



Review Article

The Evolving Role of Artificial Intelligence in the Future of Distance Learning: Exploring the Next Frontier

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Abstract

In recent years, education has become especially related to the applications provided by artificial intelligence technology through a digital environment that includes a set of tools that assist in processing and storing information. Artificial intelligence techniques contribute to the development of students' skills by providing them with advanced scientific content and building their mental capabilities faster. Moreover, these techniques support analysing student data and suggest suitable educational materials and activities for them. Artificial intelligence is a noteworthy tool for the growth of distance education, especially after the development of expert systems that have become a human advisor in many domains, as this leads to the development of education systems that adjust the level of difficulty of materials based on the student's performance in the electronic classroom, which ensures that the student continues in education and is not frustrated. This article will review the influential role of artificial intelligence applications in growing distance learning, improving the quality of education, and making it an adaptable and practical environment for students.

1. Introduction

Since the sixties of the twentieth century, artificial intelligence has started to spread in many areas to serve and support human activities and grow their skills and capabilities. Artificial intelligence techniques are characterized by their superior ability to analyse extensive data, make predictions, give results, and help create more informed decisions [1-3]. Artificial intelligence can automate specific repetitive assignments and process data, saving time and human resources, giving acceptable effects, and creating a great work environment [4-6]. Artificial intelligence has shifted from a supplemental tool to a practical one that contributes to the growth of many domains, including health and education [7-9]. These techniques assist humans in tasks that require a high degree of accuracy, such as manufacturing and product quality control [10][11]. For instance, robots and AI-powered machines can achieve highly dangerous jobs, such as working in hazardous environments or handling toxic materials. Artificial intelligence has entered the development of education and completed a suitable electronic environment for learners by relying on information technology, increasing human capabilities, and enhancing efficiency and productivity in growing a distance learning environment. In an article published in the Washington Post in 2018 by Vivek Wadhwa [12], he described the future of education as a virtual future. In addition, MOOCs were supposed to revolutionize the world of education. Still, this method did not meet expectations, as it put teachers in front of cameras and videotaping - just as the first TV programs did with radio stars and the microphone. But this is about to change through the use of virtual reality and artificial intelligence technologies. Artificial intelligence techniques contribute to increasing human capabilities; that is, it is a tool that helps accomplish many assignments and improves efficiency and productivity [13][14]. In other words, these techniques cannot replace humans; instead, they are a tool that allows people to develop their skills and enhance their performance at work.

Recently, reliance on artificial intelligence techniques has grown in developing the distance learning environment while exploiting the growth of the Internet and designing new technologies that contribute to developing students' skills and allowing them to access lectures and training courses via the Internet anywhere in the world through artificial intelligence [15][16]. Distance learning (e-learning or virtual learning) has many advantages for students and learners, as it allows them to learn at their own pace and according to their schedule. This flexibility is especially valuable for students who work full-time or have other duties that make it difficult to attend traditional classes [17][18]. Moreover, it allows students to access

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a wide range of resources and tools that are not open to them in the traditional classroom, for instance, Google Apps and Open AI. Many online training courses and lectures include interactive simulations and virtual laboratories that help students and learners acquire a more in-depth understanding of academic subjects and enable them to understand complex subjects quickly and simply [19][20]. Distance learning seeks to develop students' abilities by learning from trainers or teachers who are experts in the domain of utilizing artificial intelligence techniques. This means that students can access high-quality education and acquire new concepts from experts, regardless of their geographical location. Distance learning based on artificial intelligence techniques is vital in developing the learners' capabilities and skills that they need to achieve success. In the year 2023, the world witnessed the use of vital platforms in developing their skills and accomplishing more work, the most famous of which is ChatGPT, DALL-E, as these platforms contribute to research, writing, access to new information, solving mathematical equations, and writing code [21-25]. The COVID-19 pandemic is the basis that contributed to accelerating and forcing all academic institutions to employ distance learning and technological means in giving scientific materials to students and learners [26][27]. That is, artificial intelligence imposed itself as an aid in providing scientific material and improving learning efficiency.

The main contribution of this article is to catch the practical role of artificial intelligence techniques in the development of distance learning and how to benefit from the benefits of these techniques. In addition, the most necessary branches of artificial intelligence and its applications will be reported, as well as the importance of the fourth industrial revolution in distance learning.

2. The 4IR in Distance Learning

Distance learning is an educational experience and an academic concept that describes the relationships between the teacher and the learner in a non-traditional learning environment in which teachers and learners are separated in space, time, or both. This education method depends directly on modern communication technologies to deliver educational resources to students and learners, with the possibility of scientific material available to all. Thus, the more developed and easier-to-use the means of communication and multimedia, the more significant the matter and desire for this learning. The Fourth Industrial Revolution (4IR) refers to the current era of technology and progress in the domain of electronic device manufacturing and the development of artificial intelligence methods [28][29], robotics [30], the Internet of Things (IoT) [31][32], and communication technologies between devices (see Figure 1). The 4IR has the ability to change the way scientific material is delivered to learners through several strategies, including adaptive education, which utilizes machine learning algorithms to create an educational experience for each student individually and provide the necessary support to explain complex issues and provide appropriate responses to any question requested by the student [33][34].



Fig. 1. Fourth Industrial Revolution (4IR) domains [38].

Education through virtual reality and augmented reality, where educational content is created that simulates instruction in the real world, and this is very significant for engineering and medical students. In addition, artificial intelligence provides chatbots and virtual assistants that respond to all questions of students and learners and provide customized instructions

and education [35-37]. That is, computers can now build human-sounding written language and convert descriptive phrases into realistic images, text, code, and mathematical equations. Artificial intelligence can analyse student data and provide statistics on their knowledge of the material and scientific content and provide a detailed report to teachers. That is, artificial intelligence will be a colleague of man in accomplishing many works and helping him in developing his skills and capabilities. Also, smartphones and tablets increasingly contribute to education, as they have a set of applications that allow students to access study materials and participate in online discussions from anywhere and at any time.

Virtual reality can create distance education more accessible to students and learners who cannot access classrooms in real life. Thus, this reality provides opportunities for students to benefit from education and not leave their studies. Moreover, this reality contributes to the creation of immersive and interactive learning experiences for students, as it can transport students to different locations and environments, allowing them to explore and learn in a way that is available to them, similar to the traditional reality. For instance, students can see historical sites, natural wonders, or even other planets in the solar system and interact with them more practically and effectively. Therefore, students will have the chance to gain scientific experience and practice problem-solving skills by placing students in virtual environments where they can practice speaking and listening skills with translation to assist them in understanding other languages. Virtual reality provides experiences to teach a specific language with the possibility of saying it with a robot or any person in the same environment. High security is available in the virtual environment, intrusion prevention is subject to supervision by individuals specializing in cybersecurity, and unauthorized persons are not allowed to enter and interact with these systems [39][40]. Virtual reality provides access to learning material for students with special needs and provides all the requirements they need. Online learning platforms and virtual classrooms can facilitate collaboration and communication between students and teachers worldwide. This can lead to a more diverse and universal learning experience. For example, there are many methods of using artificial intelligence technologies and the Internet of Things that allow distance learning more flexibility in terms of when and where students can learn and acquire new skills. In short, the 4IR has the potential to make distance learning more personalized, attractive, and effective, and sharing of learning material among students and learners. As these technologies continue to evolve, we expect to see more innovative educational practices in the coming years.

3. Artificial Intelligence Techniques

Artificial intelligence is one of the sciences that resulted from the contemporary technological revolution. This science began in 1956 at a conference at Dartmouth College in the US, organized by a group of researchers to put forward the idea of artificial intelligence, which initially aimed to simulate the human mind by means of machines by analysing the mechanisms of collecting and processing information. This conference was organized by John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon, who are now considered pioneers of artificial intelligence. Researchers in various domains, including mathematics, computer science, psychology, and a group of engineers, were attending to examine the possibility of creating machines that work like the human mind by setting a set of mechanisms for the work of these machines. During the conference sessions, the researchers suggested that the primary goal of artificial intelligence science is to create machines that can work in a manner similar to the human mind in gathering and analysing information through the growth of algorithms and computer programs that have the ability to solve all issues, learn and process natural language. The Dartmouth Conference in 1956 is the foundation on which the idea of artificial intelligence was built, which helped launch new and significant domains in the development of scientific research and the service of humanity. Figure 2 illustrates the organizers of this conference and a proposal document for the Dartmouth summer research project on artificial intelligence.

Artificial intelligence is a complete description of all computers capable of performing tasks that require human intelligence in processing information, extracting outcomes and features, making decisions, and solving issues [41-43]. Recent years have witnessed a vast and significant development in artificial intelligence technologies and a large public demand for the use of these techniques, especially in the domain of healthcare, education, and many others. Artificial intelligence seeks to design algorithms and computer programs to load large amounts of data. Machine learning is one of the most important components of artificial intelligence [44-46]. It contains teaching computer systems and improves their performance through a set of algorithms that can recognize patterns in data, modify its behavior, and take advantage of its benefits. As for neural networks, which are modeled on the structure of the human brain, they are a famous approach to machine learning and one of the most popular artificial intelligence techniques. Natural language processing (NLP) is one of the main aspects of artificial intelligence techniques [47][48]. It involves teaching computers to comprehend and interpret human written and spoken language and to translate any language into a language humans understand. NLP can be used to create chatbots and virtual assistants that can naturally communicate with humans as if they were normal humans while analysing large amounts of text and generating extensive sentences as required. One of the critical techniques in artificial intelligence is computer vision, which is an essential part as it includes interpreting and understanding visual information, such as

interpreting images and video clips. This technology is being used in self-driving vehicles (autonomous vehicles), facial recognition, and object detection, such as car numbers, pedestrians, bicycles, traffic lights and road signs. The most significant techniques of artificial intelligence are artificial neural networks that try to model the way the human brain works in gathering and analysing information and extracting results in order to recognize patterns, make predictions and make decisions. Neural networks consist of linked nodes (neurons) organized in layers within a specific structure (see Figure 3). Each neuron in the network receives one or more inputs. After that, the processing stage occurs, and the output is produced and passed on to other neurons. Artificial neural networks are trained using a process called backpropagation where the weights of connections between neurons are adjusted in response to errors in the network's output. This process is employed to study data behaviors and identify new patterns to make predictions, for instance, making predictions to discover new patterns in detecting and controlling electronic attacks and not allowing attackers to enter the operating system machine.



Fig. 2. Left: Marvin Minsky, Claude Shannon, Ray Solomonoff and other scientists at the Dartmouth Summer Research Project on Artificial Intelligence (Photo: Margaret Minsky). Right: A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence (1955) [49].

Artificial intelligence is applied in many domains, including health care. It can benefit from its capabilities in data analysis, assisting in diagnosing diseases and monitoring the patient’s condition. Also, in cybersecurity, it contributes to detecting malicious programs, analysing risks, and not allowing unauthorized persons to enter the system [50-54]. Artificial intelligence has a significant role in developing teaching methods, especially distance learning, developing teachers' expertise and improving their performance in giving scientific material. Artificial intelligence has the potential to revolutionize many aspects of our lives and help us accomplish many tasks and save time and effort. However, there is another undesirable aspect of the idea of the existence of artificial intelligence, which is the idea that it may replace many jobs and dispense with humans, as well as privacy, security, and bias in artificial intelligence systems.

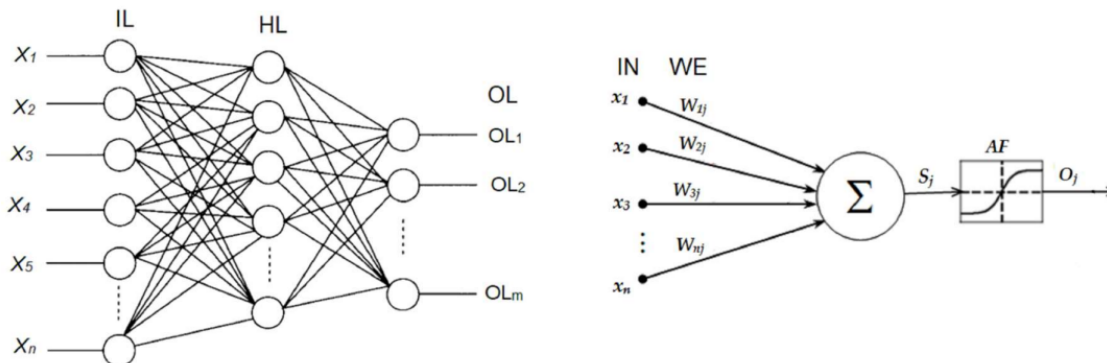


Fig. 3. The structure of the artificial neural network [55].

4. The Applications

This section will discuss the role of artificial intelligence techniques in growing and improving distance learning. These techniques can be employed as tools to process and store information and help distance learning to share scientific material among learners correctly and understandably, with the possibility of discussing lectures between learners and teachers. Artificial intelligence techniques supply simulations that provide interactive and engaging learning experiences for learners to create virtual laboratories where students can conduct experiments in a safe and controlled environment. This tool makes it more comfortable for students who do not have any access to physical laboratories to conduct experiments. Moreover, this tool allows the creation of a virtual reality that enables students to learn through practice. For instance, engineers can create virtual cities and learn about urban planning and design for cities or buildings. This tool allows students to develop customized learning experiences based on their individual learning styles and analyse their data to build the needed experiences. Furthermore, the simulation provides presentation chatbots that can provide instructions and feedback to facilitate the virtual environment for students. Simulation programs are used in learning in the subjects of chemistry, physics, piloting aircraft, performing surgeries, the pharmaceutical industry, and many others. Learners carry out experiments and different solutions as if they were in a natural laboratory while accepting mistakes, making corrections, and repeating experiments quickly, making education more stable and fun and supporting students to imagine issues and propose solutions.

In expert systems, the computer simulates human intelligence, where the computer is programmed to perform the tasks that a person acts in a normal situation that require a kind of intelligence, and the computer, in this case, gives advice and directions that support the process of progress in education. In addition, it helps lecturers evaluate assignments and research. This tool is critical in distance learning because it provides feedback and support to students. Expert systems can be operated to assess the strengths and weaknesses of learners in the classroom, analyse their performance, identify areas in which they need improvement, and grow their skills in exams. Moreover, these systems provide adaptive learning experiences for learners by analysing the learner's performance, adjusting the difficulty level of the content level, and providing all the requirements for creating distinguished scientific content. These systems are distinguished by providing a set of noteworthy notes for learners to help them identify the areas they need, improve their understanding of the material, and suggest effective practices to achieve more satisfactory results. Also, these systems act as virtual teachers and enjoyably present an excellent scientific curriculum, providing answers to questions with explanations and examples to help learners understand the scientific material. These systems provide students or learners with access to all the resources available to them such as books, videos, educational programs, and scientific articles. These systems seek to analyse learner data to gain insights into the learning process and suggest a set of mechanisms and practices to enhance learners' performance.

Artificial intelligence techniques support learners' process and retain information more virtually and grow the performance of learners who do not have time to attend traditional lessons. Indeed, these methods have high worth in developing distance learning platforms and making them more flexible and comfortable to enable all learners to succeed, excel and gain an advanced learning experience. These techniques contribute to self-discipline, time management, motivation, ability to work independently, and communication among learners. These techniques contribute to the development of knowledgeable learners by providing a flexible and self-paced learning environment, developing their individual abilities in various sciences, and motivating them to build their scientific capabilities and benefit from them in multiple domains. Artificial intelligence will be the future that provides a set of scientific materials, training courses and strategies designed to track learners' interests to grow their skills and knowledge in related fields. These techniques are practical for distance learning but are only one of the factors determining success. Teachers should have a significant role in developing students' or learners' skills and developing the skills needed to thrive in a self-directed learning environment.

5. Conclusions

Distance learning is no longer an option in our time but rather a strategic matter complementary to human formation and building a future. It is considered one of the most significant tools that help enhance the skills of the student and the learner in light of the growing knowledge explosion. Distance learning is characterized by the use of artificial intelligence techniques and applications as factors that contribute to the growth of learner skills and the acquisition of complete knowledge. The future is heading towards new education and methods that differ significantly from a traditional, classical education by utilizing artificial intelligence techniques in disseminating scientific material among learners. Artificial intelligence techniques have been able to reduce the lack of distance learning in the interactive feature between the teacher and the student, especially the difficulties that electronic platforms create. Although they provide students with information and knowledge, they make them receive the scientific material without thinking, analysing, and/or consulting. In addition, these platforms need to include the features of gradation in education and consider the variation and disparity in intelligence and the level of students in benefiting from the scientific material. Artificial intelligence techniques can play the role of a

human expert through a set of smart programs that can sort students according to their academic and knowledge levels. These techniques contribute to assisting teachers in evaluating students' performance in the online classroom, identifying their strengths and weaknesses, and giving them meaningful notes. In the future, more studies will be conducted on the practices of artificial intelligence techniques in distance learning and a review of the developments of these techniques and their role in disseminating scientific content.

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Conflict of interest

The authors declare that they have no conflicts of interest related to this study. All authors have disclosed any financial or personal relationships with organizations or individuals that could potentially bias this work.

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