Chapter 4 - Artificial Intelligence in Instructional Pedagogy: Potential Benefits and Future Implications

Muhammad Hafeez iD **, Fouzia Ajmal** iD **, Zahid Zulfiqar** iD

Chapter Highlights

> ➤ This study shows that AI is playing a big role in education. AI technologies such as virtual reality, 3D technology, and interactive simulations are being used to help students learn. Also, the use of robots as teacher assistants highlights the role of AI in education.

> ➤ AI offers a range of potential benefits for students and teachers, such as a personalized learning environment, tutoring, rapid response, personalized syllabi, customization of the academic curriculum, student assessment and ranking, admission and registration processes, adaptive group formation, and an intelligent teaching system.

> ➤ This study states that AI will significantly impact the future of education. AI will support teaching and learning processes and cause major changes in teaching.

> ➤ AI can help teachers assess student performance and create personalized learning plans for students. It can also identify students' learning deficiencies early and work on them.

> ➤ This study also notes that AI has broader applications in education. This includes the capacity to provide students with resources that can help students with different needs, such as multilingualism, hearing or visual impairments.

Abstract

The objectives of this qualitative study were (i) to overview the integration of AI in instructional pedagogy, (ii) to point out some potential benefits of AI in education, and (iii) to highlight future implications of AI in education. The analysis of previous research studies on artificial intelligence in education was used as the methodology for this study. Three research questions formulated for this study were: (i) What is the role of AI in instructional pedagogy? (ii) What are the potential benefits of AI in education? and (iii) What are the future implications of AI in education? The findings related to the research question (i): What is the role of AI in instructional pedagogy? Artificial intelligence technologies like robots, virtual reality, intelligent tutoring systems equipped with conversational and dialogue capabilities, animated conversational agents in Chabots or Cobots, deep tutors, and auto tutors are used in instructional pedagogy. The findings related to research question (ii): What are the potential benefits of AI in education? AI benefits teachers and students through the personalized learning environment, tutoring, quick response, personalized course programs, customization of the academic curriculum, AI-based resources, student assessment and grading, admissions and enrollment processes, adaptive group formation, and an intelligent tutoring system. The findings related to the research question (iii): What are the future implications of AI in education? Indicated that AI will significantly impact the future of education. It will support the process of teaching and learning.

Introduction

Background of the study

The term "artificial intelligence" (AI) was initially used by John McCarthy in 1955 to refer to a computer system that possesses the ability to execute a range of cognitive activities like those performed by humans, including communication, decision-making, learning, and problem-solving (Nilsson & Nilsson, 1998). As per Baker and Smith (2019), AI is a broad term encompassing many technologies and algorithms. In education, the earlier phases of AI often revolved around intelligent tutoring systems aimed at autonomously addressing challenges such as enhancing operator proficiency. Various definitions of Artificial Intelligence in instructional pedagogy, as stated by different researchers, are given in Table 1.

Table 1: AI in Instructional Pedagogy as Stated by Different Researchers

No	Author	Definition
1	Ross (1987)	A human-like and acceptable answer to the issues that the intelligent tutoring system sets for the user can be achieved with AI techniques. The intelligent tutoring system can then reason and comment on the solution process.
2	Hwang (2003)	AI in the realm of education can be characterized as an intelligent tutoring system designed to facilitate the management of system knowledge and operational data to enhance operator proficiency. Additionally, it involves the automated assessment of exercise progression and remedial actions during a training session by leveraging past student performance as a basis.

3	Johnson et al. (2009)	The authors defined AI as tutors that generate real-time responses using their understanding of the subject and evaluation of student analyses.

The rise of computer and information communication technologies has fueled artificial intelligence (Taş & Gülcü, 2019). AI is the ability of computers to adapt to new surroundings, address emerging circumstances, resolve issues, provide solutions, design plans, and do other jobs that require human-like intellect (Coppin, 2004). This description emphasizes that computers, computer-related technologies, machinery, and information and communication technologies have enabled computers to perform tasks that resemble human abilities, resulting in artificial intelligence. New educational technologies have made artificial intelligence widely used in education (Chen et al., 2020). Education is adopting AI technologies and algorithms every year. Figure 1 shows the rise in Web of Science and Google Scholar "AI" and "Education" research publications in 2010. Approximately 70% of the publications were published between 2015 and 2019.
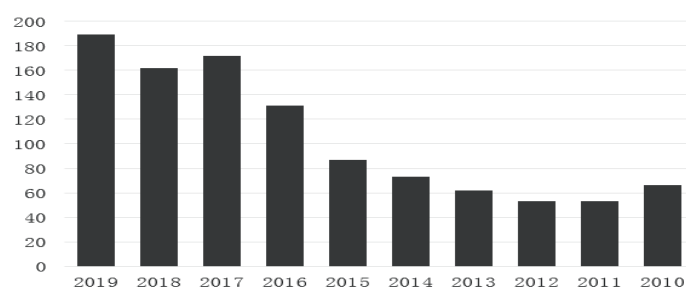

Figure 1. Papers Published in Different Data Sources on the Application of Artificial Intelligence in Education
Source (Chen et al., 2020)

The field of education is poised for substantial transformation through the impact of artificial intelligence (AI). AI has remarkable potential and can exert profound influence across various societal domains. AI has found application in diverse forms within educational institutions, encompassing instructional approaches enriched by tools designed to enhance student learning. These tools incorporate virtual reality, web-based platforms, robotic systems, video conferencing, audiovisual resources, and 3-D technology. As a result of these innovations, students receive a more individualized and profound educational experience from teachers who work more effectively and efficiently (Guan et al., 2020).

Statement of the Problem

Due to the improvement of technological tools, the teaching and learning settings have changed. Many mobile and internet devices are available, making the learning environment interesting, useful, and creative (Hafeez et al., 2022). The traditional methods of acquiring education cannot fulfill the requirements of society to compete

with the new challenges in the twenty-first century. So, it is time to integrate the advanced technological tools in education to make the education system more advanced and purposeful to compete with the current age requirements.

Objectives of the Study

The objectives of this study were: To overview the integration of AI in instructional pedagogy.
  i.   To point out some potential benefits of AI in education
  ii. To highlight future implications of AI in education.

Review of the Literature

Concept of Artificial Intelligence

Computers or robots with "artificial intelligence" can perform intelligent tasks. This phrase generally refers to building AI systems with human-like thinking, semantic comprehension, generalization, and experience learning. Since the 1940s, digital computers have successfully proven mathematical theorems and played chess. Despite greater computer processing speed and capacity, programs can only match human flexibility in jobs requiring considerable baseline knowledge. AI machines have outperformed human experts in various domains. This limits AI applications in speech and handwriting recognition, search engines, and medical diagnostics (Roll & Wylie, 2016).

As Sadiku et al. (2021) define artificial intelligence (AI), a computer system may execute human cognitive skills like reasoning and learning, normally reserved for humans. AI technology gives education a new degree of adaptability and versatility, changing the educational environment and simplifying instructors' jobs. AI will transform education. Psychologists describe human intelligence as a mix of cognitive talents. Artificial intelligence research has focused on the following intelligence components:

Learning

In the context of artificial intelligence (AI), learning encompasses various approaches. The most straightforward form involves acquiring knowledge through trial and error. For instance, in the case of a basic computer program designed for solving mate-in-one chess scenarios, it may experiment with different moves until it identifies a winning move. The program may store the solution alongside the corresponding position to enable the computer to remember this solution for future encounters with the same situation. Another form of learning in AI involves role-playing or the simple memorization of discrete items and processes, which a computer can easily accomplish. However, the challenge lies in applying a concept known as generalization. Generalization uses past knowledge to address similar new circumstances. A software that memorizes the past tense of common English verbs would struggle to create the past tense of "jump" unless it has seen "jumped" before. Software with generalization capabilities may learn the "added" rule and generate the past tense of "jump" from its experiences with comparable verbs (Pedro et al., 2019).

Reasoning

Engaging in reasoning is to draw inferences relevant to a given context. Deductive and inductive reasoning are distinct approaches in this regard. An example of deductive reasoning is: "Fred must be located either in the café or the museum." If it is established that he is not in the café, then it logically follows that he must be in the museum. On the other hand, an instance of inductive reasoning can be seen in the statement: "Previous accidents of this nature were attributed to instrument failure; hence, it is concluded that this accident was also caused by instrument failure." The crucial difference between these two forms of reasoning is that in deductive reasoning, the premises' truth guarantees the conclusion's truth. In contrast, in inductive reasoning, the premises support the conclusion without offering absolute certainty. Science frequently relies on inductive reasoning, involving collecting data and the development of initial models to describe and predict future behavior, which may be adjusted as new, unexpected data emerges. However, deductive reasoning is often used in mathematics and logic to build complex systems of irrefutable theorems from a few basic axioms and principles. Deductive inferences have been successfully programmed into computers. However, genuine reasoning extends beyond the mere act of drawing conclusions; it entails reaching conclusions that are pertinent to addressing specific problems or situations. This challenge represents a significant issue in artificial intelligence (AI) (Ouyang & Jiao, 2021).

Problem Solving

Problem-solving, especially within the field of artificial intelligence, can be defined as a methodical exploration of various potential actions with the purpose of attaining a predetermined goal or solution. There are two primary categories of problem-solving techniques: specialized and general. A specialized approach is customized for a particular problem and often utilizes unique aspects of the problem's context. In contrast, a general-purpose approach can be applied to address a variety of different problems. A commonly employed general AI method for problem-solving is means-end analysis. This approach involves incrementally closing the gap between the current situation and the desired outcome, step by step. For example, in the context of a basic robot, this may entail actions like PICKUP, PUTDOWN, MOVEFORWARD, MOVEBACK, MOVELEFT, and MOVERIGHT until the desired objective is achieved. The program selects actions from a list of potential means to progress toward the goal. Artificial intelligence systems have played a central role in finding solutions to a diverse range of problems, including tasks like determining winning moves in board games, generating mathematical proofs, and manipulating "virtual objects" within artificially generated environments (Luan et al., 2020).

Perception

In the process of perception, the environment is systematically examined using a variety of authentic or simulated sensory organs, and the scene is deconstructed into individual elements arranged in different spatial configurations. Analyzing these elements can be challenging due to factors like an object's appearance changing depending on the viewing angle, the direction and intensity of the ambient lighting, and how distinct the object is from its surroundings. Artificial perception has advanced significantly, enabling optical sensors to identify

individuals, autonomous vehicles to safely travel at reasonable speeds on open roads, and robots to collect empty soda cans from buildings (Alam, 2021).

Language

A language is a system of symbols with established meanings through convention. This concept implies that language is not limited to spoken words. For example, traffic signs serve as a form of mini-language; in some countries, the symbol for "danger ahead" is represented as "." The distinctive feature of languages is that the meanings of linguistic units are determined by convention, setting them apart from what is known as natural meaning. Examples of natural meaning include phrases like "Those clouds indicate rain" and "The decrease in pressure implies that the valve is malfunctioning." Developing computer programs capable of seemingly fluent responses in human languages within highly constrained contexts is not a particularly challenging task. Although none of these systems can claim to comprehend the entirety of the English language, they may eventually acquire language skills comparable to those of an average human. However, the question of what constitutes genuine understanding remains complex and lacks a universally accepted answer. One theory holds that language comprehension depends on both behavior and history: to understand a language, one must learn, interact, and train with other language users to integrate into the linguistic community (Becker, 2017).

Nature of AI

AI has traditionally been closely associated with computers. However, an examination of numerous research papers, particularly those focused on the field of education, reveals a shift away from the notion that AI is solely tied to computers, their hardware and software, or their equipment. Thanks to embedded computers, sensors, and new technologies, AI has expanded to include machines, robots, and buildings (Chassignol et al., 2018). The dual-sided definition and summary of AI by Chassignol et al. (2018) is that AI is a theory and a field of study. AI is a discipline of computer science that addresses cognitive difficulties, including learning, problem-solving, and pattern recognition, and adapts them (Chen et al., 2020).

Technical Aspects of AI in Education

AI-assisted education encompasses intelligent guidance, advanced virtual learning experiences, data analysis, and predictive capabilities. AI has broadened the scope of education by catering to diverse learning requirements. Both educators and students now enjoy the advantages of timely, customized training and feedback facilitated by intelligent educational systems. These systems harness a range of computing technologies, with a strong focus on machine learning, which closely aligns with statistical models and cognitive learning theories, ultimately enhancing the value and effectiveness of the learning journey. AI-based educational systems employ a multitude of strategies rooted in machine learning, data mining, and knowledge models, encompassing elements such as learning analysis, instructional components, and knowledge acquisition. At its core, an AI-powered educational system comprises instructional materials, data, and intelligent algorithms, further classifiable into system models

and intelligent technologies (Han, 2018). Table 2 provides insights into various scenarios and methodologies for the integration of AI in education.

Table. 2: Techniques for Scenarios of AI in Education

Scenarios	Techniques
Assessment of Pupils and Institutes	Academic analytics, adaptive learning technique, and individualized learning approach
Grading and Evaluation of Exams	Computer vision, image recognition, and prediction system
Individualized intelligent instruction	Baycsin knowledge interference data mining, intelligent teaching systems, and learning analytics
Smart School	Face and speech recognition, virtual laboratories, audio and video recognition, hearing, and sensing technologies
Online and mobile distance learning	Real-time analysis, edge computing, and virtual personal assistants

AI Education Model

In AI-based learning systems, the incorporation of learner models plays a pivotal role in the enhancement of self-directed learning abilities. These learner models are constructed by assimilating data pertaining to learner actions observed during the instructional process. The evaluation of learners' self-directed learning skills involves an assessment of their reasoning abilities and cognitive aptitude. Subsequently, a knowledge analysis is conducted to gauge the extent of learners' mastery of the subject matter. The objective of learner modeling is to create associations between educational outcomes and a range of elements, such as teaching approaches, learning materials, and instructional resources (Kim & Park, 2017).

Knowledge models serve as comprehensive informational structures within learning materials. They often encompass expert knowledge, and guidelines addressing common learner errors, and misconceptions. The instructional model, which combines both the knowledge domain model and the learner model, establishes guidelines for accessing the knowledge domain. This empowers educators to tailor their teaching methods and interventions according to specific student needs. As students progress in their education, they tend to exhibit more favorable behaviors, take proactive steps, and seek assistance as required. Tutoring models incorporate predefined teaching strategies that AI systems can consistently employ to provide guidance. Through various input and output mediums, the user interface serves to elucidate the students' performance levels. The advanced human-machine interface incorporates AI-related functionalities, including speech recognition, emotion recognition, and natural language interaction with learners (Terzopoulos & Satratzemi, 2019).

Intelligent Education Technologies

Educational technologies such as data mining, machine learning, and learning analytics are closely intertwined. Presently, two distinct communities have emerged in the domains of educational data mining and learning analytics. These communities share common objectives and methodologies, drawing support from various

academic disciplines, including machine learning, data mining, statistics, psychometrics, and data modeling. In the realm of learning analytics, particular emphasis is placed on large-scale test results and learning content management systems. The field of intelligent tutoring systems, which primarily deals with highly detailed cognitive processes, has given rise to the practice of data mining (Pinkwart, 2016). The intelligent education technologies under discussion encompass:

Machine Learning

Machine learning is fundamentally centered on the concept of knowledge discovery, which entails the examination of sample datasets referred to as "training data" in order to reveal significant patterns and organized information.

For instance, machine learning can be applied to assist students in making course and college selections by utilizing information like student preferences, goals, and past successes to match them with institutions where their potential can be maximized. Moreover, this technology can aid educators in understanding how students are comprehending various subjects. This insight enables teachers to adapt their teaching methods based on aggregated student performance data, potentially enhancing students' grasp of the subject matter. For example, machine learning's abilities in image recognition and prediction can be utilized to rapidly and accurately evaluate student assignments and exams, surpassing human assessment in both efficiency and precision. It's noteworthy that deep learning, a subfield of machine learning, has garnered substantial popularity. Within the domain of machine learning, decision tree learning, inductive logic programming, clustering, reinforcement learning, and Bayesian networks are some of the commonly employed methods.

Deep learning, from a technical perspective, focuses on the development of increasingly meaningful representations through the incorporation of additional layers. These layered models referred to as neural networks, are constructed with successive layers stacked upon each other to extract intricate layer-specific characteristics (Sonntag et al., 2017).

Learning Analytics

Learning analytics primarily concentrates on the collection of data concerning student attributes and knowledge entities acquired from learner models and knowledge domain models.

This approach introduces a novel technology, machine learning, into the non-technical domain of education. The overarching aim is to tailor teaching strategies to individual learners' needs and abilities. This may entail taking action to assist students who are at risk or delivering valuable feedback and educational resources. Learning analytics relies on techniques derived from a range of disciplines, including the learning sciences, data visualization, machine learning, and semantics. For example, AI-driven competency-based learning, which collects critical student data, can efficiently reveal insights about individual students and forecast the primary

competencies they should focus on. This proactive strategy empowers educational institutions to make well-informed decisions to aid their students (Rienties et al., 2020).

In addition to competency-based learning, learning analytics also leverages the adaptive learning functionalities of AI. Artificial intelligence can take into account multiple factors to classify potential students according to their risk of discontinuing their education, creating early warning systems and providing valuable insights for educational institutions. The forthcoming challenge for learning analytics is to broaden its applicability beyond its existing areas of emphasis to include disciplines like literature, the arts, interpersonal skills, and others.

These areas introduce a higher level of complexity when it comes to measuring and assessing competencies or learning outcomes. Striking a balance between applying learning analytics in specific learning environments while ensuring its adaptability for use across various courses and institutions remains a challenge. The increasing adoption of learning analytics holds promise for enhancing learning outcomes for students, teachers, administrators, and educational institutions as a whole (Salas-Pilco et al., 2022).

Data Mining

Data mining in education provides systematic and automatic answers. AI-based educational data mining establishes internal association rules and gives students personalized knowledge pieces. A few written tasks can be utilized to assess student demographics and grade data. Machine-learning regression can predict student performance and execute this study. Data mining is a powerful tool for boosting learning and understanding educational situations and students (Navale et al., 2016). Data mining uses pattern recognition and predictive modeling to reveal hidden information, helping educators improve curriculum creation. Personalizing learning experiences using knowledge domain data is a major use of AI-driven data mining.

This lets students learn at their own speed with AI. Individualized learning lets students choose subjects and lets teachers tailor lessons to their interests. Data mining helps AI build intelligence more accurately, improving results (Yahaya et al., 2020).

The Role of AI in Education

The education sector is anticipated to experience significant transformation due to the substantial potential of AI. AI possesses considerable power and has the capacity to affect various aspects of society, inciting substantial changes within them. Evidently, AI has found acceptance and practical application in the field of education, leading to significant advancements in various aspects of the industry. The utilization of AI in education, particularly in areas such as administration and instruction, has had an influence on students' learning outcomes (Zhai et al., 2021).

A variety of AI applications have been created within educational environments, as revealed by the academic sources examined in this study. These applications encompass the automation of administrative functions and

processes, the creation of educational curricula and course materials, teaching methodologies, and the enhancement of student learning procedures. AI has notably increased the effectiveness of administrative tasks, which include tasks such as overseeing students' progress, grading assignments, and delivering feedback. This enhancement has been achieved through the automation of these tasks via web-based platforms or computer programs (Hwang & Tu, 2021; Aggarwal & Girdhar, 2022).

AI has found applications within the education sector, contributing to the creation of curricula, educational materials, and lesson plans. These educational resources leverage a variety of tools and technologies, including virtual reality, web-based platforms, robotics, video conferencing, audiovisual materials, and 3-D technology. This integration of AI tools has resulted in more efficient and effective teaching practices, leading to more personalized and comprehensive learning experiences for students (Aldosari, 2020). Furthermore, a deeper examination of various sources has uncovered noteworthy insights. It has become apparent that AI's application in education has the potential to transcend the physical limitations imposed by national and international borders. This is achieved by hosting learning resources on the Internet and the World Wide Web, allowing access from virtually anywhere. Moreover, the incorporation of AI features, such as language translation tools, enables students to learn in a manner that aligns with their unique abilities and language preferences. Whether through online learning or web-based educational platforms, educational content has become readily accessible to learners across the globe (Jain & Jain, 2019).

The several publications we studied show that more focused applications of AI in education come in a variety of shapes. The broad use of AI in a variety of fields, including content development, teaching strategies, student evaluation, and teacher-student communication, was emphasized by Chassignol et al., (2018). For instance, the study by Chassignol et al., (2018) found that AI has been heavily incorporated into assessment, teaching and pedagogical approaches, curriculum building, and student-teacher communication.

Research Questions

- **RQ1:** What is the role of AI in instructional pedagogy?
- **RQ2:** What are the potential benefits of AI in education?
- **RQ3:** What are the future implications of AI in education?

Results

RQ1: What is the Role of AI in Instructional Pedagogy?

AI in Instructional Pedagogy

The analysis of selected papers reveals a prominent application of AI systems that has experienced significant growth, which is the domain of teaching and instructional support. AI has played a pivotal role in simplifying the development and utilization of highly effective teaching aids, thereby enhancing the quality of education. The various papers under scrutiny explore and highlight diverse platforms and applications of AI as an instructional tool. Mikropoulos & Natsis (2011) underscore the use of virtual reality, 3-D technology, and highly interactive simulations as educational tools that facilitate students' comprehension of various subjects. Similarly, Wartman

& Combs (2018) emphasize the application of AI in medical education through virtual reality and simulations, which guide students in practical aspects of their education, including performing procedures and understanding human anatomy. Another significant aspect of AI in education as an instructional tool is the creation and deployment of robots as teaching assistants and collaborators, often referred to as cobots. These robots are capable of conducting both basic and complex educational activities, such as teaching children how to read and pronounce words, as demonstrated by Chiu & Chai (2020). Sharma et al. (2020) highlight that the integration of AI into education, particularly in conjunction with other technologies, has led to the development and utilization of enhanced teaching tools, further enriching the instructional landscape. AI gives humanoids and other robots the ability to reason and make decisions, as well as to communicate and converse, which makes it possible to employ them as teaching and educational aids. The application of AI in instructional pedagogy is shown in Figure 2.
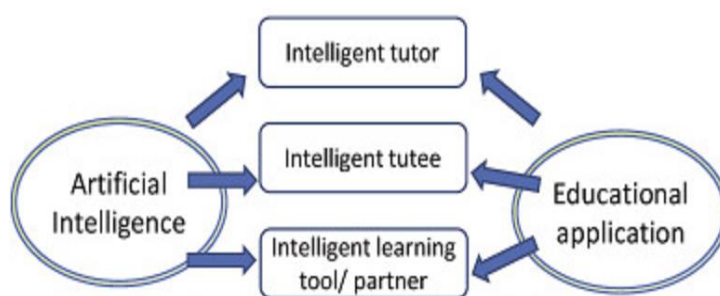
Figure.2: Artificial Intelligence in Instructional Pedagogy

Several research studies have explored the applications of intelligent tutoring systems (ITS) from various perspectives. For instance, Rus et al. (2015) discovered that ITS, capable of engaging in discussions and dialogues and integrated with animated conversational agents such as chatbots or cobots, has significantly enhanced teaching effectiveness. These findings are consistent with the ideas presented by Pokrivcakova (2019) regarding the use of artificial intelligence (AI) in education. Pokrivcakova discussed the application of AI in computer-assisted language learning (CALL), which offers customized guidance to students and helps language learners with writing and translation. Kahraman et al. (2016) explored the incorporation of AI in web-based education, particularly through AIWBES (AI in Web-Based Educational Systems). This approach imbues the platform with teacher-like capabilities, making it a powerful educational tool. Similarly, Peredo et al. (2011) investigated intelligent and adaptive web-based systems (IWBE) that view teachers as social agents within the system. The goal of this system is to understand and support teachers in their roles, providing guidance to students to ensure effective and systematic use of web-based educational technology for an enhanced learning experience. AI has been integrated into various technologies and approaches, either as a standalone educational tool or as a means to assist teachers in fulfilling their educational duties.

Performance of Instructor and Student

It would be intriguing to investigate the potential impact of artificial intelligence on both student and teacher performance within intelligent educational systems. AI systems have the potential to significantly alleviate the workload of teachers, particularly as the number of students in educational institutions continues to rise. These AI

systems can assist educators in analyzing the curriculum and course materials, subsequently offering tailored content recommendations. Furthermore, post-analysis, these systems can even generate and evaluate examinations. This automation allows teachers to allocate more of their attention to pressing issues, such as student performance (Chan & Zary, 2019). AI solutions also hold promise in effectively assessing student data in personalized teaching and self-directed learning contexts. This capability empowers teachers to develop individualized lesson plans for each student, enhancing the educational experience. Addressing the issue of human bias is another evolving challenge in the integration of AI in education. To mitigate bias, AI systems can assess essays and exams based on predefined criteria and standards. Computer vision-based AI systems, which can read and recognize handwritten documents and images, play a pivotal role in this process. These technologies not only help reduce bias but also safeguard against plagiarism and cheating (Renz & Hilbig, 2020).

AI systems have detected learning gaps in students and are proactively addressing these issues during their early education by analyzing student data. Unlike the traditional educational system, which provides uniform treatment to the majority of students, AI recognizes that optimal teaching performance cannot be achieved by applying the same teaching approach to all students (Lin et al., 2018; Verma, 2018).

As a conclusion, AI offers enormous promise for speeding up and automating administrative duties for both institutions and teachers. The marking of essays and assignments can already be automated by AI, freeing up teachers' time to deal with pupils one-on-one. New approaches to grading essays and examinations are being developed by AI developers. AI develops adaptable learning digital interfaces for students of different ages and grade levels in terms of educational resources. In addition, AI makes it possible for teachers to obtain knowledge for their students based on the complete learning ecosystem (Carin, 2020).

RQ2: What are the potential benefits of AI in education?

Some of the potential benefits of AI in education are discussed in the following lines:

Personalized Learning Environment

AI-based solutions have the capability to adapt to students' academic levels, their pace of learning, and their current educational objectives. This capacity can be instrumental in helping students select the most suitable courses for their requirements. Programs related to artificial intelligence can evaluate individuals' prior learning experiences, pinpoint their areas of weakness, and suggest relevant courses accordingly.

Tutoring

Many students need support beyond the traditional classroom setting, whether it's for exam preparation or help with homework. Finding professors with enough time to address these individual needs can be challenging. AI chatbots and tutors can provide students with personalized guidance for their unique learning styles outside the classroom. AI technologies can play a crucial role in helping students identify and enhance their areas of weakness.

Quick Response

During the educational journey, students often need assistance in resolving their queries, and this assistance is typically sought from specialized experts. Artificial intelligence (AI) can provide rapid responses to students' inquiries, ensuring that learning resources are accessible around the clock, seven days a week. With the assistance of AI, students have the flexibility to study from any location and at any time. This enables them to access high-quality education without incurring additional costs associated with living or travel expenses.

Personalized Course Programs

AI-based tools may assess students' learning abilities and history to offer teachers an overview of their weak points that demand assistance. It enables the creation of tailored educational curricula by collecting and analyzing student data. An appropriate learning program can now be established in the future.

Customization of the Academic Curriculum

Artificial intelligence (AI)-powered machines have the ability to tailor academic curricula to individual needs. The integration of AI technologies in global classrooms enables the inclusion of students with hearing or vision impairments, as well as those who are ill and unable to attend classes. In the traditional educational system, instructors evaluate students based on their assignments and tests, which can be time-consuming. However, when AI is introduced into this context, it can efficiently handle these tasks. Furthermore, AI assists in offering guidance on addressing learning gaps.

AI Provides Resources

People who speak different languages, those with hearing or vision impairments, or individuals conversant in various languages can all derive advantages from the capabilities of artificial intelligence (AI). One example of an AI-driven application is Presentation Translator, which provides real-time subtitles. For instance, with the assistance of Google Translate, students can both read and hear content in their native language. Contemporary technologies such as virtual reality (VR) and gamification prove valuable for fostering greater engagement in meetings and interactions.

Student Assessment and Grading

Multiple choice examinations were previously occasionally assessed by computers, and now advancements are being made that would allow written solutions, such as paragraphs and assertions, to also be rated by computers. As a result, a teacher's job is made simpler, there is no time wasted, and the time saved can be used to focus more on the growth and assessment of each individual student.

Admissions and Enrollment Processes

In the future, artificial intelligence (AI) has the potential to play a significant role in managing the processes related to admissions and enrollment, although its complete capabilities remain to be fully realized. AI has the capacity to assist students in improving their at-home study routines and in planning for exams. In the future, AI will have the capability to adapt to diverse learning approaches. The advancement of more advanced tutoring and study systems can be attributed entirely to AI. The educational sector is presently exploring various applications of AI, including the concept of AI mentors to support students.

Adaptive Group Formation

Students can be divided into groups by AI that are most suited for specific assignments. Adaptive group formation is the term for this. Software using artificial intelligence that can evaluate student essays right away. These writings are added to a central database, and the database's prior essays may be used to compare future articles. Computer-based AI in education enables individualized, flexible, and perceptive instruction.

Intelligent Tutoring System

The Intelligent Tutoring System promotes one-on-one individualized tutoring. They can make a verdict against an individual student based on neural networks and algorithms. Students are already being exposed to a plethora of higher education options because to AI. AI has the potential to completely transform the sector of education. Robots can improve grammatical accuracy and generate digital material. Teaching in the schools has already begun to be digitalized.

RQ3: What are the future implications of AI in education?

A suitable exam may be swiftly created using AI to understand a student's needs. It can instantly create a customized learning plan for each student, repeat classes as necessary, and demonstrate to pupils their level of knowledge. Artificial intelligence (AI) might give teachers a virtual teaching assistant, freeing up the teacher's time to roam around the classroom and encourage learning. Involving parents in the educational process and giving them the knowledge, they require to support their children's success outside of the classroom may boost parents as well as teachers and students more broadly. Teachers should take advantage of this chance to become knowledgeable about the potential applications of AI and to be open to dialogues with students. The future evolution of Artificial Intelligence in Education is shown in Figure 2.
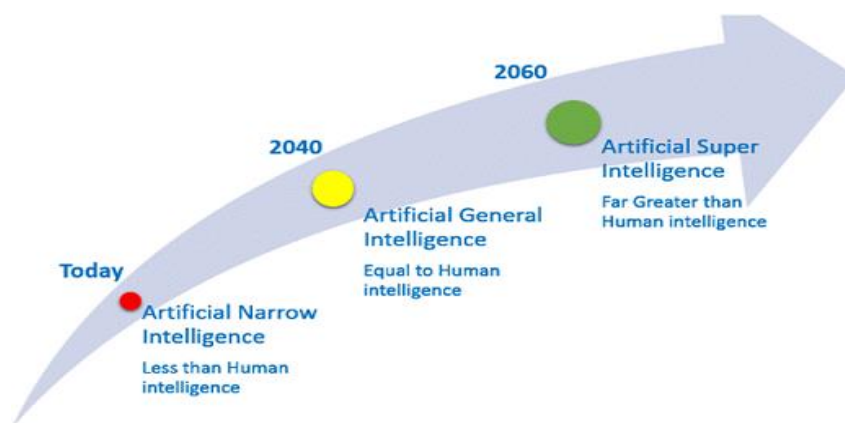
Figure. 2: Future Evolution of Artificial Intelligence in Education (Ongsulee, 2017)

Recommendations

On the basis of the results of the study following recommendations have been stated:

1. More studies should be done on the application of artificial intelligence in education especially in instructional pedagogy to explore the more beneficial knowledge of AI in education.
2. Artificial intelligence should be included in the curriculum at all levels of education for the practical implications of Artificial Intelligence in education.
3. There should be a project related to the application of artificial intelligence in education at the higher education level to gain hands-on experience in artificial intelligence.

Discussion for Implications

AI is an advancing technology with the potential to revolutionize various aspects of our social interactions. In the realm of education, AI has initiated the development of innovative teaching and learning solutions, currently undergoing testing in various scenarios (Panigrahi, 2020). A fundamental objective of AI in education is to offer personalized learning assistance or support to individual students, taking into account their learning progress, preferences, and personal traits. For instance, an AI system can replace a tutor by monitoring students' learning processes, assessing their academic progress, and providing immediate support tailored to their needs. Through interdisciplinary collaboration, an intelligent tutoring system can be created to cater to students' anticipated needs. This system not only enables students to study, practice, and interact with peers and professors but also offers guidance, assistance, and support based on their specific circumstances or requirements. Conversely, if educators possess an understanding of AI technology's capabilities and attributes, they can incorporate appropriate AI applications into their courses to enhance students' learning outcomes, motivation, and engagement.

This study aimed to explain how AI is used in instructional pedagogy. The study was formulated to find the answers to three research questions. The findings related to each research question are discussed as:

Findings Related to RQ1

The first research question of this study was "What is the Role of Artificial Intelligence in Instructional Pedagogy?" The findings related to this research question are discussed in the following lines:

a.   AI has simplified the development and utilization of highly efficient teaching aids, significantly enhancing educational quality.

b.   The simulation-based lessons give students an actual or practical learning experience by utilizing various technologies, such as virtual reality, to illustrate or teach pupils concepts or realistically exhibit contents.

c.   Better teaching tools have been created and are now being used as a result of the integration or use of AI in education, more specifically as instructional tools and in conjunction with other technologies.

d.   AI gives humanoids and other robots the ability to reason and make decisions, as well as to communicate and converse, which makes it possible to employ them as teaching and educational aids.

e.   The realization of teaching efficacy has been aided by intelligent tutoring systems that are equipped with conversational and dialogue capabilities as well as animated conversational agents in the form of chatbots or cobots.

f.   Writing and translation aids in language learning, as well as computer-assisted language learning that gives students or learners personalized instructions.

g.   Intelligent Web-Based Education (IWBE) systems in which teachers are examined and portrayed as social agents. The system then aims to comprehend and support teachers in carrying out their mandates, to give instructions and directions to students, with the goal of ensuring that the technology, web-based education, used in education is an effective and methodical way to improve learner experience.

h.   Deep Tutor and Auto Tutor are examples of learner-centered systems that encourage customization and individualized material based on the learner's skills and requirements, therefore improving the learner's experience and supporting the attainment of the stated learning objectives.

Findings Related to RQ2

The second research in this study pertained to the potential advantages of artificial intelligence in education. The conclusions regarding this research question are presented in the following lines:

AI Benefits for Students

Personalization: Personalization is a significant trend in education, facilitated by the incorporation of AI. This trend allows students to experience tailored learning programs that consider their unique backgrounds and interests. AI plays a crucial role in this by adapting to each student's level of knowledge, pace of learning, and educational objectives, ensuring that every student can optimize their learning experience. Furthermore, AI-driven tools can evaluate students' past academic performance, identify areas requiring improvement, and suggest suitable courses, thereby creating numerous opportunities for a customized and highly effective learning environment.

Tutoring: Personalization is a prominent trend in education, marked by the individualized approach to learning programs made possible by the integration of AI. Through AI, students now receive customized learning experiences tailored to their unique backgrounds and interests. AI has the capacity to adapt to each student's level of knowledge, pace of learning, and ultimate educational objectives, ensuring that every student maximizes their learning potential. Moreover, AI-driven tools can analyze students' previous academic achievements, identify areas in need of improvement, and suggest relevant courses, thereby creating numerous opportunities for a personalized learning environment.

Quick Responses: Few things are as frustrating as posing a question and waiting three days for a response. Teachers and staff often encounter a daily deluge of repetitive inquiries. AI, equipped with support automation and conversational intelligence, can promptly furnish answers to the most commonly asked questions by students. This not only alleviates a significant burden on teachers' time but also reduces the time students need to seek information or await responses to their inquiries.

AI Benefits for Teachers

Personalization: AI can customize educational programs for kids and teachers alike. By examining students' learning styles and prior performance, AI can furnish instructors with valuable insights into which courses and lessons require reassessment. Armed with this data, teachers can devise highly effective learning programs tailored to each student's specific needs. Moreover, educators can adapt their curriculum to address prevalent knowledge gaps or areas of concern before a student falls significantly behind, thus ensuring a more personalized and effective educational experience for all.

Answering Questions: AI-powered chatbots can respond to a range of common and repeated inquiries posed by students without consulting a faculty person since they have access to the complete body of information at a given institution. By avoiding the teacher, AI gives them more time to devote to lesson planning, curriculum research, or enhancing student engagement.

Findings Related to RQ3

The third inquiry in this study revolved around the prospective implications of artificial intelligence in education. The conclusions related to this research query are presented below:

The impact of AI on the future of education is poised to be substantial, with AI playing a supportive role in teaching and learning processes. The domain of education is not immune to the rapid advancements in technology, particularly in areas such as artificial intelligence (AI), machine learning (ML), and robotics. To fully harness AI's potential for the benefit of all, it is essential to introduce the younger generation to AI at an early stage and integrate this technology into the classroom. Teachers have already observed that many students are active users of social media platforms, indicating their receptiveness to the educational possibilities presented by AI.

Conclusion

The development of artificial intelligence has marked the onset of a new era in computer-assisted learning. AI systems can assume roles such as intelligent tutors, tools, or tutees, enhancing decision-making processes in educational settings by incorporating human intelligence. The convergence of AI and education opens a new window of opportunity to significantly elevate the quality of instruction and learning. Intelligent technologies that support tasks like assessments, data collection, learning enhancement, and innovative instructional strategies can be valuable assets for educators. Asynchronous learning and intelligent tutoring systems have the potential to improve students' learning outcomes. Moreover, the integration of AI with education represents a transformative shift not only in the field of education but also in human knowledge, cognition, and civilization. Consequently, AI in education is rapidly emerging as a prominent research area within the domain of computer-assisted learning and is poised to be a topic of considerable debate in the future.

References

Aggarwal, R., & Girdhar, N. (2022). The role of artificial intelligence in the education sector: possibilities and challenges. Machine Learning, Block chain, and Cyber Security in Smart Environments, 17-39.

Alam, A. (2021, November). Possibilities and Apprehensions in the Landscape of Artificial Intelligence in Education. In 2021 International Conference on Computational Intelligence and Computing Applications (ICCICA) (pp. 1-8). IEEE.

Aldosari, S. A. M. (2020). The future of higher education in the light of artificial intelligence transformations. International Journal of Higher Education, 9(3), 145-151.

Baker, T., Smith, L., & Anissa, N. (2019). Education AI rebooted? Exploring the future of artificial intelligence in schools and colleges. Retrieved May, 12, 2020.

Becker, B. (2017). Artificial intelligence in education: what is it, where is it now, where is it going. Ireland's Yearbook of Education, 2018, 42-46.

Carin, L. (2020). On artificial intelligence and deep learning within medical education. Academic Medicine, 95(11S), S10-S11.

Chan, K. S., & Zary, N. (2019). Applications and challenges of implementing artificial intelligence in medical education: integrative review. JMIR medical education, 5(1), e13930.

Chassignol, M., Khoroshavin, A., Klimova, A., & Bilyatdinova, A. (2018). Artificial Intelligence trends in education: a narrative overview. Procedia Computer Science, 136, 16-24.

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. Ieee Access, 8, 75264-75278.

Chiu, T. K., & Chai, C. S. (2020). Sustainable curriculum planning for artificial intelligence education: A self-determination theory perspective. Sustainability, 12(14), 5568.

Coppin, B. (2004). Artificial intelligence illuminated. Jones & Bartlett Learning.

Guan, C., Mou, J., & Jiang, Z. (2020). Artificial intelligence innovation in education: a twenty-year data-driven historical analysis. International Journal of Innovation Studies, 4(4), 134-147.

Hafeez, M., Ajmal, F., & Zulfiqar, Z. (2022). Assessment of Students' Academic Achievements in Online and Face-to-Face Learning in Higher Education. Journal of Technology and Science Education, 12(1), 259-

273.

Han, L. (2018, December). Analysis of new advances in the application of artificial intelligence to education. In 2018 3rd International Conference on Education, E-learning and Management Technology (EEMT 2018) (pp. 608-611). Atlantis Press.

Hössjer, O., Díaz-Pachón, D. A., & Rao, J. S. (2022). A formal framework for knowledge acquisition: going beyond machine learning. Entropy, 24(10), 1469.

Hwang, G. J. (2003). A conceptual map model for developing intelligent tutoring systems. Computers & Education, 40(3), 217-235.

Hwang, G. J., & Tu, Y. F. (2021). Roles and research trends of artificial intelligence in mathematics education: A bibliometric mapping analysis and systematic review. Mathematics, 9(6), 584.

Jain, S., & Jain, R. (2019). Role of artificial intelligence in higher education—An empirical investigation. IJRAR-International Journal of Research and Analytical Reviews, 6(2), 144z-150z.

Kahraman, S. A. İ. R. (2016). Estimating the penetration rate in diamond drilling in laboratory works using the regression and artificial neural network analysis. Neural Processing Letters, 43(2), 523-535.

Kim, K., & Park, Y. (2017). A development and application of the teaching and learning model of artificial intelligence education for elementary students. Journal of The Korean Association of Information Education, 21(1), 139-149.

Lin, P. H., Wooders, A., Wang, J. T. Y., & Yuan, W. M. (2018). Artificial intelligence, the missing piece of online education? IEEE Engineering Management Review, 46(3), 25-28.

Luan, H., Geczy, P., Lai, H., Gobert, J., Yang, S. J., Ogata, H., ... & Tsai, C. C. (2020). Challenges and future directions of big data and artificial intelligence in education. Frontiers in psychology, 11, 580820.

Mikropoulos, T. A., & Natsis, A. (2011). Educational virtual environments: A ten-year review of empirical research (1999–2009). Computers & education, 56(3), 769-780.

Navale, G. S., Dudhwala, N., Jadhav, K., Gabda, P., & Vihangam, B. K. (2016). Prediction of stock market using data mining and artificial intelligence. International Journal of Computer Applications, 134(12), 9-11.

Nilsson, N. J., & Nilsson, N. J. (1998). Artificial intelligence: a new synthesis. Morgan Kaufmann.

Ongsulee, P. (2017, November). Artificial intelligence, machine learning and deep learning. In 2017 15th international conference on ICT and knowledge engineering (ICT&KE) (pp. 1-6). IEEE.

Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: The three paradigms. Computers and Education: Artificial Intelligence, 2, 100020.

Panigrahi, C. M. A. (2020). Use of artificial intelligence in education. Management Accountant, 55, 64-67.

Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). Artificial intelligence in education: Challenges and opportunities for sustainable development.

Peredo, R., Canales, A., Menchaca, A., & Peredo, I. (2011). Intelligent Web-based education system for adaptive learning. Expert Systems with Applications, 38(12), 14690-14702.

Pinkwart, N. (2016). Another 25 years of AIED? Challenges and opportunities for intelligent educational technologies of the future. International journal of artificial intelligence in education, 26(2), 771-783.

Pokrivčáková, S. (2019). Preparing teachers for the application of AI-powered technologies in foreign language education. Journal of Language and Cultural Education.

Renz, A., & Hilbig, R. (2020). Prerequisites for artificial intelligence in further education: identification of drivers,

barriers, and business models of educational technology companies. International Journal of Educational Technology in Higher Education, 17(1), 1-21.

Rienties, B., Køhler Simonsen, H., & Herodotou, C. (2020, July). Defining the boundaries between artificial intelligence in education, computer-supported collaborative learning, educational data mining, and learning analytics: A need for coherence. In Frontiers in Education (Vol. 5, p. 128). Frontiers Media SA.

Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education. International Journal of Artificial Intelligence in Education, 26(2), 582-599.

Ross, P. (1987). Intelligent tutoring systems. Journal of Computer Assisted Learning, 3(4), 194-203.

Rus, V., Niraula, N., & Banjade, R. (2015, March). DeepTutor: An effective, online intelligent tutoring system that promotes deep learning. In Twenty-ninth aaai conference on artificial intelligence.

Sadiku, M. N., Ashaolu, T. J., Ajayi-Majebi, A., & Musa, S. M. (2021). Artificial Intelligence in Social Media. International Journal of Scientific Advances, v2, i1.

Salas-Pilco, S. Z., Xiao, K., & Hu, X. (2022). Artificial Intelligence and Learning Analytics in Teacher Education: A Systematic Review. Education Sciences, 12(8), 569.

Sharma, K., Giannakos, M., & Dillenbourg, P. (2020). Eye-tracking and artificial intelligence to enhance motivation and learning. Smart Learning Environments, 7(1), 1-19.

Sonntag, D., Zillner, S., Smagt, P. V. D., & Lörincz, A. (2017). Overview of the CPS for smart factories project: Deep learning, knowledge acquisition, anomaly detection and intelligent user interfaces. In Industrial internet of things (pp. 487-504). Springer, Cham.

Taş, N., & Gülcü, A. (2019). *Bilgisayar Destekli Öğretimin Temelleri [Fundamentals of Computer Aided Instruction]*. Erzurum: Ertual Akademi.

Terzopoulos, G., & Satratzemi, M. (2019, September). Voice assistants and artificial intelligence in education. In Proceedings of the 9th Balkan Conference on Informatics (pp. 1-6).

Verma, M. (2018). Artificial intelligence and its scope in different areas with special reference to the field of education. Online Submission, 3(1), 5-10.

Wartman, S. A., & Combs, C. D. (2018). Medical education must move from the information age to the age of artificial intelligence. Academic Medicine, 93(8), 1107-1109.

Yahaya, L., Oye, N. D., & Garba, E. J. (2020). A comprehensive review on heart disease prediction using data mining and machine learning techniques. American Journal of Artificial Intelligence, 4(1), 20-29.

Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., ... & Li, Y. (2021). A Review of Artificial Intelligence (AI) in Education from 2010 to 2020. Complexity, 2021.

Author Information

Muhammad Hafeez

https://orcid.org/0000-0002-3262-7014

Institute of Southern Punjab

Multan

Pakistan

Contact e-mail: *mh9589041@gmail.com*

Fouzia Ajmal

https://orcid.org/0000-0002-7346-2025

International Islamic University

Islamabad

Pakistan

Zahid Zulfiqar

https://orcid.org/0000-0002-6691-9373

National College of Business Administration and Economics

Multan

Pakistan

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