# A Review of AI-Enabled Personalised Teaching (2021–2025): Progress, Impact, and Future Directions

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## Abstract

*Between 2021 and 2025, AI-enabled teaching emerged as a key innovation in addressing global educational challenges such as teacher shortages, learning disparities, and skills gaps. For the first time, it promised to give learners outside of a lab or limited settings, a personal teacher available to support their diverse needs in highly personalised ways 24/7. This paper critically reviews the evolution of AI-integrated teaching, synthesising insights from existing literature alongside findings from four major research studies conducted by the authors during this period. Central to these investigations is OIAI, an AI-teacher system developed and piloted by the researchers across Africa, Europe, Asia, North America and South America. These form the basis of a pioneering implementation in two African nations; Kenya and São Tomé and Príncipe, in 2025.*

## Introduction

Early research into the concept of using AI to teach and learn between 2019 and 2020 started building on the idea of improved learning experiences and outcomes with AI. Primarily at that time chatbots were looked at as standalone instruments with limited narrow scope. An over whelming focus was on language learning because of its wide use and narrow focus on only one discipline which has continued (e.g., Madhuri, Fatma, Kumari, Pathak, & Faizal, 2024). Furthermore, chatbots always were perceived as tools lacking human likeness and the personal touch important for developing more teacher like personas and experiences (Cerny, 2023). This was a narrow viewpoint of what teaching is and studies prior to this timeframe also were limited to the avenues of narrow and focused use cases of AI in teaching and learning. These included basic explanations or questions and answers and were mostly very small-scale lab style experiments. This idea of course has been there for a while but was limited by the then advances in AI. A notable early AI teacher experiment was SCHOLAR, developed by Jaime Carbonell in 1970 (Guan, Mou, & Jiang, 2020). A famous more recent example was the Jill Watson bot released in the Georgia Institute of Technology in 2016 as an experiment and then further research was done on it between 2018-2020 (Design Intelligence Lab, 2025). Similarly, early research funded by Innovate UK in 2021 in South Africa was conducted where a chatbot, developed by the researchers of this paper and Otermans Institute, acted as a teaching mentor and learning guide (a virtual coach) on a MOOC platform called Weave Connect targeting women (Otermans, & Aditya, 2024). They investigated the role of AI-driven chatbots in supporting the educational and career development of underserved women. The key findings showed that these women had a positive user experience and found the Virtual Coach to be engaging, trustworthy, and helpful in guiding their learning paths, and now knew what to learn next. Also, interacting with the chatbot increased the women's confidence and clarity regarding their career progression. Therefore, this study concluded that AI-powered virtual coaches can effectively support the upskilling of underserved women by providing accessible, personalised, and engaging learning experiences. Such tools have the potential to bridge educational gaps and promote lifelong learning, aligning with global development goals.

### Objectives

The aim of this paper is to develop a comprehensive and reliable review on the implementation, effectiveness, and pedagogical impact of AI teachers in learning with a focus on one-to-one teaching delivered by the AI to learners. This includes examining how AI-driven teaching tools are used to support learning, evaluating their outcomes across diverse contexts, and identifying best practices and theoretical frameworks that inform their integration into teaching and learning processes. The paper focuses on the growing ability of the technology to move outside of controlled settings into mainstream and public use.

## Methodology

The study employed a systematic review to build a dependable evidence base for on the use of AI teachers. A systematic review is a method that promotes transparency and repeatability, resulting in a thorough and credible synthesis of existing literature (Dixon-Woods, 2011, p. 332). To ensure comprehensive coverage of relevant research, five major academic databases were searched: ACM Digital Library, ERIC (Education Resources Information Centre), Web of Science, Academic Search Complete, and Google Scholar. These databases include a diverse range of studies, including those from non-Western contexts that challenge Eurocentric perspectives (Otermans, Nagada, Aditya, & Pereira, 2024). The criteria for inclusion were

availability of full text, presence of an abstract, and publication between 2021 and 2025. The researchers conducted the literature search using the following search terms: "AI teacher". The term "AI teacher" was chosen as the core focus was looking at teaching delivery by an AI to users with a preference to one-to-one teaching delivery especially outside the classroom. One-to-one delivery and personalised teaching by AI were removed as being that specific resulted in having few to no papers.

## Analysis

A total of 144 articles, along with the research question, were identified. The researchers reviewed the titles and full texts to determine their relevance to the research question. Final decisions on inclusion were made collaboratively, based on the following criteria:

- Does the article describe the use of an AI teacher?
- Does it evaluate the effectiveness of an AI teacher for learning outside the classroom?
- Does it discuss how an AI teacher can be used for one-to-one learning?
- Does it discuss how AI and AI teachers can be used for enhanced personalised learning?
- How does it describe the human likeness of an AI teacher?

After thorough discussion, 22 selected research outputs were deemed relevant (see Figure 1). Each article was read in full and summarised, and some earlier conference proceedings conducted by the researchers were added where they supported the findings.

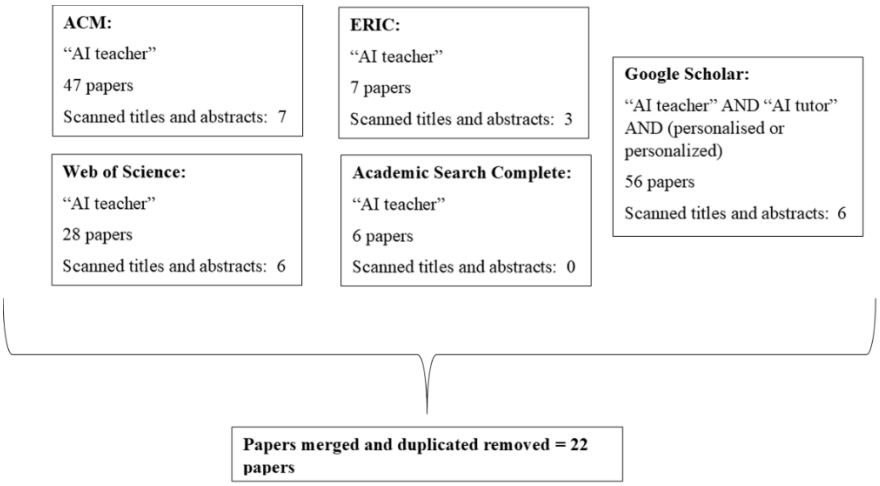


***Figure 1: Overview of Databases Used and Identified Papers.***

### Analysis and Discussion

Artificial intelligence is increasingly recognised for its potential to transform education, moving beyond simple tools to function as intelligent instructional agents and teachers (Malik, & Shah, 2025; Qin, Hao, Yu, Liu, & Zhang, 2025). This evolution, as found in the literature review, is enabling advancements in personalised learning, allowing AI teachers to directly engage students, teach in a one-to-one capacity, support learning outside the classroom, and incorporate aspects of human likeness, although limitations

persist in fully replicating the complex role of human educators (Aditya, Silvestri, & Otermans, 2024; Mulian, Shlomov, Limonad, Noccaro, & Buscaglione, 2024; Bai, Cheng, Zhang, Qin, Xu, & Zhou, 2025; Habib, Sattar, Iqbal, & Saleem, 2025; Malik, & Shah, 2025; Qin, Hao, Yu, Liu, & Zhang, 2025).

**Personalisation Caused by Learning Directly by AI**

A primary opportunity for AI in education is individualised learning, where AI can tailor instruction to each student's specific needs and characteristics (Bühler, Jelinek, & Nübel, 2022; Dehraj, & Hussain, 2024). AI systems are being developed to provide personalised learning experiences (Aditya et al., 2024; Habib et al., 2025; Sack, & Little, 2025) moving beyond a one-size-fits-all approach (Bühler et al., 2022). This personalisation can involve adaptive feedback, customised learning paths, and dynamic content delivery. AI tutors and teachers can assess student performance in real-time, identify weaknesses, and adjust the curriculum or learning pathways accordingly (Aditya et al., 2024). Studies show that personalised support and instructions tailored to a student's strengths and needs can lead to improved grades, higher engagement, and a better attitude toward learning (Habib et al., 2025). AI can create custom learning tracks for students, helping them reach goals or identify weak points to work on. The degree of personalisation can be enhanced by the amount of data collected about the student. Intelligent tutoring systems, powered by AI, are seen as having the potential to significantly transform online learning through enhanced personalisation (Ye, Sun, & Li, 2021). Please note that for the purpose of this paper the terms “tutoring” and “teaching” are used interchangeably because of their similarities in line with the criteria selected for this review. AI can also be used to support teachers and their workload. Fan, Zhou, Yu, Wu, Gu, & Peng, (2025) introduced LitLinker, an interactive system powered by large language models designed to assist elementary school teachers in creating interdisciplinary literature lessons. Evaluations, including a within-subjects study with 16 participants and expert interviews with 9 teachers, demonstrated that LitLinker enhances the depth of interdisciplinary integration, reduces teachers' workload, and is perceived as a valuable tool for expanding instructional strategies. While this is not directly in line with the review’s criteria, it is worth mentioning because such systems can help teachers and the AI teacher in part encompasses such tasks (Aditya et al., 2024).

**Outside of Classroom Learning with AI Teachers**

AI teachers are being explored to support learning that occurs outside the conventional classroom setting, particularly in asynchronous environments (Aditya et al, 2024; Ji, Han, & Park, 2024). While traditional asynchronous systems like MOOCs have faced challenges with low engagement and completion rates (Duncan, Premnazeer, & Sithamparanathan, 2022), AI teachers offer a potential solution by providing scalable and consistent educational experiences. AI can provide round-the-clock availability, meaning students can access support and learning materials whenever they need them. AI systems integrated into asynchronous platforms, such as AI chatbots or teaching assistants in MOOCs, can increase engagement and make learning more interactive (Calabrese, Rivoli, Sciarrone, & Temperini, 2022). Furthermore, they can add value like becoming a Virtual Coach or a career mentor on the platform (Otermans, & Aditya, 2024). This interactive capability allows for what was traditionally unidirectional learning to become a two-way conversation. Students can leverage AI teachers for personalised support outside of scheduled learning hours, enabling them to clarify doubts, ask questions, and delve deeper into topics at their own pace and time. The interaction data generated from students using AI teachers outside the classroom can provide educators with valuable insights into student learning, helping them understand areas where students excel

or struggle (Aditya et al., 2024). Studies on AI teachers delivering courses in asynchronous settings have shown noteworthy completion rates of over 60%, high engagement, and high satisfaction, suggesting potential effectiveness compared to traditional asynchronous methods like MOOCs (Aditya et al., 2024). AI is viewed by some as the "missing piece" for online education (Kim, Merrill, Xu, & Sellnow, 2020).

### AI Teacher That Directly Teaches Students

The concept of an AI teacher, functioning as a direct instructor rather than just a tool or assistant, is gaining traction (Malik, & Shah, 2025). AI instructional agents are designed to emulate the role of a teacher by delivering content and guiding the learning process. These systems can deliver lectures dynamically, provide real-time content delivery, and actively structure and sequence instructional material. Beyond content delivery, AI teachers can also provide real-time feedback, corrective suggestions, and step-by-step guidance. They can automate tasks such as grading assignments and assessing student understanding. AI-based tutoring systems are being compared directly with human teachers in terms of their effectiveness on learning outcomes (Habib et al., 2025). While some studies indicate that AI-lectured classes can result in test scores comparable to those taught by human instructors (Bai et al., 2025), the benefits are often contingent upon the AI agent being designed for real-time interactivity and personalisation. AI teachers are being developed for various subjects and skills, including motor skills and foreign language learning. For instance, an AI product called Teddy AI is providing early years education (Otermans, Baines, Livingstone, & Aditya, under review), Khanmigo provides maths and other core school curriculum education (Bailey, & Warner, 2025), and OIAI is now enabling educators to upload their own content making the AI teacher content agnostic (Venturz, 2024). In the future, AI could generate entire personalised courses and customise complete curricula, although current generative AI used for content creation often still requires human review. AI can function as a solo teacher or collaborate with human teachers in co-teaching models (Aditya et al., 2024). It can also support teachers on their teaching. Markel, Opferman, Landay, & Piech (2023) introduced a chat-based training tool that uses GPT-powered student simulations to help novice teaching assistants practice teaching through realistic, low-pressure scenarios. Evaluations showed that this improved teaching assistant's engagement, adaptability, and confidence. Therefore, AI is transforming teaching & learning and contributing to the reform of education. Finally, such AI teachers that can teach and support learners on a one-to-one basis could give access to learners who currently not receive any direct teaching support. According to UNESCO (2025), the world needs 44 million primary and secondary teachers alone by 2030 to provide basic teaching access and universal basic education.

### AI Teachers That Teach One-To-One to Students

A key advantage of AI in education is its capacity for one-to-one instruction and support. Unlike human teachers who must manage an entire class, a virtual teacher can dedicate specialised attention to individual students. AI teachers are designed to support interaction initiated by the learner and adapt their responses based on student input (Qian, & Unhelkar, 2022). They can function as conversational tutors or AI teachers that directly answer student questions. AI teachers allow students to ask personalised questions tailored to their specific learning needs and to engage in dialogue about problems they encounter. This individualised interaction facilitates personalised support, allowing students to clarify doubts and receive feedback specifically relevant to them (Aditya et al., 2024; Otermans, Baines, Pereira, Livingstone, & Aditya, 2024). AI tutors have the potential to provide individualised support for learners and offer scaffolding tailored to the individual student. The design emphasis on supporting personalised pace and responsive interaction

highlights the potential of AI instructional agents for enhancing individual learning experiences. The ability of AI to create custom learning tracks also supports a one-to-one tailored approach (Li, Sun, & Qiu, 2024) and can also be used to develop personalised experiences for learners with neurodiversities.

**Human likeness of AI**

AI instructional agents are often designed with the goal of emulating aspects of human teacher behaviour and appearance (Tack, & Piech, 2022). This can involve creating animated on-screen avatars or virtual instructors (Aditya et al., 2024; Takita, Kodama, Hatada, Narumi, & Hirose, 2024), using natural language dialogue, and even employing multimedia presentations (Qin et al., 2025). Training AI teachers on human behavioural data, such as human teaching interactions, can enable the AI to generate behaviours that are similar to those of human teachers. Research has explored the effects of AI teacher appearance and voice on learning outcomes, with some findings suggesting that young children may have comparable preferences for AI-generated pedagogical agents and human teachers in certain contexts (Bai et al., 2025; Otermans, Sharma, Singh, & Aditya, 2024). Conversational AI systems are defined as systems that mimic human conversational abilities (Aditya et al., 2024). However, a significant limitation is that AI tutors often lack the emotional intelligence, empathy, motivation, nuanced understanding, warmth, encouragement, and sense of belonging that human teachers provide (Habib et al., 2025). While AI can provide structured learning and engage students, they may struggle to respond effectively to students' emotions. There is a recognised "significant gap" in AI tutors' ability to replicate the emotional and social support offered by human educators. Concerns exist regarding the potential for AI teachers to be dehumanising or desensitising. Despite advancements in creating anthropomorphic agents or intelligent virtual humans, research suggest that the human touch and social connectivity provided by human presence remain valuable, even when AI teachers are utilised (Aditya et al., 2024). Therefore, many suggest that AI should be primarily supplement, rather than completely replace, human teachers, emphasising the importance of human-AI collaboration. However, progress is exponential, and this limitation will become obsolete very soon. Back in 2021, already AI teachers were scoring high in several human-like dimensions (Aditya, Otermans, & Pereira, 2021) and after all generative AI passed the Tutoring test better than a human in 2025 (Cuthbertson, 2025). The relevance of subtle limitations in perceived human likeness for populations which have lower access to quality teaching is limited (UNESCO, 2025). There is also research suggesting that absolute human likeness may not be ideal for creating AI teachers because of the perception of an uncanny valley by users while interacting with the AI (Mishra, Ramanathan, Tulsulkar, & Thalmann, 2022). Finally, deep research is currently being undertaken to further humanise AI in the realm of teaching including for early childhood (Seo, Yang, & Kim, 2024).

**Limitations**

While the potential of AI in education is significant and advancements are being made across the areas discussed, several limitations and challenges must be noted. Comparative studies, particularly randomised controlled trials directly comparing AI agents as teachers with expert human teachers across diverse subjects and educational contexts, are still limited. One paper showed that AI teachers can be as effective as human instructors and may serve as a valuable teaching tool in educational settings (Otermans, Nagada, Baines, & Aditya, under review). There is a lack of empirical research on hybrid AI systems that effectively integrate both structured content delivery and dynamic learner interaction. This is being tested by the researchers in 2025 in São Tomé and Príncipe and Kenya. The effectiveness of AI agents is not universal

and is contingent on their design; benefits may vanish if they lack real-time interactivity or personalisation. AI teachers currently struggle to fully replicate the emotional and social support provided by human educators, lacking empathy (Sharma, Klemettilä, & Tanaka, 2025) nuanced understanding, and the ability to respond effectively to student emotions**.** Findings from studies conducted in specific settings (e.g., a moderate-difficulty, lecture-based university course) may not generalise to other types of courses or pedagogical approaches like problem-based learning or team-based learning. Most studies focus on immediate learning outcomes, leaving the long-term effects on retention, knowledge transfer, or study habits unclear. The effectiveness of AI is heavily dependent on the quality and diversity of its training data, which can introduce biases and potentially lead to homogenised learning outcomes despite personalised approaches. Practical challenges include the cost of implementation, the need for specific technical expertise and infrastructure, data privacy and security concerns when handling sensitive student information, and potential resistance to the adoption of AI by educators.

## Case Studies

In 2021, OIAI was launched as a first of its kind fully digital human teacher. It worked with voice and text and included a full humanistic avatar for human likeness. Although narrow in its first use case of focusing on soft skills and employability skills curriculum, it achieved several significant breakthroughs. Firstly, it was tested on multiple HCI benchmarks and scales to check for human likeness (Aditya et al., 2021). These scales included the System Usability Scale (Brooke, 1996), which assessed how easy and intuitive the AI trainer was to use, revealing usability scores below the standard benchmark of 68, likely due to language barriers. The Competence and Warmth Scales (Fiske, 2012) measured perceptions of the trainer's intelligence and interpersonal qualities, with high ratings indicating users viewed the AI as both competent and warm. The Social Attractiveness and Trustworthiness Scale (Nass, Isbister, Lee, 2000) gauged the trainer's likability and reliability, and users found the AI socially appealing and trustworthy. Lastly, the Social Presence Measure (Li, Kizilcec, Bailenson, Ju, 2016) evaluated the perceived engagement and presence of the AI during interactions, with results showing users felt a strong sense of connection. Overall, the AI trainer was perceived positively in terms of interpersonal and social qualities, although its usability required refinement at that time for broader application. This is similar to findings of Chen et al. (2023) on the perception and acceptance of an AI-driven robotic teacher sampled by 665 pupils. Their findings revealed generally positive attitudes toward AI teachers, with the relationship between task difficulty and acceptance mediated by anxiety, ease of use, and perceived usefulness, offering valuable insights for the development of effective AI educational tools. For OIAI, this then led to further developments including the AI teacher now doing webinars with larger cohorts of students. It was then realised that AI plays a pivotal role in personalisation of learning, e.g. every learner has different questions and thoughts which AI can deal with in a personal manner, and the focus returned to one-to-one learning.

This led to focusing on new systems to hyper personalise learning and this time across regions and educational backgrounds. Localisation was now a key aspect and the full-scale utilisation of generative AI models with finetuning and use case-oriented engineering came to fruition. Of the many early studies, one was in Kenya in 2023 where 193 students & educators of the Catholic University of Eastern Africa received 12 lessons from the AI teacher on Employability and Digital skills (Goal setting and Motivation, CV Writing, Effective Communication Skills, Self-Awareness and Wellbeing (Including social media use), Presentation Skills, Time Management and Procrastination, Leadership and Personal Growth, Organising

and Problem Solving, Critical Thinking). The results were spectacular (Berglund, Otermans, Aditya, & Silvestri, 2025). Learners spent over 60 minutes on average per lesson, aligning with the intended 60–70-minute design. Three additional topics were offered, and 75% of learners participated in these topics. Notably, 91.9% recommended the programme to others. Learners appreciated the clear explanations, the AI teacher, and the ability to learn at their own pace without compromising on quality. Regarding usefulness, 94.6% rated the AI teacher as very or extremely useful. Overall satisfaction was high, with 90.7% reporting they were very or extremely satisfied with the programme. Finally, there was a completion rate of 23.3% despite such a system being implemented by the students for the very first time; in fact, such a system was not used in Kenya prior to that time. Furthermore, the provision was not compulsory and yet the completion rate was higher than the global average of 7-14% (Duncan et al., 2022). The researchers further finetuned the system and this led to similar engagements in other countries including Palestine, Turkey and Chile covering Asia, Europe and South America. The result was an increase to up to 64% completion rates primarily driven by personalisation of learning (Aditya et al., 2024).

Parallelly, OIAI built a Retrieval-augmented generation (RAG) system that allowed for ingestion on most topics and areas of learning. This allowed institutions to upload their existing content and nations to input parts of national curriculum for the AI to teach. This further broadened the scope of teaching as compared to the narrowness of AI in 2019-2021. One of the first use cases of this was to move away from teaching only students and to teach the trainer to build a 'train the trainer' model. The first research on this was done in India and it showed very good outcomes (Otermans, & Aditya, 2024). More specifically the teachers who used the system had low digital skills and were not digitally native with a mean age of 36 years old. Despite this, there was a completion rate of 45.8% and on average 67 questions were asked to the AI per lesson indicating high engagement levels. Surveys completed at the end of the programme showed that 85.8% of participants found the AI teacher very or extremely useful, and 66.7% reported being very or extremely satisfied with the programme. Similarly, the now content-agnostic AI system started to support learners in schools in the UK in 2024. In 2025, completion rates surpassed 95% when the AI system was further optimised around personalisation and used by over 200 students at the University of Technology and Applied Sciences in Oman.

## Discussion

This study evaluated the effectiveness, accessibility, and overall impact of AI in teaching across various educational levels, with a focus on OIAI's application. AI teachers have shown significant effectiveness in improving learning capabilities of students including reading (Neitzel, & Reilly, 2024). The ability to personalise learning has been celebrated as one of the core competencies of AI-powered teaching systems and this is revolutionising education globally. Like OIAI in Kenya, Africa and other systems mentioned above in other continents, AI systems that have been tested in West Africa have shown that 6-weeks of after-school work with an AI tutor could lead to 2 years of typical learning gains (De Simone, Tiberti, Mosuro, Manolio, Barron, Dikoru, 2025). Finally, what is becoming clear is that individual tutoring support is known to improve average test scores by 2 sigma (Bloom, 1984), and an AI teacher is the only way to provide individualised teaching to all learners.

Empirical data from AI-delivered programmes, particularly at university level, provide concrete evidence of AI system's benefits and limitations. More importantly, results reveal a rapid shift from small-scale AI

pilot projects to full-scale curriculum integration in many institutions and now for governments, underscoring AI's transformative role in teaching and wider education. From the identified research, mainly OIAI demonstrates the ability to enhance personalised learning and student performance. It beckons the question of whether the initial chasm has now been crossed and therefore whether now is the time that is ushering in the availability of personal AI teachers for all. Nevertheless, the research identifies persistent barriers such as infrastructural deficiencies, unequal digital access, and educator adaptation challenges that must be addressed for successful national implementation and lays out current and future steps to address these. While these limitations will lessen over time, the researchers are actively working to solve some key elements like infrastructure issues where EDGE AI is being deployed now allowing learners to interact with the AI teacher with limited to no internet connectivity. This is being implemented in 2025 for learners in São Tomé and Príncipe and Kenya. Its outcomes will be shared in future research.

## Conclusion

The paper concludes that AI-enabled teaching, as exemplified by OIAI and visible through the trend in literature between 2021-2025, holds significant promise for scalable and equitable education reform globally. In Kenya and across Africa, it offers a roadmap for national adoption, recommending sustained investment in digital infrastructure, educator training, and policy frameworks at a time when teacher shortages are extremely high with Kenya and the lack of digital upskilling of teachers and learners is becoming critical (Citizen Digital, 2025) in Africa. With the right support and approach, Kenya can position itself as a continental leader in AI-driven education, creating a replicable model for pan-African transformation.

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