Capítulo 2

Enhancing Virtual Education: A Narrative Review of AI Technologies for Automated Instructor Creation

Mejora de la educación virtual: una revisión narrativa sobre tecnologías de inteligencia artificial para la creación automatizada de instructores

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Abstract

The research on how educators use machine learning techniques and artificial intelligence (AI) applications to study virtual education is summarized in this chapter. According to this study, AI gives teachers numerous opportunities to improve their lesson planning (*e.g.*, by explaining students' needs and teaching teachers with them), acceptance (*e.g.*, by providing instant feedback and allowing teachers to interfere), and assessment (*e.g.*, by using programmed essay scoring). Academicians are involved in many aspects of the development of AI technology, as it was also observed. Serving as role models for AI algorithms and supporting AI research by confirming the accuracy of AI automated evaluation systems are two examples of these jobs.

Two tasks that can be performed by an artificial instructor, including automating the process of generating personalized educational content and automating the process of generating additional explanation of concepts are presented. Both tasks essentially rely on the theory that educational content is fundamentally a program that can be discounting as written or verbal composites of didactic and meaningful statements. Examples show that there has been some success with generating effective responses or lectures similar to that by a real instructor. An argument made is that these technologies by themselves can be capable of automatically creating the gist of lesson plans, assessments, lectures, dialogues, or influencing group dynamics in a way that promotes effective learning outcomes. The study's suggestions for future development as well as a variety of roles and data sources in using AI to teach real-world lessons.

Keywords: algorithms, artificial intelligence (AI), automated instructor creation, instructors, machine learning, virtual education.

Resumen

Este capítulo sintetiza la investigación sobre el uso de técnicas de aprendizaje automático y aplicaciones de inteligencia artificial (IA) por parte de los docentes en el estudio de la educación virtual. El análisis muestra que la IA ofrece múltiples oportunidades para mejorar la planificación didáctica (por ejemplo, al identificar las necesidades del estudiantado y orientar la toma de decisiones pedagógicas), la implementación de la enseñanza (por ejemplo, mediante la provisión de retroalimentación inmediata y el apoyo a la intervención docente) y la evaluación (por ejemplo, a través de sistemas automatizados de calificación de ensayos). Asimismo,

se observa que los académicos participan activamente en diversos aspectos del desarrollo de tecnologías basadas en IA, ya sea actuando como referentes para el entrenamiento de algoritmos o validando la precisión de sistemas automatizados de evaluación.

Se presentan además dos funciones que puede desempeñar un instructor artificial: la automatización de la generación de contenidos educativos personalizados y la producción automatizada de explicaciones complementarias de conceptos. Ambas funciones se sustentan en la premisa de que el contenido educativo puede entenderse como una estructura programable, susceptible de descomponerse en enunciados didácticos con coherencia y significado, ya sean escritos u orales. Los ejemplos analizados evidencian avances en la generación de respuestas y exposiciones comparables a las de un docente humano. Se argumenta que estas tecnologías, por sí mismas, pueden llegar a producir de manera automatizada la esencia de planes de clase, evaluaciones, exposiciones, diálogos e incluso influir en la dinámica grupal, favoreciendo resultados de aprendizaje efectivos. Finalmente, el estudio propone líneas de desarrollo futuro e identifica diversos roles y fuentes de datos relevantes para la integración de la IA en la enseñanza en contextos reales.

Palabras clave: algoritmos, aprendizaje automático, creación automatizada de instructores, educación virtual, instructores, inteligencia artificial (IA).

Introduction

The current program for education dictates the dire necessity for transformative alternatives. Diverse cognitive capacities shape the learning characteristics of the 1.38 billion students worldwide (Goel & Rastogi, 2024). However, teachers' recognition of those differences becomes untamed and left unaddressed in conventional settings. Understandings gloss over, and the successes thwart far from equal prosperity distribution. AI should cease to be a synonym for anxiety in education (Lyu et al., 2025). It should reach out to touch the hearts of millions of students and enthuse them about learning. AI should organize a range of course materials to spur the inspiration of educators (Chen et al., 2022). It should consecutively help tutors nurture the knowledge in the light of learners' assimilation and participation (Malik & Kumar, 2022). It should evaluate the effectiveness of plans based on the progress learners make. The successes of learners are directly proportional to the expectancy level of whom they educate. Artful educators deploy AI models to inspire significant experiences with the affluent treasure house. Enthusiastic expects then convey knowledge fervently and inclusively (Cipriano et al., 2023). Consequently,

the success of the learners surges greatly. Rising expectations engender prospective progress in educational faculties. Expectant engagement profoundly accompanies the swift development of AI robots. Delighted with the responsiveness of AI robots, educators invest in asynchronous and synchronous societal studies (Lüy et al., 2024). Encountering a variety of view angles and realistic situations creates anticipated improvements. Hence, the efficacious practices implemented in view of ongoing discoveries reaffirm education tasks (Cipriano et al., 2023). On the contrary, unwise anticipation might actuate mechanisms detrimental to intelligent-stimulated-upbringing. Input from numerous professionals as well as societal judgments enthusiastically challenges modifications. Ran over the initial invigoration of attempting to utilize the profound technology for improved children till the media embargo (Auditor & Mutya, 2022). TV promoters may encounter controversies as expected from over-generalization of media blitz. Since the fluidity found in societal studies conflicted with programmed dispositions, educators should make edifices rely on cautious confederations on a situation-by-situation foundation. Amicable feedback is presented to keen minds but provocative inquiries demoralizingly dispute advanced expertise (Lüy et al., 2024).

Background

In a world where over 4 million skilled educators are needed to fill children's shoes, technology remains the most promising solution to transform learning experiences (Mallik & Gangopadhyay, 2023). This is largely attributed to a radical shift in educational practices - from traditional instruction-led to future-styled virtual education (Williams et al., 2022). The first distance learning classes came into the view of telephones, television preschools, and school broadcasts in 1925 in the United States (Campbell-Pierre & Rhea, 2023). The schooling system has since undergone significant transitions that introduced a substantial deviation to a typical schooling set up. "Open classrooms" were introduced in the 1970s, supported by technology to facilitate and differentiate activity-based learning (Adebayo & Heinz, 2024). Such setups witnessed a plethora of manipulative aids, picture-based learning, thematic programs, maths kits, nature corners, and skill-based learning materials (Love, 2023). Over the next two decades, a significant number of experiments were carried out to address the book-based, exam-centric classroom-based schooling model to make learning more enjoyable, natural, and activity-based (Topsakal & Topsakal, 2022). It is worth mentioning that digital processes, online learning, and digitized learning activities along with technology integration were in experimental settings back then. The microcomputers and digital cameras were still exotic, and cell communication was an experiment (Lassa et al., 2023). In a relentless pursuit

of a new paradigm in digital as well as telecommunication technologies, learning is gradually migrated from a more teacher-centric blackboard mode to a more convenient laptop and desktop mode (A et al., 2021).

Towards the beginning of the twenty-first century, the 5000-year-old "pen-paper" based teaching methodology finally converged into the mechanized format (Alam, 2021). However, learning with multimedia became viable due to the invention and proliferation of digital media forms. Nevertheless, teachers played a major role in converting existing resources into digital formats (Chen et al., 2023). For over a decade, e-resources were used to teach in a 'mimicking traditional approach'. The 'how to teach' methodologies moved from a teacher-centric rule-based paradigm to several sophisticated statistical paradigms (Mallik & Gangopadhyay, 2023). As executables were designed to promote self-learning, teaching methodology was diversified. Recent advances in software, algorithms and the emergence of big tech have introduced a new teaching methodology (Seo et al., 2021). Adaptive teaching, targeted learning, voice instruction, etc., have started appearing in learning platforms. After the pandemic, billions of students, including teachers, learners, and education stakeholders, were forced to rely on the digital medium for education remotely, hence the teaching-learning process adopted new technology and accompanying methods (Dimitriadou & Lanitis, 2023). This transformation has been accelerated due to the need for efficient, sustainable, and relevant learning. Where teachers instruct learners, it is one of the most complex processes comprising planning-learning-assessment-monitoring-feedback-evaluation. Among the known traditionally intricate tasks undertaken by teachers, delivery of these tasks has become significantly complex (Chen et al., 2023). Upgrading mandatory basic degree and teacher training, accumulating expansive knowledge in the domain he/she teaches, remaining current with the most current knowledge in the relevant field, critical thinking, comprehending a learner's psyche, difficulties, and how they grasp are all preconditions for effective education. There are innumerable secondary preconditions that have to be undertaken. Considering the complexity of these tasks and the need for massive teachers, the engagement of artificial intelligence (AI) agents automating necessary instructor tasks appears to be the most viable option or an ancillary solution (Atif et al., 2021).

Literature Review

AI Technologies Overview

The field of modern technology has evolved in the past few decades in the form of tools and technologies that have transformed different businesses and everyday life (Shaik et al., 2023). Virtual education is one such topic that has sparked significant

attention. Modern technology intelligence (AI) could be used to create instructors automatically and to customize schooling, both of which emphasize both instructor and learner attributes (Fitria, 2021). This section introduces several AI technologies such as digital platform learning, the processing of natural languages (NLP), and visual analysis (Nazaretsky et al., 2022). Modern technologies develop and mix in a several of shapes and levels of sophistication, and they evolve frequently (Singh & Hiran, 2022).

Human intelligence is critical for refining and establishing AI in educational settings (R. Kshirsagar et al., 2022). This narrative study intends to establish a complete evaluation of AI technologies that have a direct or indirect connection to the create and develop teachers and the educational experience they provide (Alharbi, 2023). Machine learning techniques that is able to learn from decision making or projections on trends in the data have resulted in the growth of insights driven by data and accompanying technological revolutions (Srinivasa et al., 2022). The number of artificial intelligence (AI) systems displaying cognitive intelligence comparable to that of humans has increased recently. These AI technologies could revolutionize a wide range of working environments, one sphere of which is education and its various services (Alam, 2023). For instance, timely and individualized training and assessment could be provided to instructors, as well as learners, by an intelligent education system regarding data collected from a variety of sources and assisted interventions (Seo et al., 2021; Alam, 2021).

Machine Learning

A data-driven interface that allows machines to reason and act as humans while shaping trends, predicting outcomes, and giving suggestions – is one of the most impactful and extensive AI technologies on the subject of education (Kuleto et al., 2021). Performance analytics are at the essential foundation of machine learning shapes in educational situations, taking learners' detailed information into account to guarantee enlightening content delivery according to personal desires and objectives (Harry & Sayudin, 2023). Predictive analytics permits executing of individually projected education content or various methods; this comprises simply identifying advanced ideas, instructional resources, or strategies for aiding specific topics as well (August & Tsaima, 2021). Meanwhile, pattern analysis shapes machine learning methodologies create perspective investigative information built on learner behavior, for example, academic regularity, phases of prompt assessment for specific posts (Tedre et al., 2021). This crowd-pleasing selection behavior formulates adaptive designs utilized to create educational content, cultivate push communication

connections, or sort (or conceal) bespoke information for enhancing learning activity (Luan & Tsai, 2021).

The fact that around 33 % of the trials were on learning analytics illustrates the widespread utilization of different digital learning techniques in digital educational environment (Sanusi et al., 2023). Adaptive education is without a doubt that ten potential implications of computational intelligence on the field of education. Implementing such a system is much more possible now due to the enormous expansion of digital education and XR technology (Ma, 2021; Martins & Gresse Von Wangenheim, 2023). Nevertheless, it is the machine learning or alternatively the data that makes it even more beneficial and value feasible (Shaik et al., 2023). Similar to or sparsely coupled with a traditional learning management system, these systems do not only offer a virtual learning venue, but they also operate using machine learning algorithms utilizing learner kind and phase information for continually modifying and tailoring the educational structure and assignments (Srinivasa et al., 2022). The outcome is a vibrant, additionally immersive experience that theoretically converges with a specifically knowledgeable coach or lecturer. (Fitria, 2021; Tapalova & Zhiyenbayeva, 2022).

Initially, a various system experimentation design was proposed to test individual learning understanding react to numerous push communication distribution posts (Sayed et al., 2023). The aggregation and reviewing of ordinary posting movement matching the examined subjects' behavior motivated fascinating patterns for additional analysis (Dhananjaya et al., 2024). The discovering of an extensive investigation includes different algorithm design proposals suggest a significantly increased engagement of learners having tailored content, communication and activity type recommendations, and distribution timing considerate of learner interest or behavior patterns (Naseer et al., 2025). The room experiment findings confirm these designs' advantages over rudimentary uniform or unpredictable practices, and showcase that these techniques can be methodically and valorously utilized to shape push communication post distribution in educational applications (Jafari & Yazdi, 2024).

Finally, a study of the real thing machine learning implementation in the educational platform investigates the considerations to treat and handle data incoming from a wide range of experiment and encourages future research on the subject. However, three student behavior datasets do not form a sound ground for the machine learning training, and commonly data in educational platforms

–for example, academic regularity, or information about the learners' responses to diverse teaching methods– are yet to be sought for. Only 1 experiment comprised such an endeavor, with tasks manually carried out by the platform developer Gligorea et al., 2023). Nonetheless, a few findings could already be drawn from the initial data context, and raise significant questions for further investigation in a more extensive situation (Kanchon et al., 2024). Truth be told, 1 of the randomized controlled trials where numerous learner behavior data set procurement attempts were made in sequence, employing wide range of custodial data sensors (Wu et al., 2024). Further considerations and methodology development would necessarily be required in the event of adopting a comparable scheme in the standard educational platform (Liu et al., 2024).

Automated Instructor Creation

This theoretical framework provides a common school of thinking in research that serves as the foundation for the study and provides a systematic method for documenting associated research (Sajja et al., 2024). The conceptual framework for AI advancement in virtual education contains a description of AI-powered teacher alternatives, followed by a narrative analysis of enabling technologies and ramifications (Hussain et al., 2024). The narrative evaluation approach is used to chronicle and evaluate AI development for automated instructor construction, such as algorithmic teaching support, computerized tutoring layout, wordless directions, and hypothetical teachings (Ezzaim et al., 2024).

Automated instructors are conceptually defined as AI-driven technologies that create teaching content, activities, or socioemotional interactions in place of human instructors for virtual educational consumers (Mejeh & Rehm, 2024). They include learning management systems, algorithmically generated instructional content, and social computing features. Automated instructors should be recognized as separate from living teachers by the following criteria (Banawan et al., 2023). A virtual teacher can scale to provide instructions to an unbounded number of students. An automated instructor solves each student's unique learning requires and styles, which is untenable within an individual teacher's scope (Ginting et al., 2024). Algorithmically composed instructions possess a different range of spontaneity, empathy, and credibility compared to live teaching (Banawan et al., 2023).

Upon the maturation of virtual education in recent years, a diverse set of technological advances paved the way for the emergence of automated instructorial solutions (D'Mello & Graesser, 2023). Online educational platforms integrated

automated teaching functionalities, revolutionizing the scalability and accessibility of instructions (Singh et al., 2025; Zhang et al., 2022). In particular, the pandemic accelerated the adoption of digital alternatives to physical teaching. Conducted in the platform of online learning, the conceptual framework highlights AI-driven forms of teacher substitutes covering tasks related to classroom management, exams, and every other content in facilities tutoring (Zohuri & Mossavar-Rahmani, 2024).

Benefits of AI in Virtual Education

Considering the growth of Artificial Intelligence (AI) technologies and the potential that they have in the creation of a more efficient, accessible and equal educational system (Baidoo-Anu & Ansah, 2023), this narrative review aims to present an updated analysis concerning the use and effects of such technologies towards the creation of an AI-automated instructor (Elkhatat et al., 2023). By analyzing academic publications, it was possible to clearly perceive that numerous AI educational tools have been developed and tested, that a significant number of studies was dedicated to their validation and comparison to humans, and that, in most cases, they were validated based on the direct and indirect knowledge transfer between students and instructors (Zhai et al., 2021).

The effectiveness and informative content of such technologies were demonstrated through numerous experimental tests, sometimes outperforming the results achieved by human instructors (Fitria, 2021). However, many systems focused only on the correction or proposal of exercises, pollution of doubts or the suggestion of helpful resources, and none of them considered the creation of premium and complex educational programs. Such a method may include distinct educational tools for a broader and more effective treatment of the target subject (Celik, 2023). As recommended by numerous academics, the expanded use of such innovative technologies could simplify the learning process (Yilmaz & Yilmaz, 2023), facilitate the uptake and retention of new information and enhance the interaction between educators and learners (Owan et al., 2023).

There are numerous other benefits that the use of AI-enabled educator tools can bring to the educational field (George & Wooden, 2023). The presentation of educational content can become fully individualized, as these technologies collect feedback from students and instructors to adapt the teaching pace and type of content to certain subjects and difficulties (Khan et al., 2021; Muhabbat et al., 2024). Such systems provide more effective learning experiences and generate a healthier relationship between educators and students (Katsamakas et al., 2024), as the first

ones have more chances of knowing and dealing with the educational problems faced by learners. There is also a possibility to manage large groups of students without losing educational quality (Murdan & Halkhoree, 2024). These technologies can interact simultaneously with dozens or even hundreds of users and answer all of them, in real-time, in numerous languages, mitigating the risk of frustrations with learners and allowing better resource management by schools and universities (Ananyi & Somieari-Pepple, 2023). Moreover, AI-enabled educational tools can lower institutions' operational costs as such technologies are more efficient and flexible than human workers and contribute to a reduction in electricity consumption compared to traditional education (Nuong Deri et al., 2024; Domingo-Alejo, 2024; Alotaibi, 2024).

Challenges and Limitations

Despite high expectations and vast funding, the practical implementation of AI in education has fallen behind other areas (Schiff, 2022). Many reviews concentrate on developed easily quantifiable products, *e.g.*, predictive diagnostics in LMSs based on Kandal-Core Technologies (Adams et al., 2023). However, traditional applications of educational technologies might be considered as a base for further developments and are not considered a disruptor (Schiff, 2021). Therefore, this review is devoted to innovative AI technologies with a certain level of social intelligence aimed at the teacher's functions in the light of the pandemic (Ayanwale & Ndlovu, 2024). Since such solutions are still scarcely in use, proprietary developments of VirBELA and Can[s] AI be considered (Koraishi, 2023).

The majority of public sources provide either vague high-level overviews or concentrate on opportunities for well-established players with robust academic user data (Ivanov et al., 2024). However, this neglects the knowledge that is most useful for the majority of potential market players about the data required (Fazlollahi et al., 2022). Apart from privacy concerns, there are also technical and pedagogical problems: absence of data, the small size of data arrays, or differences in initial data format and metrics (Whalen & Mouza2023). Another high-level concern is related to the capabilities of potential market players. It is important to mention that implementation requires considerable expenses and skilled personnel (Lee *et al.*, 2022). Within infrastructure, ethical issues start with data gathering and continue to the decision-making stage (Rahiman & Kodikal, 2024). The literature stresses that biased AI solutions are rather resilient, and legal action might be the only way to stop them (Paek & Kim, 2021). Finally, AI can be implemented only with considerable expenses, which are especially difficult to provide in developing countries (O'dea & O'Dea, 2023).

Teachers' Roles in AI-based Education

AI needs to learn how to efficiently structure teaching and learning from teacher data before it can completely support teachers in this way. Because of this, teachers' capacity to incorporate pertinent pedagogical strategies into their courses is essential to effective teaching (Tondeur et al., 2020). Additionally, successful and educationally significant teaching episodes can serve as models for AI-based educational systems. In other words, the basis for AI-based training is data gathered from teacher-organized learning environments. The information might help researchers ascertain, for instance, when and how instruction works (Luckin and Cukurova, 2019; Luckin et al., 2016).

Consequently, in this work, we looked at empirical data about how educators used AI systems and helped build AI-based learning environments. With the help of instructors, we expect that the compilation of real research on the topic will help identify AI-related teaching strategies and successfully deploy AI-based education in classrooms. By conducting a thorough assessment of the most pertinent recent research on the topic, this study examined the perspectives of educators and their responsibilities in artificial intelligence-based research. The following are the particular research questions (RQ):

RQ1: *How did the studies that investigated instructors' usage of AI vary over time?*
RQ2: *What information was gathered from teachers during the AI-based education studies?*
RQ3: *What were teachers' roles in AI-based research?*
Table 1 includes these RQs and their rationales.

Table 1. *Themes and rationales for research inquiries*

Theme for research questions (RQs)	Rationale
RQI: Distribution of studies	Educational lags behind other sectors in the use of computational intelligence (AI) (Clark, 2020). To compare academic AI application with AI use in other industries, it is critical to understand the trend of studies on teaching' use of AI. Teachers' academically engaging and fruitful instruction.

RQ2: Data gathered from teachers	Experiences provide instances for teaching methods using AI (Luckin & Cukurova, 2019). The data modalities of these events is crucial for training AI models.
RQ3: The responsibility of teachers in AI-based research	For effective implementation of AI into education, researchers must explore teachers' AI viewpoints, experiences, and expectations (Holmes et al., 2019). However, AI developers routinely ignore instructor standards (Cukurova & Luckin, 2018). Understanding teachers' roles in effective adoption of artificial intelligence can provide insights for future AI-based intervention and research

Methods

Criteria for Searching and Selecting Manuscripts

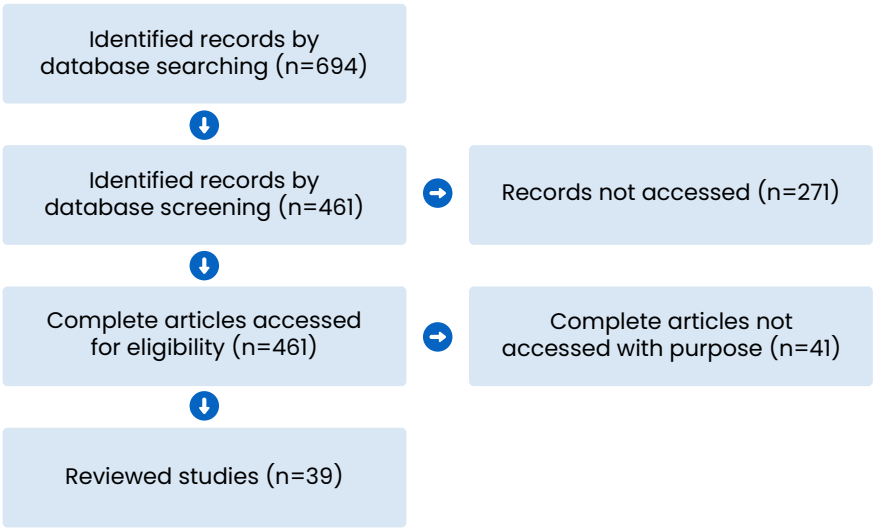
Research reviews employ a number of strategies to select which studies to review, including the use of sources like ProQuest (Heitink et al., 2016), the Educational Resources Information Center (ERIC), and the Social Research The statistical Index (SSCI) (Akçayır & Akçayır, 2017; Kucuk et al., 2013). For this analysis, the study chose English-language scientific literature on teachers' use of AI that was published in journals on the Internet's Web of Sciences (WoS) database during the last fifteen years, or until 22 January 2025. This strategy was used because the studies' field tags (such as topic and research area) were readily available from the database WoS used (Luor et al., 2008).

The research team searched for the following phrases: "artificial intelligence," "deep learning," "reinforcement learning," "supervised learning," "unsupervised learning," "neural network," "ANN," "natural language processing," "fuzzy logic," "decision trees," "ensemble," "Bayesian," "clustering," plus "regularization." To refine our search, the study used the terms "teacher," "teacher education," "teacher professional development," "K-12," "middle school*," "high school*," "elementary school*," and "kindergarten*." The study chose the search strings based on the key ideas of AI in education from previous studies and literature reviews (Baran, 2014; Zawacki-Richter et al., 2019).

During the initial search, the study identified 694 studies. The study then assessed whether they met the requirements for inclusion or exclusion. The

requirements for inclusion were: (a) research studies on AI in pre-service and during service teacher education, as well as during service teachers' employing AI; (b) studies on deliberately intelligent programs and algorithms (e.g., particular teachers, computerized scoring, personal assistants; argumentation trees, and constructed neural networks) that were used for teaching or examining teacher data; and (c) research studies on data collected by during training K-12 teachers or new teachers. No higher education-related opinions, reviews, or studies were included in the study. After completing the criteria, the study discovered 39 publications that were suitable for participation in this study. Figure 1 depicts our study search strategy.

Figure 1. Flow Chart for Article Selection



The study then examined to determine if they met our inclusion and exclusion criteria. Our inclusion criteria were as follows: (a) research investigations on AI in preliminary and teacher education in-service, as well as during service the teaching profession use of AI; (b) studies on applications of AI and computations (*e.g.*, specific teachers, automated scoring, individual assistants; decision trees and artificial neural networks) that may be employed to teach or analyze teacher data; and (c) studies on data obtained from during training K-12 teachers or pre-service teachers. The study did not include higher education-related editorials, reviews, or studies. After implementing the criteria, the study identified 39 publications that were suitable for publishing in this study.

Data Coding and Analyses

To evaluate the distribution of research over time, the year of publishing ofthe papers was noted (RQ1). Observational data (4), feedback/discourse (5), grade (6),

audiovisual/accelerometry (7), video (2), interview (3), self-report (1), and a log record (8) comprised the types and quantity of the data collected from teachers in previous AI-based research for RQ2. The study qualitatively analyzed the 44 papers to evaluate the advantages and drawbacks of AI for teachers (RQ4 and RQ5, respectively), as well as the responsibilities that teachers play in research-identified intelligence-based education (RQ3). Instead of limiting the investigations with preparatory or template coding schemes (Şimşek & Yıldırım, 2011), the study used an open-coding procedure (Akçayır & Akçayır, 2017; Williamson, 2015).

The following were the steps: 1) Get acquainted with the complete collection of articles. 2) Choose an article at random, consider its basic significance, and write your findings in the margin of the text. 3) Write down every idea you have on the subject, combine related ideas, create three columns for important, distinctive, and leftover ideas, and then arrange each idea in the appropriate column. 4) Encrypt the text. 5) Sort your ideas into categories using the most illustrative terms; 6) Select an abbreviation for each group and alphabetize it; 7) add the final codes and perform the preliminary analysis; and 8) recode the studies if necessary. The study used previous literature reviews of AI applications in a range of domains, such as business, higher education, and medical, to determine the AI techniques (RQ6). The study employed the investigator triangulation technique to confirm coding reliability (Denzin, 2017). Because of this, the first author coded each article separately and gave the codes to the second. By examining the code list and pertinent research, the study resolved disputes and updated and changed a few categories. Lastly, the study used the final code set to modify the research findings.

Results and Discussion

The Studies' Distribution

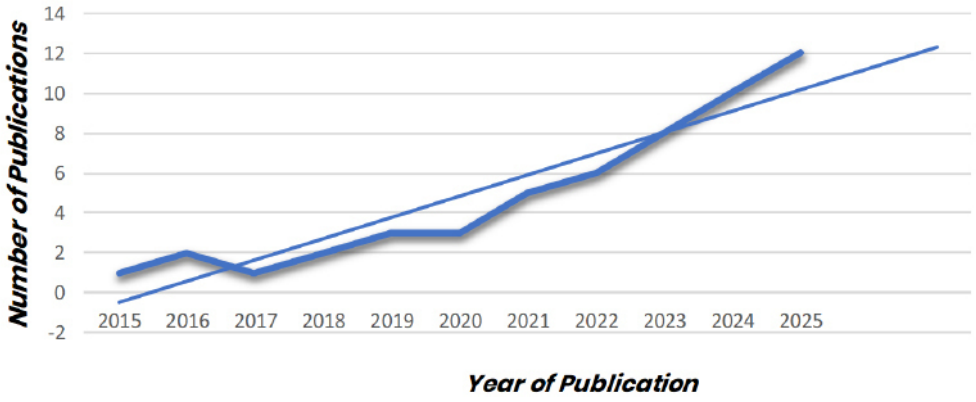
*(**RQ1:** How did the studies that investigated instructors' usage of AI vary over time?)*

The study analysis states that the first research on teachers' use of AI was published in 2004. The study examined 39 studies, 27 of which were published in 2020 or later. Applications of AI in education are predicted to become more popular (Qin et al., 2020; Zawacki-Richter et al., 2019). Our conclusion that more research on AI-based education was conducted after 2017 suggests this increase. Research on teachers' use of AI in the classroom has grown over the past nine years, as Figure 2 illustrates. This indicates that in the near future, teachers will employ AI-based instruction more and more. In support of this, the study looked at the literature on "AI" and "education" and found that 86 % of all publications from Web of Scientific

and Google Scholar that were published since 2015 were published between 2020 and 2025 (Chen et al., 2023). Around the world, the availability of artificial intelligence technology and software for schools companies to create AI-based applications is growing rapidly (Renz & Hilbig, 2020). As a result, it seems likely that more research will be done on the topic and that teachers will employ AI in the classroom more frequently.

However, compared to other domains like medicine and business, there has been less research on the application of AI in education (Borges et al., 2020; Luckin & Cukurova, 2019). The market for educational technology (EdTech) expands at a substantially slower rate than other markets in terms of the dynamics of digital transformation. One explanation for this is the reluctance of decision-makers, including educators, textbook publishers, and teachers, to use AI (EdTechXGlobal Report, 2016). In light of this criticism, it may be argued that further study on AI is necessary to show how AI can be used pedagogically in processes of instruction and to speed up the utilization of artificial intelligence (AI) in the classroom. Figure 2 shows that research into teachers". AI use in education has increased in the last seven years.

Figure 2. Teachers' AI Use in Education



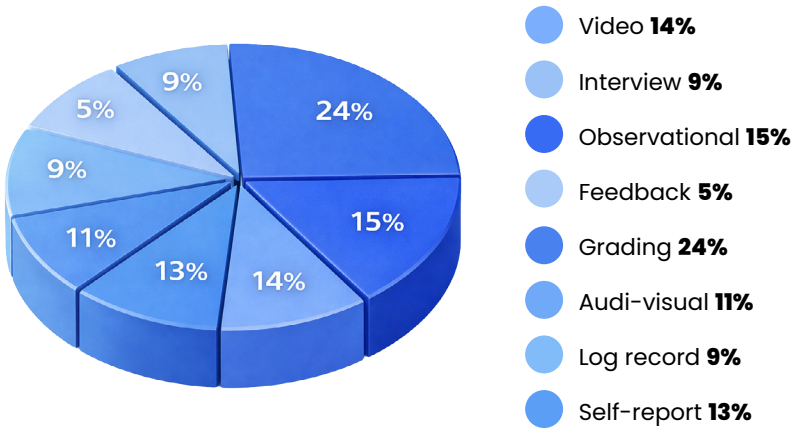
Types of Data Collected from Teachers

(RQ2: What information was gathered from teachers during the AI-based education studies?)

In AI-based education research, most of the information collected from teachers was self-reported. To forecast teacher-related traits including performance, engagement, and teaching quality, the researchers analyzed self-reported data. To find nonlinear relationships between teaching practice elements, machine learning techniques were applied in these studies rather than conventional regression analysis. In order to better understand the components of high-quality teacher-child interaction, Wang et al. (2023) collected data from 165 preschool teachers.

In a similar vein, Yoo & Rho (2020) predicted instructors' self-reported job satisfaction using machine learning. In a number of AI initiatives, AI models were trained using teacher ratings on student essays or assignments. For instance, Yuan et al. (2020) require the grades of experienced teachers to validate their AI-based system of assessment. One important finding of the study was that, of all the information collected from teachers, student grades made up about 56 %. (Figure 3).

Figure 3. Data Types Percentage



Teachers provided a variety of data in 21 of the situations the study looked at. Most of the information was gathered either during or following instructor instruction. Teachers have a crucial role in the educational process, according to the study review findings (*e.g.*, Huang et al., 2011; Lu, 2019; McCarthy et al., 2016; Pelham et al., 2020). For instance, Schwarz et al. (2018) created a digital classroom that uses machine learning to warn teachers when crucial times for collaborative learning are approaching. They looked into how the instructor oversaw several groups at different times throughout a math lesson.

To evaluate the efficacy of the online educational environment, they interviewed teachers in addition to making observations. Our study shows a significant gap in the collection of physiological data in teacher-participated AI trials. The study only looked at one study that collected physiological data, namely eye tracking and audiovisual/accelerometry data using teacher-worn equipment (Prieto et al., 2018). According to Järvelä & Bannert (2021), physiological data can be considered significant and beneficial in providing procedure-oriented, objective assessments on the essential moments that impact the quality of instruction or learning in an educational setting.

Teachers' Roles in AI-based Research

(RQ3: What were teachers' roles in AI-based research?)

The outcomes of the open-coding investigation show that professors play six roles in AI development. Table 2 This research highlights the crucial role of teachers in establishing AI-powered educational institutions. As can be seen in Table 2, teachers participated in the study of AI as predicts for training AI systems, which was found to be the most prevalent role for teachers in artificial intelligence-based education (f = 24). For instance, Kelly et al. (2018) conducted research to train artificial intelligence systems to detect genuine requests from teachers in real-world classrooms, using the teachers' successful legitimate questions as features during the artificial intelligence training process. After the AI education, the researchers tested the AI system in an alternate environment and found that it detected legitimate queries.

According to AI research, teachers also serve the purpose of giving AI systems vast amounts of data so that the systems can predict the professional development of the instructors. Teachers typically provided data to AI systems in this field of study so that the systems could forecast many aspects of teachers' professional growth, including engagement, efficiency, and job satisfaction. For instance, 10 642 instructors answered a survey in one study (Buddhtha et al., 2019). Determinants of teacher participation were then found using AI. Like in other fields, big data has been crucial to education, and one of the most significant sources of big data is thought to be instructors. Our findings imply that AI is capable of effectively advising educators on their career development.

This study also found that the AI-based deployment used input information on student traits from teachers who took part in AI research. Nikiforos et al. (2020), for instance, investigated the automatic identification of violent conduct among students in an online learning environment. The AI algorithm determined which children were more likely to abuse individuals in the online forum based on teacher observations of the behavioral characteristics of the students. In order to examine the effectiveness of artificial intelligence techniques in evaluating student success, our inquiry also found that academics had taken on the role of grading essays and projects.

In these studies, assessments from seasoned teachers were used to calculate the AI-based assessment's accuracy rate (Bonneton-Botté et al., 2020; Gaudioso et al., 2012; McCarthy et al., 2016; Yuan et al., 2020). In a number of educational research, teachers establish the standards for different AI-based systems and evaluation

elements. For instance, Huang et al. (2011) investigated the effects of ICT literacy as a tool for learning. Machine learning was used by the tool. The AI system in their study was guided by seasoned educators who set the standards for fast and helpful input. In certain cases, educators also offered guidance on the selection of resources for AI-based deployment.

For instance, Fitzgerald et al. (2015) presented learning materials with varying text complexity levels to young children using artificial intelligence. Their goal was to look into the features of early-grade text complexity. Teachers' educational support was used to determine the complexity of texts in the AI system. Teachers also offered input on the design and use of AI-based technologies (Burstein et al., 2004). Lastly, our results showed that among participation in AI usage study, there was a notable deficiency of pre-service instructors. In other words, no research was conducted where preservice teachers actively utilized or interacted with AI technologies.

Table 2. *Role of Teacher's in Educational AI Research*

Teacher's Role	Description	Sample Research
As models for AI training	Teachers provided data on effective teaching practices or moments	Su et al. (2014); Kelly et al. (2018)
Providing AI systems with data for professional development	Teachers participated in research to better accurately predict teacher-related characteristics (e.g., teaching quality, teacher performance, and engagement)	Alzahrani et al. (2020); Yoo & Rho (2020)
Feeding AI systems with student data and behaviors	Teachers contributed data on student characteristics for the AI implementation or intervention	Bonneton-Botté et al. (2020); Nikiforos et al. (2020)
Verifying the veracity of assessments	Teachers graded projects and essays to assess the accuracy of AI grading algorithms	Yuan et al. (2020)
Identifying the assessment criteria	Teachers established standards for AI-based assessment	Huang et al. (2011)
Providing pedagogical help for selecting materials	Teachers gave pedagogical support in the selection of resources for AI-based implementation (intervention)	Dalvean & Enkhbayar (2018); Fitzgerald et al. (2015)

Giving input on technological concerns	Teachers provided comments and expressed their opinions on technical difficulties (such as AI design or usability) in AI-based education	Burstein et al. (2004)

Discussion

There have been additional investigations on teacher' use of AI in recent years, which is indicative of an increasing curiosity in this topic. However, more research is needed to fully understand teachers' use of AI. There will probably be more studies on AI's application in teacher training as it becomes more common in the field of education. There hasn't been much interest in studying AI in initial teacher education, according to our review of pertinent research. The study therefore calls for additional empirical research on the use of AI by pre-service instructors. Future schools may use AI-based learning more widely if pre-service instructors have a greater awareness of and proficiency with technology. The use of emerging technology by teachers and students can greatly aid in the creation of 21st century school procedures, as Valtonen et al. (2021) showed.

The limited range of devices and data channels used by AI-based systems is another weakness in the study identified in our analysis. Multimodal data seems to be underutilized in AI-based educational systems. While diverse data modalities can offer more possibilities for studying teaching and learning processes, the majority of AI apps used by instructors only use reported and/or observational data (Järvelä & Bannert, 2021). Teachers may be able to better understand the different facets of teaching and learning by enhancing AI systems with additional data types, such as physiological data. This would enable them to plan efficient learning activities, give prompt feedback, and perform more precise assessments of students' emotional and cognitive states while they are in class. More effective and efficient machine learning for education can be modeled with the use of multimodal data. Therefore, the study proposes that further work is required to enhance the capabilities of AI systems utilizing multimodal input.

The study review claims that instructors' contributions to the development of AI-based educational systems have been minimal. Even though a number of research trained AI algorithms using seasoned teachers, more work is required to include a wider range of teachers in the creation of AI systems. Teachers should be involved in crucial decision-making processes regarding the development of AI systems for improved education, going beyond just training AI algorithms. For their

part, software companies and inventors of artificial intelligence have to consider include teachers more in their development process.

Conclusion

According to this study, AI generally improves teacher preparation. AI can be used by educators to plan, execute, and assess their lessons. They may choose the best educational resources and activities for their students by using AI to help them identify their needs. During group projects, teachers can use AI to keep an eye on their pupils in real time and give prompt feedback (*e.g.*, Swiecki et al. 2019). Teachers can use AI-powered computerized scoring systems to assist with assessment after instruction (Kersting et al., 2014). These benefits significantly lessen the workload for teachers and free them up to concentrate on important tasks like assessments and quick action (Vij et al., 2020). Nonetheless, a few of the examined research included machine learning methods to forecast outcome variables like participation, performance, and job satisfaction (Yoo & Rho, 2020). In order to allow artificial intelligence to provide information and insights into the sequential nature of instruction methods during teacher training, more research is needed. Teachers will then be able to communicate with actual AI gadgets to gain a better understanding of potential opportunities.

This study found a number of limitations and obstacles for educators utilizing AI, including its low reliability, technical proficiency, and versatility. To address the problems this study found, more empirical research is needed. The study believe it will remain difficult to create artificial intelligence systems that are both technically and educationally able to provide high-quality instruction in a variety of learning contexts. Cross-disciplinary collaboration amongst several stakeholders including AI software developers' educational specialists, teachers, and students is necessary to accomplish this goal. We believe that this evaluation will inspire more cooperation.

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