دور تطبيقات الذكاء الاصطناعي في تعزيز الاستراتيجيات التعليمية في التعليم المدرسي (مراجعة الأدبيات)

The Role of Artificial Intelligence Applications in Enhancing Educational Strategies in School Education (A Literature Review)

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الملخص:

يتزايد دور الذكاء الاصطناعي في التعليم بسرعة، كما تنتشر المراجعات والتحليلات الوصفية في الأدبيات التربوية حول هذا الموضوع. وهدفت الدراسة إلى مراجعة الأدبيات المتعلقة بدور تطبيقات الذكاء الاصطناعي في تعزيز الاستراتيجيات التعليمية في التعليم المدرسي. وقد تم تحليل 30 مقالا منشورا، لتحديد الأدوار المنوطة بالذكاء الاصطناعي فيما يتعلق بالمتعلمين، والمعلمين، والمعرفة، والبيئة الصفية عمومًا، مثل: دعم التحفيز أو تقديم تغذية راجعة مخصصة، بهدف تعزيز العملية التعليمية في التعليم المدرسي. تشير النتائج إلى وجود تداخل كبير بين دور المعلمين وما يتم تطوير الذكاء الاصطناعي لتحقيقه في مجال AIED. وعلى الرغم من أن أتمتة دور المعلمين بشكل كامل قد تبدو غير ممكنة في المستقبل المنظور، إلا أن طموح الأبحاث في هذا المجال يسير نحو أتمتة عدد متزايد من أدوار المعلمين. واعتمدت الدراسة على منهجية المراجعة المنهجية، من خلال تحليل المحتوى لعدد من الدراسات السابقة (30 دراسة) التي تناولت توظيف الذكاء الاصطناعي في تعزيز الاستراتيجيات التعليمية في التعليم المدرسي، والتحديات المرتبطة بذلك. وتوصلت الدراسة إلى عدد من النتائج، من أبرزها: مساهمة تطبيقات الذكاء الاصطناعي في تعزيز دور المعلمين وجعله أكثر شمولا وتكاملا، كما تساعد على إثارة دافعية الطلبة، وتحفيزهم على استمرارية التعلم، وتوظيف استراتيجيات التعليم المختلفة بفعالية وكفاءة، وتُسهم في رقمنة المناهج وتوفير تعليم افتراضي ملائم لمستويات الطلبة كافة، كما تمكن من الكشف عن جوانب القوة والضعف لدى الطلبة، مما يسمح بتقديم التوجيه المناسب لقدرات كل طالب، وبالتالي تنمية مهاراتهم المتنوعة.

الكلمات المفتاحية: الذكاء الاصطناعي، التعليم المدرسي، تطبيقات الذكاء الاصطناعي، الاستراتيجيات التعليمية، الذكاء الاصطناعي في التعليم.

Abstract:

The role of artificial intelligence (AI) in education is rapidly expanding, and reviews are descriptive analysis are alsom increasingly prevalent in the educational literarture. The study aims to review existing literature on the role of artificial intelligence (AI) applications in enhancing instructional strategies in school education. A total of 30 published articles were analyzed to identify the roles assigned to artificial intelligence (AI) in relation to learners, teachers, knowledge, and the classroom environment as a whole—such as supporting motivation or providing personalized feedback—with the goal of improving the educational process in school settings. The findings reveal a significant overlap between teachers' roles and what artificial intelligence (AI) is being developed to achieve within the field of AIED. Although fully automating teachers' roles may not be feasible in the foreseeable future, the ambition of research in this area appears to be the automation of an increasing number of educational functions traditionally performed by teachers. A systematic review approach was adopted, using content analysis of 30 prior studies focused on the employment of AI in enhancing educational strategies in school education, as well as the challenges associated with this enhancement. The study reached several key findings, most notably of which are: 1. The contribution AI applications contribute to enhancing and expanding the teacher's role, making it more comprehensive and integrated. 2. They also help stimulate students' motivation, encourage continued learning. 3. They employment the effective and efficient use of various teaching strategies. 4. Moreover, contribute to curriculum digitization and provide appropriate virtual learning for students of all levels. 5. AI also enables the identification of students' strengths and weaknesses, thus allowing for personalized guidance tailored to each learner's capabilities, which in turn fosters the development of various student's skills.

Keywords: Artificial Intelligence, School Education, AI Applications, Educational Strategies, Artificial Intelligence in Education (AIED).

Introduction:

Educational systems around the world are continuously striving to reform and develop their programs and strategies in order to keep pace with the rapid and continuous global transformations across various fields—particularly those brought about by the Fourth Industrial Revolution and its scientific and technological impacts. In response, these systems have begun integrating artificial intelligence (AI) technologies and investing them across various educational activities to serve their purposes their functions with greater speed, accuracy, quality, and distinction. This is especially evident in teaching and learning in schools, along with the advanced instructional strategies and methods associated with them.

The term *Artificial Intelligence (AI)* refers to machines that simulate certain aspects of human intelligence, such as perception, learning, logical reasoning, problem-solving, linguistic interaction, and creative action. AI encompasses a wide range of technologies applied in student teaching and learning processes, including classical AI, machine learning, supervised learning, decision trees, unsupervised learning, reinforcement learning, neural networks, deep learning, and generative adversarial networks (GANs).

Moreover, AI technologies used in educational processes vary and include tools such as chatbots, computer vision, natural language processing (NLP), and sensors (UNESCO, 2022: 9–10).

The integration of artificial intelligence into teaching and learning processes relies on five key principles:

1. Perception – Computers perceive the world through sensors.
2. Representation and Reasoning – Computers generate symbols using data structures to represent knowledge and perform reasoning.
3. Learning – Computers have the ability to learn from data.

4. Natural Interaction – Intelligent systems are capable of communicating using various human languages.
5. Societal Impact – AI contributes positively to society by increasing productivity, enabling new types of services, and creating new job opportunities (Touretzky & McCune, 2022: 4).

Artificial Intelligence (AI) offers a range of benefits in student teaching and learning processes. These include: monitoring attendance and homework; utilizing a data-mining approach known as *learning analytics* to analyze big data generated by learning management systems in order to provide insights for teachers and guidance for students. Learning analytics can also predict students who are at risk of failure. Moreover, AI has demonstrated its ability to organize learning content across core systems based on learners' personal needs and academic levels. AI can also facilitate new methods of assessment, such as adaptive and continuous assessment powered by AI technologies. In addition, dialogue-based tutoring systems employ natural language processing and other AI techniques to simulate step-by-step spoken educational dialogues between teachers and students as they work through online tasks—often in computer science subjects (UNESCO, 2021: 11–12). For artificial intelligence to be effectively integrated into student teaching and learning processes, teachers must possess a set of essential competencies. These include: the ability to describe both the positive and negative impacts of Artificial intelligence, understanding how to integrate digital content with AI technologies, knowing who has the right of access to student data, how that access is monitor, how long data is retained, recognizing that AI systems assess student progress based on predefined domains and being able to explain how a particular AI system can benefit all students regardless of their cognitive, cultural, economic, or physical differences, and being capable of using AI-related projects and applications to help students understand AI ethics and the use of data in education and training (European Commission, 2022:

29–30). Students must also have a set of competencies to effectively engage with AI in their learning processes. These competencies include: distinguishing between strong and weak AI and providing examples of each, differentiating between AI-related problems and other types of problems in computer in computer science, identifying areas of AI application based on their specific features—such as robotics, language processing, image processing, cognitive systems, and artificial life; determining the type of data needed for a specific problem and preparing that data appropriately. Additionally, students should be able to explain how AI systems collect data through sensors and interact with the world through actuators, identify and describe areas of society impacted by AI, find and classify examples of AI from their everyday lives, and analyze the implications, opportunities, and challenges that AI presents for their own learning and educational development (Michaeli et al., 2023).

The successful integration of artificial intelligence into student teaching and learning processes depends on adherence to a set of ethical values. These include: supporting children's growth and well-being, ensuring inclusivity that encompasses all children and serves their best interests, prioritizing fairness and non-discrimination among children, protecting children's data and privacy, ensuring their safety, and providing transparency, explainability, and accountability in AI systems that involve children. Furthermore, it is essential to empower governments and companies by equipping them with knowledge about AI and children's rights, prepare children for current and future developments in the field of AI, and create an enabling environment for child-centered AI (UNICEF, 2021: 32–42).

There are numerous models for employing artificial intelligence in student teaching and learning processes, along with related strategies and teaching methods. These include:

- **Intelligent Tutoring Systems (ITS)**: where the learner follows a step-by-step sequence of tasks and receives individualized instruction or feedback without the need for teacher intervention.
- **Dialogue-Based Tutoring Systems**: where the learner follows tasks through natural language conversation.
- **Language Learning Applications**: which support learning by providing access to language courses and dictionaries, along with real-time automated feedback on pronunciation, comprehension, and fluency.
- **Exploratory Learning Environments**: which offer learners multiple representations that enable them to identify their own methods for achieving learning goals.
- **Formative Writing Assessment**: where learners receive regular, automated feedback on their writings.
- **AI-Supported Collaborative Learning**: which enhances group-based learning activities using AI tools and systems (European Commission, 2022: 14-15).

Study Problem:

The problem is summarised in identifying what previous literature has presented regarding the role of artificial intelligence (AI) applications in educational strategies, as well as the challenges facing their implementation in school education, through a review of the relevant educational literature. Despite the rapid advancements brought about by the information and communication revolution in the current era, AI still does not receive the necessary attention in many educational institutions—particularly in school education. AI is considered one of the most prominent elements of information technology that has significantly impacted various fields, including education. It simulates human abilities such as thinking, problem-solving, and performing both simple and complex tasks, which has led many

countries around the world to move toward adopting AI across multiple sectors.

Study Questions:

The **study** problem is framed by the following questions:

1. What is the role of artificial intelligence applications in enhancing educational strategies in school education, according to the educational literature (previous studies)?
2. What are the challenges and obstacles facing artificial intelligence in enhancing educational strategies in school education, based on the educational literature (previous studies)?

Study Objectives:

The study aimed to:

1. Review recent published studies on the use and effectiveness of artificial intelligence applications in enhancing the educational strategies.
2. Examine the challenges and obstacles affecting the effective implementation of artificial intelligence applications in school education.

Significance of the Study:

The significance of this study stems from the following points:

- This study may contribute to highlighting the role of artificial intelligence applications in enhancing educational strategies in school education.
- It may offer proposals for integrating AI applications into teaching strategies.
- The study could help develop and improve the educational process to align it with the demands of the twenty-first century.
- It may aid in identifying the most important AI applications that enhance educational strategies and how to effectively employ them in school education.

Study Methodology:

Both researchers employed the descriptive method in this study, which relies on describing specific phenomena, events, or objects by collecting facts, information, and observations about them, detailing their conditions, and reporting their status as they exist in reality. Additionally, the content analysis method was used, which involves a systematic and precise description of written texts—such as studies, articles, and books—by identifying the subject and objectives of the study (Al-Mahmoudi, 2019). This exploratory study relied on the methodology of content analysis of the educational literature (previous studies). This methodology involves citing the most relevant published studies and works related to the research, highlighting the role of each study in understanding the research topic, according to Grønmo (2019). The aim is to review and collect data from previously published studies that examine AI applications, benefits, challenges, and potential obstacles in using AI in school education. The purpose is to shed light on the latest research developments in the same field, identify contradictions and gaps if any, and discuss the contribution of each study to the understanding of the topic. Moreover, this approach analyzes the current knowledge on a subject objectively and comprehensively, helping to determine the focus and context of the research paper. Also, the study addresses the issue from an objective perspective to ensure the applicability of the results in a practical educational environment. It also derives conclusions from the analysis of previous studies and employs concepts found in the sources to assess the feasibility of applying AI to enhance educational strategies.

Both researchers established a set of criteria for selecting the educational literature (previous studies) related to the role of artificial intelligence applications in enhancing educational strategies in school education. These criteria included:

- All selected studies are scientific in nature.
- The studies are recent, limited to the last ten years, from 2013 to 2022.
- They are published in high-impact journals.
- They are accessible through global databases such as the Internet, Dar Al-Manthumah, and Google Scholar.
- They are directly relevant to the role of artificial intelligence applications in enhancing educational strategies in schools.

Study Limitations:

This literature review was limited to studies related to artificial intelligence applications, their total 30 studies, and their role in enhancing and improving educational strategies in school education.

Study Terms:

1. **Artificial Intelligence (AI):** Al-Sharqawi (2011) defined artificial intelligence as a branch of computer science that enables the creation and design of computer programs that simulate human intelligence; allowing computers to perform certain tasks carried out by humans that require thinking, understanding, speaking, and moving logically. Similarly, Mira and Qati' (2019) defined AI as the science that encompasses computer programs characterized by specific features that allow them to imitate human capabilities, including the ability to learn.

2. **Artificial Intelligence Applications:** They are defined as applications within computer science that provide programs capable of performing tasks requiring human-like performance, such as thinking and problem-solving.
3. **Educational Strategies:** They are defined as the methods and means used by the teacher to deliver the scientific content to students.

Theoretical Framework of the Study:

The theoretical framework of the study includes the following themes:

Concept of Artificial Intelligence:

Although artificial intelligence (AI) is considered a modern field, it has existed for a long time. John McCarthy, cited in Beyaz (2020), defined AI as the simulation of human functions by computers, such as learning and problem-solving. Al-Saud (2016) described AI as a science that aims to enable computers to simulate the processes within the human mind, and to perform the same tasks carried out by humans with greater accuracy and higher efficiency. In this context, artificial intelligence is defined as the ability to make computer programs simulate human behaviors and mental abilities. The greatest proof of AI's thinking skills and capabilities is the fact that true artificial intelligence is a system capable of learning autonomously, according to Gupta et al. (2020).

Mahmoud (2020) indicated that intelligence is the ability to understand and comprehend new concepts, whereas the term "artificial" relates to things produced by specific elements, unlike natural things that arise as a result of human intervention.

Al-Sumaidi (2009: 321) defined artificial intelligence as programs and systems that simulate the intellectual sides of humans, such as discovering meanings, the ability to think, learning from past experiences, and the

capability of the machine to perform tasks that require human intelligence, such as logical reasoning, learning, and the ability to adapt.

Mousa (2019) defined AI as a system comprising intelligent software and hardware designed to build machines that perform complex human tasks by mimicking the human brain's methods of learning, thinking, decision-making, and problem-solving, and subsequently employing the results of this study to develop intelligent systems and software.

Objectives of Artificial Intelligence:

One of the main objectives of artificial intelligence is that it fundamentally relies on the principles of induction and reasoning, possessing the ability to make decisions and solve problems even in the absence or incompleteness of some basic data. It also aims to comprehend the nature of human intelligence through computer programs and systems capable of simulating humans in solving problems or making specific decisions (Ibrahim, 2015).

Types of Artificial Intelligence:

Al-Burai (2022) identified three types of artificial intelligence, namely:

- **Weak or Narrow Artificial Intelligence:** It is considered the simplest and most widely used type of AI. It performs a single task and cannot go beyond it. Else, it is pre-programmed to simulate the human mind.
- **Strong or General Artificial Intelligence:** In this type, artificial intelligence develops to a level that equals human thinking and functions. Such systems operate based on learning from data, experiences, and acquired knowledge, enabling them to make autonomous and independent decisions from humans.
- **Super Artificial Intelligence:** It is considered one of the most advanced and potentially dangerous types of artificial intelligence, still under experimentation. Its goal is to design machines that surpass

human intelligence and the ability to learn, applying it across all fields of human intelligence.

Applications of Artificial Intelligence:

The applications of artificial intelligence in student teaching and learning processes are diverse and multifaceted, encompassing related strategies and teaching methods. The most significant of these applications can be outlined as follows:

- **Artificial Neural Network:**

It is defined as a system that processes data in the same way as the human neural network works, consisting of a group of cells that process information (Abd Al-Majeed, 2009). The neural network is characterized by several features, such as relying on a mathematical foundation. It is considered one of the intelligent information processing technologies that mimic the human brain and deal with various types of data (quantitative and qualitative). Additionally, it has the ability to store implicit knowledge based on previous cases, and finally, it can be applied in different scientific fields (Al-Abbasi, 2013).

- **Intelligent Agent:**

It is one of the applications of data mining from the internet and databases. It operates through software packages that perform one or more repetitive or predictable tasks, such as accomplishing more complex tasks in administrative fields. For example, digital management systems. can program this agent to make decisions based on the user's previous choices. Some of the tasks that an intelligent agent can perform include responding to customers, replying to their messages, and listening to their suggestions about services and products (Yaseen, 2005).

- **Ability to Learn and Self-Development:**

The idea of machine learning and skill acquisition began from the concept of human learning, where a person can learn through observation, experimentation, study, and listening. Based on this, artificial intelligence research has aimed to build machines that simulate the human mind, programmed to have the ability to learn, build knowledge, understand concepts, make decisions, and solve problems (Sammut, 2013).

AI Tools for Teachers:

AI tools are diverse and constantly evolving to keep up with technological advancements, as well as to fit the variety of educational tasks required. Adlawan (2024) pointed out the most important of these tools, which are:

- **Edcafe for Artificial Intelligence:**

  Lesson planning, teaching resources, test creation, flashcards, reading comprehension, image generation, text-to-speech conversion, custom chatbots, slides, classroom management, and teacher collaboration.

- **Artificial Intelligence from ClassPoint:**

  Instant test creation from PowerPoint slides (question types based on Bloom's taxonomy), that supports multiple languages.

- **Subtext:** An AI tool for students to write stories, allowing story creation on any topic in a unique way through AI algorithms. It also provides book summaries, reviews, and quotes to help select books to read, and offers a community for connecting with readers and participating in book discussions.

- **Magic School AI:** Lesson planning, creating IEP (Individualized Education Program), developing SEL (Social-Emotional Learning)

plan, designing multiple-choice assessments, and generating teacher jokes (up to 50 AI-powered educational tools), all in one tool.

- **Gamma AI:** Instant text-to-slide generation (comes with pre-designed templates and layouts, plus a comprehensive presentation toolkit!)
- **Formative AI:** Real-time feedback and assessment generation (offers various types of assessments) (Adlawan, 2024).

Method and Study Population:

The chosen method was a systematic review based on the steps proposed by Rhodes (2011): defining inclusion and exclusion criteria, screening titles and abstracts to exclude irrelevant studies, adding references considered missing, detailed analysis of relevant studies, data extraction, synthesis, and conclusion. An inductive analysis (Corbin and Strauss, 2015) was conducted by creating a network of codes, which was established after the first ten papers, using the MaxQDA software. One of the authors scanned the titles and abstracts, as well as coded the documents. The coding network was modified and validated by both authors. Therfore, this literature review was based on a collection of 48 documents addressing the role of the teacher in the field of AIED (Artificial Intelligence in Education). Besides, the study sample consisted of 30 studies focusing on the role of artificial intelligence applications in enhancing educational strategies in school education according to the educational literature, as well as the challenges facing artificial intelligence in promoting educational strategies in school education in light of the educational literature.

Presentation of Literature Review Results (Previous Studies) According to the Questions:

#	Study Results	The Study
	The Role of Artificial Intelligence Applications in Enhancing Educational Strategies in School Education	
1	The proposed system is effective in improving academic achievement in geography, enhancing problem-solving skills, and developing positive attitudes and motivation toward learning geography.	Chu & Sung (2016).
2	AI can assist with administrative tasks in school institutions by processing vast amounts of data quickly and accurately, identifying precise patterns, providing essential advice to students, and evaluating and grading numerous exam papers. Moreover, AI can significantly enhance certain aspects of education, such as administrative and instructional tasks, including assessment and tracking of grades.	Popenici and Kerr (2017).
3	Digital AI technologies are transforming the way education is delivered by creating personalized learning environments and more efficient delivery channels. As technology advances, education will become increasingly learner-centered due to AI and similar technologies. Consequently, education systems and teachers will need to adapt their service delivery to better serve students and enhance their comfort. AI will shift the role of teachers from merely providing information to guiding students, as adaptive intelligent learning technologies tailor instruction to each student's individual needs. For example, within such an educational system, students can choose when and where to learn, enabling AI to significantly improve the delivery of education and make it more learner-friendly. Additionally, AI can be used in designing curricula in school institutions to ensure a high level of efficiency.	Meikleham and Hugo (2020).

4	The use of artificial intelligence software in the process of designing curricula and producing textbooks will not require a long time or great effort; it can accomplish the same tasks in less time and with higher efficiency. Consequently, the educational content will be automatically updated and finalized in a way that suits the student's abilities and needs. One of the advantages of artificial intelligence is that it serves the student both inside and outside the classroom. For example, an intelligent assistant can identify the student's strengths and weaknesses, understand their capabilities, and recognize topics they do not understand or find difficult. Accordingly, it can present the educational material in a manner that matches the student's comprehension and abilities, providing the necessary support at the right time.	Bozkurt & Goksel (2018).
5	Artificial intelligence makes students more positive, exploratory, and better at memorizing information while resisting forgetting. It also helps them connect ideas and understand and comprehend tasks and activities.	Abu Shamala et al. (2013).
6	Artificial intelligence provides learning activities that meet the cognitive needs of students; it studies and analyzes the responses of the target group and makes appropriate decisions aimed at delivering content that suits their interests. It also contributes to students acquiring many modern technical skills that align with the Fourth Industrial Revolution.	Florea & Radu (2019).
7	By employing some artificial intelligence applications in the educational process—such as intelligent learning systems, smart content, virtual reality (VR), augmented reality (AR), Layer applications, Aurasma, and augmented applications—it becomes possible to address certain challenges and issues related to various aspects including the educational process, educational administration, teachers, learners, parents, and learner assessment.	Mahmoud (2020).
8	The application of artificial intelligence in education can significantly change the role of teachers and educational models.	Popenici & Kerr (2017).

9	Providing school students with advice, it works on a relatively simple algorithm that mainly handles repetitive and predictable tasks. This illustrates the potential impact of artificial intelligence in enhancing administrative tasks. With rapid developments in technology and artificial intelligence, such as machine learning, AI will soon develop enough complexity to learn and make accurate predictions that can inform educational models in school education and enhance teaching and learning.	Popenici & Kerr (2017).
10	In addition to simple conversational interfaces, artificial intelligence can also engage students through interfaces with intertwined contexts (interaction of strategies, processes, and elements within a single context).	Barrett et al. (2019).
11	AI systems can analyze curriculum pacing and student behavior, suggesting actions students should take to keep up with their educational requirements. Aggregated contextual data can also assist administration in making institutional decisions related to program analysis and scheduling to enhance educational strategies. Consequently, AI can analyze homogeneous student data patterns and use the findings to improve both student performance and institutional outcomes. It is noteworthy that AI has the capability to improve teaching quality in education, help provide personalized learning environments for students, and assist in grading, even for complex student tasks.	Guan et al. (2020).
12	AI can be used to quickly and accurately assess many students, allowing teachers more freedom to engage in empathetic teaching — that is, teaching students to connect emotionally with the scientific content they receive — which helps determine how beneficial that content is for them.	Guan et al. (2020).
13	Emotional teaching, alongside AI's ability to match students' competencies with industry requirements and create a personalized remote learning environment, can improve the quality of learning. However, some data collected by AI—such as student engagement—may not provide meaningful educational insights due to the complexity of classroom	Sapci & Sapci (2020).

	dynamics. Undoubtedly, the use of AI enhances the learning experience and helps develop certain skills that may be difficult to acquire through traditional methods, according to the study by Sapci & Sapci (2020).	
14	AI tools such as adaptive e-learning systems and AI-based virtual environments effectively contribute to enhancing the learning experience and developing new competencies among medical students. This is achieved by creating virtual reality environments that simulate real-life settings, enabling students to learn and gain experience they might not otherwise have access to—such as performing surgical operations. Therefore, AI can be used to train students in skills that cannot be physically practiced. AI can also help identify the strengths and weaknesses of existing educational systems by using machine learning and data mining tools to independently analyze educational systems when exploring big data.	Rienties, et al. (2020).
15	Students use AI tools such as machine learning and data mining to understand the complex physiological aspects of sports-related issues and to identify technological methods that can help alleviate these problems. The information obtained is then applied in physical education, especially in high-level physical education. AI facilitates better alignment between theoretical research, sports intelligence, and competitive physiology. Therefore, the application of AI in education can contribute to a deeper understanding of various educational sectors. Additionally, AI applications have an impact on teaching practices.	Meera & Qate' (2019).
16	The application of "immediate assessment" has also proven to be more effective than other methods. In addition, AI can be applied to complement teaching activities in order to enhance the overall quality of education.	Cao, Xue, et al. (2020).
17	In the same context, artificial intelligence is transforming the way education is delivered, making it more efficient and learner-centered.	Ally, (2019).

18	Moreover, teachers can use artificial intelligence to increase students' interest in learning. Ben Haj et al. found that integrating technology into the teaching of new concepts not only reduces negative learning behaviors but also enhances positive learning behaviors among students, as they remained motivated to participate, actively engaged, and more interested in the subject matter.	Benhadj, et al. (2019).
19	To engage students in the technological components of artificial intelligence within their education and to enhance their understanding of what they are learning, educational institutions can utilize new AI technologies as a tool to encourage student participation in their learning activities while integrating them into their educational systems. Artificial intelligence offers a strategy that teachers can use to improve the efficiency of their lessons. One way AI will transform the education system is by enhancing instruction through eliminating the need for repetitive teaching or spending additional time with students to ensure their understanding of a given topic.	Aldosari, (2020).
20	When educational institutions implement AI systems in lecture halls, laboratories, and interactive learning spaces, students engage directly with these systems and ask the clarifying questions they need without wasting time or feeling embarrassed. By using such a strategy, AI plays a supportive role as it enhances learning efficiency without requiring additional resources from teachers.	Aldosari, (2020).
21	Adopting artificial intelligence in education can also lead to transforming teaching curricula to become more competency–based.	Wartman & Combs (2018).
22	Artificial intelligence also helps increase access to education by substituting for teachers in areas that may be difficult to reach.	Timms (2016).
23	One of the advantages of artificial intelligence is its ability to transform current teaching methods and enhance their efficiency.	Naidoo & Singh– Pillay (2020).

24	These systems assist teachers in school education institutions with teaching and lesson preparation, especially in institutions with large numbers of students. Therefore, teachers in school education institutions can use artificial intelligence to deliver high-quality educational materials without increasing their workload. Additionally, AI has the capability to provide recommendations on how students can improve their academic performance. Since AI can detect hidden patterns and analyze the vast amounts of data typically found in school education institutions to reach new conclusions, it can help identify students' needs, create personalized study plans for them, or offer other personalized educational recommendations.	Paiva, et al. (2019).
25	Teachers in school education institutions can use this technology to ensure that each student receives appropriate personalized attention. Artificial intelligence enhances the effective implementation of educational strategies that focus on student engagement and active learning.	Zain & Sailin (2020).
26	Technologies such as artificial intelligence and big data analytics help ensure the effectiveness of educational strategies like flipped learning curricula. These technologies are used directly or indirectly through other programs to ensure that digital learning is both effective and engaging. Consequently, teachers can use AI to create dynamic and interactive learning environments. Learning can be supported through AI applications that enhance learners' experiences and provide opportunities for reflection on their learning.	Woolf &, et. D (2013).
27	Chatbots, which are one of the applications of artificial intelligence, have proven to be effective in education, particularly in language learning, as they focus on the learners' interests.	Fryer, et al. (2019).
28	AI applications can be utilized in education across various areas, including online learning, classroom dynamics, and foreign language acquisition.	Sha'aban (2020).
29	One of the most important challenges facing artificial intelligence is the lack of training for educational decision-makers on AI, as	Al-Mutairi (2019).

	well as the rare of intelligent technologies used in decision-making, and the inadequate training of staff on artificial intelligence.	
30	Linking artificial intelligence with education poses many challenges, the most prominent of which is achieving a balance between using AI for education and learning for the advancement of AI.	Bakkari (2022).

Study Results:

The educational literature addressed the study variables related to the role of artificial intelligence applications in enhancing educational strategies in school education, in light of educational literature and the challenges facing AI in enhancing these strategies. The researcher reviewed 30 studies to answer the study questions, which are as follows:

Results Related to the Answer of the First Question: "What is the role of artificial intelligence applications in enhancing educational strategies in school education in light of the educational literature?"

Referring to the educational literature, the researchers found a set of previous studies related to the role of artificial intelligence applications in the teaching and learning process, which are mentioned as follows:

The augmented reality-based inquiry demonstrated the effectiveness of the proposed system in improving academic achievement in geography, problem-solving skills, and the development of positive attitudes and motivation for learning geography, according to a study by Chu and Sung (2016). Additionally, the use of the Earth Google program enhances students' ability to identify spatial and temporal changes and analyze these changes, as reported by Liu and Xiang (2017). Artificial intelligence holds great potential to increase the efficiency of many aspects of education that require accuracy or involve repetitive workloads. For example, AI can assist

with administrative tasks in school education institutions by quickly and accurately processing vast amounts of data, identifying precise patterns, providing essential advice to students, and grading many test papers. Moreover, AI can significantly enhance certain educational aspects, such as administrative and instructional tasks, including assessment and grade tracking, according to the study by Popenici and Kerr (2017). Using artificial intelligence software in the process of designing curricula and producing textbooks does not require long time and effort; rather, it performs the same work in less time and with higher efficiency. Consequently, the educational content will update automatically and become finalized in a form that suits the student's abilities and needs. Another advantage of artificial intelligence is that it serves the student both inside and outside the classroom. For example, a smart assistant can identify the student's strengths and weaknesses, understand their capabilities, and detect the topics they do not comprehend or find difficult. Accordingly, it can deliver the educational material to the student in a way that matches their understanding and abilities, providing the necessary support at the appropriate time.

According to a study by Bozkurt and Goksel (2018), there are six main drivers of the Fourth Industrial Revolution: people and the internet, computing and communications, the Internet of Things, artificial intelligence, big data, the sharing economy, and the digitization of things. Additionally, there are three main technological domains emerging from the Fourth Industrial Revolution: the physical domain, the biological domain, and the digital domain. Furthermore, six applications of the Fourth Industrial Revolution can be employed in the teaching and learning of geography: artificial intelligence, big data, cloud computing, the Internet of Things, robotics, and nanotechnology, according to a study by Al-Amiri and Al-Talhi (2020). Artificial intelligence makes students more positive, exploratory, better at retaining information, and more resistant to forgetting.

It also helps them connect ideas and understand and comprehend tasks and activities, according to a study by Abu Shamala et al. (2013).

Artificial intelligence is a technological revolution that impacts all fields, including education. Also, AI enhances both teaching and learning processes and helps personalize the AI learning experience while assisting teachers in the learning process. Its applications enable the simulation of individualized human lesson experiences, where intelligent AI-based educational systems provide learning activities tailored to the cognitive needs of students. These systems study and analyze the responses of the target group and make appropriate decisions aimed at delivering content that matches their interests. Furthermore, AI contributes to students acquiring many modern technical skills that align with the Fourth Industrial Revolution, according to the study by Florea and Radu (2019).

By employing certain artificial intelligence applications in the educational process—such as smart learning systems, intelligent content, virtual reality (VR), augmented reality (AR), and applications like Layer, Aurasma, and other augmented applications—some of the challenges and issues can be addressed. These challenges relate to the following aspects: the educational process, educational administration, teachers, learners, parents, and learner assessment, according to a study by Mahmoud (2020).

The application of artificial intelligence in education can significantly change the role of teachers and educational models. According to a study by Popenici and Kerr (2017), AI can help enhance human capabilities in education in areas such as teaching, learning, and administrative functions in school education institutions. For example, Deakin University in Australia uses IBM's Watson supercomputer—an early form of AI—to provide advice to school students. Watson operates on a relatively simple algorithm that mainly handles repetitive and predictable tasks, demonstrating the potential impact of AI in enhancing administrative tasks. Therefore, with rapid

advancements in technology and AI, particularly in machine learning, AI will soon develop sufficient complexity to learn and make accurate predictions. This capability can inform educational models in school education and enhance teaching and learning processes.

However, Popenici and Kerr (2017) point out that despite the reasonable effectiveness of such systems, they have some limitations, such as the inability to handle complex human interaction and management, as well as the potential bias from the designers of AI systems. Undoubtedly, education is primarily a human-centered interactive endeavor, and integrating AI would eliminate part of this human-to-human interaction. According to Timms (2016), this integration will also require significant changes in the education system for teachers, students, and other stakeholders, which may create resistance to change in adopting AI applications, as noted by Pence (2019).

In addition to simple conversational interfaces, artificial intelligence can also engage students through context-rich interfaces that involve the interaction of strategies, processes, and elements within a single context. According to Barrett et al. (2019), AI systems can analyze the pace of curricula, student behavior, and suggest actions that students should take to meet their educational requirements. Collective contextual data can also assist administration in making institutional decisions related to program analysis and scheduling to enhance educational strategies. Furthermore, AI can analyze students' homogeneous data patterns and use the results to improve both student performance and institutional effectiveness. It is noteworthy that AI has the capability to improve the quality of teaching in education, help provide personalized learning environments for students, and assist in grading—even for complex student tasks—according to Guan et al. (2020). For example, the Java Light SIDE program was used to classify medical articles written by graduate students, achieving accuracy rates ranging from 94.6% to 98.2%, comparable to human grading. This

demonstrated that artificial intelligence can be used to evaluate many students quickly and accurately, thereby giving teachers more freedom to engage in empathetic teaching—known as teaching students how to feel about the scientific content they receive—which helps determine the usefulness of that content for them.

According to a study by Guan et al. (2020), empathetic teaching combined with AI's ability to match students' competencies with industry requirements and create personalized remote learning environments can improve the quality of learning. However, some data collected by AI, such as student engagement, may not provide meaningful educational insights due to the complexity of classroom dynamics. Undoubtedly, the use of AI enhances the learning experience and helps develop certain skills that may be difficult to acquire through traditional methods, as noted by Sapci and Sapci (2020). AI tools, such as adaptive e-learning systems and AI-based virtual environments, enhance learning experiences and develop new competencies for medical students by creating virtual reality environments that simulate real-life settings. This enables students to learn and gain experience in scenarios they might not otherwise access, such as performing surgical operations. Therefore, AI can be used to train students in skills for situations where physical training is not feasible. Artificial intelligence can also help identify strengths and weaknesses in existing education systems by using machine learning and data mining tools that independently analyze educational systems through big data exploration. According to Rienties et al. (2020), educational institutions can collect extensive data from their educational settings and process it through AI algorithms to evaluate system efficiency. The system identifies strengths, areas for improvement, and recommends possible adjustments based on specific institutional contexts. However, these institutions need to consider educational aspects during data mining to ensure the applicability of the

results. Therefore, educational institutions can use AI to leverage their strengths and improve their educational systems.

Besides classroom education, artificial intelligence can also help in improving scientific research in the field of sports (physical education). For example, physical education systems in China have enabled master's and doctoral students to advance their research strategies by analyzing large amounts of sports-related data in a short time and identifying unique relationships.

According to the study by Lv and Song (2020), students use AI tools such as machine learning and data mining to understand the complex physiological aspects of sports-related issues and identify technical methods that can help alleviate problems. They then apply the information they obtain in physical education, especially at the high-performance level. AI facilitates easier alignment between theoretical research, sports intelligence, and competitive physiology. Therefore, applying AI in education can enhance deep understanding across various educational sectors. Additionally, AI applications have an impact on teaching, as noted by Mira and Qate' (2019), where "immediate assessment" is considered more effective than others. Moreover, AI can be used to complement teaching activities to improve the overall quality of education, according to Cao, Xue, et al. (2020). In this regard, artificial intelligence is changing the way education is delivered, making it more efficient and learner-centered. According to Ally (2019), emerging digital technologies such as artificial intelligence are transforming education by creating personalized learning environments and more efficient delivery channels. As technology advances, education will become increasingly focused on the learner due to AI and similar technologies. Consequently, education systems and teachers will need to adjust their service delivery to better serve students and accommodate their needs. AI will shift the role of teachers from simply providing information to guiding and mentoring, as adaptive intelligent

learning technologies cater to the individual needs of each student. For example, in such an educational system, students will have the flexibility to determine where and when they learn. Therefore, AI can significantly improve education delivery, making it more suitable for learners. Also, AI can also be used to design training courses in school education institutions to ensure a high level of efficiency.

According to Meikleham and Hugo (2020), their study found, as noted by Kokorova et al., that even when some people were familiar with certain AI concepts, they still held a negative perception of research outcomes that use artificial intelligence. This negative perception creates a potential barrier that must be addressed to promote the integration of AI in academic research. Researchers will no longer need to limit themselves regarding the type or amount of data they can collect and use.

Teachers and system designers can use artificial intelligence as a strategy to enhance students' self-awareness. Loftus and Madden (2020) suggest that teachers can work with students throughout all stages of the learning process, transforming data to create a metacognitive layer within the education system. Essentially, when students learn about data-driven artificial intelligence, they gain deeper insight into their own learning, their role in the new educational system, and how AI systems will affect them. Additionally, teachers can use artificial intelligence to increase students' interest in education. Also, Benhadj et al. (2019) found that integrating technology into teaching new concepts not only reduces negative learning behaviors but also enhances positive learning behaviors among students, as students remained motivated to participate, actively engaged, and showed greater interest in the subject (Benhadj, et al., 2019).

The researchers concluded that when teaching digital citizens, integrating technology into the teaching process is an invaluable tool that can enhance outcomes. This conclusion aligns with the recommendation of

Loftus and Madden (2020) to engage students with the technological components of artificial intelligence in their learning to deepen their understanding of what they study. Therefore, educational institutions can use new AI technologies as a tool to encourage students' active participation in their educational activities while integrating these technologies into their educational system. In addition, Artificial intelligence offers a strategy that teachers can use to improve the efficiency of their lessons. One of the ways AI transforms the education system is by enhancing teaching through eliminating the need for teachers to repeat content or spend extra time ensuring students understand a particular topic.

According to Aldosari (2020), when educational institutions implement AI systems in lecture halls, laboratories, and interactive study spaces, students interact directly with these systems and ask many clarifying questions they need, without wasting time or feeling embarrassed. This strategy allows AI to play a supportive role by enhancing learning efficiency without requiring additional resources from teachers (Aldosari, 2020).

In line with what has been mentioned, the adoption of artificial intelligence (AI) in education can also lead to a shift in teaching curricula, making them more competency-based. According to Wartman and Combs (2018), integrating AI into teaching strategies in medical schools will not only affect teaching and learning processes but also change students' focus and the education system. Understanding AI's ability to perform most fact-based thinking tasks faster than humans will shift the focus of education toward the skills students need to apply in their practice and encourage lifelong learning. Therefore, AI can change learning strategies by shifting the focus of education to relevant and applicable skills, instead of wasting effort on activities that can be easily completed. AI also helps increase access to education by replacing teachers in areas that may be difficult to reach, for example, according to Timms (2016).

One of the advantages of artificial intelligence (AI) is its ability to transform and enhance the efficiency of current teaching methods. According to Naidoo and Singh-Pillay (2020), AI is one of the key elements of the Fourth Industrial Revolution, enabling teachers who adopt such technologies to reorganize existing teaching methods and acquire new knowledge to enhance pedagogy. This leads to more efficient learning in subjects like mathematics and supports professional development. Moreover, the study found that the majority of higher education teachers (80%) were open to using these technologies in their teaching practices. Therefore, integrating technology into current teaching methods can help identify opportunities for improvement.

Additionally, artificial intelligence (AI) can also enhance access to educational resources. Services like 101 CRAM use AI to digitize textbooks and summarize them into useful guides with concise summaries for students. According to Sourani (2020), these systems assist teachers in school institutions with teaching and lesson preparation, especially in schools with large numbers of students. Therefore, teachers in school settings can use AI to provide high-quality educational materials without increasing their workload. Moreover, AI has the capability to offer recommendations on how students can improve their academic performance. Since AI can detect hidden patterns and analyze vast amounts of data typically found in educational institutions, it can reach new insights. This enables AI to help identify students' needs, create personalized study plans, or provide other individualized educational recommendations.

According to Paiva et al. (2019), teachers in school institutions can use this technology to ensure that each student receives the appropriate personal attention. Artificial intelligence enhances the effective implementation of educational strategies that focus on student engagement and active learning. Furthermore, according to Zain and Sailin (2020), AI

technologies and big data analytics help ensure the efficiency of educational strategies, such as flipped learning curricula. These technologies are used directly or indirectly through other programs to ensure that digital learning is effective and encouraging. Consequently, teachers can use AI to guarantee dynamic and interactive learning environments. Therefore, learning can be further supported by AI applications that enhance learners' experiences and provide opportunities for reflection on their learning.

According to Woolf et al. (2013), conversational robots, which are a type of artificial intelligence application, are effective in language education as they focus on learners' interests. Furthermore, Fryer et al. (2019) indicate that AI applications in education can be utilized in various areas, including online learning, classroom dynamics, and foreign language acquisition, as supported by Shaaban (2020).

The are results related to answering the second question: "What are the challenges facing artificial intelligence in enhancing educational strategies in school education in light of educational literature?"

One of the main challenges facing artificial intelligence is the lack of training for leadership responsible for educational decision-making on the use of AI technologies, in addition to the scarcity of intelligent technologies used in decision-making processes, and an urgent need to establish training programs for personnel to handle AI, according to Al-Mutairi (2019). Furthermore, integrating artificial intelligence with education poses several major challenges, most notably achieving parity and integration between artificial intelligence and human intelligence to ensure the fulfillment of educational and learning goals, as highlighted by Bakari (2022).

There are several obstacles to employing artificial intelligence applications in schools, such as: teachers not using AI applications, lack of technical support, absence of financial incentives, insufficient expertise, and

a lack of positive attitude among teachers toward using AI applications, according to the study by Al-Ghamdi and Al-Farani (2022).

There are several challenges and issues related to the following aspects: (the educational process, educational administration, teachers, learners, parents, and learner assessment), according to Mahmoud's study (2020). In Kenya, students use modern tools and technological means slowly, ineffectively, and in a way that does not keep up with the times. Additionally, the shortage of computers is one of the biggest challenges in covering the curriculum and completing it on time, which greatly affects the move towards e-learning, according to the study by Oira (2018).

Modern technologies like artificial intelligence often face challenges that limit their effective application and adoption. Among the most prominent challenges noted by Mahmoud (2020) are the weak digital infrastructure and poor internet connectivity in most educational institutions, the lack of awareness about the importance of employing AI technologies, and the skepticism of decision-makers regarding their current necessity. Additionally, there is insufficient attention to training and developing teachers in using AI technologies, concerns that AI implementation might undermine the teacher's role, and finally, some students' preference for traditional learning methods with full reliance on the teacher.

Mukherjee (2020) points out that artificial intelligence systems can only be effective when used by specialists to enhance their capabilities. Many other researchers agree with this assertion, emphasizing that AI cannot completely replace teachers, and attempts to do so would lead to inefficiencies in the learning process. According to Wang (2020), AI is also likely to face many barriers because, unlike previous technologies such as PowerPoint, which easily adopt existing traditional teaching strategies, AI may cause significant disruption for both teachers and learners, prompting resistance to change. Similarly, Pence (2019), in a study assessing higher

education students' perceptions of AI, found that only 39.06% of participants agreed that AI would have a positive impact on education.

According to Kairu (2020), some students also value human-to-human interactions more than human-to-technology interactions. For example, one study found that 62% of students believed that the teacher's personality was more important for learning than artificial intelligence. Similarly, Vinichenko et al. (2020) noted that AI is likely to face significant barriers before being widely accepted in education systems.

Educational institutions have the opportunity to adopt artificial intelligence to improve educational strategies by using computers to perform simple tasks and focusing on creating an effective and highly efficient learning environment that many students and teachers can easily access and benefit from. However, some educational stakeholders, as well as the complexity of human interactions, may limit the effectiveness of integrating AI into education. Using AI requires a trained and qualified person to apply it efficiently to ensure the smooth and effective progress of the educational process. If the teacher is not sufficiently qualified to implement AI, this will hinder the achievement of its intended goal, which is to develop and improve the educational process. Additionally, the high cost of employing AI is one of the major obstacles to its integration in education, a cost that most educational institutions cannot bear. Besides the expense of providing AI systems in these institutions, there is also a need for programmers and data specialists, which adds further pressure on the budget.

Additionally, most of the studies reviewed in this literature indicate that artificial intelligence enhances the role of teachers and leads to the development of effective and efficient educational models within institutions, ensuring high-quality education. AI is designed to elevate and augment the capabilities of teachers without completely replacing their role. No matter how advanced AI systems and applications become, they still require human

intervention in some form. In fact, AI systems will transform the role of the teacher into a more comprehensive one, where the teacher becomes a facilitator, guide, and mentor in the educational process. Most studies have also confirmed that employing artificial intelligence provides educational institutions with the opportunity to analyze big data and identify ways to improve their current strategies to enhance performance for both teachers and learners. Big data analysis enables students to conduct research more easily and extensively, linking vast and complex data with minimal effort and time. Additionally, data analysis benefits teachers by allowing more accurate and comprehensive assessment of student performance and monitoring of their grades compared to traditional methods. Else, most studies have also agreed that artificial intelligence applications help motivate students to continue learning and make the educational process more effective. For example, through the feedback provided by most AI applications, which inform learners about the correctness or incorrectness of their actions, help maintain their enthusiasm to persist in learning, and show them their progress stages in the educational process. Additionally, this feedback increases learners' desire to learn, thus making the learning environment more active and effective.

Most studies have also shown that students' use of AI applications and interaction with them increases their ability to acquire various contemporary skills, such as decision-making, problem-solving, forecasting, deep analysis, logical and organized thinking, and creative thinking. One of the most important advantages of employing AI applications in education, highlighted by these studies, is the ability to identify students' strengths and weaknesses and thus provide the appropriate methods and guidance tailored to each student's abilities and educational needs. This contributes to improving academic performance, increasing productivity, and enhancing the quality of future outcomes. While educational institutions have adopted AI to gain as many of these benefits as possible, AI is best

seen as a complementary tool to enhance teachers' capabilities and increase learners' productivity. Furthermore, the literature review revealed that although AI can enhance educational strategies, there remains a need to educate more stakeholders in education to change their perceptions about the importance of integrating and employing AI in education.

In the digital age, the impact of technology on education is inevitable, but it may take some time before all education stakeholders fully adopt new technologies. Artificial intelligence offers a significant opportunity that educational institutions can use to improve their teaching strategies and elevate education to a higher level of productivity. Higher education institutions, in particular, will benefit from integrating AI because it facilitates the demands of more complex research through data analysis. Moreover, eliminating simple tasks in such institutions will enable teachers and learners to focus on enhancing the effectiveness of learning outcomes. While AI can greatly enhance teaching by improving instructional, learning, research, and administrative processes, it cannot fully replace human elements. AI still requires substantial human contribution to ensure efficiency. Therefore, although AI can be used in educational institutions to improve educational strategies, it is also important to prepare all beneficiaries before its implementation, and the process should be gradual to ensure success.

Study Conclusions:

The study reached several conclusions, as follows:

- Artificial intelligence applications contribute to enhancing the role of teachers, making it more comprehensive.
- AI applications enable educational institutions to analyze data and benefit from its features.

- AI applications help stimulate students' motivation and encourage their continuous learning.
- AI applications assist in employing various educational strategies.
- AI applications contribute to digitizing curricula and providing suitable virtual education for all student levels.
- AI applications help identify students' strengths and weaknesses, thereby offering appropriate methods and guidance tailored to each student's abilities, which contributes to developing their diverse skills.

Study Recommendations and Proposals:

Based on the findings, the study recommends the following following:

- The importance of integrating artificial intelligence applications into school curricula and including them in curriculum development plans.
- The necessity of organizing training courses for school teachers to integrate and utilize AI applications in their teaching.
- The importance of establishing the necessary infrastructure in school institutions and providing the required devices to support the use of AI applications.

Proposals:

- Conduct applied research on the effectiveness of artificial intelligence applications in enhancing school education strategies.
- Conduct similar studies on employing artificial intelligence in developing school curricula in specific subject areas.

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