

Artificial Intelligence and the Future of Education

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Abstract

This article deals with artificial intelligence and its impact on education. To start with, the basics of artificial intelligence (AI) are discussed with a special focus on what AI is, how it is related to machine learning and deep learning and how an AI system works with special reference to the importance of data and algorithms. The applications of AI in education, such as personalized learning, personalized curriculum, AI teachers, smart content, smart classrooms, intelligent tutoring systems, etc., are also discussed. The various challenges associated with successfully implementing AI in the education sector are also discussed briefly. Finally, how AI could also be helpful in the conduct of research is described.

Keywords: Artificial intelligence, personalized learning, customized curriculum, AI teacher, intelligent grading systems, gamification

Introduction

Education is the process of enabling learning- be it knowledge (cognitive domain), physical skills (psychomotor domain), attitudes, etc. (affective domain). Learning helps achieve the ultimate goals of education, i.e. to produce a competent professional, a responsible citizen, and a good human being. Over the years, the methods of imparting education have changed significantly with the growth of technological developments around the world. Information and Communication Technology (ICT), for example, has revolutionized the way education is imparted with an increasing focus on online education, e-learning, MOOCs, blended learning, online examinations, etc. Since technology is a journey and not a destination, in this chain of technological advancements, artificial intelligence is another disruptive technology that is totally going to transform the way education is imparted

at present. NEP-2020 (NEP document) also acknowledges the significant potential of AI and advocates for its incorporation into the education system to enhance efficiency, effectiveness, and accessibility. The Internet of Things (IoT) and artificial intelligence (AI) have already been incorporated into the curriculum for classes VI through X by the Central Board of Secondary Education. Given the increasing importance of AI in education, even India's first AI University has now started functioning in Karjat, near Mumbai, from 2023.

What is this AI, how it works and how it is going to transform the education sector in the country with reference to curriculum designing, teaching-learning, assessment, research and the roles of the teachers are the questions that will be addressed in this article.

What is artificial intelligence?

Human intelligence is the ability to

understand, learn, think, or solve new or complex situations. Artificial Intelligence (AI), the intelligence of machines, is nothing but simulating human intelligence into computers so that they can think and act like humans. It is worth noting that, unlike human intelligence, which uses the brain, memory and intelligence, artificial intelligence is based on information provided by humans. This is the biggest difference between human intelligence and artificial intelligence. Some other differences between artificial intelligence and human intelligence are that AI processes information faster and more accurately adapts to changes, and is goal-oriented. AI machines are capable of perceiving, thinking, understanding language, recognizing sounds and images, learning and problem solving, etc. AI, which is a branch of computer science, is not a single technology but actually encompasses several technologies that work together to enable devices or machines to function with an intelligence that is as human-like as possible. Some common examples of AI in our day-to-day life are Google Maps, google search engine, spam filters, automatic language translation, Wolfram Alpha answer engine, Chat GPT, and intelligent digital personal assistants like Siri, Cortana, Alexa, etc. All of these are driven by AI. The most innovative developments based on artificial intelligence include recognition of the face and voice, speech recognition, foreign language translation and machine vision, driverless cars, manufacturing robots, chatbots, virtual workers, etc.

Artificial Intelligence, Machine Learning, and Deep Learning

In the context of artificial intelligence, the terms machine learning and deep learning are often used interchangeably with artificial intelligence. While they are related, they are certainly not

synonymous. Machine learning is a subset of artificial intelligence that aims to enable computers to perform various tasks without explicit instructions (Bell & Blackwell,2022; Chang et al.,2018). Machine learning also refers to the development of computers that can access different types of data and use it to learn on their own. Conversely, deep learning is a branch of machine learning that is based on neural networks (Fan et al.,2021). Neurons are like little messengers in our brains that send and receive messages throughout our body, allowing us to think, feel, move, and interact with the world around us. Artificial neural networks on which deep learning is based mimic the functioning of the human brain. The way data is delivered to the machine is the main distinction between machine learning and deep learning. While deep learning uses multilayer neural networks, machine learning methods usually require organised data.

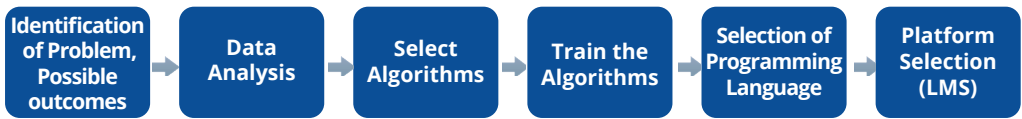
How does artificial intelligence work?

To perform various tasks with minimal human intervention, AI systems are designed to generate information and make decisions based on it. A knowledge base is a database containing facts, theories, and rules that intelligent machines can use to make decisions. Artificial intelligence starts with a lot of information from different sources when building a knowledge base. This information includes speech, text, images, content and results and is the life of information. In order to process and analyse enormous volumes of data, find patterns, and make predictions or judgements based on those patterns, artificial intelligence systems use algorithms and computational models (see figure). Therefore, data is the fuel that drives AI innovation and enables AI systems to mimic human intelligence. Whether in education, healthcare, finance or entertainment, data-driven

AI is transforming every industry and shaping the future. Without data, AI won't have the foundation it needs to work effectively. It is important to note that the quality of information is crucial in the field of artificial intelligence. AI systems pick up knowledge from the

data they are given, and if this data is biased or lacks diversity, it can result in biased decisions and conclusions. The adage "garbage in, garbage out" applies here; poor or biased data can make AI models ineffective, leading to biased decisions and inaccurate predictions.

Figure-1: Steps in the Design of an AI System



Artificial Intelligence in Education

Artificial intelligence has the potential to transform the way education is delivered. The power of AI is so great that it is going to redefine 21st century education. Some of the changes the world is going to witness in the education sector due to the introduction of AI are:

(i) **Personalized learning:** In the field of education, the concept of personalized or individualized learning is becoming increasingly popular and is recognized as the future of education. The traditional teacher-centric method of teaching, which is linear and like a 'one size fits all approach' to education, is slowly losing favour among students and educationists as this is not able to meet student's academic needs or fuel a passion for learning. An educational strategy known as "individualised learning" adjusts lessons to each student's unique requirements, abilities, and interests. Each student is unique, meaning they have different needs, understandings, learning abilities, and knowledge. Personalized learning focuses on transforming classroom instruction by customizing tasks, instructions, content,

and assessments to align with each student's unique needs and abilities (Bakhshi & Rarh, 2023). AI gathers and examines student performance data to provide educators with information to make informed decisions, identify gaps, and improve teaching strategies.

(ii) **Customized curriculum:** The first step in personalized learning is developing a personalized or individualized curriculum. AI can assist in curriculum development with the ability to tailor curriculum to the specific needs of each student. AI algorithms can develop personalized learning paths by analyzing student data, including learning preferences, strengths and weaknesses. Every student then can receive a study plan based on what they know and how they learn best. Personalized learning plans are a unique benefit that AI provides to every student.

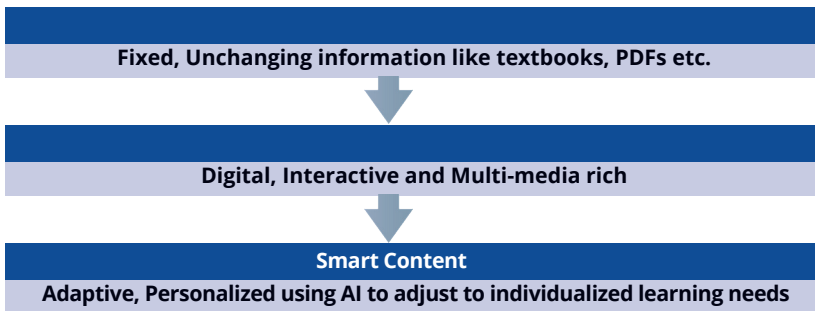
(iii) **Artificial intelligence teacher:** In the light of personalized curriculum, the next step toward personalized learning is personalized support that AI teachers can provide to each student. Visualize a classroom

where every student has a virtual AI mentor who is always ready to help. These intelligent learning systems use AI algorithms to analyze the strengths and weaknesses of individual students and personalize learning materials accordingly. Whether it is providing more explanation, more practice or more resources, AI tutors can provide personalized support to ensure that students learn at their own pace and reach their full potential.

- (iv) **Smart content:** Smart content refers to personalized content that is customized for each user, taking into account demographics, behaviour, and

engagement. Smart content can be activities, quizzes, lesson plans, etc. This content is dynamically updated based on who is viewing it. It is also called dynamic content, as opposed to the multimedia-rich static content that is the basis of e-learning and MOOCs. Smart content always produces better results than static content and is very useful in the context of personalized learning (Grace et al.,2020; Silvana & Fajar,2016). AI can help you create high-quality training materials that meet your learning goals, including interactive videos, quizzes, and simulations, and recommend resources appropriate for different needs.

Figure-2: Transition from Static Content to Smart Content



- (v) **Smart Classroom:** AI-based virtual classroom or smart classroom is a solution that bridges the gap between physical and remote learning. These virtual classrooms can foster collaboration among students by allowing them to work on group projects, engage in interactive discussions, and share ideas and feedback. This encourages collaboration, communication, and a sense of community among students. In smart classrooms, AI collects and analyzes large amounts of data about student

performance, engagement, and learning patterns. AI analyzes student data to provide personalized guidance, adaptive feedback and interventions to meet individual learning needs and improve performance. AI-powered virtual classrooms enable teachers to monitor student progress and pinpoint areas of difficulty, facilitating targeted support and resources to assist students in overcoming challenges and attaining academic success. By analyzing large amounts of data faster and more accurately, AI can help

you derive unique insights from data that would otherwise take weeks or months to process manually.

(vi) Intelligent Assessment System: Assessment and evaluation are key components of education systems, but they are time-consuming and inclined to human error. AI can easily simplify the assessment process and make it more accurate and efficient. Artificial intelligence tools like Gradescope, ZipGrade, and ClassPoint AI can be of excessive help in this regard. AI-based grading systems can analyze and grade student assignments, essays, and even open-ended questions. Using machine learning algorithms, these machines can identify patterns and provide students with consistent and reliable advice. This allows teachers to focus on personal instruction and support rather than spending too much time on grading.

(vii) Artificial intelligence-based supervision: Maintaining academic integrity during evaluation has grown in importance as online and remote learning develop. AI-based proctoring helps make online exam monitoring more efficient and scalable. AI can use facial recognition, eye tracking, and audio analytics to detect distrustful behavior and perceive plagiarism or AI-generated content to improve educational integrity.

(viii) Intelligent student support system: AI-based student support systems can provide students with 24/7 support to resolve issues and provide

timely assistance. By providing immediate support, AI-based student support systems promote student success and ease the burden on teachers. For example, chatbots can be integrated into educational platforms to answer common questions, advise on administrative procedures, and provide academic advice. These chatbots use natural language processing to understand student questions and respond with relevant information.

(ix) Natural Language Processing (NLP): Enabling machines to comprehend and interpret spoken and written language similarly to humans is the main goal of this branch of artificial intelligence. NLP integrates computer science, machine learning, deep learning, and linguistics to enable computers to analyse unstructured text or speech data and extract pertinent information from it (Khurana et al.,2023; Collobert et al,2011). It is a tool used to help machines understand, analyse, process and interpret human speech. NLP plays an important role in many applications, such as chatbots, virtual assistants, speech-to-text, machine translation, auto-correction, etc. NLP systems can convert text to speech and speech to text. The steps for this conversion are: (i) People talk to machines. (ii) The machine captures the sound. (iii) Audio is converted to text. (iv) text data processing; (v) the data is converted into sound; and finally (vi) the machine responds to the human by playing the audio file. Predictive typing and spell check features in search engines that help you by suggesting the next

word in a sentence when you type a keyword are examples of natural language processing (NLP). As an example, ChatGPT exemplifies natural language processing technology powered by artificial intelligence, enabling chatbots to engage in conversations that mimic human interaction and beyond. Language models are adept at answering questions and supporting tasks like drafting emails, essays, and coding.

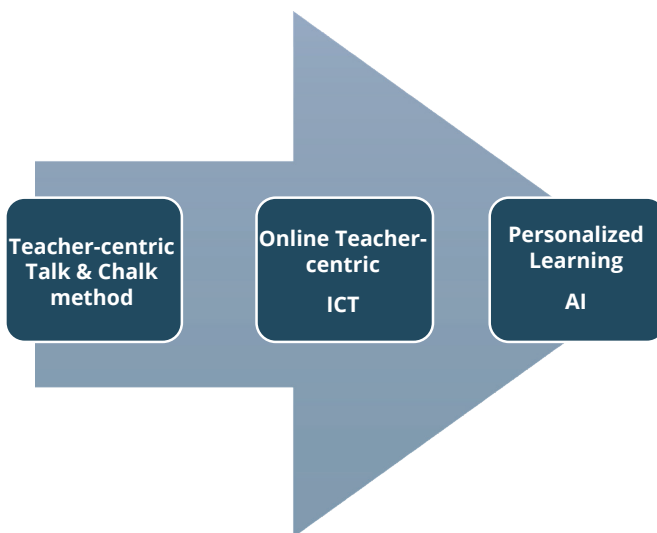
- (x) **Gamification and educational games:** Gamification is based on the theory that if learning is based on game concepts such as competition, incentives, and goal achievement, students will be more engaged in their learning and achieve greater academic success. A variety of e-learning games are available for both individuals and teams. Artificial intelligence can be integrated into learning games to provide personalized challenges, track progress and adapt gameplay to individual learning styles, enabling interactive and participatory learning processes.

- (xi) **Virtual laboratory:** AI can simulate experiments in virtual labs, letting students perform experiments in a safe and controlled environment. Virtual labs can provide hands-on experience in a variety of scientific fields, promoting a deeper understanding of concepts.

- (xii) **Interactive simulations:** AI-based interactive simulations can help students visualize complex scientific phenomena. These simulations can be used to make abstract ideas more concrete by demonstrating concepts in physics, chemistry, biology, and other sciences.

- (xiii) **Augmented Reality (AR) and Virtual Reality (VR):** By integrating AI with AR and VR technologies, immersive learning experiences in science education can be crafted. This allows students to engage with 3D models, embark on virtual tours, and interact with virtual objects, thereby deepening their grasp of intricate scientific concepts.

Figure-3: Evolution of Learning Process



Artificial Intelligence in Research

AI has become an essential part of research in various fields: right from using NLP for literature reviews to providing powerful tools and techniques to quickly analyze large data sets, discover patterns and gain insights through predictive models. Deep learning is used for image and pattern recognition tasks (Wu et al.,2011) in fields such as biology, astronomy, and medicine, where researchers must analyze and interpret complex visual data (Hu & Buehler,2023). AI speeds up the drug discovery process by analysing biological data to pinpoint potential drug candidates and forecast their effects (Jiménez-Lunaa et al.,2021; Chen et al.,2023). This approach can markedly decrease the time and cost accompanying developing new medicines compared to traditional, resource-intensive procedures such as wet laboratory testing, validation, and synthesis in drug discovery. Complex simulations and models to test hypotheses and predict outcomes can also be easily implemented using AI. AI is also used in climate modelling, satellite data analysis, and environmental monitoring. This helps researchers understand climate change (Huntingford et al.,2019; Cowls et al.,2023), predict natural disasters, and analyze the impact of human activities on ecosystems (Chen et al.,2023). For more than a decade, the authors of this manuscript have been using an AI technique called Genetic Algorithm (GA) (Goldberg,1989) in computational chemistry research, focusing on theoretical designing of low band gap electrically conducting polymers. While designing an in-silico polymer, there are several possible ways to arrange the homopolymer units to form a polymer chain having the desired physical and chemical properties. Consequently, generating polymer chains with tailor-made properties is highly challenging

and requires significant computational resources. To address this issue, our research group has explored the use of metaheuristic optimization and search methods to streamline the process. GA is one such widely used technique in science and technology that has also proven to be very useful in solving optimization problems (Arora & Bakhshi,2010; Arora & Bakhshi,2011; Kapoor & Bakhshi,2013). The authors have been able to successfully calculate and predict the theoretical properties of various binary and ternary conducting polymers, donor-acceptor type copolymers and biopolymers. AI is proving to be a very useful tool in making calculations faster, more accurate and computationally less expensive.

(i) Disadvantages of AI

Despite its significant benefits, AI technology also presents numerous risks and potential dangers that warrant consideration.

(ii) Job Replacement

AI's capability to automate processes, rapidly generate content, and operate continuously may result in human job displacement. In fact, many jobs, including those that are repetitive or predictable and those that require critical thinking, critical analysis, research-based, or specialized skills, will be at risk due to AI, automation, and robotics. In this regard, traditional positions of data entry clerks, secretaries, accountants, mechanics, and machine repairmen could be replaced by experts specializing in data analytics, AI, machine learning, big data, and digital transformation.

(iii) Privacy Concerns

Data gathered and stored by AI systems might be processed without user consent or awareness and could be

accessed by unauthorized individuals in the event of a data breach.

(iv) Ethical issues

The development of AI systems often lacks transparency, inclusivity, and sustainability, potentially leading to unexplained harmful decisions by AI and negative consequences for users and businesses.

(v) Environmental costs

Deploying large-scale AI systems could necessitate substantial energy consumption for data processing, potentially leading to heightened carbon emissions and water usage.

High Cost of AI Implementation

AI requires appropriate infrastructure and resources to operate effectively and efficiently. This includes a reliable internet connection, hardware devices, software platforms, data sources, and human expertise. However, many educational institutions lack these prerequisites, which can widen the digital divide and worsen educational inequalities.

Other negative consequences of AI in education

Despite the tremendous changes that AI will bring to education, there are some negative consequences of integrating AI into education. These include (a) Lack of human interaction due to over-reliance on technology, (b) AI reduces students' reflective and critical thinking skills, negatively affecting their creativity, (c) AI may pose a threat to teachers' job security, (d) AI adoption is costly, (e) Lack of emotional intelligence, (f) Problem of accessibility and equity, and (g) Need to train teachers in the use of AI.

Conclusion

Artificial intelligence is changing the way we learn, teach, and research. With the ability to personalize learning, deliver personalized curriculum, automate various administrative tasks, deliver smart educational content, create virtual teachers and smart classrooms and more, AI will shape an exciting future for education. Nevertheless, it is crucial to confront ethical, environmental, and privacy considerations, ensuring that education remains a guiding light of opportunity and advancement in a constantly evolving world.

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