The Effective Role of Artificial Intelligence and Machine Learning in Early Childhood Education Process

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Abstract:

Instructional technology plays an important (unique) role in modern education because it provides learning experiences for students to improve their education. The modern trend is the incorporation of educational technology, especially computers, for the education of preschool children. This fact creates the need to study the development and application of methodologies geared to young children. This is done by integrating artificial intelligence (AI), machine learning (ML) methods into educational technology resources.

This paper aims at how to apply AI and ML in the education of preschool children to meet their specific learning needs. Discuss computational learning systems that integrate intelligent methods, and learning robots geared to early childhood providing the infrastructure for activities that cannot be carried out by non-technological means, that focus on children and learning in accordance with their development.

Key Words: Educational technology, adaptive media systems in early childhood education, artificial intelligence (AI), and machine learning (ML).

1. Introduction

Artificial intelligence (AI) is intelligence demonstrated by machines. AI has developed rapidly as a lot of money has been invested to promote the development of AI in the fields of scientific research, education and other fields [1]. Instructional technology is one area of interest for AI. Educational technology includes the technological resources and methodologies used in education to meet specific educational needs [2], [3]. Instructional technology focuses on the latest resources to provide advantages to students and educators over methods that do not use technology [4]. The integration of educational technology may help provide the infrastructure for activities that cannot be carried out by traditional means or address specific educational problems [5]. The use of educational technology may provide students with motivation to learn so that their attention is captured and encouraged to participate in creative activities [6]. As well as incorporating unique features into the educational environment such as multimedia-based interaction and visualization of the problem-solving [7]. Technology also supports pedagogical

methods such as collaborative learning and linking schools with their community [8]. Interactive whiteboards and programmable games along with computers, game consoles, and robots are common tools in early childhood education [9]. AI methods have been applied in computer-based learning in order to provide enhanced learning experiences [10]. The quality of education in preschool that is called early childhood is critical for children and their families, and also for civilized societies facing growing social divisions that can be mitigated through the impact of AI [11].

This paper is organized as follows: Section 2 covers a background on the role of early childhood education technology. Section 3 presents a brief overview about bbenefits of Artificial Intelligence (AI) and Machine Learning (ML) for Students, School and Teacher. Section 4 presents the role of AI as an approach to integrating robotics into early childhood education, Section 5 discusses teaching methods, curricula, and adaptive media systems based on the use of AI and ML in early childhood education. Section 6 presents the results education. The last section concludes and illustrates the future work.

2- The role of educational technology in early childhood:

Technology plays an important role in the field of education, especially in early childhood education, as this field contains technological resources and methodologies used in education, Accordingly AI and ML methods have been applied in the field of educational technology to meet educational needs, as it focuses on the latest resources to provide students and teachers with the required educational needs [12]. Instructional technology can be integrated into the educational environment given the issues that need to be dealt with in a particular class of students. Technology can help in dealing with certain educational problems, as it provides the infrastructure for activities that are difficult to implement by non-technological means. And one of the reasons that called for the use of educational technology is that it may provide students with motivation to learn as it works to attract their attention and encourage them to participate in creative activities [13]. It is possible to integrate unique features into the educational environment using technology such as multimedia-based interaction and problem-solving process. Also, educational technology supports educational approaches such as collaborative learning and constructivism, acquaints students with the resources and principles necessary for the information society, and provides the necessary means to link schools with their communities [14].

Since computer-based learning is an important aspect of educational technology, computers have been used in education since the 1950s because they can be exploited in multiple ways by students and teachers working in groups or individually. However, educational technology involves a mixture of resources besides computers and is based in early childhood education. The common types of technology resources used in education at this stage are computers, programmable games, game consoles, interactive whiteboards, and robots [15].

3-A Brief Overview about Benefits of AI and ML for Students, School and Teacher:

Artificial intelligence (AI) and machine learning (ML) play an important role in early childhood education as they have several benefits, including:

(1) AI and ML were used to automate tasks, because teachers do not only teach. They spend a lot of time evaluating homework, marking exams, recording papers, preparing lectures, managing educational materials, etc., and this exhausts them. AI will automate these tasks to have more time to do their primary work of teaching [16].

(2) AI and ML can ensure that educational programs are customized for individuals. There are already programs, games, and adaptive learning programs for students. This emphasizes the needs of each student [17].

(3) AI and ML can help teachers create different types of smart content that makes teaching and learning more convenient for the teacher and students [18].

(4) Information visualization, where web-based study, simulation and visualization environments are different ways of perceiving information that AI can run [19].

(5) Learning content can be created and updated regularly using AI and ML [20].

(6) Teacher education, using AI, where teachers get comprehensive information available to them and they will have a deeper and broader knowledge base than before [21].

(7) Identify weaknesses. AI will be able to identify when some students miss specific questions, by alerting teachers to re-teach the material for students to understand [22].

(8) Helping both teachers and students to acquire any subject at any time of the day using AI robots [23]. As shown in the figure 1.
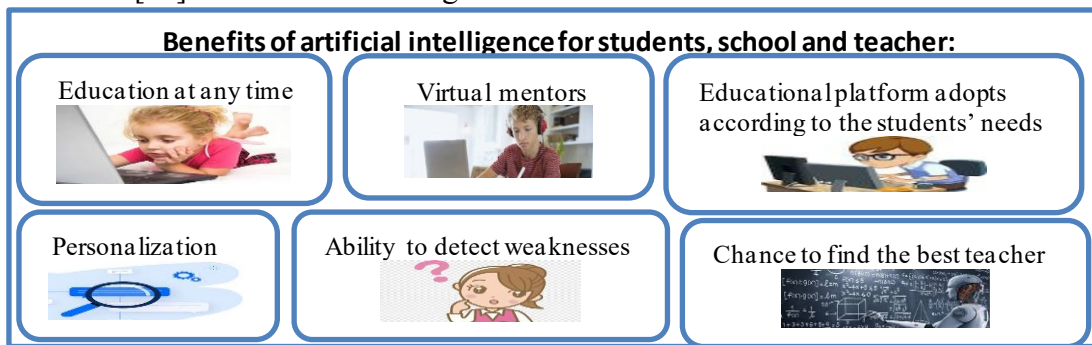

Figure 1: Benefits of artificial intelligence for students, school and teacher:

4- The Role of Artificial Intelligence as an Approach to Integrating Robotics into Early Childhood Education:

Artificial intelligence has played an important role as an approach to integrating robotics into early childhood education, as it helps bridge social gaps, especially for pre-kindergarten children, Robots can present math, science and technology concepts in a playful way that encourages them to get excited about further exploration in these sciences, Scientific experiments have proven that young children are curious to know the world around them, so early childhood is a good time to spark children's interest in programming and robotics [24].

Teaching and integrating robotics into education is a very easy process, using practical and screens-free tools like KIBO. This educational robot (KIBO) attracts tech-savvy children, who have interests in physical activities, arts and culture. KIBO can bring life to any topic as it can integrate itself into the curriculum and many disciplines such as science, mathematics, social studies, natural sciences, literacy, storytelling, arts, music, dance, and crafts. KIBO also allows children to fly with their imaginations in the sky, all without having to spend time in front of smartphones or computers.The AI-powered BeanQ robot is considered to be an early educator, to provide continuous stimulation to children using AI, BeanQ creates a detailed profile of the child through their daily interactions allowing parents to analyze their children's development [25], [26].

RoBoHon is another AI-powered robot that has the ability to learn. It was used on children with autism in a hospital in China, and it succeeded in dealing with them, especially towards the hyperactivity and repetition that these children show. Bosco is a mobile application that also uses AI to predict and prevent digital threats to individual children online. This helps parents monitor their children's digital usage and guide them around any red flags, without compromising their freedom or privacy. The use of robots also helps early learners become engineers, programmers, designers, writers, and artists [27], [28].

5- Discussions

Recent research indicates that a child's early years are formative years, as a child is born with about 100 billion neurons, and that the brain produces connections between these neurons [29]. By age three, it is twice as much as it was at birth, and they are produced at a faster rate than at any other time in life. Also, the strongest predictor of a child's future academic success is responsive relationships in the first three years of life [30].

In this stage (early childhood), we find that game-based learning plays an important role because it matches the children's tendencies and promotes cooperation between them. Therefore, early childhood education should include both early childhood curricula such as language, arts, mathematics, science, special education, and teacher-directed activities for students. Hence, the use of AI and ML in education at this stage plays an important role as it covers a variety of resources such as computers, digital photo cameras, games, robots, and various types of software. In addition to making it possible to record data related to children, which contain the opinions of students, parents and teachers. Data on child labor can be saved on the interactive board because it is very popular with children because it forms interactive screens that facilitate cooperative work for young children through the use of fingers and gestures, and this is a source of happiness for them. The robots also record homework and activities. There is another set of software tools available for this stage. These tools are based on multimedia and web-based activities and can also use virtual learning environments.

Modern education tends to use intelligent educational systems (IES), which are e-learning systems tailored to the needs of the learner, with the aim of guiding him to reach the appropriate educational activities to achieve his goals. This is done by integrating AI and ML methods used to learn the characteristics of the learner in the field of teaching children. The most common types of IESs are: Intelligent Learning Systems (ITS) and Adaptive Hypermedia Learning Systems (AEHSs) using intelligent methods. We find that smart teaching systems take into account the characteristics of the learner, such as the level of knowledge, intelligent transportation systems focus on AI technologies. Therefore, these systems are able to perform teaching tasks such as selecting and sequencing learning items, and deciding when and how help is needed. As for the adaptive educational hypermedia systems, they were developed to work on web environments, due to the possibility of direct navigation to the educational pages compatible with the student.

Many web-based smart learning systems combine Intelligent Transportation Systems (ITS) technologies and Adaptive Hypermedia Learning Systems (AEHS) to deliver more effective learning activities. There is an urgent need for a combination of AI and ML methods to achieve all tasks such as: structural and relational schemas and rule-based reasoning used in educational tasks, Genetic algorithms are also used in offline tasks related to optimizing system units, in online tasks such as sequencing learning content elements, Structural and relational diagrams are also used to represent structural and relational knowledge which are useful for representing domain knowledge. IES Early Childhood content should be based on multimedia rather than text such as images, sounds, animation, or video.

6- Results

Studies and experiments were conducted on children in early childhood from 1995 to 2021 in the United States of America, Greece, the United Kingdom, Australia, Finland and Austria. Along with four other studies in Asia regarding AI teaching tools, activities, knowledge and impacts on learning and teaching in the field of ECE (early childhood education). These studies and experiments used interviews; observations, evaluations, and then questionnaires.The results of these experiments were conducted on children were that there are two ways to integrate AI into ECE. The first way is that the Internet of Games, and smart, networked games, provides an age-appropriate solution to enhance young children's learning and development. The second way is, an Intelligent Teaching System (ITS), and AI-enabled e-learning systems, can provide a supportive learning space for children. According to a study presented at the 2013 International Conference on Human Robotics, robotic teachers can enhance exam results when they interact with students via embedded social interactions. In another study conducted by (Williams, Park, & Breazeal, 2019) on smart education for children, they indicated that the Internet and smart games enhance the learning and development of young children. Jin (2019a)

also found in his study that the application of the AI teaching system and the application of the assessment of the AI system are appropriate for children. In another study (Nan, 2020) has designed AI teaching platforms to improved children's learning enthusiasm. As indicated (Kewalramani et al., 2021) in a study he conducted that learning AI and inquiry skills enhance the learning process of young children.

These results also prove that AI and ML can significantly improve early childhood teaching and learning, and can also positively influence the learning of young children, and facilitate teacher training and teaching. The combined effect has the potential to create a competitive advantage for children, build new capabilities, increase the quality of education, make better and faster decisions, take advantage of massive amounts of data and analytics, and use advanced knowledge-based educational systems to enhance the educational process of children.

While the experiments and studies are conducted on early childhood children in traditional schools in some developing countries confirmed that the traditional curricula center on the subject and not on the child or life. In a study by Elkind (1988), Katz (1987), Zigler (1986), and representatives of the National Association for the Education of Young Children (1986) they indicated that there should be no excessively structured formal education of young children and they made major objections to school programs. Where these programs are, they will inevitably adopt formal teaching methods that are developmentally inappropriate for young children. Herman (1984) and Puleo (1988) research on public school programs for young black children in America indicates that these children need comprehensive programs that include social services and participation, as well as non-formal approaches and methods. And also note that the extra hours of a long day are stressful for young children, and do not improve program quality.

One of the most important results are that the traditional education system does not maintain a balance of theoretical and practical learning, as it lacks the practical aspect in educating children. It also paralyzes the creative and critical thinking of children, because it lacks child-centered learning, lacks focus on larger concepts or structures, lacks educational process-oriented learning, and it lacks focus on critical thinking. Figure 2 shows the effect of traditional education and smart education on early childhood stage.
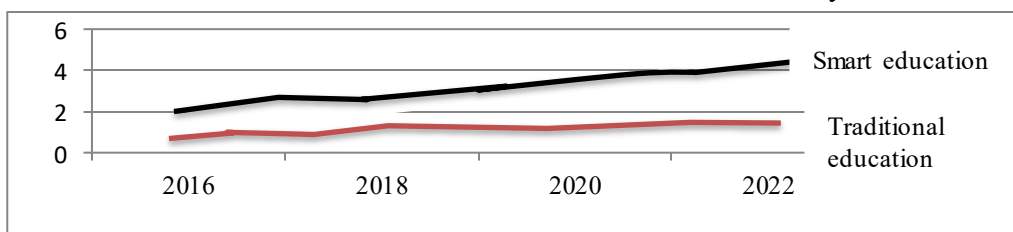

Figure 2: The average impact of education on early childhood

7- Conclusions and Future Work

Global trends are now looking to use more technology in various fields. This is due to the emergence of AI, which has become an advantage for the education sector. AI helps teachers advance their work and better influence students. It also allows educators to create scholarly content that suits their students, providing them with all the information they need, while ensuring personalized learning. The use of modern educational aids based on AI, including robots, has become one of the most important tools used in the education of young children. When combined with AI and ML in the educational process, the combined effect has the potential to create a competitive advantage for children, build new capabilities, increase the quality of education, make better and faster decisions, and benefit from vast amounts of data and analytics. Many new applications and research fields of interest to both the teacher and the child will develop covering knowledge-based systems to enhance the educational process of children. But most developing countries have refrained from implementing AI, ML and using robots due to the high costs.

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