in Figure 9 below [12].

It is reported that AI literacy consists of a technological and a human dimension; the technological dimension is concerned with data and algorithm literacy, while the human dimension comprises raising awareness about the limitations and risks of AI. The AI-powered education tools offer opportunities across various aspects of education, which are categorized here as formal and informal

learning, teaching, evaluation, school management, as well as mapping and matching of skills. The focus is on the category of learning, with special attention on comprehensive and personalized Intelligent Tutoring Systems (ITS) and how these could bring about equality, equity, inclusion, and improved learning outcomes. The intelligent tutoring system discovers patterns and trends indicating individual student's strengths, weaknesses, level of knowledge, and speed of learning. It helps to develop predictive analytics and a customized curriculum for each student within a framework of macro concepts. The learning material for the customized curriculum is accessible online at any time. Intelligent tutoring systems also support differently-abled students, linguistic minorities, and other marginalized groups according to their needs. Teachers are empowered by ITS with additional AI-powered tools for effective administration, teaching, and evaluation. Moreover, AI-powered tools support school/college management and enable the mapping and matching of skills [12].

Fig.9 Intel's five key programs for implementation of AI [12]

AI in education systems has contributed considerably to the achievement of SDG 4 in India, resulting in appreciable level of equality, equity and inclusion in education. The responsible and human-centered application of AI in the Indian education sector has progressed significantly. Personalized intelligent tutoring systems have also led to improved learning outcomes by replacing the obtrusive one-size-fits-all approach with individually optimized curricula based on a cascade of data and AI-powered detection of patterns and trends that are beyond the capabilities of human-teachers to process. However, in order for this vision to become a reality, a range of challenges and risks related to use and management of AI would have to be addressed first, both at the global level and at the national level in India [12].

The following recommendations describe actions to be taken, potential challenges, risks, and thus promote extensive use of AI and its related tools [12]:

- Embrace the versatility of Artificial Intelligence in education systems
- Expand AI literacy efforts
- Encourage all students and teachers to have access to the latest technology
- Involve faculty members, students and educationists in developing AI products
- Place ownership of data with the faculty members, students and other stakeholders.
- Create effective public-private partnerships
- Improve public trust in Artificial Intelligence
- Correct algorithmic biases and the resulting discrimination
- Consider the ethics of Artificial Intelligence in education as an utmost priority
- Create an overall regulatory framework for Artificial Intelligence in education.

4.8.1 Advancement of Artificial Intelligence in Education

The rapid advancement of information and communication technology (ICT) in the twenty-first century, including artificial neural networks, natural language processing, and deep learning, has brought disruption in the fields of education, image recognition, speech recognition, production systems, and automation. AI has evolved faster and it is applied in agriculture, cyber-security, education, healthcare, industry, etc [12].

There is a sudden rise in use of AI in the educational sector. AI is used as a supporting tool, and the learner acts as a collaborator with

the system. This is based on Bayesian networks, NLP and it is grounded in cognitive learning theory and social constructivism. AI is used to empower humans, where it is considered a tool to supplement human intelligence and learners as a core of AI in education. This is based on Machine Learning (ML) and Deep Learning (DL), grounded in connectivism learning theory and complex adaptive systems, for example, Recurrent Neural Networks, which are neural networks used for sentiment analysis and video classification.

Teachers explain various aspects of AI to students (Figure 10a). Students also explore AI for design thinking (Figure 10b). Thus, AI technologies can bring positive disruption to the education system by providing a personalized learning experience, real-time feedback and support to students, as well as by assisting teachers in tracking the learning performance of students and conducting large-scale assessments. Teachers can diagnose and identify students' problems in real time and provide interventions to improve students' learning outcomes. In addition, AI can help policymakers to take precise decisions based on the issues identified to reform the education system [12]. So AI is widely used in several interdisciplinary areas such as educational, psychological, computational sciences, and applied philosophy (Figure 11).

Fig. 10a Teacher explains various aspects of Artificial Intelligence to her students [12]

Fig. 10b Student explores endless dimensions of design thinking [12]

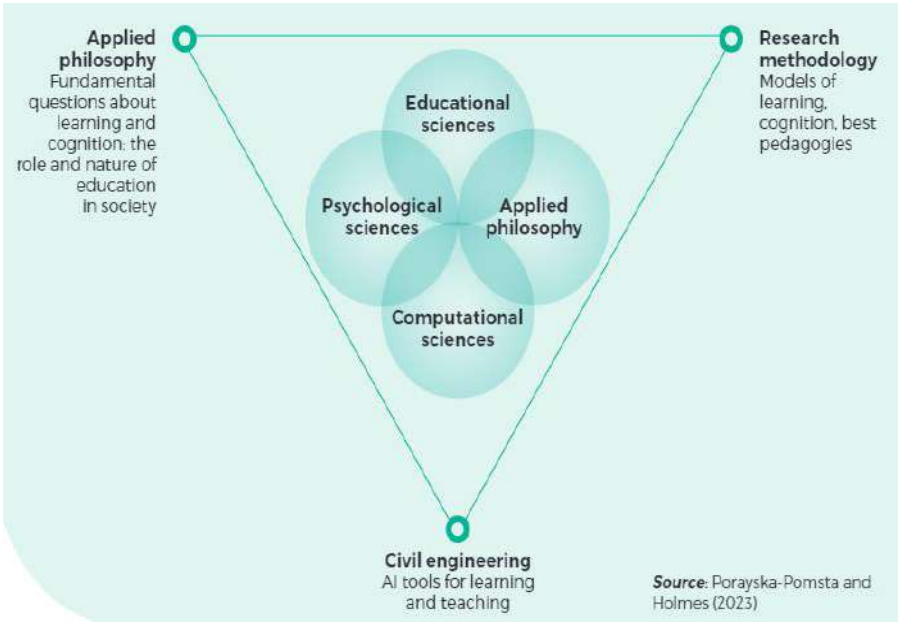

Fig.11 Illustration of interdisciplinarity of AI in education that includes educational, psychological and computational sciences and applied philosophy [12]

4.8.2 UNESCO's view on Artificial Intelligence

AI could help humanity to overcome many serious social problems. But at the same time, AI presents a series of complex challenges, particularly in terms of ethics, human rights and security – *Audrey Azoulay, Director-General of UNESCO [12].*

AI impacts UNESCO's areas of expertise, education in particular. UNESCO expects education to be profoundly transformed by AI in terms of teaching tools, ways of learning, access to knowledge and teacher training. While UNESCO acknowledges the immense opportunities that AI holds for the UN 2030 Agenda for Sustainable Development, the Organization also maintains that it is essential to tackle the ethical issues related to AI, as a part of UNESCO's overall effort to reduce inequalities in access to knowledge and research [12].

UNESCO has appointed a Chair in AI to study AI as a driver and compliment for solutions and strategies towards the achievement of the SDGs. In 2021 UNESCO launched an AI Global Policy portal with partners, who aim to contribute to the following areas [12]:

- Provide advice and assistance to member states on national policy and development programmes.
- Offer Massive Open Online Courses (MOOCs) on AI.
- Build Teachers' competencies in teaching and using AI in education.
- Build AI literacy and digital skills.

4.8.3 AI based solutions for Education

UNESCO has advocated that the implementation of AI in education systems can revolutionize the teaching-learning process. Accordingly various AI techniques and AI-powered tools could be used in education as described below [12]:

Intelligent Tutoring Systems (ITS)

Teachers can use ITS as supporting aids to conduct assessments, track learning progress and provide regular feedback to individuals.

Natural Language Programming (NLP)

NLP techniques can be used for formal and informal learning. They help to translate digital content into different languages, which can help students understand concepts in their mother tongue quickly. AI provides learning opportunities and access to online learning materials in remote areas that may not have access to comprehensive physical resources.

Artificial Intelligence / ML / NLP / Computer Vision / AR / VR

AI based Machine Learning, NLP, and Computer Vision with face recognition, speech recognition, augmented reality/virtual reality labs can be used extensively for teaching and learning, and to actively involve students in learning and practice. Accordingly smart/virtual schools, colleges and universities can be created on similar lines of Open Distance Learning (ODL) to deliver quality content to remote locations at any point of time and for easy access by anyone from any place.

Computer Vision / RPA / Chatbots

AI-based techniques like Computer Vision, Robotic Process Automation, Chatbots and image recognition can assist teachers in monitoring large classrooms, assessing and grading the assignments of masses, and thus help to reduce workload of teachers/instructors. Chatbots help extensively for evaluation of answer scripts, marking of assignments, grading students' performance, etc. Chatbots even help the learners in writing small programs through coding.

Artificial Intelligence with Machine Learning

Integration of AI (ML) in school/college administration can save much time for teachers. Tasks such as taking attendance and tracking students' submissions, learning progress may be automated using AI (ML) through face recognition, image recognition and text recognition, which could reduce teachers' workload. This will provide more opportunities for teachers to interact with students technically and thus develop a one-to-one relationship, and also to collaborate with colleagues for more effective output in teaching. With respect to the problem of drop-outs, AI can monitor the learning activities of registered students. Based on learning behaviour parameters, the system can track students who are facing difficulties and send feedback to their instructors to help them take remedial measures to support such students. In addition, AI-based systems can help teachers identify

learning styles, individual needs and thus allow teachers to customize learning content based on students' preferences [12].

AI for Mapping and Matching of Skills for Job

AI can help job seekers find the right job based on registered users' information, which includes education, skills and goals. In addition, AI can also recommend the training / skills required for a particular job, and the user can complete the relevant course(s) to avail a particular job. This can help meet the demands of a skill-based workforce for Industry 4.0/5.0 in which we see the transformation of industry through the intelligent networking of machines and automated processes with the help of information and communications technology.

The Government of India understood the potential of AI to transform millions of lives in the country and therefore identified five major areas for the use of AI-driven technology: agriculture, education, healthcare, smart cities and infrastructure, smart mobility and transportation. In 2018, the Ministry of Electronics and Information Technology of India (MeitY) constituted four committees to promote AI and to develop a policy framework for AI. The following were the key recommendations from the four committees [12]:

- Develop a National Artificial Intelligence Resource Platform of India that will create an ecosystem where people will build solutions using shareable data, information, tools, literature, etc., individually or in collaboration with others.
- Identify national missions to integrate AI in different key sectors like agriculture, health, education, etc.
- Support AI research for the challenges identified in the Indian context by providing sufficient research funding.
- Develop cyber security techniques and tools that use AI to defend against cyber-attacks more effectively.

In 2020, the Ministry of Education (MoE), Government of India highlighted the importance of AI in the education sector and advocated the development and implementation of new courses in AI for higher education to develop AI skills among students to meet the needs of present and future job requirements. Accordingly, AICTE came out with a policy to approve AI based engineering programmes and many engineering institutions have started undergraduate courses in AI and related disciplines. Several schools started offering AI-related courses to students.

Artificial intelligence finds a prominent mention in the National Education Policy 2020. NEP 2020 was launched by the Ministry of Education on July 29, 2020, under the dynamic leadership of our Prime Minister Shri Narendra Modiji, to initiate reforms in school and higher education in India. The NEP 2020 has five foundational pillars: access, equity, quality, affordability, and accountability. It also emphasizes the integration of AI in education, acknowledging that 'India must also take the lead in preparing professionals in cutting-edge areas that are rapidly gaining prominence, such as artificial intelligence, big-data analysis, machine learning, in addition to genomic studies with vital applications to health, environment, and sustainable living, which will be woven into undergraduate education for enhancing the employability of the youth [12].

NEP 2020 highlights several important areas in which the application of AI is mentioned. It recommends introducing courses related to AI at all levels of education to develop the skills required to meet the current demands of industry. In this regard, the policy recommends introducing computational thinking at a foundational stage of children's education so that India plays a leadership role in the fields of AI, machine learning, and data science, among others. Computational thinking will involve puzzles and game-based learning in the early stages, and coding will be introduced in the middle schools as teachers start teaching coding in school itself (Figure 11). In 2021, the MoE also suggested leveraging the advantages of AI and ML in language and translation, personalized learning, and enhanced learning [12].

NEP 2020 advocates the development of hardware and software that use Artificial Intelligence, machine learning, big-data analytics, block-chain, smart-boards, adaptive systems, etc., to improve students' learning and identify their learning paths. It goes on to advocate for developing AI-based software to track and identify students throughout their stay in school, based on their learning data, and

thus provide information about students' strengths, weaknesses, and areas of interest, in order to help students make decisions about the careers they choose.

SWAYAM, a Government of India programme designed to achieve access, equity, and quality in education, uses its platforms to bridge the digital divide and disseminate online courses for rapid adoption. AI will play an important role in data annotation, image classification, and speech processing in online and vocational programmes. A National Educational Technology Forum is being set up by the Ministry of Education to enhance learning, assessment, planning, and administration for both school and higher education, in which AI will play an important role in making data-driven decisions. The NEP 2020 also highlights the importance of ethics in the development and deployment of AI-based technologies. Issues of data privacy, data protection, law, and standards of data handling have been addressed in the current policy [12].

Fig.11a Coding class in progress [12]

Fig.11b Teacher explains how to code and student make an AI model [12]

4.8.4 Tracking Learning Outcomes and Assessing Competencies using AI

Automated assessment systems are important for bridging the gap created by socio-economic inequalities in the Indian education sector that not only suffers from an acute shortage of teachers but also struggles with the issue of teachers' time being wasted. The most promising applications of AI in education are automated assessment systems. The AI disciplines of Natural Language Processing (NLP) and Machine Learning (ML) have facilitated significant progress in the quality of these systems. For example, a specific category of these systems is called 'Automated Essay Scoring' which evaluates writings, essays, projects, etc. Automated assessment systems have different features, ranging from providing overall scores and delivering instantaneous feedback to offering guidance for improvement. The overall trait is that they perform a certain task efficiently; for example, the quantification and analysis of learning progress and competencies, an undertaking that is typically very time-consuming for teachers, especially in case of large-scale entrance exams for admission to educational institutions.

Automated e-assessment systems in schools and colleges located in remote areas, rural regions and sub-urban settlements could save teachers' time, and thus allowing them to focus on in-classroom activities and on offering personal attention to each student. Additionally, these systems remove human bias and manual errors from assessments and grading, while providing evaluation of individual students relative to their peers across the city, district or nation. This would be possible through a centralized automated assessment system that possesses training and test datasets from across the nation. All these represent the modern Intelligent Education System as illustrated in Figure 12.

4.8.5 Intelligent Tutoring Systems for Personalized Education

AI-powered systems for personalized education are also called Intelligent Tutoring Systems (ITS), which received a significant boost from recent improvements in Machine Learning and Deep Learning techniques. ITS as shown in Figure 13 is driven by AI, which presents the content in a tailored manner that is adaptive and agile to students' needs, and customizes the learning path for students, based

on their levels of comprehension and cognition. ITS provides individual guidance, support, feedback and is linked to adaptive curriculum sequencing, which works on the principle of mapping the knowledge and skills of students to design a customized curriculum for everyone [12].

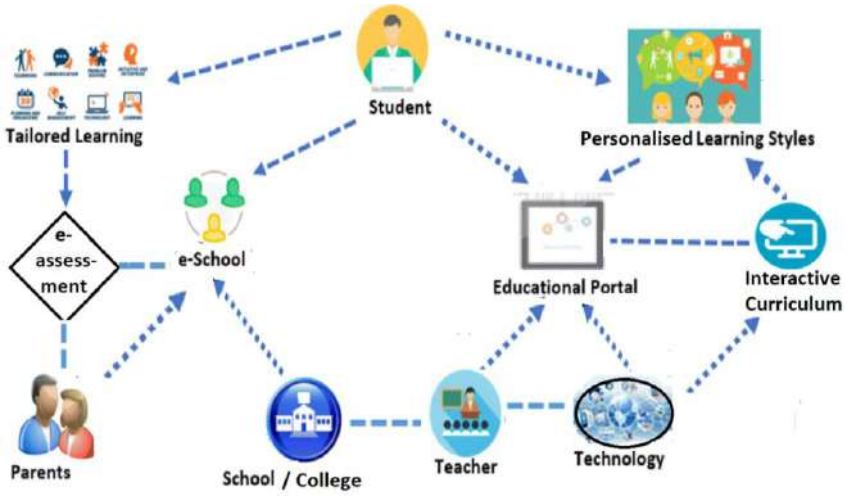

Fig.12 Illustration of modern intelligent education system

Personalized education includes online learning and game-based learning (Figure 14). It does not only require communication in both directions, but also in an inclusive manner. The initial step in personalized learning is to equip students with digital technologies that provide educational content on a web-based platform. The entire course material, including video lessons, assessments, discussion forums, virtual simulators and quizzes, has to be made available online. Based on their pace of learning and progress, performance in customized micro-assessments and evaluation in full-scale is made. Therefore, developers should ensure appropriate options for students' input through speech recognition and other modalities such as gesture and gaze-based input, for which AI solutions have been developed and are being refined. These could be implemented as AI-driven chatbots or avatars. Students take courses on integrating Python with Artificial Intelligence. So AI has created a buzz in the mind of many students (Figure 15).

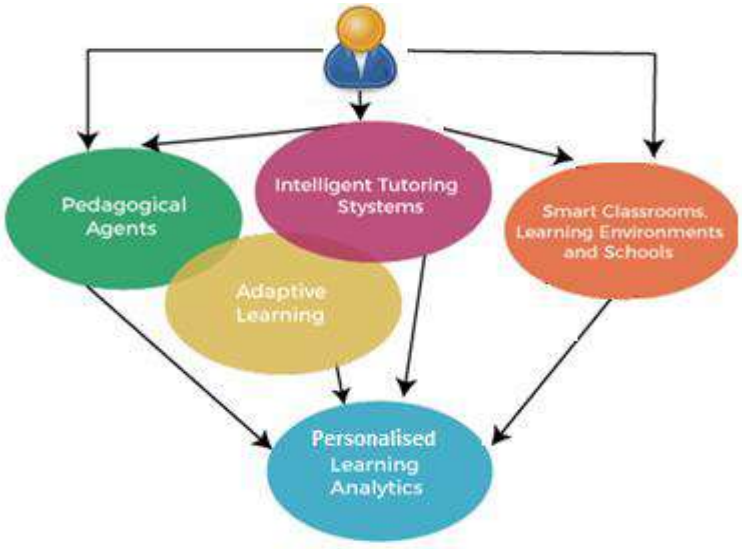

Fig.13 Intelligent tutoring system model

Fig.14a AI-powered personalized learning **Fig.14b Game-based learning to hone math skills [12]**

Fig.15a Students take a course on integrating Python with Artificial Intelligence[12]

Fig.15b Emerging technologies like AI created a buzz in the mind of many students [12]

The rapid spread of Covid-19 and the resulting closure of schools and educational institutions in 2020 have created a need for remote educational infrastructure. AI has ushered in a new era of remote education that reached more students and automated all those functions of teaching that do not require a human instructor. With the aid of such systems, courses taught by one teacher can be recorded and broadcasted live to students over a large geographical region, thereby enabling mass education during times of crisis like the Covid-19 pandemic.

From the students' perspective, AI solutions installed in learning devices (laptops, desktops, tablets, mobile phones, etc.) can translate the teacher's words in real-time for students who are not fluent in the primary medium of instruction, while providing auto-generated subtitles for easier comprehension. Besides digital textbooks and digital study materials provided from a central repository, machine learning algorithms along with text translation helped to create content that is personalized for each student's requirements. So, AI-based text summarization and voice transcription solutions installed in learning devices can help transcribe complete lectures/lessons into comprehensible, small paragraphs in multiple languages with great accuracy. This implies that a lecture delivered centrally can be customized for students through distributed, decentralized content translation and transcription systems.

Another important application of AI is in collaborative learning. Collaborative learning is efficient, yet group formation may not happen easily, especially in virtual environments. So, AI systems can assist in various ways, for example, by forming the most suitable groups based on the skills of the members, through appointing intelligent virtual agents, or by offering intelligent moderation. Thus students from different parts of the country, who never met each other otherwise, could become collaborators; even international groups could be formed by using AI-powered translation technology. Thus AI-powered, remotely delivered learning material could be greatly enhanced by AI-supported technologies such as augmented reality, virtual reality and meta-verse [12].

4.8.7 Vision for AI in 2030

It is expected that by 2030, AI in education systems will contribute considerably with efforts to achieve SDG 4 in India and will help to address issues related to equality, equity and inclusion in education. The Beijing Consensus on AI and Education in 2019 discussed the opportunities and challenges of AI in education and developed the following recommendations for governments and other stakeholders among UNESCO's Member States [12]:

- Planning AI in education policies.
- Using AI for education management and delivery.
- Using AI to empower teachers for teaching.
- Using AI for learning and assessment.
- Ensuring ethical, transparent and auditable use of education data and algorithms.
- Developing values and skills for life and work in the AI era.
- Monitoring, evaluating and researching the impacts of AI applications in education.
- Promoting equitable and inclusive use of AI in education.
- Supporting gender-equity in AI-based education.
- Using AI to offer life-long learning opportunities for all.

5. Education 5.0

With an extensive use of AI in education and related activities, there is a quick transition from Education 4.0 to Education 5.0 in late 2022 due to the quick emergence of Generative AI. With a passion for AI and its transformative power, Mandi [13] presented a new perspective to the world of education and industry. The Generative Artificial Intelligence refers to a branch of AI, which focuses on creating a new content rather than analyzing existing data. This new technology has undergone rapid advancements in recent years, enabled by progress in neural networks and machine learning. Generative AI has diverse applications across industries ranging from creative work through education to important medical discoveries. Nevertheless, it poses ethical concerns about data bias, misinformation, reliability, and job displacement, which must be addressed responsibly.

5.1 Brief History of Generative AI

The origin of Generative AI can be traced back to the 1950s, when scientists began conceptualizing intelligent machines that could create original content. In the 1960s and 1970s, early experiments generated rudimentary art, music, and text. However, these results were basic and limited in scope. The major steps occurred in the 2000s with statistical approaches like Markov chains, which powered the first automated writing systems. Then, in 2014, Ian Goodfellow introduced Generative Adversarial Networks (GANs), an innovative model architecture that paved the way for highly realistic AI-generated content. In post-Covid-19 era, there is a big buzz about deep learning and reinforcement learning that led to today's state-of-the-art Generative AI models like ChatAI, ChatGPT-3, ChatGPT-4, DALL-E, Google Bard, etc. The explosive growth of data analysis and computing power catalyzed this big performance leap. As models scale up, the quality, diversity, and complexity of the content so produced get improved [13].

5.2 Key Technologies Powering Modern Generative AI

There are key technologies that have enabled the recent breakthroughs in Generative AI as described below:

5.2.1 Transformers

Transformers are made up of novel neural network architecture based on an attention mechanism that learns contextual relationships between words and images. Transformers first introduced in 2017, now excel at language-related tasks and are the driving force behind models like ChatGPT-3.

5.2.2 Generative Adversarial Networks (GANs)

GANs consist of two competing neural networks – a Generator that creates new content, and a Discriminator that evaluates how realistic it is. The two networks are pitted against each other in a training regime that produces highly convincing outputs.

5.2.3 Diffusion Models

Diffusion models create content by starting with random noise and reversing a diffusion process over repeated neural network passes. This technique achieves both high fidelity and variety in the generated content.

5.2.4 Reinforcement Learning

Reinforcement learning optimizes generative models to produce outputs that meet specified objectives and constraints, rather than just mimicking training data. This expands creative possibilities.

The convergence of these technologies has led to the recent explosion of Generative AI with many capabilities. These models are now billion-parameter behemoths, trained on internet-scale datasets.

5.3 Capabilities of Modern Generative AI

Today's most advanced Generative AI models exhibit good creativity and versatility far beyond previous systems. They can create / produce [13]:

- ***Text*:** Stories, poems, news articles, conversational dialogues based on text prompts.
- ***Image*:** Photo-realistic pictures and art-works based on existing images or text descriptions.
- ***Audio*:** Life-like speech, vocals, music, and other sounds.
- ***Video*:** Computer-generated videos that mimic real-footage and deep-fakes.
- ***Data*:** Artificial data for training machine learning models.
- ***Code*:** Lines of codes or functional computer programs from simple descriptions of objectives.
- ***3D Models*:** Three-dimensional models of objects, scenes, and architectures.

5.4 Key Benefits of Generative AI

The important and key benefits of Generative AI include [13]:

- ***Accessibility*:** Easy access by democratizing content creation and enabling wider participation.
- ***Analysis & Insight*:** Identifying non-obvious trends and patterns in data, and help in sorting.
- ***Creativity*:** Proposing creative / crazy ideas that humans may not conceptualize.
- ***Personalization*:** Tailoring the content to individual user needs and personal interests.
- ***Productivity*:** Automating rote, repetitive tasks to augment human productive capabilities.
- ***Time Saving*:** Faster transaction and cheaper generation of content at scale saves time.

So the Generative AI, if applied judiciously, will overwhelmingly transform the way how the content, text, images, videos are produced and utilized across industries/organisations and society for education, business and future activities.

5.5 Risks and Challenges of Generative AI

The Generative AI models inspite of exhibiting several positives, pose some underlying issues, which need resolution. Some of the possible risks and challenges include [13]:

- ***Bias*:** Generative AI models can perpetuate and amplify societal biases and toxic view-points within training data.
- ***Misinformation*:** The synthetic data/media generated from models can spread false information if used maliciously.
- ***Privacy*:** Generative AI models may encode identifiable aspects of people without consent.
- ***Job Displacement*:** Automating creative work could disrupt many human professions and livelihoods.
- ***Legality*:** There will be questions over ownership, copyright, and plagiarism issues around AI-produced content.
- ***Security*:** There is a security lapse to identify theft if synthesized data is misused, leading to potential financial fraud.

Addressing these challenges through the governance framework, audit, and regulations will be crucial as Generative AI reaches a common-place for use by all.

5.6 Application Areas and Outcome

The breadth of potential applications of Generative AI spans virtually every industry. While promising, it also necessitates careful evaluation of whether generative AI's use-cases are beneficial versus harmful for the society. It is advisable to balance the benefits versus concerns. The Generative AI in various forms is finding its utility in many industries including education as described below [13]:

5.6.1 Creative Fields

The Generative AI augments human creativity in areas like email drafting, script writing, visual art drawing, song and music composition, and design. Concept generation, ideation, simulation and modeling can be automated.

5.6.2 Media and Entertainment

The Generative AI mimics life-like avatars, generates game characters, enables virtual influencers, and result in automated film production. It could expand creative possibilities and animation.

5.6.3 Customer Service

The Generative AI powers conversational activities that can understand requests and generate detailed, personalized responses. This improves customer experience and saves response time.

5.6.4 Drug Discovery

The Generative AI proposes new recipes for drugs, examines new molecular structures of drugs and evaluates drug quality faster than humans. This accelerates the overall drug discovery timeline.

5.6.5 Cyber-Security

The Generative AI allows generating cyber synthetic data for training machine learning models to detect threats, and thus propose security and safeguard. Deep-fakes generated from models can also stress-test cyber-threat detection systems.

5.6.6 Interview by ChatGPT

The last couple of months have been all about ChatGPT, the AI chatbot that has taken the World by storm and surprise. People have been using it to compose music, write poetry, write essays, generate content, generate ideas, and what not? And now, the chatbot has conducted its biggest interview ever. Microsoft Co-founder Bill Gates and UK Prime Minister Rishi Sunak answered some questions posed by ChatGPT, and the conversation is worth remembering. From talking about the advice they would give to their younger-selves to revealing the job that they would like AI to do for them, Bill Gates and Rishi Sunak answered an array of questions. Bill Gates shared the video of the interview on LinkedIn and wrote, "Rishi Sunak and I were interviewed by an AI chatbot and had a great conversation about the future. Spoiler alert: it's bright" [14].

It is reported that ChatGPT asked first question to Bill Gates about the impact of technology on global economy and job market in the next ten years. Bill Gates, answering the same, said that we need to be more efficient as there is a labour shortage in healthcare and education. "Hopefully technology like AI can help us to be more efficient," he said [15].

5.7 The Future Trajectory of Generative AI

The Generative AI is still early in its evolution. Here are some future milestones expected:

- More industries will adopt Generative AI to enhance operations, products, and services. This results in integration into existing workflows that will improve over the time.
- Specialized vertical models will emerge for different domains like education, healthcare, law, science etc.
- Multimodal models that combine capabilities – data, images, text and voice – will enable more complex, contextual generation.
- Reinforcement learning and human-in-the-loop training will produce increasingly nuanced, controllable outputs tuned to user needs.
- Regulation and industry standards will develop to address data privacy, bias, and misuse related concerns.
- Generative AI will expand access and participation for underserved communities through inclusive data practices and personalized applications.

The next decade will likely see the transition of Generative AI from novelty to mass adoption across the whole educational spectrum. Its evolution must balance transformative progress and responsible ethical application for maximum broad benefit.

The new AI Chatbot, Chat GPT is a Saviour for Microsoft 365 Sysadmins! The Chat AI has several tools shown in Figures 16–20 that can perform several tasks, such as: (a) Chat AI can answer any questions; (b) Chat AI acts as a writing assistant; (c) Chat AI will help to choose any topic to deal with; (d) Chat AI will help to solve Maths problems; (e) Chat AI summarizes files and articles; and (f) Chat AI generates

photos from text. Similarly, Chat GPT acts as a superfast AI chatbot; Chat GPT Voice Assistant converts speech to text; and Chat GPT helps developers solve any code. The features of each of the AI devices are self-explanatory, as depicted in Figures 16–20 below:

Fig. 16a Chat AI answers any question

Fig. 16b Chat AI assists in writing

Fig. 17a Chat AI has various topics to choose

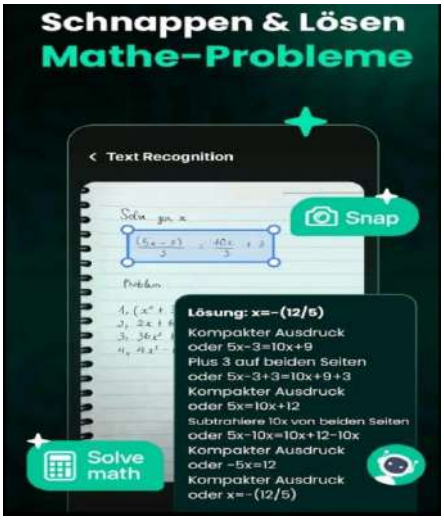

Fig. 17b Chat AI helps to solve Maths problem

Fig. 18a Chat AI summarizes Files and Articles

Fig. 18b Chat AI generates Photos from Text

Fig. 19 Chat GPT is a Superfast AI Chatbot

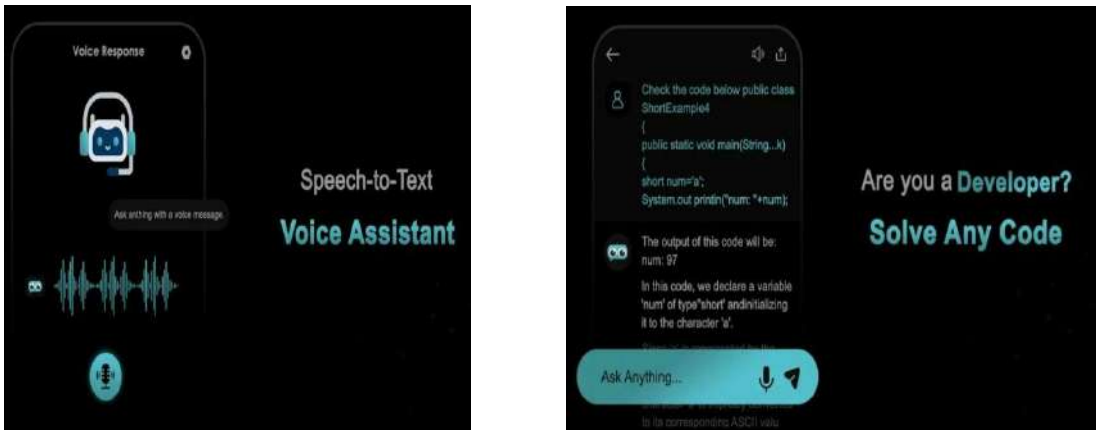

Fig. 20a Chat GPT Voice Assistant converts Speech to Text

Fig.20b Chat GPT helps Developer to Solve any Code

5.8 QS Global Academic Survey

There has been a ***QS Global Academic Survey*** [16] this year to explore the impact of Generative AI tools (such as ChatGPT, Google Bard, DALL-E, etc.) in businesses and in the higher education sector. The survey includes the following important questions and the readers of this paper shall try to answer these questions for their own knowledge-sake and offer their feedback/opinion on the importance and use of Generative AI tools for education in their own institutions.

Q1. How familiar are you with Generative AI technologies such as language models, text generators, image or video creators, etc.?

- ○ Very familiar
- ○ Moderately familiar
- ○ Slightly familiar
- ○ Not familiar at all

Q2. Have you personally used or interacted with any of the Generative AI technologies?

- ○ Yes
- ○ No

Q3. Which platforms have you used professionally? (Please select all that apply)

- ☐ Runway ML
- ☐ NVIDIA StyleGAN
- ☐ Unity ML-Agents
- ☐ Hugging Face
- ☐ OpenAI GPT-3
- ☐ IBM Watson Studio
- ☐ TensorFlow
- ☐ Google Colab
- ☐ PyTorch
- ☐ DeepArt

Q4. Please select what for you have used AI technologies (tick all that apply):

- ☐ Automated Literature Reviews
- ☐ Content Summarization
- ☐ Essay writing
- ☐ Language Translation and Transcription
- ☐ Tutoring and Educational Materials
- ☐ Idea Generation
- ☐ Data Analysis and Visualization
- ☐ Plagiarism Detection
- ☐ Research Paper Writing
- ☐ Simulations and Modelling
- ☐ Journal publication
- ☐ General Content Recommendation
- ☐ Other

Q.5-8 Please indicate to what extent you agree with the following statements:

5. Generative AI has a positive impact on students' learning experience
6. Generative AI will have a negative impact on the education sector
7. It is essential that universities incorporate Generative AI to their curriculum
8. Generative AI is helping the Higher Education sector to thrive

- ○ Strongly disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly agree

Q.9-11 Please indicate to what extent you agree with the following statements:

9. Gen AI tools should be regulated
10. Gen AI is helping to reduce social inequalities
11. Gen AI is contributing to a better society

- ○ Strongly disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly agree

Q12. Has your institution implemented any Generative AI technologies in the classroom or educational processes?

- ○ Yes
- ○ No

Q13. What effect do you think Gen AI technology has on your current workplace during 2023?

- ○ Negligible impact
- ○ Minimal impact
- ○ Moderate impact
- ○ Significant impact
- ○ Transformational impact

Q14. Which areas in academia do you think Gen AI impacts?

- ☐ Curriculum Development
- ☐ Pedagogical Approaches
- ☐ Assessments and Grading
- ☐ Student Support and Counseling
- ☐ Administrative Tasks
- ☐ Admissions and Enrollment
- ☐ Research Practices
- ☐ Inclusive Education
- ☐ Other

Q15. In your opinion, what skills would students improve using advancements in Generative AI? (select all those applicable options)

- ☐ Aptitude / Analytical / Quantitative skills
- ☐ Communication
- ☐ Depth of knowledge in subject
- ☐ Active learning
- ☐ Ethics and Social Responsibility
- ☐ Emotional Intelligence
- ☐ Resilience & Flexibility
- ☐ Sustainability mindset
- ☐ Negotiating skills
- ☐ Organizational skills

- ☐ Business Management
- ☐ Creativity
- ☐ Problem-solving skills
- ☐ Interpersonal skills
- ☐ Leadership
- ☐ Ability to work in a team
- ☐ Entrepreneurship
- ☐ Language skills
- ☐ Other

Q16. What challenges or barriers do you face in implementing or using Generative AI technologies in your Institution / University? (select all that apply)

- ☐ Resistance to Change
- ☐ Ethical Concerns
- ☐ Data Availability and Quality
- ☐ Security and Privacy
- ☐ Intellectual Property
- ☐ Maintenance and Scalability
- ☐ Interpretability and Bias
- ☐ Technical Complexity
- ☐ Regulation and Compliance
- ☐ Pedagogical Integration
- ☐ ROI and Justification
- ☐ Limited Resources
- ☐ Other

Q17. What do you feel when reading about Generative AI? (select all that apply)

- ☐ Surprise
- ☐ Curiosity
- ☐ Interest
- ☐ Surprise
- ☐ Enjoyment
- ☐ Fear
- ☐ Guilt
- ☐ Contempt
- ☐ Sadness
- ☐ Disgust
- ☐ Anger
- ☐ Shame/shyness
- ☐ Other

Q18. How do you perceive the role of Gen AI in society?

- ○ Very positive
- ○ Somewhat positive
- ○ Neutral
- ○ Somewhat negative
- ○ Very negative

Q19. In your opinion, how can Colleges / Universities better prepare graduates for the advance of generative AI?

Q20. Is there any additional feedback or comment you would like to provide regarding the impact of Generative AI on your institute/organization?

CONCLUSIONS AND RECOMMENDATION

Education is the manifestation of perfection already in man. Education is a complex, multi-stage process of building character through acquiring knowledge, skills, ethics, and wisdom to lead a happy human life. Education without character and self-discipline is meaningless. Hence, the real purpose of education is to impart knowledge, shape character, instill confidence, inculcate ethos and universal human values, and enable the learner to lead a peaceful life with an essence of life-long learning skills and contribution to society. There has been a great evolution of the educational process over a very long period of time. Similar to the industrial revolution, which has evolved from Industry 1.0 over time to Industry 5.0, education has also evolved from

Education 1.0, which was primal, to the most modern present-day Education 5.0.

AI played a vital role for more than 20 years during Education 4.0. During this year, due to the advent of prominent digital technologies such as Generative AI, there has been a quick transition from Education 4.0 to Education 5.0. The Generative AI represents a monumental technological leap in machine creativity to augment human innovation. It will profoundly reshape how content is created and used virtually across the educational domain and every industry. The capability of Generative AI in quick production of text, codes, images, pictures, audio, and videos has the potential to greatly enlarge human capabilities and democratize its access to all on matchless scale.

However, as with any powerful technology, a considerable concern about ethical principles is required to steer Generative AI's progress in a socially constructive direction. There are potential risks around issues like data bias, misinformation, and job displacement that could incur harm if not conscientiously addressed. Hence, developing a nuanced and measured understanding of Generative AI's capabilities and limitations among both individuals and institutions is essential.

It is recommended that by embracing Generative AI with a balanced mindset, we can work to maximize its benefits while minimizing its risks and limitations. Some initiatives to check, audit, and renew algorithms, implement thoughtful regulations, and democratize access for users play a vital role in popularizing generative AI models. Ultimately, Generative AI, if developed and deployed responsibly, can become a constructive tool that propels creativity, discovery, problem solving, personalization, and human progress in future.

Every new technology itself is neither intrinsically good nor bad; so it is our collective responsibility to shape its trajectory down to a path aligned with altruism, ethics and human values for public good. If everyone develops positive thinking about Generative AI, it can open new, creative frontiers in art, science, technology, business, education, engineering, research, and beyond in the years to come.

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