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BEYOND THE ALGORITHM ON HOW AI WILL REDEFINE HUMAN PROGRESS: FROM DIRECTION TO EMPOWERMENT

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Abstract:

This position paper presents a critical analysis of the evolution of Artificial Intelligence in Education (AIEd) through three distinct paradigms: AI-directed (learner-as-recipient), AI-supported (learner-as-collaborator), and AI-empowered (learner-as-leader). Through a comprehensive review of literature spanning three decades (1990-2021), the study examines the theoretical foundations, implementation approaches, and practical applications of each paradigm. The analysis reveals a progressive shift from technology-centered to learner-centered approaches, highlighting the transformation of learners' roles from passive recipients to active leaders in their educational journey. The paper identifies critical challenges in integrating AI with educational theories and proposes a framework for future AIEd development that emphasizes human agency, personalized learning, and ethical considerations. The findings suggest that successful AIEd implementation requires balancing technological advancement with pedagogical principles, while maintaining focus on human-centered learning experiences. This work contributes to the field by providing a structured framework for understanding AIEd's evolution and guiding future development toward more effective, learner-centered educational technologies.

Keywords:

Artificial Intelligence in Education (AIEd), Educational Paradigms, Learner-centered Education, Human-AI Collaboration, Educational Technology Integration, Adaptive Learning Systems

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Introduction

Artificial Intelligence in Education (AIEd) emerged from the integration of Artificial Intelligence (AI) into different learning technologies, revolutionizing instructional design and learner interaction. Such transformation includes Intelligent Tutoring Systems (ITSs), learning robot, teaching analytics dashboards, and adaptive learning platforms that improve human-computer interactions (Chen, Xie, & Hwang, 2020). In the last 30 years, AIEd has become one of the most potent innovation drivers in the education sector, allowing the new method of teaching and studying previously unreachable by classroom teaching methods (Hwang et al., 2020). This technology has facilitated the personalized learning process and eroded the traditional roles of instructors and advanced the creation of advanced education systems (Baker, T., Smith, L., & Anissa, 2019; George & Wooden, 2023).

The use of several AIEd methods, such as natural language processing, artificial neural networks, machine learning, deep learning, and genetic algorithms, has led to the development of smart learning environments, which can detect behavior, predictive modeling, and learning recommendations (Chen, Xie, Zou, et al., 2020; Rowe, 2019). However, with ongoing computerization of the education sector, AIEd is currently a main area of research, and the artificial intelligence can offer fundamental change to the process of acquiring knowledge, cognitive growth, and cultural learning patterns (Hwang et al., 2020). In this development, AIEd proves that it has the potential to support the innovations in the educational field that are not restricted to the classroom. It provides innovative solutions to contemporary learning issues and redefines the position of educational technology in the process of teaching and learning (Guan et al., 2020; Schiff, 2021).

Nevertheless, although AI has a transformative potential in education, the mere adoption of more advanced AI technologies does not necessarily lead to better educational results (Tapalova & Zhiyenbayeva, 2022). The applicability of AI in education is closely connected with its alignment to the key pedagogic and philosophical views since various kinds of educational technologies can produce significant effects on the quality of both learning and teaching (Pedro et al., 2019; Yadav, 2025). However, despite a large body of research on different facets of AIEd, such as its classifications, methods, issues, and prospects, there is a huge knowledge gap in the existing state of knowledge (Baker, T., Smith, L., & Anissa, 2019; Chen, Xie, Zou, et al., 2020; Chiu et al., 2023; Hwang et al., 2020). In particular, there is scarce research that properly examines three essential factors: the variety of functions that AI can fulfill in education, how AI can be integrated with the existing educational and learning theories, and the degree to which AI technologies can change the teaching and learning process. Therefore, this knowledge gap is an indication that further research is necessary beyond the technical aspects of implementation to explore the underlying relationship between AI technology and educational concepts. This type of research is necessary to make sure that AI really works to improve the learning process instead of merely being a technological layer (Hwang et al., 2020).

In addition, this paper aims to fill this gap in the current body of research through critical analysis of the AIEd based on three alternative paradigms and assessing their theoretical, pedagogical, and computational features. Consequently, the paper is a comprehensive examination of the application of these paradigms in solving various learning and teaching challenges through using AI techniques by explaining how it applies in schools. The work has developed a robust reference framework of AIEd future initiatives by carefully discussing

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theoretical underpinning, conceptual studies and practical applications of these paradigms. Moreover, this framework will lead to development of the field, promotion of learner-centered strategies, enhancement of human agency, and life-long learning that are the keys to success in the modern innovation-based knowledge economy. These paradigms and their implications are analyzed to create a guideline of the functioning of educators, researchers, and developers in AIEd, delivering the required practical recommendations and explaining why the focus on the basic objectives of education is more important than technological advancement.

Theoretical Foundations and Current Challenges in AIEd

One of the core issues that AIEd struggles with is how to better meet the needs of learners, when it is best to deliver the content, and how to empower students so that they have ownership of their education process (du Boulay, 2000). Nevertheless, although AIEd involves the use of the latest methods in computing and processing information, the mere use of advanced technology does not necessarily result in better learning and positive educational outcomes (Rehan, 2023).

However, it is important to note that one of the issues that remain unresolved in the present research is the lack of connection between AI methods and theoretical underpinnings, which also has a strong effect on the success of AI problems in the educational context (Dzogovic et al., 2024). This gap has been emphasized in a number of systematic reviews carried out by different research teams. For instance, a review of 146 articles focusing on AI applications in higher education revealed a concerning lack of critical reflection on theoretical, pedagogical, and ethical implications (Bearman et al., 2023). Similarly, a review of 45 influential AIEd articles has found that few studies included established learning theories, including situated learning, collaborative learning, and adaptive learning theories (Mohammed et al., 2024).

This detachment is further illustrated by the observation of 109 articles on automated feedback systems that found that the majority of articles did not provide their theoretical basis of learning or educational framework even though such theoretical underpinnings are essential in the context of system implementation (Maier & Klotz, 2022). In turn, such negligence is especially problematic since various forms of educational technologies are bound to represent diverse pedagogical attitudes.

In order to overcome such challenges, one will have to examine the different uses of AI technologies in the educational system in accordance with the theoretical frameworks of education and learning (Hwang et al., 2020). Therefore, the main paradigms will be synthesized in this position paper by describing the theoretical basis, conceptual, and practical implementations of the main paradigms, and, finally, providing a wide reference framework which would guide the future AIEd practice, research, and development.

Research Methodology

The aim of the study is to interpret the key paradigms of AIEd, focusing on their theoretical backgrounds, conceptual frameworks, and practical implementations. The study is based on three research questions:

- How do AI technologies assume different roles in educational settings?
- What connections exist between AI and established educational and learning theories?
- In what ways do AI technologies influence learning and instructional processes?

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Therefore, in order to provide systematic answers to these questions, the study adopted a systematic literature review methodology within the following systematic procedures:

Literature Selection Process

1. Database Coverage: The literature search was conducted in the major academic databases, Web of Science, Scopus, Science Direct, and Wiley Online Library, Association of computing Machinery (ACM), Institute of Electrical and Electronics Engineers (IEEE), Taylor and Francis, and Elton B. Stephens Company (EBSCO) in order to embrace all the relevant researches.
2. Search Strategy: The search strategy involved the combination of keywords associated with AIEd theory:
    - AI-related terms: "artificial intelligence," "AI," "AIED," "machine intelligence," "machine learning," "intelligent tutoring system," "expert system," "recommender system," "feedback system," "personalized learning," "adaptive learning," "prediction system"
    - Theory-related terms: "theory," "theoretical," "theoretical framework," "behaviorism," "cognitivism," "constructivism," "connectivism," "complexity"
3. Temporal Scope: The literature review included publications published 1990-2021, reflecting the development of AIEd in three decades.
4. Categorization Framework: The articles were chosen and systematically divided in terms of their theoretical foundation, which included significant educational and learning theories, such as behaviorism, cognitivism, constructivism, connectivism, and complexity theory.
5. Analysis Approach: The review explored the connection between AI technologies and educational theories, the functions of these technologies in learning and teaching, and the effects of technologies on education. The systematic review resulted in the identification of three separate paradigms that are going to be discussed further in the following sections.

Results

The history of AIEd shows that there are three unique paradigms, each of which depicts a different connection between AI technology and learners. These paradigms show the development of AI in the educational process and the transformation of the role of learners:

1. AI-Directed (Learner-as-Recipient): In the first paradigm, AI plays a regulatory role in the cognitive learning processes and the learners play the main role as recipients of AI-provided services and directions.
2. AI-Supported (Learner-as-Collaborator): The second paradigm is more of a collaborative type of relationship where AI is used as a supportive tool, with learners playing an active role in the technology as collaborative partners of the learning process.
3. AI-Empowered (Learner-as-Leader): In the most progressive paradigm, AI serves as the tool of empowerment, allowing learners to assume authority and control in the process of learning. Within this model, learners are engaged in leading their learning experience using AI as a tool.

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These paradigms reflect a gradual development of AIEd, moving towards a more learner-centered model, with the role of the learner changing to an active leading role in the process of education. Table 1 illustrates how AIEd paradigms have shifted from direction to empowerment.

Table 1: Evolution Of AIEd Paradigms from Direction to Empowerment

Paradigm	Theoretical Foundation	Implementation Approach	Technologies	Example Applications
Paradigm One: AI-Directed (Learner-as-Recipient)	Behaviorism	Intelligent Tutoring Systems (ITSs)	Statistical relational techniques	ACT Programming Tutor; Stat Lady
Paradigm Two: AI-Supported (Learner-as-Collaborator)	Cognitive & social constructivism	Dialogue-based Tutoring Systems (DTSs); Exploratory Learning Environments (ELEs)	Bayesian networks, Natural language processing, Markov decision trees	QUE exploratory environment
Paradigm Three: AI-Empowered (Learner-as-Leader)	Connectivism, Complex adaptive systems	Human-computer cooperation; Personalized/adaptive learning	Brain-computer interface, Machine learning, Deep learning	Real-time MOOC predictive modeling

The findings presented above illustrate how AIEd has evolved from directive to collaborative and ultimately to empowered learning models. This progression marks not only a technological transformation but also a pedagogical and ethical one, emphasizing the growing agency of learners. The following discussion interprets these paradigm shifts in greater depth, exploring how each phase redefines the relationship between AI, human cognition, and education. This structural transition highlights the growing autonomy of learners as AI evolves from a directive to an empowering force within education.

Paradigm One: AI-Directed (Learner-as-Recipient)

Learners primarily function as consumers of AI-generated instructional content, reflecting a technology-directed model of education. This method is also marked by AI systems that symbolize field knowledge and control the learning paths, and learners are guided by established instructional patterns. In addition, the theoretical premise of this paradigm is well in the ground of behaviorism through the arguments made by (Skinner, 1958) which focuses on the clear arrangement of content sequences aimed at inducing the right behavior in learners.

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According to this model, learning is considered as a process of learning new things through programmed instructions which present the new concepts in logical, incremental steps, instant feedback about wrong answers and maximum positive reinforcement of the desired behavior. Learners in this paradigm act as receivers who respond to a set of known sequences of knowledge, undergo learning procedures and processes as dictated by AI, and perform learning processes that are set to pursue predefined objectives. Moreover, the AI capabilities of this paradigm resemble the teaching machines used by (Skinner, 1958), which were more concerned with the logical way the subject matter should be presented, allowing overt responses by the learners and also giving them direct feedback on whether they had the correct response or not. The striking shortcoming of this paradigm is that these AI systems do not simulate the emerging knowledge and skills of learners, and do not provide their feedback with the consideration of individual learners. Therefore, this is the least learner-centered of the AIEd paradigms with its rigid, pre-established structure in which the standardized content delivery is more valued than the individualized learning experience.

The earliest ITSs are good illustrations of this AI-guided paradigm in action. An example of such an implementation was the Adaptive Control of Thought (ACT) Programming Tutor that illustrated the principles underlying the paradigm by keeping a database of rules of production of knowledge about programming, statistically calculating the probability of students learning a rule, and providing them with a sequence of exercises (in which such probability values were computed) based on these calculations (Anderson et al., 1995). Besides, the further evolution of Stat Lady tutoring system also demonstrates the features and progress of this paradigm. The first non-intelligent version was the example of a rigid, predetermined one as the content of the curriculum was presented in a fixed order, the learner had to solve pre-set problems, and was assumed to have mastered one set of problems before being allowed to move onto the next one (Anderson et al., 1995). Later, intelligent version of the system showed progress although it continues to play the role of director of the paradigm. It did online pretests to evaluate the level of initial student knowledge, applied different strategies to monitor the current learning conditions, and used data to make informed decisions on the acquisition of the mastery level or requirements of remediation. Also, historical surveys confirmed that ITSs during that period were based on knowledge representation based on rules and automated feedback and had a strict and system-controlled learning direction (Alkhatlan & Kalita, 2018; Ouyang & Jiao, 2021).

Under this paradigm, AI applications are typically implemented in the form of statistical relational techniques that present the knowledge in the form of production rules, track and identify specifics of student behavior, as well as give automated feedback and clues (Anderson et al., 1990; Ouyang & Jiao, 2021). In this way, the adoption framework supports the importance of AI as the leader of the process of learning, where learners use AI services to perform cognitive inquiry, solve issues, and complete set learning goals (Wang et al., 2024). The strategy provides a system, learning and guided environment that is still structured and includes different levels of adaptive instruction depending on the learner performance. It is important to note that the first AIEd paradigm poses a key question: what is the amount and nature of learner information, which will be useful to represent, diagnose, and guide the process of acquiring knowledge and skills? Nevertheless, despite having certain systems in this paradigm that gather information on learners to determine their learning states, the AI system has full control over learning material, processes, and objectives, essentially coercing learners to follow prescribed courses (Alkhatlan & Kalita, 2018; Ouyang & Jiao, 2021).

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Conversely, one of the major weaknesses of this strategy is that it may result into stereotypical expectations regarding the performance of learners. Because the system functions mostly on the part of the expert or system and yet on the part of the individual learner, no attention has been given to individual learner characteristics, needs and goals, then, the system can have a set of rigid expectations regarding what learners are expected to achieve. This uniform method is especially a problem with ill-defined problems that must be approached with more flexible and nuanced methods of learning. Thus, to overcome these shortcomings, especially the problem of AI being an opaque black box that is controlling the learning process, the field has developed into a second paradigm (Ouyang & Jiao, 2021). In the subsequent version, learners will no longer be passive receivers, but active participants of the learning process, which will be a major change in the relationship between AI and learners.

Paradigm Two: AI-Supported (Learner-as-Collaborator)

In this second paradigm of AIEd, there is a significant change in the relationship between AI technology and learners. The AI system does not rely on a governing power, but it becomes a supportive element, and learners become active agents in the process of self-learning. Therefore, this paradigm is theoretically informed by the cognitive and social constructivism, which asserts that learning is formed as a result of the interactions between learners and people, information and technology in socially situated settings as postulated by (Bandura, 1986) and (Vygotsky, 1978). In current educational practice, this collaborative paradigm is exemplified by adaptive AI learning environments such as Duolingo Max, which adjusts instruction dynamically through conversational AI feedback, and Khan Academy's GPT Tutor, which provides interactive, Socratic-style guidance (Duolingo, 2023; Khan Academy, 2024). Similarly, ChatGPT-powered classroom assistants allow learners to co-construct understanding through inquiry-based dialogues, reflecting the learner-as-collaborator model in real-world settings (OpenAI, 2024).

In this context, AI systems and learners develop active and mutually dependent relationships aimed at maximizing individualized, learner-centered learning (Bakhmat et al., 2025). The AI platform will continuously collect and process personal learner data to better and adjust its student model, and learners will actively cooperate with the system to increase the performance and effectiveness of their learning. As (Kujundziski & Bojadjiev, 2025) observe, this type of collaborative relationship is a clear improvement over the directive approach of the first paradigm.

Moreover, the paradigm represents a significant step towards genuinely learner-centered education due to the continuous cooperation between human learners and AI systems (Bakhmat et al., 2025). The focus is no longer upon established learning routes but rather on the adaptive interactive learning process that is sensitive to the needs and preferences of individual learners. It is important to note that the transformation shows the more advanced concept of how technology may be used to facilitate and improve the learning process, at the same time keeping the learner agency.

Implementations of Paradigm Two: Interactive Learning Systems

Numerous AI applications have been developed in this paradigm, especially in Dialogue-based Tutoring Systems (DTSs) and Exploratory Learning Environments (ELEs), which are aimed at mediating interactions between AI systems and learners (Yuan et al., 2024). In particular, such implementations work in two dimensions: system analysis and interaction with the learner. For

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example, contemporary AI-powered platforms like Duolingo Max employ reinforcement learning and natural language processing to adaptively respond to learner input, demonstrating how AI systems and learners collaborate to refine knowledge construction in real time.

System Analysis and Adaptation

The AI systems in this paradigm receive and analyze multimodal data to come up with accurate perceptions of the status of the learners. As an example, (Ji et al., 2025) used Markov decision process to dynamically produce and improve production rules using the current learner data, which produced a more precise representation of knowledge compared to the traditional models based on experts. In the same manner, (Cao et al., 2025) have also used dynamic Bayesian network models to model various skill hierarchies and their mutual relationships that increase the accuracy of knowledge representation of learners.

Learner Communication and Exploration

This paradigm involves the learners working with the system and learning how the system does its decision-making process and make the correct choice regarding the course of learning (Gao, 2024). One such example is the Query-based User Environment (QUE) exploratory environment that allowed learners to explore the discrepancies between learners and the system in rule-based ITSs (Hassan, 2024). Therefore, by the use of the why not and what if questions, learners were able to investigate the reasoning of the system, which contributed to deeper comprehension of the interactive learning situations.

Technical Implementation

High-level AI algorithms, such as Bayesian networks, natural language processing, and Markov decision trees, are used to process mass data of multimodal data, obtain high accuracy in the results, and produce communicative visualizations (Chaabene et al., 2025). This technical basis allows two-way interaction with significant communication between the learners and the system. Nevertheless, this paradigm is a tremendous improvement in the pre-destined directions of Paradigm One, which will create a more cooperative and learner-focused paradigm by learning each other with AI systems and learners. This development shows how AI can be used to aid personalized learning without the process of active involvement of the learner in education.

Yet, despite the fact that Paradigm Two is a major improvement of the AIEd, it encounters numerous issues related to the optimal alignment of information provided by the learners and the AI functioning (Ouyang & Jiao, 2021; Walker & Ogan, 2016). One of the key issues has been how much and how best learner data can be included in AI systems to improve student modeling, capture the various facets of learning process and come up with truly adaptive instruction (Ouyang & Jiao, 2021). It is important to note that the core issue here is to create long-lasting human-computer synergetic interactions. The interaction is complex in nature because both learner data and system states are dynamic. Further, the two components have hierarchical structures that are very complex and continuously change during the learning process. Therefore, the difficulty is especially clear in the necessity of AI systems to deliver real-time analysis and immediate feedback so that learners could use it efficiently to improve their learning processes in the present (Ouyang & Jiao, 2021).

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To solve these shortcomings, AI systems should advance to constantly gather and compute the data generated by learners and give real-time discovery chances to learners to make decisions. But even these advances can be insufficient to generate more learner agency in the educational process. This awareness has resulted in the creation of Paradigm Three where learners are raised to a leadership position in their learning process and they are no longer in the collaborative relationship as in Paradigm Two.

Paradigm Three: AI-Empowered (Learner-as-Leader)

The third AIEd paradigm is a paradigm shift, which places the learner agency at the core of it and considers AI to act as a means of enhancing the humanity-based intelligence (Yan, 2025). The theory behind this technique is the complexity theory, which views education as a complex adaptive system in which synergistic interaction of various components: learners, instructors, information, and technology is the key to optimizing intelligence in learners. A complex adaptive system (CAS) refers to a dynamic learning environment composed of interdependent agents—students, teachers, and AI systems—that continuously adapt to each other's behaviors. In education, this means that AI not only responds to learner input but also evolves alongside human cognition to co-create knowledge and innovation. This intricate educational ecosystem should define the development of AIEd and its implementation in the context of the knowledge that AI technologies are part of a more significant system, and the main participants in it are people (Torrisi-Steele, 2025). Therefore, this acknowledgment has given rise to a number of approaches that are human-centered such as human-computer cooperation, human-centered AI systems, human-AI collaboration, and human-centered AIEd (Li et al., 2025). These methods put emphasis on human conditions, expectations and contexts in the development and application of AI technologies.

In this paradigm, AI has been used as an augmented intelligence enabler making it highly transparent, accurate and effective support systems. In particular, the teachers get comprehensible, decipherable, and individualized tools to support the learner-centered learning process, whereas the students are offered the leadership roles of their learning process, where risks of AI automation are actively managed at the same time, allowing them to achieve learning results more effectively. In this way, it is a major advancement in AIEd, which serves as its eventual end, the improvement of human intelligence, ability and potential with the help of technology in education (Kong et al., 2025). In turn, such a last paradigm represents the evolution path of AIEd as it is possible to see how AI can be practically used in educational practices without losing the human agency and encouraging personal development. It creates a model in which technology will be used to enhance and not to supplant human abilities and a more balanced and efficient learning environment will be achieved.

Implementation of Paradigm Three: Human-Computer Cooperation Systems

The integration of high-quality AI methods with human decision-making processes is manifested through human-computer cooperation systems and shows that the results of Paradigm Three in AI-empowered learning and leader-as-learner are quite promising (Li et al., 2025). Recent studies have demonstrated the use of EEG-based brain–computer interfaces (BCI) that detect learners' attention levels and cognitive load in real time. These systems enable AI to support individualized instruction, monitor engagement, and dynamically adjust the learning pathway. This implementation works under two main avenues namely, technological advancement and human empowerment.

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Advanced Technical Integration

The latest AI technologies such as brain-computer interface, machine learning, and deep learning allow continuous gathering and processing of data and provide data accuracy, transparency, and interactivity (Khosravi et al., 2022; M & R, 2025). Moreover, recent developments in the form of smart wearable, cloud computing, and Internet of Things technologies have radically changed the pattern of human-AI interaction (Hong et al., 2025). The changes in technology have, in turn, transformed the role of AI in the educational process, especially in the creation of human-artificial cognition systems (Jiang et al., 2024).

Enhanced Human Decision-Making

With the help of AI-based personalized information systems, the processes of teaching and learning can be more effectively decided. Indicatively, (Ouyang & Jiao, 2021) have come up with a deep learning model based on recurrent neural network classification of real-time Massive Open Online Course (MOOC) predictive modeling that enables direct communication between instructors and learners. In a similar manner, (Khurramov et al., 2025) utilized AI methods to develop human intelligence enhancement by using prediction and classification algorithms on the objective of improving the visibility of the process of decision-making by expert tutors. The key points of this paradigm are the significance of synergetic interaction, integration, and collaboration between AI systems and human intelligence to generate adaptive and personalized learning experiences. Moreover, the effectiveness of this method depends on AI features and on the successful combination of technology innovation with human knowledge and decision-making, which form a more extensive and efficient learning space.

Overall, the three paradigms reflect a continuous and dynamic transformation in the epistemological foundation of Artificial Intelligence in Education (AIEd)—from systems of control to ecosystems of co-creation. This transformation demonstrates not only the rapid advancement of AI technologies but also a philosophical reorientation toward human-centred and ethically grounded learning. In contemporary practice, these paradigms are evident in the use of ChatGPT-based tutoring systems**,** adaptive learning platforms such as Duolingo Max**,** and GPT-powered guidance tools in Khan Academy**,** which exemplify the integration of AI as a *cognitive partner* rather than a mere instructional instrument. Furthermore, this evolution aligns with the (UNESCO, 2021) Recommendation on the Ethics of Artificial Intelligence*,* which underscores human oversight, transparency, accountability, *and* empowerment as the cornerstones of responsible AI deployment in education. Hence, the discussion reinforces that future AIEd frameworks must preserve the balance between automation and human agency to ensure ethical, equitable, and meaningful learning experiences in the age of intelligent technologies.

Challenges and Future Directions in Paradigm Three

The key issue of Paradigm Three is to deal with the multi-layered complexity in enabling AI systems and education processes to be integrated (Alfredo et al., 2024; Holstein et al., 2020). In particular, such complexity is also prone to such issues as the necessity to harmonize three essential factors: the complexity of the learning processes, the complexity of AI systems, and the diversity of the education settings. Therefore, the further evolution of the sphere of AIEd should be concentrated on the development of systems that will help establish uninterrupted contact between all stakeholders and ensure the correspondence between models of AI and human values (Ozmen Garibay et al., 2023). Such systems are required to facilitate new learning processes and must be able to leverage learner tendencies and behaviors, deliver a set

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of interpretable and actionable results, enable learners and instructors to reflect on the learning processes, and form iterative learning development loops through AI adaptation (Alfredo et al., 2024).

Moreover, new frameworks, e.g., human-centered AI systems, human-AI collaboration, and human-centered AIEd have foundational frameworks that can be used to work with such issues (Chauhan, 2024). Nevertheless, several dimensions should also be addressed as sustainable AIEd development includes pedagogical issues, social and cultural aspects, technical application, ethical concerns, inclusion and equity concerns, teacher training necessities, and inclusive data gathering measures (Holstein et al., 2020).

Finally, the Paradigm Three aims to realize three core objectives, i.e. enabling learners to assume full agency in the learning process, maximizing AI methods to offer real-time feedback about emergent learning, and critically assessing the way AI changes learning in complex, intertwined education systems (Kong et al., 2025). This holistic approach is the future of educational technology in which the human agency and technological development collaborate in harmony to deliver improved learning results.

Discussion

The gap between the educational and learning theories and AI technologies has not been notably represented in the literature of AI studies, which is why there is a pressing necessity to strengthen theoretical underpinnings (Sinha, 2025). Moreover, this position paper, based on the basic learning theories, introduces a system of three different AIEd paradigms to be used in studying how AI methods can be applied to solving educational issues in a methodical manner. The initial two AI-directed (learner-as-recipient) and AI-supported (learner-as-collaborator) paradigms have persisted in the field in the last thirty years. Next, the appearance of the third paradigm (AI-powered, learner-as-leader) marks a significant change in the direction of the integration of the human and AI intelligences and the efforts to address the most crucial issues such as the algorithmic bias, the structure of governance, and AI decision-making transparency (Cheong, 2024; Hanna et al., 2025). Three important considerations to be made in the evolution to Paradigm Three are:

1. Multimodal Data Collection: Innovations in technologies allow enhancing the interpretation of human learning using various data collection procedures that will give a more detailed picture of the behavior of learners and their needs (Giannakos & Cukurova, 2023; Mohammadi et al., 2025).
2. Real-time AI Algorithms: New advanced algorithms can enable feedback and interaction with his or her human factor in a more timely manner that encourages more responsive and adaptive learning (Alfredo et al., 2024; Cukurova, 2025).
3. Multidimensional Attributes: Recognizing social, cognitive, emotional, philosophical, and ethical dimensions remains crucial, as human characteristics related to perception and cognition cannot be fully replicated by AI (Cheong, 2024; Hanna et al., 2025).

Conclusions

This study conceptualizes the progressive evolution of Artificial Intelligence in Education (AIEd) through three paradigms: AI-Directed, AI-Supported, and AI-Empowered, that collectively redefine the relationship between technology and human learning (Mustafa et al., 2024; Wang et al., 2024). The analysis reveals that AIEd has evolved from a directive model emphasizing automation and control toward an empowering framework that strengthens human

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agency, collaboration, and creativity (Alfredo et al., 2024). Each paradigm demonstrates a deeper alignment between technological innovation and pedagogical philosophy, highlighting the ethical responsibility to maintain human oversight, transparency, and inclusivity in AI-driven education (Zhu et al., 2025). Moving forward, the development of AIEd should not only enhance adaptive intelligence but also preserve empathy, critical thinking, and social connection—ensuring that technology continues to serve as a tool for empowerment rather than substitution.

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References

Alfredo, R., Echeverria, V., Jin, Y., Yan, L., Swiecki, Z., Gašević, D., & Martinez-Maldonado, R. (2024). Human-centred learning analytics and AI in education: A systematic literature review. *Computers and Education: Artificial Intelligence*, *6*, 100215. https://doi.org/https://doi.org/10.1016/j.caeai.2024.100215

Alkhatlan, A., & Kalita, J. (2018). Intelligent tutoring systems: A comprehensive historical survey with recent developments. *ArXiv Preprint ArXiv:1812.09628*.

Anderson, J. R., Boyle, C. F., Corbett, A. T., & Lewis, M. W. (1990). Cognitive modeling and intelligent tutoring. *Artificial Intelligence*, *42*(1), 7–49. https://doi.org/https://doi.org/10.1016/0004-3702(90)90093-F

Anderson, J. R., Corbett, A. T., Koedinger, K. R., & Pelletier, R. (1995). Cognitive Tutors: Lessons Learned. *Journal of the Learning Sciences*, *4*(2), 167–207. https://doi.org/10.1207/s15327809jls0402_2

Baker, T., Smith, L., & Anissa, N. (2019). *Educ-AI-tion rebooted? Exploring the future of artificial intelligence in schools and colleges*. https://www.nesta.org.uk/report/education-rebooted/

Bakhmat, N., Barbashova, I., Mamychenko, S., Ponomarova, M., & Mozulenko, D. (2025). The History of Pedagogy as a Paradigm Shift: The Role of AI at the Current Stage. *Cadernos de Educação Tecnologia e Sociedade*, *18*(se1), 234–246.

Bandura, A. (1986). Social foundations of thought and action. *Englewood Cliffs, NJ*, *1986*(23–28), 2.

Bearman, M., Ryan, J., & Ajjawi, R. (2023). Discourses of artificial intelligence in higher education: A critical literature review. *Higher Education*, *86*(2), 369–385.

Cao, W., Mai, N. T., & Liu, W. (2025). Adaptive knowledge assessment via symmetric hierarchical Bayesian neural networks with graph symmetry-aware concept dependencies. *Symmetry*, *17*(8), 1332.

Chaabene, S., Boudaya, A., Bouaziz, B., & Chaari, L. (2025). An overview of methods and techniques in multimodal data fusion with application to healthcare. *International Journal of Data Science and Analytics*, 1–25.

Chauhan, A. (2024). *Human-AI Collaboration: Exploring Synergies and Future Directions*. https://doi.org/10.22541/au.172560988.80084396/v1

Chen, X., Xie, H., & Hwang, G.-J. (2020). A multi-perspective study on Artificial Intelligence in Education: grants, conferences, journals, software tools, institutions, and researchers.

Journal of Information System and Technology Management
JISTM
EISSN: 0128-1666
Volume 10 Issue 41 (December 2025) PP. 23-38
DOI: 10.35631/JISTM.1041003

Computers and Education: Artificial Intelligence, *1*, 100005. https://doi.org/https://doi.org/10.1016/j.caeai.2020.100005

Chen, X., Xie, H., Zou, D., & Hwang, G.-J. (2020). Application and theory gaps during the rise of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, *1*, 100002.

Cheong, B. C. (2024). Transparency and accountability in AI systems: safeguarding wellbeing in the age of algorithmic decision-making. *Frontiers in Human Dynamics*, *Volume 6-*. https://doi.org/10.3389/fhumd.2024.1421273

Chiu, T. K. F., Xia, Q., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, *4*, 100118.

Cukurova, M. (2025). The interplay of learning, analytics and artificial intelligence in education: A vision for hybrid intelligence. *British Journal of Educational Technology*, *56*(2), 469–488. https://doi.org/https://doi.org/10.1111/bjet.13514

du Boulay, B. (2000). *Can We Learn from ITSs? BT - Intelligent Tutoring Systems* (G. Gauthier, C. Frasson, & K. VanLehn (eds.); pp. 9–17). Springer Berlin Heidelberg.

Duolingo. (2023). *Duolingo Max: AI-powered language learning*. Duolingo Blog. https://blog.duolingo.com/duolingo-max

Dzogovic, S., Zdravkovska-Adamova, B., & Serpil, H. (2024). From Theory to Practice: A Holistic Study of the Application of Artificial Intelligence Methods and Techniques in Higher Education and Science. *Human Research in Rehabilitation*, *14*(2).

Gao, Q. (2024). Decision support systems for lifelong learning: Leveraging information systems to enhance learning quality in higher education. *J. Internet Serv. Inf. Secur*, *14*(4), 121–143.

George, B., & Wooden, O. (2023). Managing the strategic transformation of higher education through artificial intelligence. *Administrative Sciences*, *13*(9), 196.

Giannakos, M., & Cukurova, M. (2023). The role of learning theory in multimodal learning analytics. *British Journal of Educational Technology*, *54*(5), 1246–1267. https://doi.org/https://doi.org/10.1111/bjet.13320

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

Hanna, M. G., Pantanowitz, L., Jackson, B., Palmer, O., Visweswaran, S., Pantanowitz, J., Deebajah, M., & Rashidi, H. H. (2025). Ethical and bias considerations in artificial intelligence/machine learning. *Modern Pathology*, *38*(3), 100686.

Hassan, W. M. (2024). *INTELLIGENT TUTORING SYSTEM ONTOLOGY*.

Holstein, K., Aleven, V., & Rummel, N. (2020). A Conceptual Framework for Human–AI Hybrid Adaptivity in Education. In *Artificial Intelligence in Education: 21st International Conference, AIED 2020, Ifrane, Morocco, July 6–10, 2020, Proceedings, Part I* (Vol. 12163, pp. 240–254). https://doi.org/10.1007/978-3-030-52237-7_20

Hong, H., Dai, L., & Zheng, X. (2025). Advances in Wearable Sensors for Learning Analytics: Trends, Challenges, and Prospects. In *Sensors* (Vol. 25, Issue 9). https://doi.org/10.3390/s25092714

Hwang, G.-J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Education. In *Computers and Education: Artificial Intelligence* (Vol. 1, p. 100001). Elsevier.

Journal of Information System and Technology Management
JISTM
EISSN: 0128-1666
Volume 10 Issue 41 (December 2025) PP. 23-38
DOI: 10.35631/JISTM.1041003
Ji, X., Sun, L., & Huang, K. (2025). The construction and implementation direction of personalized learning model based on multimodal data fusion in the context of intelligent education. *Cognitive Systems Research*, 101379.

Jiang, Y., Huang, Q., & Li, Y. (2024). Application Strategies of Brain-computer Interface in Education from the Perspective of Innovation Diffusion Theory. *Brain-Apparatus Communication: A Journal of Bacomics*, *3*(1), 2376368. https://doi.org/10.1080/27706710.2024.2376368

Khan Academy. (2024). *Khanmigo: GPT-powered tutoring assistant*. Khan Academic Blog. https://blog.khanacademy.org/khanmigo

Khosravi, H., Shum, S. B., Chen, G., Conati, C., Tsai, Y.-S., Kay, J., Knight, S., Martinez-Maldonado, R., Sadiq, S., & Gašević, D. (2022). Explainable Artificial Intelligence in education. *Computers and Education: Artificial Intelligence*, *3*. https://doi.org/10.1016/j.caeai.2022.100074

Khurramov, A. J., Axmedshaeva, M. A., Mukhitdinova, F. A., Xudayberdiyeva, G. A., Almosova, S. S., Makhamatov, M. M., & Khayitov, S. R. (2025). Artificial Intelligence in Education: Analysis and Assessment of Legal Knowledge Using AI Tools. *Qubahan Academic Journal*, *5*(3), 264–293.

Kong, X., Fang, H., Chen, W., Xiao, J., & Zhang, M. (2025). Examining human–AI collaboration in hybrid intelligence learning environments: insight from the Synergy Degree Model. *Humanities and Social Sciences Communications*, *12*(1), 1–14.

Kujundziski, A. P., & Bojadjiev, J. (2025). Artificial Intelligence in Education: Transforming Learning Landscapes. In *Reimagining Intelligent Computer-Assisted Language Education* (pp. 1–54). IGI Global.

Li, H., Fang, Y., Zhang, S., Lee, S. M., Wang, Y., Trexler, M., & Botelho, A. F. (2025). ARCHED: A Human-Centered Framework for Transparent, Responsible, and Collaborative AI-Assisted Instructional Design. *ArXiv Preprint ArXiv:2503.08931*.

M, A. L., & R, R. (2025). A comprehensive review of AI-based brain-computer interface with prefrontal cortex and sensory-motor rhythms systemization for rehabilitation. *Results in Engineering*, *27*, 106483. https://doi.org/https://doi.org/10.1016/j.rineng.2025.106483

Maier, U., & Klotz, C. (2022). Personalized feedback in digital learning environments: Classification framework and literature review. *Computers and Education: Artificial Intelligence*, *3*, 100080.

Mohammadi, M., Tajik, E., Martinez-Maldonado, R., Sadiq, S., Tomaszewski, W., & Khosravi, H. (2025). Artificial intelligence in multimodal learning analytics: A systematic literature review. *Computers and Education: Artificial Intelligence*, *8*, 100426. https://doi.org/https://doi.org/10.1016/j.caeai.2025.100426

Mohammed, A. T., Velander, J., & Milrad, M. (2024). A retrospective analysis of artificial intelligence in education (AIEd) studies: Perspectives, learning theories, challenges, and emerging opportunities. In *Radical Solutions for Artificial Intelligence and Digital Transformation in Education: Utilising Disruptive Technology for a Better Society* (pp. 127–141). Springer.

Mustafa, M. Y., Tlili, A., Lampropoulos, G., Huang, R., Jandrić, P., Zhao, J., Salha, S., Xu, L., Panda, S., Kinshuk, López-Pernas, S., & Saqr, M. (2024). A systematic review of literature reviews on artificial intelligence in education (AIED): a roadmap to a future research agenda. *Smart Learning Environments*, *11*(1), 59. https://doi.org/10.1186/s40561-024-00350-5

Journal of Information System and Technology Management
EISSN: 0128-1666
JISTM
Volume 10 Issue 41 (December 2025) PP. 23-38
DOI: 10.35631/JISTM.1041003
OpenAI. (2024). *ChatGPT in education: Integrating AI for learning support*. OpenAI Blog. https://openai.com/blog/chatgpt-education

Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: The three paradigms. *Computers and Education: Artificial Intelligence*, *2*, 100020. https://doi.org/https://doi.org/10.1016/j.caeai.2021.100020

Ozmen Garibay, O., Winslow, B., Andolina, S., Antona, M., Bodenschatz, A., Coursaris, C., Falco, G., Fiore, S. M., Garibay, I., Grieman, K., Havens, J. C., Jirotka, M., Kacorri, H., Karwowski, W., Kider, J., Konstan, J., Koon, S., Lopez-Gonzalez, M., Maifeld-Carucci, I., … Xu, W. (2023). Six Human-Centered Artificial Intelligence Grand Challenges. *International Journal of Human–Computer Interaction*, *39*(3), 391–437. https://doi.org/10.1080/10447318.2022.2153320

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

Rehan, H. (2023). Shaping the future of education with cloud and AI technologies: enhancing personalized learning and securing data integrity in the evolving edtech landscape. *Australian Journal of Machine Learning Research & Applications*, *3*(1), 359–395.

Rowe, M. (2019). *Shaping Our Algorithms Before They Shape Us BT - Artificial Intelligence and Inclusive Education: Speculative Futures and Emerging Practices* (J. Knox, Y. Wang, & M. Gallagher (eds.); pp. 151–163). Springer Singapore. https://doi.org/10.1007/978-981-13-8161-4_9

Schiff, D. (2021). Out of the laboratory and into the classroom: the future of artificial intelligence in education. *AI & Society*, *36*(1), 331–348.

Sinha, T. (2025). Beyond Good AI: The Need for Sound Learning Theories in AIED. *Technology, Knowledge and Learning*. https://doi.org/10.1007/s10758-025-09843-9

Skinner, B. F. (1958). Teaching Machines. *Science*, *128*(3330), 969–977. https://doi.org/10.1126/science.128.3330.969

Tapalova, O., & Zhiyenbayeva, N. (2022). Artificial intelligence in education: AIEd for personalised learning pathways. *Electronic Journal of E-Learning*, *20*(5), 639–653.

Torrisi-Steele, G. (2025). AI and the Humans in Higher Education. In *AI Integration Into Andragogical Education* (pp. 209–230). IGI Global Scientific Publishing.

UNESCO. (2021). *Recommendation on the ethics of artificial intelligence*. https://unesdoc.unesco.org/ark:/48223/pf0000380455

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (Vol. 86). Harvard university press.

Walker, E., & Ogan, A. (2016). We're in this Together: Intentional Design of Social Relationships with AIED Systems. *International Journal of Artificial Intelligence in Education*, *26*(2), 713–729. https://doi.org/10.1007/s40593-016-0100-5

Wang, S., Wang, F., Zhu, Z., Wang, J., Tran, T., & Du, Z. (2024). Artificial intelligence in education: A systematic literature review. *Expert Systems with Applications*, *252*, 124167. https://doi.org/https://doi.org/10.1016/j.eswa.2024.124167

Yadav, S. (2025). Reimagining Education With Advanced Technologies: Transformative Pedagogical Shifts Driven by Artificial Intelligence. In *Impacts of Generative AI on the Future of Research and Education* (pp. 1–26). IGI Global.

Yan, L. (2025). From Passive Tool to Socio-cognitive Teammate: A Conceptual Framework for Agentic AI in Human-AI Collaborative Learning. *ArXiv Preprint ArXiv:2508.14825*.

Journal of Information System and Technology Management
EISSN: 0128-1666
JISTM
Volume 10 Issue 41 (December 2025) PP. 23-38
DOI: 10.35631/JISTM.1041003
Yuan, L., Hoel, T., & Powell, S. (2024). Navigating AI in Education—Towards a System Approach for Design of Educational Changes. In *Artificial Intelligence in Education: The Intersection of Technology and Pedagogy* (pp. 75–92). Springer.

Zhu, H., Sun, Y., & Yang, J. (2025). Towards responsible artificial intelligence in education: a systematic review on identifying and mitigating ethical risks. *Humanities and Social Sciences Communications*, *12*(1), 1111. https://doi.org/10.1057/s41599-025-05252-6