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REVIEW ARTICLE

THE EVOLUTION OF LEARNING: A SURVEY OF AI TECHNOLOGIES IN EDUCATION

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Abstract

AI technology has revolutionized education, simplifying management, enabling personalized learning, and enhancing student engagement. From initial Intelligent Teaching Systems (ITS) to advanced adaptive learning algorithms, AI's impact on education has been profound. This piece delves into AI's history in schools and its applications, including personalized learning, language education, and administrative efficiency. While AI offers benefits like automated tasks and 24/7 student support, it also raises concerns such as discrimination and privacy breaches. Balancing these advancements with ethical considerations is crucial to ensure equitable and responsible implementation of AI in education.

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Introduction:-

The two-sigma problem in AIED seeks to match human tutoring effectiveness, driving advancements towards "faster classrooms" [1]. While computers aid in step-by-step problem-solving, modern education emphasizes broader competencies like metacognition and teamwork [2]. However, current models often lack student agency and tailored support. Adaptive tutoring systems offer personalized instruction [3], while online learning, encouraged by digitization, empowers students' learning autonomy [4]. Addressing these gaps is essential for equitable, effective AI-driven education.

Related work

Adaptive intelligent tutoring systems are gaining traction, offering customizable instruction to cater to individual learning needs [3]. The rise of online learning, facilitated by digitization, enhances student autonomy and accessibility [4]. A shift towards online education is evident, with universities launching numerous online programs to meet evolving student demands [5]. Speed is crucial in selecting online courses, with mobile learning becoming increasingly essential for students [6]. According to [7], 19% of prospective students would consider another online degree program offered by the same school. The absence of online options may lead students to explore alternatives elsewhere, risking enrolment loss for institutions. [7] Also emphasizes the importance of speed in selecting online courses, with a significant portion of applicants making decisions within the first month of their search. Mobile learning is crucial for online students, highlighting the need for institutions to optimize accessibility through technology. Additionally, [8] examines the impact of COVID-19 on education, recommending strategies for progression. Home education scrutiny and disrupted assessments are discussed, with occasional benefits noted despite challenges. The COVID-19 pandemic has accelerated the adoption of AI in various aspects of education, from tracking the virus's spread to enhancing learning experiences [9]. Despite the benefits, challenges such as digital infrastructure and technical issues persist [10]. Smart education leveraging AI and IoT holds promise for

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improving learning outcomes through enhanced interaction and adaptability [11]. However, successful implementation requires political support and consideration of instructors' roles and technological barriers [12].

Research gaps

AI in education has made strides, yet further research is imperative for its optimal utilization. While adaptive ITS offer personalized learning potential, their efficacy across diverse learners remains uncertain. Limited research on adapting ITS for disabled and underrepresented students underscores gaps in understanding intersectionality's impact. Moreover, long-term benefits of online education lack comprehensive study despite its post-COVID prevalence, necessitating exploration of digital access issues. Ethical concerns, including data protection and bias, demand attention, alongside technical challenges in resource-limited settings. Bridging these gaps is vital to enhance learning quality and inclusivity, requiring collaborative efforts and policy changes for sustainable AI integration in education. In summary, addressing these research voids is pivotal to maximize AI's positive impact on student learning.

The Early Applications of AI in the Classroom

During the 1970s and 1980s, AI devices like Intelligent Teaching Systems (ITS) emerged in schools, offering personalized lessons by adjusting materials and pacing based on individual performance. Natural Language Processing (NLP) in language learning apps allowed students to interact with computer programs using everyday language, enhancing language skills [13].

Technology in education today

Today, educational technology is integral in schools, teaching students essential computer skills alongside traditional subjects. Educational standards, like "The ISTE Standards for Students," now emphasize creativity, communication, collaboration, critical thinking, and digital citizenship. Similarly, the Partnership for 21st Century Skills promotes technology literacy for empowering students in a rapidly changing world [14]. Most teachers support these standards, aiming for students to master technology and leverage digital tools for learning, ensuring they are well-equipped for the future.

Artificial intelligence, machine learning, deep learning

Beginning in 1956, AI has been a recognised academic discipline. Since then, it has seen multiple waves of optimism and has been divided into different sub-fields. Technical factors, such as particular aims and tools (like "logic" or "ANNs"), mostly serve to divide these subfields.

Artificial intelligence

Defining AI is challenging due to its evolving nature and interdisciplinary roots. Specialists from fields like linguistics, neuroscience, and psychology contribute to AI, each with their own perspectives and terminology. Various scholars have attempted definitions, ranging from machines mimicking human intelligence to systems understanding and learning from data to achieve goals. AI encompasses fields beyond computer science, including information science, psychology, linguistics, neuroscience, philosophy, and mathematics. Despite efforts, there's no universally agreed-upon definition, making AI a vast and multidisciplinary field. In essence, AI involves computers performing cognitive tasks, typically associated with human minds, such as learning and problem-solving [15-17].

Machine learning

Machine Learning (ML) evolved from AI, specifically focusing on computational learning and pattern recognition. Its core aim is enabling data to be learned and utilized for predictions. In 1959, Arthur Samuel coined the term "ML" to denote learning without explicit programming. Moreover, [18] offers a formal definition: "a computer program learns from experience E in tasks T, improving performance measure P with experience." ML deploys models on input data to make predictions, transcending rigid program instructions. It's universally recognized as a method for training smart agents with vast data. While ML contributes major components like clustering, classification, and RL, achieving general AI remains elusive, despite being a subset of AI. ML's interdisciplinary nature spans various fields, rooted in statistics, as per [19].

Deep Learning

In 1986, Rina Dechter introduced the concept of layered processing, later termed Data Layered Processing (DL), to the machine learning (ML) community, while Igor Aizenberg and colleagues applied it to Artificial Neural Networks (ANNs) in 2000. DL employs multiple layers to extract higher-level features from data, with three main

types: supervised, semi-supervised, and unsupervised, as [20] notes. Though termed "neural networks," ANNs differ significantly from biological brains, being more symbolic and static. Recent neural network advancements have boosted AI capabilities. Neuroscience has guided neural network development, highlighting architectural and algorithmic constraints. DL is a subset of ML, which, in turn, is a subset of AI, as seen in AIED applications encompassing both MLEd and DLEd.

AI in Education

NITI Aayog's "Responsible AI" suggests AI's potential in education, improving learning experiences and lowering dropout rates through customized interventions, showcasing AIED's utility. Educational institutions increasingly employ AI technologies like virtual teaching assistants, adaptive learning platforms, and chatbots for efficiency. AI's connection with education spans three domains: "learning about AI," "learning with AI," and "preparing for AI," fostering inclusive education. AIED facilitates remote learning, benefiting students regardless of location or health, exemplified by platforms like Coursera. Adaptive learning, a standout AIED application, tracks student progress and tailors materials accordingly. AI-driven admissions processes in Higher Education Institutions (HEIs) mitigate bias, ensuring fair selection, while AI enables global classrooms accessible to diverse students. [21][22]

AI in Technical Education

AI enhances technical education quality, as advocated by the All India Council for Technical Education (AICTE). AICTE recommends Bachelor of Technology programs with AI and data science concentrations, integrating AI into existing B.Tech.curriculum. AICTE's report reveals a surge in Indian colleges offering courses in AI, data science, and related fields since 2019–20, totalling 127 institutions. AI not only streamlines educational administration but also enriches teaching methods and empowers instructors. It's a lifelong learning tool, facilitating transcription of lectures and creating localized teaching materials as per NEP 2020. Chatbots find diverse applications in technical education, from enrolment management to success analysis [23].

Potential of Artificial Intelligence in Education

AI's integration into education heralds a transformative era, employing virtual reality, personalized algorithms, and automation to enhance learning. Teachers leverage AI to tailor lessons based on individual student data, optimizing engagement and performance [24]. Students benefit from round-the-clock support through AI-powered chatbots, immersive learning via virtual reality, and dynamic personalized quizzes. AI's data analysis capabilities empower educators to create tailored lesson plans, fostering better academic outcomes. Furthermore, AI, including ChatGPT, accelerates research by swiftly analyzing vast data volumes, aiding in text summarization, sentiment analysis, and language translation, though ultimately, researchers retain decision-making responsibilities [25].

AI in foreign language education

Advancements in deep learning, networked learning, and data processing have propelled AI applications like Intelligent CALL (ICALL), promising customized learning experiences. ICALL's adaptive algorithms offer personalized feedback, minimizing time and cost while enhancing student engagement. By analyzing individual and group learner actions, ICALL predicts future performance, adjusts study materials, and provides immediate feedback, catering to diverse learning preferences. It fosters self-paced learning, targeted improvement, objective assessment, and efficient resource evaluation, though ethical considerations arise with its extensive personalization. [26][27]

Utilising AI writing assistants

AI writing assistants, utilizing natural language processing and machine learning, aid in augmented writing, guiding users through the process. Correcting grammar, offering improvement suggestions, and supplying supplementary materials for researchers [28], they empower foreign language learners to independently navigate writing tasks, fostering self-correction and reflection. Integration of AI enhances students' self-regulation and independence. Prominent AI writing assistants include Essaybot, Grammarly, ProWritingAid, Textio, and AI Writer.

Education with ChatGPT

Concerns arise regarding ChatGPT's use in grading written tasks, potentially undermining traditional assessment methods like essays. Educators fear students may exploit ChatGPT for easy content generation, bypassing plagiarism detection due to its convincing language generation [29]. Resistance to change in assessment practices persists despite critiques of dullness and ineffectiveness in written assignments. ChatGPT's ability to generate content without comprehension or evaluation raises further apprehension. However, its essay-generating capabilities

present novel classroom applications. Experts advocate for AI technologies like ChatGPT to enhance learning experiences, urging a shift towards viewing assessments as opportunities for both student and teacher growth [30]. Despite its disruptive potential, ChatGPT offers opportunities to revitalize education through interactive lessons and immersive learning experiences.

Relying on intelligent tutoring systems (ITS)

Intelligent Tutoring Systems (ITS) offer digital alternatives to traditional classroom instruction, comprising domain, student, teaching, and interface models. Learner models, algorithms, and neural networks inform learning paths, content selection, and cognitive scaffolding, benefiting large-scale distance learning institutions with thousands of students [31]. Evolving from reactive to interactive systems, NLP-based tutoring systems provide remedial feedback and customized educational materials, accessible online or as downloadable software. Examples include Word Bricks, CASTLE, and Web Passive Voice Tutor. Additionally, Adaptive and Intelligent Systems for Collaborative Learning Support (AICLS) aim to foster social skills and knowledge through collaborative learning. Meta-analyses emphasize the importance of adaptability and inconspicuous integration for AICLS effectiveness [32].

Impact of AI on Educational Administration

AI streamlines classroom instruction and eases administrative burdens by automating tasks like scheduling and grading, freeing up teachers to focus on teaching and student support. Additionally, AI provides valuable insights to educators and administrators through data analytics, aiding decision-making in areas such as educational policies and resource allocation [33]. Chatbots and virtual assistants powered by AI offer immediate student support, enhancing efficiency and accessibility by providing assistance throughout the learning process.

Challenges and Concerns of AI in Education

Incorporating AI into classrooms brings many benefits but also raises ethical concerns. AI's potential to perpetuate bias and compromise student privacy is worrisome. Teachers note AI's ability to provide insightful answers, posing challenges for plagiarism detection. Additionally, as technology advances, there's fear of job loss among educators due to automation of administrative tasks. Ensuring equitable access to AI-powered education is crucial, especially with the rise of online learning. Bridging gaps in resources and access is essential for all students, irrespective of financial background or geographical location.

Conclusion:-

The integration of AI has transformed educational practices, evolving from language learning tools to virtual assistants and personalized learning systems. It streamlines administration, fosters student engagement, and tailors learning experiences. Chatbots and virtual assistants provide 24/7 support, while AI handles administrative tasks and data analysis for personalized lessons. However, ethical concerns arise regarding job displacement, bias, privacy, and accountability. Responsible use of AI in education requires collaboration among educators, policymakers, and technologists to ensure transparency and fairness. Despite challenges, AI offers the potential to enhance global education and cater to diverse learning needs, guided by values of excellence, fairness, and inclusivity.

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