AI AND STUDENT FEEDBACK

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Abstract

AI has the potential to have a transformative effect on teaching, learning, and assessment. This paper reviews recent literature on AI Education (AIEd). The paper makes recommendations for the development of edtech learning platforms using AI. This paper reviews recent literature on AI Education (AIEd). The review was conducted in three stages: the first and second were systematic reviews conducted in 2023; the third stage provides a narrative review of emerging issues since Chat GPT has been part of debates about AIEd. The literature reflects positive progress regarding personalised learning journeys, AI-enhanced grading and evaluation, conversational agents for speaking and listening practice, and early interventions for struggling students. The review extends to the incorporation of AI within educational administration, encompassing learning analytics and predictive capabilities. The originality of this study arises from the paucity of studies on AI in the context of bricks and mortar school classrooms. The rigour of the study is the result of the systematic selection of current, targeted peer-reviewed studies. Emerging studies each make their own contributions to knowledge in areas such as learning design, adaptive learning, modelling, and knowledge mapping. There were concerns about privacy, biased input leading to stereotypical judgments, and ethics and privacy. Furthermore, the study acknowledges the need for ongoing research into AI Ed.

Keywords: AI, artificial intelligence, edtech, machine learning.

1 INTRODUCTION

This paper adds a synthesis of findings from recent literature on AI Ed related to its integration of AI Education. It highlights a shift towards personalised learning journeys. The synthesis examines the specific roles of AI in education, including the creation of campus digital assistants, the benefits and issues of AI deployment for student wellbeing, and the evolution of AI Ed platforms. The review also emphasises the need for AI Ed platforms to be grounded in theory, to use dynamic modelling for personalised learning, and to consider the integration of GPTs for adaptive learning experiences and personalised tuition. In terms of gaps in the literature, the paper identifies a gap in systematic reviews linking AI to educational technology and the need for better communication between edtech and AI spaces, and policymakers.

Digital learning platforms have supported education since the late 1990s [1] and have gradually evolved by exploiting technological developments. Artificial Intelligence (AI) may offer the next opportunity to significantly enhance digital learning platforms for both students and tutors as it mimics humans' cognition, learning, dialogue, and problem-solving [2].

The influence of AI may be multifaceted but there is not yet a consensus around agreed definitions. Earlier debates about the various taxonomies of educational technologies (edtech) have been reconsidered, considering the rapid adoption of AI. Author [3-6] discussed a chasm between contested taxonomies and the hybridity and fluidity of edtech, and these papers drew from earlier studies that were often non-empirical, though they may have had empirical validation [7-10].

2 METHODOLOGY

2.1 Stage 1

Stage 1 of the systematic review in Author [5] narrowed the search to chatbots and wellbeing. The paper used bibliographic databases, notably the Social Science Citation Index (SSCI), Academic Search Ultimate (EBSCO HOST), Project Muse, Directory of Open Access Journals (DOAJ), Arts & Humanities Citation Index, Cambridge Core, and Linguistics and Language Behaviour Abstract (LLBA). To narrow the search, the paper applied specific filters such as: "full text online", "peer-reviewed journals", "open access", "articles", "years 2018–2023", "artificial intelligence", "students", "education", "machine learning", "conference proceedings", and "books". Books that were selected were those informed by

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recent studies [11-13]. The initial focus was on exploring the role of AI in secondary or high school education, beginning from the year 2018, as this marked the start of a significant increase in related studies on LLM [13]. The research explored a variety of AI applications, including virtual teaching assistants, voice-activated AI, and coachbots [4, 5]. Additionally, the review paid attention to machine learning digital assistants like Siri, Cortana, and Alexa [14-17], while other chatbots use pattern matching or decision trees [14-16, 4]. The next stage was to place the term “artificial intelligence” in double inverted commas, so that Proquest and Springer would return phrases instead of words. The search could be more specifically focused by adding “AND” in upper case and enclosed double inverted commas. The paper found that the most fruitful words and phrases that would accompany “Chatbot” “AND” were wellbeing, mental health, education, artificial intelligence, AI, resilience, conversational agents, learning, collaboration, humanity, schools, and meta-analysis [4]. The search results would be narrowed further by de-selecting any studies before 2015, which is when prominent AI applications such as Siri from Apple and intelligent personal assistants (IPAs) like Amazon’s Alexa and Microsoft’s Cortana experienced mass adoption [4]. While there were not enough meta-analyses for a second-order synthesis, the next phase of this paper used Google Scholar and the university database to select appropriate journals [18, 4].

2.2 Stage 2

This paper’s search strategy was also designed to further examine the intersection of artificial intelligence (AI) and education by investigating keywords such as “machine learning”, “intelligent systems”, “large language models”, “natural language processing”, “chatbots”, “GPT”, and “data mining”. The objective is to understand their application in the educational context, particularly within virtual learning environments. To achieve this, the research focused on papers that link AI (context) with education (objective) and involve an AIEd platform or environment. The research scope will be restricted to articles published in English, peer-reviewed, and released in the last five years, which aligns with the introduction of large language models in 2018 [19]. Additionally, the authors reviewed the articles’ abstracts and conclusions to eliminate inappropriate articles before performing a complete review. Consequently, a total of 56 articles were reviewed for this work.

3 RESULTS

3.1 Stage 1

In the top 50 cited articles, frequently used keywords are AI (n=215), education, (38), machine learning (18), higher education (15), physical education (13), and technology (12) [4]. In terms of themes, the review noted that AI applications, including chatbots and virtual reality systems, have been used to address rising mental health concerns among young people, especially amid the pandemic [20, 21]. This is accompanied, however, by attendant concerns about the ethics, reliability, and neutrality of AI data [22-27]. Concerns were raised about potential changes in children's brain development and the risk of AI developing 'psychopathic' behaviors [22, 23]. Another highlighted issue was the potential deception of students by AI and the need for more refined conceptual tools and a sense of 'augmented ethics' [28].

Author [5] deployed the PRISMA model to ensure that the review was rooted in empiricism [29]. An advantage of this approach was to resist a rush to firm generalisations in favour of an ‘interpretive understanding’ [4, 30]. This approach continued in the chapter on AI in Author [5]. Constructivist grounded theory helped distil and sharpen potentially unwieldy or contradictory data [31, 18]. In addition to this, the approach enabled a more pragmatic acknowledgment of multiple realities [4]. Limitations to a consensus around these developments were the impact of the pandemic, a time lag between the commencement of studies and their date of publication, a tendency for a restricted number of preliminary studies in light of the dominance of universities in the studies, and the pursuit of high citation rates [32, 4]. While many impactful studies are disseminated on social media and the blogosphere, they are excluded here as there is a risk of lacking academic rigour [4].

3.2 Stage 2: Pre Chat GPT

Systematic and comprehensive reviews at the start of the 2020s demonstrated that AI has been extensively adopted in various educational domains, including administration, instruction, and learning. AI Ed has been recognised as having an impact on broader technological advancements on employment and educational administration [22, 33]. Some earlier reviews identified an emphasis on embedding AI technologies in both formal and informal educational settings and integrating them into students' daily

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lives [34]. Reviews spanned two decades and identified gaps and areas of improvement [35, 36]. While some review papers have provided an overview, there have been more focused studies on specific aspects of education, for example, a survey on AI techniques for adaptive educational systems in e-learning platforms [1]. In terms of teaching, learning, and assessment, there were studies as early as 2020 examining student learning performance predictions and the rate of dropouts. AI can assist in educational processes and content, offering real-time data evaluation, automated scoring, and potential improvements to educational programmes [22]. Conclusions pointed to emerging studies as the pace of AI gathered momentum, for example, the increasing importance of personalised learning, which was viewed as promoting more efficient, personalised learning experiences, with potential applications in assessment, grading, and intelligent, bespoke teaching [1, 22, 37]. In terms of limitations and concerns this stage of the review, there were ethical and privacy issues related to data collection, teachers' challenges in interpreting statistical data, and other concerns [22]; a limited focus on real-time AI applications in education and lack of dataset discussions [33, 1] and potential biases in selected research articles, possibly leaning towards older publications [33].

3.3 Stage 2: Administration and assessment

The literature has focused on ways in which AI can minimise the time educators allocate to administrative chores, allowing a more concentrated focus on the delivery of pedagogical content [33]. Furthermore, AI's capabilities extend to student assessment and grading, even with formative assessment of open-ended questions [38]. There is also the possibility of crafting individualised teaching methods and generating customised learning plans anchored in students' data. Recent studies have demonstrated innovative methods of data analysis, such as multiple regression, explorative studies, and confirmatory composite analysis, focusing on the effectiveness of chatbot design and their role as pedagogical agents. Online intelligent platforms are reflecting the broader integration of AI into educational pedagogy and providing personalised learning experiences [33, 39, 40]. Indeed, this adoption of tools is accompanied by integration with broader AI trends. This convergence of tools and wider phenomena is a global phenomenon and the literature is chronicling personalised and adaptive student learning that combines the strengths of self-study and cooperative learning with potentially revolutionising pedagogical methodologies [33, 1, 41-43]. This transformative potential is being reported globally [34, 44, 45].

Despite hyperbolical claims, much of the literature is cautious, even sceptical. While AI ED’s interactivity may be viewed as a strength, comparative effectiveness and holistic integration require further exploration [41, 40]. In the context of higher education institutions, the benefits of AI in education are clear, but the practicalities of integration, especially considering regional nuances, pose logistical and pedagogical challenges [45, 33, 40]. Furthermore, there are regional disparities in terms of adoption and these affect AI Ed’s educational impacts [33, 22, 45]. These challenges may be addressed through a targeted focus on smart education, to ensure inclusive, adaptive learning experiences [34, 40]. Crucially, emerging literature reflects a need for a sound pedagogical grounding through ongoing diagnostics and analysis of responses to feedback [34, 46, 40]. This dynamic, not static, may help the integration of AI tools, though alignment with human-driven teaching methodologies and existing educational frameworks remains a challenge [34, 47, 40].

3.4 Stage 3: narrative review and conclusions

3.4.1 Chat GPT

The rapid adoption of Chat GPT has served as a catalyst for the acceleration of progress in large language models (LLM) and natural language processing (NLP). AI has had a significant impact on many domains such as customer service, security, and banking. From late 2022, Chat-GPT has amplified the potential for sophisticated AI-aided text generation. Indeed, Chat GPT has been considered as a valid co-author of academic papers [48]. At the same time, the disruptive nature of Chat GPT’s unprecedented adoption rate has intensified fears of misinformation and calls for tighter regulation [49, 4, 50]. Furthermore, Chat GPT’s imitative sophistication has been posited alongside its child-like heuristic learning [51]. Both LLM and AI Ed have previously been shown to help automate time-consuming teaching activities such as planning, scheduling, and feedback; the hope is that teachers may be liberated to spend more time focusing on teaching activities and interacting with students [52-54, 4]. Collaborative studies like Kasneci et al. [37] list the potential for Chat GPT to have an impact on multiple areas of teaching, learning, and assessment, though they also explore risks of bias, the need to upskill teachers, and the danger of deskilling students [37]. On a more granular level,

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Chat GPT has been successful in enabling chemistry students to generate their own short answer questions [55].

The use of Chat GPT in education mirrors wider debates about the risk of applying outdated or discredited learning theories onto new technologies. Examples of these are learning styles [40] and Bloom's Taxonomy [55]. Recent and emerging studies indicate the growing popularity of Chat-GPT in AIEd articles and an increasing adoption rate of AI across various application domains, including profiling and prediction. Concerns are linked to misinformation of hallucinations [56]; there were concerns about earlier GPT's mathematical, semantic, and ethical limitations in 2020 [57]. There was a paucity of literature on Chat GPT in UK schools at the time of writing. Further study will examine the challenges regarding the integration of Chat GPT into existing platforms, learning management systems (LMS), and management information systems (MIS) [4].

3.4.2 Integration of AI Chat GPT

The literature is demonstrating evidence that automatic feedback improves students' performance without increasing teacher workload [11]. For example, Devlin et al. [58] devised a language representation model called BERT (Bidirectional Encoder Representation), which improved results across eleven natural language tasks. While AIEd may be deployed to enhance and optimise teaching, proponents of it do not intend to replace teachers [41, 36]. AIEd may also pose ethical and privacy issues that must be considered before they are adopted by educational institutions [23, 28, 59, 4].

The integration of Artificial Intelligence (AI) in the educational sector is a prominent theme across many studies. The role of AI in education is often seen as both transformative and facilitative, reshaping the nature and distribution of tasks [22]. Literature isolates two primary areas where AI intervenes: the educational process and the educational content [22]. Chen, Chen, and Lin [33] develop this by indicating that AI had, at the time of writing, already infiltrated the educational space, with impacts noticeable in areas such as administration, instruction, and learning [33]. In terms of administration, the literature reflects an ambivalence regarding algorithmic decision making versus human decision making; this ambivalence draws on evidence about perceptions of efficiency and fairness [60]. Commonly studied AI applications in the educational sector range from automated grading and real-time student performance evaluation to identifying improvement areas in educational programs and offering personalised learning pathways with streamlined data management [1]. Despite the innovation in terms of the iterative and collaborative development of AI applications and the research methods deployed, there is still a paucity of systematic reviews linking AI to edtech [4]. Moreover, potential momentum may be hindered by an absence of consistent communication between the edtech space, the AI space, and policymakers. One reason for this might be the limited access that those operating outside academia have to peer-reviewed literature and clear dissemination of studies. This may also lead to a lack of criticality toward research evidence in the domains of AI and educational technologies [61, 4].

3.4.3 Futures

Roll and Wylie's [34] systematic review posits two distinct trajectories for AI's impact on education: one that builds upon current classroom practices (evolutionary) and another that integrates technology more deeply into students' daily routines (revolutionary). Despite these forward-looking projections, their meta-analysis of AI research across three decades also highlights a conspicuous absence of focus on holistic learning skills in AI-enhanced education, such as metacognition, critical thinking, and collaboration [34]. While AI's integration into education has potential for crafting individualised and efficient learning experiences, there remain a series of challenges and limitations that need addressing. Future studies could probe the ethical implications of AI, especially concerning data ownership. Additionally, there is a need to investigate AI's feasibility across diverse educational scenarios and contexts. There's also a call for deeper explorations into the interplay between AI or machine learning techniques and the unique characteristics of learners. Indeed, the conflation of Machine Learning (ML) and AI in the educational sphere spans various applications, from curating personalised learning experiences to foreseeing student performance and aiding educators. One example is a chemistry-specific study of pre-training Chat GPT versus fine-tuning data points from a dataset [62]. Several techniques, such as K-Nearest Neighbors (KNN), Naïve Bayes, Regression, Random Forest, Decision Tree, Support Vector Machine (SVM), and Neural Networks, have found their way into educational platforms [63, 36].

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3.4.4 Personalised learning

The transformative potential of AI in higher education institutions is a global phenomenon, with diverse cultures and geographies [45, 34, 44]. While the benefits of AI in education are evident, the practical challenges associated with its integration, especially considering regional variations, pose complex issues that require careful consideration [45, 33, 40]. The universal allure of AI is undeniable, but regional disparities and adoption rates affect educational impact and measurable outcomes [45, 33, 22]. The emergence of AI-driven platforms designed to offer personalised learning experiences represents a significant development in educational pedagogy. These platforms are designed to cater to the individual needs and preferences of students, aligning with the global drive towards personalised and adaptive learning in the field of AI-enhanced education [41, 22, 40]. AI-enhanced learning pathways combine the benefits of self-directed study with collaborative learning [33, 1, 64]. While this encourages interactivity, engagement, and active participation, there are questions regarding the comparative effectiveness and integration of AI into education [41, 40]. Indeed, questions about personalisation of learning may necessitate a reconsideration of how students learn - even if this means adapting the term, 'learning styles'. The myth of learning styles may have been debunked as far back as the 1990s but elements of it still persist. It is widely acknowledged that learning styles have been judged as dichotomous, conceptually confused and lacking empirical evidence [65, 66]. If AI can identify and support diverse learning behaviours and ensure inclusive educational experiences, how much of this is relevant to the notion of learning styles [34]? Tapalova & Zhiyenbayeva [40] acknowledged that while individualised learning pathways may appear to be a logical way to support students, the evidence finds that this personalisation does not always accelerate learning. The problem arises when outdated or discredited pedagogies are bolted onto emerging technologies. An example of this is the use of static modelling - based on inaccurate pre-test data [40, 47]. Tetzlaff et al. [47] favour dynamic modelling. Here, dynamic means effective learning that is open to change when students are being instructed and when they interact with that instruction. Dynamic modelling, therefore, also necessitates dynamic assessment, during which frequent checks on progress and understanding may identify changes in the learner characteristics [47]. One important variable, however, is the alignment, or lack of alignment with human-driven pedagogies teaching that frequently inhabit existing educational frameworks [34, 40]. A further proposal is the development of a more human-centred AI, which is ethical and designed to minimise risk and reflect human values [67]. Others would argue that human values are exactly the problem with AI's propensity to spread misinformation, even bigotry [23]. A great deal of work is emerging in this area, but it has been de-selected from this review, as it needs to be more embedded into the overall literature.

4 CONCLUSIONS

This section will draw conclusions from the literature and make recommendations for how an AI ED platform might develop its AI functionality. All recommendations will act on the recommendation that research into AI could benefit from being grounded in theory [39]

4.1 Taxonomies

This review develops earlier issues surrounding the taxonomies of edtech by positioning the literature in the context of AI Ed. The rapidity with which new developments in AI are emerging may necessitate the need for taxonomies of AI to acknowledge fluidity, hybridity and the use of folksonomies, as well as taxonomies. This may require more opinion pieces that draw on social media and blogs, as the ethical approval and peer review process can delay the production of potentially transformative content [4].

4.2 Personalised learning

AIEd functionality could create a more personalised learning experience for each student by continually re-assessing individual strengths, weaknesses, and an ongoing, dynamic assessment of developing interaction with learning [47, 40]. This may require the implementation of machine learning techniques that suit the learning outcomes [68, 36]. It would be advisable to consider embedding Chat GPT's functionality, without making compromises on ethics or risking data security [33, 37]. At the time of writing, Chat GPT's iterations are outpacing expectations to a great extent. Chat GPT's functionality will continue to develop, which will necessitate agile and adaptable architecture. The starting point, however, may be to deploy chatbots as educational assistants to answer students' questions and provide instant feedback. This can enhance the learning experience by ensuring that students receive timely assistance. One of the recommendations of Author [4] was an instrumental case study of one AI Ed

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platform. More work is also needed to track how accelerating adoption of GPTs may normalise pupils' ability to tutor themselves.

4.3 Virtual assistants

Aligned to Chat GPT's functionality, AI Ed could incorporate voice-activated AI, similar to Siri, Cortana, and Alexa, to facilitate student-teacher interactions and make administrative tasks more efficient [69, 14]. In the initial iterations, there will be no immediate plans to incorporate VR for immersive experiences. Virtual assistants will need to be programmed and trained to avoid discriminatory practices and judgments. This becomes more acute when the AI provides an immersive experience. There is a great deal in the literature about various AI applications in education, among which are virtual teaching assistants and voice-activated AI systems. At the time of writing, it looks likely that AI Ed platforms may seek to embed virtual teaching assistants, similar to those created via Chat GPT. These may help students by answering queries, giving instant feedback, and assisting with homework or assignment clarifications. The virtual TA may be customisable; it may be a static virtual entity. As with all AI Ed developments, the reality at ground level will inevitably be tethered to debates about ethics, practice, and policy. These debates become more pressing when the learning journey is individualised, even customisable.

4.4 Predictive analytics to create personalised learning journeys

AI could predict at-risk students from within AI Ed platforms' database and provide early, tailored interventions, with instant feedback, real-time data analysis, and automated grading. This could facilitate an AI-driven pathway for each student in GCSE English, centred around their individual abilities and areas for improvement in reading, writing, and speaking and listening. These pathways could be built on a student model that takes a granular, adaptive approach to misconceptions [70].

AIEd could facilitate personalised learning journeys by continuously reassessing students' individual strengths and weaknesses, requiring the implementation of suitable machine learning techniques. Furthermore, the architecture of AIEd platforms, including chatbots and virtual assistants, should be agile and adaptable to enable it to focus on student support and administrative efficiency without compromising ethics or data security. Predictive analytics could be used for early and tailored interventions for at-risk students and accelerate the design and implementation of personalised learning pathways. Future AI Ed platforms may include virtual teaching assistants and voice-activated AI systems to facilitate student-teacher interactions, with live and ongoing feedback to ensure improvement and effectiveness over time.

4.5 Feedback and continuous improvement

The intention behind AI in education is to optimise and enhance teaching rather than to replace human educators. There may be mechanisms, however, for teachers to offer feedback on the platform's performance. AI should be viewed as an auxiliary tool complementing the teacher's role. Continuous feedback loops should ensure the platform evolves and becomes even more effective over time. As with all AI, results and datasets will need to be explainable, so that the sources or results and deductions made are transparent. A clear limitation of this paper is that there are likely to be significant progress in the development of Chat GPT and other GPTs and LLM by the time of publication; the global literature is quickly responding to the pedagogical opportunities and ethical and practical issues around Chat GPT in education. That said, the pace of change of AI places the researcher in an impossible situation that resembles the Myth of Proteus, who changed shape whenever people got close to him revealing his infinite knowledge [3].

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