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# A CONCEPTUAL FRAMEWORK OF AI TOOLS AS A COGNITIVE TOOL IN HIGHER EDUCATION

**Abstract.** The rapid adoption of artificial intelligence (AI) technologies in higher education has attracted growing academic interest. At the same time, it has raised concerns among teachers. While existing research largely emphasizes technological efficiency or academic integrity risks, fewer studies address how AI can be pedagogically integrated to support learning without undermining students' cognitive engagement. The study synthesizes peer-reviewed literature in the areas of AI-supported learning, educational technology, and higher education using an analytical and theoretical research design. This study develops a pedagogical framework that conceptualizes AI as a cognitive tool rather than a substitute for human thinking. The proposed framework conceptualises the AI tool as a cognitive tool operating through three connected functions in pedagogy: scaffolding, cognitive support, and reflection. These roles are integrated into a logical framework based on constructivist and sociocultural learning theories. By providing a logical and practically useful model for ethical AI integration in higher education, the study enhances AI-enhanced teaching.

**Keywords:** AI in Education, AI-driven tools, Cognitive Tool, Pedagogical Scaffolding, Critical Thinking, cognitive tool

## Introduction

Kasneci et al., (2023) and Zawacki-Richter et al., (2019) systematic investigations show that the emergence and active implementation of large language models (LLMs) have led to a noticeable increase in the role of artificial intelligence in the higher education system. Generative artificial intelligence (GenAI) can create new content - including text, images, video, audio, and software code - by learning patterns from existing data. In this study, the discussion primarily refers to generative AI systems based on LLM, such as ChatGPT and similar tools, generally used by students for explanation, feedback, and problem exploration in a learning context.

Its fast popularity has generated a lot of conversation about academic integrity, assessment, and teaching in the future. The arrival of AI tools has noticeably changed, for instance, students can now quickly get brief explanations, alternative views of understanding phenomena in nature. Sometimes AI tools help with step-by-step problem walkthroughs, which make independent learning easier (Bearman et al., 2022). Many instructors worry that AI could promote superficial learning or erode pupils' capacity for independent thinking (Rudolph, 2023).

Meanwhile, past technological innovations in education were often viewed with concerns, yet over time, tools such as computers, calculators, and internet resources became recognised as valuable cognitive aids and, when thoughtfully integrated into teaching practices (Adom & Ferdinand James, 2019; Pakdaman-Savoji et al., 2019).

From this point of view, the key issue is not the presence of AI tools in education, but the way it is pedagogically integrated into learning activities. Against this background, this study suggests that AI can make a positive contribution to learning when it is deliberately used as a cognitive tool that supports, rather than replaces, students' thinking.

Recent studies on artificial intelligence in education emphasize the importance of aligning AI use with established learning theories (Wang et al., 2024). Aspects of AI-supported learning that have

been discussed in earlier studies of Yan et al. (2025) and this study bring these perspectives together by presenting a unified pedagogical framework that conceptualizes AI as a cognitive tool supporting different phases of the learning process.

This paper develops a conceptual framework that explains how artificial intelligence can function as a cognitive tool to support learning in higher education. It synthesizes relevant literature and presents three key pedagogical functions of AI-scaffolding, cognitive support, and reflection- by an analytical discussion of their implications for teaching and learning. These functions provide a structured lens for understanding how AI can support cognitive engagement while maintaining students' active role in the learning process.

This study is significant as it contributes to the growing body of research on AI in the HE role. It provides a theoretically grounded framework that conceptualizes AI as a cognitive tool supporting student thinking, rather than replacing it. The proposed model offers practical value for educators by outlining how AI can be meaningfully integrated into learning processes to enhance cognitive engagement, reflection, and independent learning.

The subsequent section presents the analytical findings and the proposed conceptual framework. Finally, the paper concludes with a discussion of the implications for teaching and learning in HE.

## Literature Review

### AI in Higher Education

AI is gradually moving beyond the scope of an assistive technology and is beginning to play a role as a structural element of the educational environment, influencing the ways in which we think and learn. Also appears concerns of academic dishonesty, which means HE is still negotiating its relationship with AI.

Crompton & Burke (2023) suggested that the conversation movement is moving from "Can we use AI?" toward "How should we use AI in a way that preserves authentic and meaningful learning?" In recent years, there has been a significant increase in AI research in higher education. AI is making huge inroads into higher education institutions, modifying how students learn and how instructors teach. Zawacki-Richter et al. (2019) demonstrate that much of this material focuses on technical applications, automations, and efficiency benefits. Kasneci et al. (2023) recent research suggests opportunities such as personalized assistance and adaptive learning with worries relating to reliance and academic dishonesty. A common weakness of his body of research is the lack of an explicit educational framework. Existing studies primarily focus on defining AI competencies and technical applications, while offering limited insight into how learning can be structured around AI to promote meaningful cognitive engagement (Zawacki-Richter et al., 2019; Kasneci et al., 2023; Wang et al., 2024).

There is a need to design educational frameworks with learning theory alignment, models, and scaffolding. A systematic review of 69 empirical studies found that personalized adaptive learning, which tailors the learning experience to the level and needs of each student and provides timely feedback, is most often associated with improved academic performance (41 studies out of 69, ≈ 59%) and increased student engagement (25 studies out of 69, ≈ 36%) (Du Plooy et al., 2024). Even though results vary by context, successful implementation remains an important challenge despite broad student recognition. The correlation of students' performance with test scores, course completion, conceptual understanding, and short-term and long-term learning goals (Kwak, 2025).

AI can help students learn English more effectively than traditional techniques (Rukiati et al., 2023). AI tools make learning more adaptable and interesting by adapting to each student's level and needs, providing immediate guidance, and allowing students to learn in their own adaptive manner. Some studies show that AI language models encourage students to experiment and explore new studies more effectively than traditional methods. For instance, in English learning, because the learners are different, it means giving more detailed information regarding their own abilities.

Wang et al.'s (2024) research indicates that AI considerably increases English language learning when applied properly and sensibly. Although the integration of AI in higher education has great potential, its pedagogical execution and applications are still restrictive. Ismail et al. (2024) research,

about educator development, and AI literacy encouragement are required to fully realize the potential of AI in education in delivering appropriate educational experiences for learners. AI can be applied as a learning subject to foster active participation, critical analysis and innovation while being academically honest. When implemented correctly, AI improves rather than being self-sufficient in thinking. (Slade et al., 2025). According to a quantitative quasi-experimental study of engineering and computer science students, AI-based adaptive learning technologies substantially enhance student engagement and comprehension, consequently positively influencing academic performance in undergraduate and STEM courses. (Fakhrudin et al., 2025).

**AI as a Cognitive Tool**

Cognitive technologies are characterized as methods that are helpful in the development of learners' intellectual skills rather than replacing human cognition. Within this framework, AI can be viewed as a tool for reasoning, problem-solving, and reflection. According to Holmes et al. (2021) and Shaples (2022), AI has the ability to operate as a learning scaffold or provide cognitive guidance when embedded in structured tasks. However, the literature lacks integrative frameworks for transforming these concepts of theory into pedagogically applicable and interactive models. Yavich (2025) explains that AI tools support teaching strategies that promote autonomous and reflective thinking. Similarly, Stuchlikova and Weis (2024) highlight that AI can enhance learning in HE by personalized support and adaptive learning. However, careful integration is required to avoid overdependence and maintain students' critical and independent thinking. Gerlich (2025) concludes that the link between frequent AI tool application and lower critical thinking is affected by cognitive withdrawal. It is explained by learners' disengagement from active cognitive processing. These findings imply that unstructured AI use may have a greater impact on students with lower educational achievement, emphasizing the importance of pedagogical practices that encourage reflective and responsible AI interaction.

From a constructivist perspective, AI tools support individualized and flexible learning experiences, but ethical considerations are necessary to ensure that AI integration does not undermine core educational principles (Marphala & Ajani, 2019). The analysis demonstrates that there is a trend in literature to imagine AI as a united and human-like entity. Nevertheless, such a wide paradigm ignores the diversity of AI technologies and their many functional and cognitive implications. They are useful for policy advancement, complicating proper analysis, and pedagogical application (Dumouchel, 2023). The relevance of cognitive framing of AI acceptance, according to Li (2025) the cognitive processing methods and contextual circumstances affect people's perceptions of AI more than technological attributes. In addition, their impact is generally confined to improving comprehension of individual texts and the identification of significant concepts of different subjects, with limits in cross-study comparison between tasks and higher-level conceptual clear analysis. Polin & Levine, (2025) findings suggest that a hybrid model approach is essential. In subject matter integration and complicated interpretation, AI supports all analytical stages. AI is conceptualized as a cognitive tool that supports learning through guidance, problem-solving, and reflection rather than replacing human thinking. Its effectiveness depends on structured pedagogical use, as unregulated use may reduce cognitive engagement.

**Theoretical Foundations**

In this study, analytical, sociocultural, and cognitive perspectives are used to interpret how AI supports different aspects of learning, including reasoning processes, interaction, and reflection. This perspective builds on sociocultural approaches to learning, which view learning as an active process shaped through interaction with tools, environments, and others (Vygotsky, 1978). From this point of view, learning is not passive, but involves active engagement, with AI serving as a tool that can support thinking and learning.

Additionally, for the two concepts, constructivist and sociocultural perspectives, this study offers the cognitive tool theory. This tool is designed to get involved in processes such as interpretation, reflection, and analysis. From this point of view, AI systems function as mediational means that

scaffold reasoning and make thinking processes explicit. The results are also informed by the theory of distributed cognition, which posits that cognitive processes are not confined to the individual but are distributed across tools, representations, and social interactions.

Overall, this perspective aligns with the view that AI can function as an external cognitive resource that supports reasoning and problem-solving without replacing the learner's cognitive agency (Cukurova, 2024).

## Methods and Materials

The analytical perspective was used to examine how AI supports reasoning and problem-solving, the sociocultural perspective to understand interaction between learners and tools, and the cognitive perspective to explore reflection and self-regulation processes.

The literature published from 2019 to 2025 indicates that research on AI in HE is commonly framed around three dominant perspectives: AI as a tool for efficiency and productivity, AI as a source of pedagogical and ethical concerns, and AI as a cognitive tool supporting learning processes.

It does not collect primary data or reviews; it integrates peer-reviewed results. The results are based on examination of published articles about using AI tools in HE for various purposes between 2019 and 2025. The goal addressed the conceptual gap in AI-enhanced pedagogy. This offered framework concludes a review of the literature with theoretical interpretation and analytical synthesis.

Peer-reviewed articles and scholarly reports from established journals in higher education and educational technology were selected, with a focus on published studies that investigate pedagogical design, cognitive engagement, assessment practices, and the use of AI as a cognitive tool in learning contexts. These studies were analyzed using analytical, sociocultural, and cognitive learning perspectives to discover pedagogically relevant patterns of AI use. Throughout the evaluated literature, recurring studies were found and integrated into a set of higher-level instructional roles of AI, which influenced the creation of the suggested framework.

Based on this methodological framework, the study investigates the pedagogical interpretation and integration of AI as a cognitive tool in higher education, with a focus on enhancing learning while sustaining students' independent and autonomous thinking.

## Results

This section presents the main findings and the proposed conceptual framework. This study pays particular attention to the use of AI in physics education as a representative domain for analyzing cognitive processes in learning.

**Analytical Overview of the Literature**

This section presents an analytical overview of the literature. Castilio-Martinez (2024) argues that the existing research mostly views AI mainly as an instrument of productivity and improving efficiency. The results indicate that automating some administrative tasks optimizes processes, workflow enhancement, improving features and performance characteristics. Other researchers investigate AI as a source of pedagogical and ethical concerns. The concerns about academic integrity and honesty, students' reliance and decreasing cognitive engagement, possible weakening of independent self-studying, characterizing AI as a destructive factor, assessment redesign, and more explicit institutional guidelines. (Zhai C et al., 2024). In contrast, a relatively smaller but conceptually significant body of work examines AI as a cognitive and pedagogical tool integrated into the learning experience. Studies in this stream examine how AI can scaffold reasoning, facilitate cognitive reflection, and encourage learners' independence, and they more explicitly draw on established learning theories like constructivism, sociocultural learning, and self-regulated learning to frame AI as a mediator of cognitive activity rather than a substitute for human thinking. (Tsakeni et al., 2025; Fan et al., 2025)

Overall, the analytical overview highlights a clear imbalance in the literature: while AI is widely addressed in terms of efficiency, ethics, and institutional governance, its pedagogical role remains under-theorized. A small number of studies directly link AI integration in educational theory, which

highlight the need for conceptually informed frameworks that explain how AI can enhance cognitive engagement and significant learning in HE. (Garzon et al., 2025).

The next section presents the key pedagogical functions of AI identified in the analyses.

**Identified Pedagogical Functions of AI**

In the review studies, three consistent pedagogical functions of AI were noted. First, AI can serve as scaffolding by providing structured guidance that supports students' progress. Secondly, AI can function as a cognitive aid, assisting learners in analyzing information, organizing ideas, and exploring alternative solutions. Third, AI serves as a reflective tool by prompting learners to justify their reasoning, assess their comprehension, and engage in self-reflection. These findings are organised around three key pedagogical functions: scaffolding, cognitive support, and reflection. The summary of these findings is presented in Table 1.

**Table 1.** *Analytical findings across studies on AI use in Higher education*

| Analytical Dimension | Dominant Patterns in the Literature | Pedagogical Interpretation | Contribution of This Study |
|---|---|---|---|
| Framing of AI | AI viewed as automation or risk | Technology-centered framing limits learning potential | Reframes AI as a cognitive tool |
| al Design | Unstructured use linked to surface learning | Learning quality depends on task design | Emphasizes pedagogical structuring |
| Cognitive Engagement | Higher engagement with guided AI use | AI mediates thinking when scaffolded | Identifies scaffolding as a core function |
| Student Dependency | Dependency emerges without constraints | Dependency is a design issue | Proposes gradual release of support |
| Reflection | Rarely emphasized | Cognition is essential for deep learning | Positions AI as reflective tool |
| Assessment | Traditional assessment loses validity | Process-oriented assessment needed | Provides theoretical basis for redesign |

Three consistent ways that AI facilitates pedagogical studies. Results show how AI enhances learning in a variety of subjects, program outcomes, and educational contexts by supporting students' thinking. They are:

- AI helps learners by delivering a comprehensive framework that facilitates the handling of challenging problems. Advice, guided questions, suggestions, or detailed instructions can be considered as an example. It decreases challenge and boosts self-confidence. The degree of support can be gradually decreased as students grasp subject matter better, enabling them to work more effectively and independently. In this way, AI advances students' learning without taking away their independence; rather, it progressively strengthens it.
- AI also serves as a mirror, allowing students to see how they think. By formulating queries, offering criticism, or making comparisons between different strategies, it gently leads them. This encourages students to reflect on how they approach learning tasks, assess their progress in studies, and provide more detailed explanations of the reasoning processes. Helping with a particular task is only one aspect of this type of reflection. It aids in the development of a crucial skill, such as becoming conscious of one's own ideas, assessing the efficacy of one's learning techniques, and eventually identifying strategies that are suitable for them.

- AI helps learners to think more methodologically and clearly by acting as a "mental training simulation", which promotes the crucial phases of information processing, such as data organization and structuring, breaking down complex scientific problems by dividing them into parts, and investigating different strategies and potential solutions. AI does not provide only simple, ready-made answers. Mainly, it encourages students to study subject matter completely and actively. This method is regarded as a cognitive tool that is particularly useful in tasks that require analysis, comparison, and evaluation processes. They are components of critical thinking.

These perspectives provide the theoretical basis for identifying key pedagogical functions of AI, including scaffolding, cognitive support, and reflection. This framework illustrates that AI support in HE takes into account all the described 3 roles, playing the role of an assistant. But not considering it as an all-knowing authority. AI has different and various functions in a wide range of subjects, from literature to physics-related subjects. One of the important things is using AI widely, which means that technologies - the capacity for independent thought - will promote development, engagement, and introspection. Finally, empowering the students is more important than just giving an answer. AI can be a dependable assistant in Physics education at every level of problem-solving. Instead of offering pre-made solutions, it guides learners in breaking down complex problems on their own, identifying significant laws and phenomena, and formulating a plan of action. Considering AI as an assistant, it makes it easier to organize equations, compare various approaches to solving them, and find logical components between physical concepts. Moreover, it promotes intersection by posing queries that compel students to think about their presumptions, the true significance of the findings, and how the solution could differ in different circumstances.

All of these desires are towards one thing: improving students' comprehension of physics and their ability to solve problems without taking the place of the most crucial component - their own independent thought. AI remains in the background as the process of thinking at the core of the educational process.

## Discussion

The findings are discussed in relation to the proposed conceptual framework and existing literature. The study fills the gap by providing a view of AI as a cognitive tool that does not replace nor automates students' thinking but supports their intellectual processes. This shift means the discussion from technological capabilities to pedagogical capabilities to pedagogical goals and connects the use of AI with proven learning theories. This research analysis reveals that most of the current researchers consider AI as either an aid to increase productivity or as some kind of threat to pedagogy. But very few researchers have presented AI as some kind of facilitator in the learning process. It helps shape the learning process itself.

These findings are consistent with previous studies highlighting the role of AI as a cognitive support tool in learning (Holmes et al., 2021; Kasneci et al., 2023).

The role of AI as an intelligent assistant also discloses fully how it contributes to the development of complex forms of thinking. After using correctly and adequately, it can be considered such as analytical activities, comparing alternatives, and refining arguments. These findings challenge the notion that AI inevitably leads to superficial learning and demonstrate that its real educational impact is determined primarily by pedagogical impact. The next idea is about AI, considering AI as a learning support, as a tool for Pedagogical functions. In this part we consider three functions. They are scaffolding, cognitive assistance, and reflection. These functions facilitate students in moving ahead with complex problems through a carefully designed structure that allows them to use in various areas and the model is described in Figure 1.

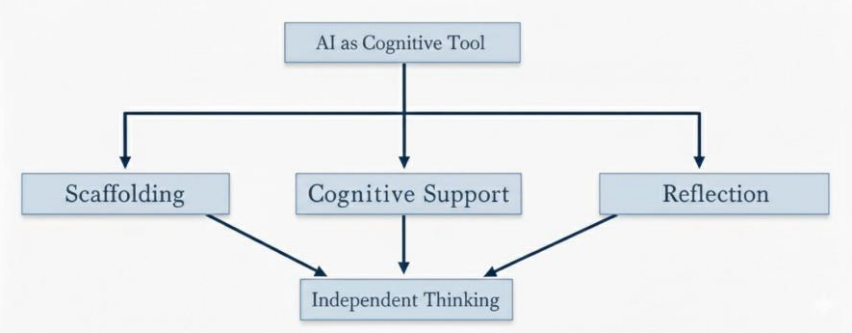


**Figure 1.** Conceptual model of AI as a cognitive tool in physics education

Another finding, considering AI instruments such as scaffolding, is also described in terms of dependency and design. One issue that was raised in relation to studies carried out on students is that of dependence on AI. Conversely, the problem is not using AI technology, but concerns about its uncontrolled use. Therefore, the research question is a pedagogical design of using AI tools, but is not about capabilities.

One of the main concepts described in this study is the engagement of AI tools as a cognitive tool. According to the relevance of this study, previous studies have paid little attention to the reflective use of AI instruments. Instead, these results illustrate reflection in interaction with technology. While students address the results of AI-created material, explain the basis for assessment, and articulate the rationale for that determination, it confirms the capability of artificial intelligence to enhance cognition and promote self-regulation of learning. This study also describes the implications of Assessment Practices. The results are shown in Table 1, describing a growing disconnect between traditional methods and AI-enabled learning environments. Such tools undermine the efficiency of assessment practices that concentrate on the end outcome. Our results support the need for a shift in emphasis towards process, with a focus on the ability to justify, argue, and critically reflect. In recognizing the potential of AI as a cognitive tool, the research provides a theoretical foundation for a paradigm shift in assessment approach. While capturing the value of technological potential. It ensures the integrity of the learning institution environment.

Finally, according to pedagogical contributions and pedagogical contributions, this results in a debate with both pedagogically sustained models, which position AI as a facilitator within the learning process in HE. Opposing these approaches focus solely on technological capabilities or potential risks. It means that the AI promotes intellectual engagement, assists in learning, stimulates reflections - but only meaningfully integrated into HE.

This aligns with concerns raised in recent research about over-reliance on AI and its impact on critical thinking (Gerlich, 2025). This finding is consistent with previous studies that highlight the role of AI in supporting cognitive processes (Holmes et al., 2021; Kasneci et al., 2023). Despite the diversity of positions in the literature, a comprehensive analysis reflects that the conflicting research results are not related to AI technology itself, but to the specifics of its pedagogical integration. Positive educational effects are consistently evident in conditions of structured support, guiding questions, and reflective activities. At the same time, unsupervised or unstructured use of AI is associated with the risk of cognitive unloading and reduced depth of information processing. Thus, the decisive factor is the instructional design, not the presence of AI in general.

The proposed model imagines a structured integration of AI into the physics learning process. The use of AI should be integrated into the stages of solving physics problems such as analyzing the conditions, identifying key laws and concepts, choosing a solution strategy, testing hypotheses, and then reflecting on them. In this context, AI acts not as a source of ready-made answers, but as a means of supporting reasoning. AI support should be gradually reduced as students develop skills in independent analysis and application of physical principles. Assessment practices should focus on the solution process, the rationale for choosing laws, and the interpretation of the results obtained, rather than solely on the correctness of the numerical answer. This approach allows AI to be used as a tool for developing conceptual understanding and critical thinking in physics.The proposed

framework extends previous work by integrating cognitive, sociocultural, and metacognitive perspectives (Shaples, 2022; Yavich, 2025).

An analysis of peer-reviewed studies (2019–2024) revealed a consistent pattern: conflicting results in the literature are related not to the AI technology itself, but to the nature of its pedagogical integration. Positive effects are observed with structured use of AI (support, guiding questions, reflection), while unstructured use is associated with the risk of cognitive unloading. Thus, instructional design is the decisive factor.

Based on the identified patterns, a model for the structured integration of AI into physics instruction is proposed. It is advisable to include AI in the problem-solving stages (condition analysis, strategy selection, hypothesis testing, reflection), gradually reducing the amount of support and shifting the assessment to the reasoning process. This approach promotes the development of conceptual understanding and critical thinking.

## Conclusion

The obtained results indicate that the educational impact of AI is determined by the nature of its pedagogical integration. When incorporated into structured learning tasks, AI promotes the development of analytical thinking, reflection, and student independence. Unstructured use increases the risk of superficial learning. Therefore, the decisive factor is not the technology itself, but the logic of its pedagogical design. The proposed model sets guidelines for the methodologically sound use of AI in higher education.

Future research may focus on empirical validation of the proposed framework and its application in specific disciplinary contexts, including physics education.

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**References**

Adom, D., & Ferdinand James, D. (2019). Historical overview of educational technology in the 20th and 21st centuries. In M. Khosrow-Pour (Ed.), Advanced methodologies and technologies in modern education delivery (pp. 1–90). IGI Global. https://doi.org/10.4018/978-1-5225-7365-4.ch001

Bearman, M., Dawson, P., Ajjawi, R., Tai, J., & Boud, D. (2024). Developing evaluative judgement for a time of generative artificial intelligence. Assessment & Evaluation in Higher Education, 49(6), 893–905. https://doi.org/10.1080/02602938.2024.2335321

Castillo-Martinez, I. M., Flores-Bueno, D., Gómez-Puente, S. M., & Vite-León, V. O. (2024). AI in higher education: A systematic literature review. Frontiers in Education, 9, 1391485. https://doi.org/10.3389/feduc.2024.1391485

Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: The state of the field. International Journal of Educational Technology in Higher Education, 20, Article 22. https://doi.org/10.1186/s41239-023-00392-8

Cukurova, M. (2024). The interplay of learning, analytics and artificial intelligence in education: A vision for hybrid intelligence. British Journal of Educational Technology, 56(3), 469–488. https://doi.org/10.1111/bjet.13514

Du Plooy, E., Casteleijn, D., & Franzsen, D. (2024). Personalized adaptive learning in higher education: A scoping review of key characteristics and impact on academic performance and engagement. Heliyon, 10, e39630. https://doi.org/10.1016/j.heliyon.2024.e39630

Dumouchel, P. (2023). AI and regulations. AI, 4(4), 1023–1035. https://doi.org/10.3390/ai4040052

Fakhrudin, M. U., Heru, R. C., Paroli, Siahaan, M. M., Mutiara, B. A., & Rafika, A. S. (2025). Enhancing academic achievement in higher education through adaptive learning algorithms. Proceedings of the 2025 International Conference on Computer and Information Technology

(ICCIT 2025). IEEE. https://doi.org/10.1109/ICCIT65724.2025.11167094
Fan, F., Wang, S., & Dinuer, M. (2025). Enhancing students' metacognition with innovative AI-based metacognitive reflective learning tools. IEEE Transactions on Learning Technologies, PP(99), 1–18. https://doi.org/10.1109/TLT.2025.3580536
Garzon, J., Patiño, E., & Marulanda, C. (2025). Systematic review of artificial intelligence in education: Trends, benefits, and challenges. Multimodal Technologies and Interaction, 9(8), 84. https://doi.org/10.3390/mti9080084
Gerlich, M. (2025). AI tools in society: Impacts on cognitive offloading and the future of critical thinking. Societies, 15(1), 6. https://doi.org/10.3390/soc15010006
Holmes, W., Porayska-Pomsta, K., Holstein, K., Sutherland, E., Baker, T., & Koedinger, K. (2021). Ethics of AI in education: Towards a community-wide framework. International Journal of Artificial Intelligence in Education, 32, 504–526. https://doi.org/10.1007/s40593-021-00239-1
Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., … Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. Learning and Individual Differences, 103, 102274. https://doi.org/10.1016/j.lindif.2023.102274
Kwak, M. J. (2025). The effectiveness of AI-driven tools in improving student learning outcomes compared to traditional methods. Issues in Information Systems, 26(4), 233–247. https://doi.org/10.48009/4_iis_2025_120
Li, F., Wei, X., Wang, C., Zhang, C., Yu, G., Yang, Y., & Liu, Y. (2025). How do users perceive AI? A dual-process perspective on enhancement and replacement. Telematics and Informatics Reports, 19, 100227. https://doi.org/10.1016/j.teler.2025.100227
Maphalala, M. C., & Ajani, O. A. (2025). Leveraging artificial intelligence as a learning tool in higher education. Interdisciplinary Journal of Education Research, 7(1), a01. https://doi.org/10.38140/ijer-2025.vol7.1.01
Pakdaman-Savoji, A., Nesbit, J. C., & Gajdamaschko, N. (2019). The conceptualisation of cognitive tools in learning and technology: A review. Australasian Journal of Educational Technology, 35(2), 1–24. https://doi.org/10.14742/ajet.4704
Polin, B. A., & Levine, L. (2025). Enhancing literature reviews through AI integration: A case study on cognitive efficiency. Acta Psychologica, 260, 105626. https://doi.org/10.1016/j.actpsy.2025.105626
Rudolph, J., Tan, S., & Tan, S. (2023). ChatGPT: Bullshit or the end of traditional assessments in higher education? Journal of Applied Learning and Teaching, 6(1), 342–363.https://doi.org/10.37074/jalt.2023.6.1.9
Rukiati, E., Wicaksono, J. A., Taufan, G. T., & Suharsono, D. D. (2023). AI on learning English: Application, benefit, and threat. Journal of Language and Communication Technology, 1(2). https://doi.org/10.25047/jlct.v1i2.3967
Sharples, M. (2022). Automated essay writing: An AIED opinion. International Journal of Artificial Intelligence in Education, 32, 1119–1126. https://doi.org/10.1007/s40593-022-00300-7
Slade, J. J., Byers, S. M., Becker-Blease, K. A., & Gurung, R. A. R. (2024). Navigating the new frontier: Recommendations to address the crisis and potential of AI in the classroom. Teaching of Psychology, 52(3), 254–261. https://doi.org/10.1177/00986283241276098
Stuchlikova, L., & Weis, M. (2024). From information to insights: Reimagining critical thinking pedagogy in the age of artificial intelligence. Proceedings of the 2024 International Conference on Emerging eLearning Technologies and Applications (ICETA 2024) (pp. 591–598). IEEE. https://doi.org/10.1109/ICETA63795.2024.10850787
Tsakeni, M., Nwafor, S. C., Mosia, M., & Egara, F. O. (2025). Mapping the scaffolding of metacognition and learning by AI tools in STEM classrooms: A bibliometric–systematic review approach (2005–2025). Journal of Intelligence, 13(11), 148. https://doi.org/10.3390/jintelligence13110148
Wan Ismail, W. S. A. B., Awang, N. A., & Mohd Pauzi, N. (2024). An overview of the use of artificial intelligence (AI) tools in higher education. International Journal on E-learning and

Higher Education, 19(3), 27–40. https://doi.org/10.24191/ijelhe.v19n3.1932
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/10.1016/j.eswa.2024.124167
Wang, X., Huang, R., Sommer, M., Pei, B., Shidfar, P., Rehman, M. S., Ritzhaupt, A. D., & Martin, F. (2024). The efficacy of artificial intelligence-enabled adaptive learning systems from 2010 to 2022 on learner outcomes: A meta-analysis. Journal of Educational Computing Research, 62(6), 1348–1383. https://doi.org/10.1177/07356331241240459
Yavich, R. (2025). Will the use of AI undermine students' independent thinking? Education Sciences, 15(6), 669. https://doi.org/10.3390/educsci15060669
Yan, Y., Liu, H., Zhang, H., Chau, T., & Li, J. (2025). Designing a generalist education AI framework for reshaping teaching and learning practices. Applied Sciences, 15(14), 7758. https://doi.org/10.3390/app15147758
Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education. International Journal of Educational Technology in Higher Education, 16(1), 1–27. https://doi.org/10.1186/s41239-019-0171-0
Zhai, C., Wibowo, S., & Li, L. D. (2024). The effects of over-reliance on AI dialogue systems on students' cognitive abilities: A systematic review. Smart Learning Environments, 11, 28. https://doi.org/10.1186/s40561-024-00316-7

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# ЖОҒАРЫ БІЛІМ БЕРУДЕГІ ЖИ ҚҰРАЛДАРЫНЫҢ ТҰЖЫРЫМДАМАЛЫҚ НЕГІЗІ КОГНИТИВТІК ҚҰРАЛ РЕТІНДЕ ҚАРАСТЫРУ

**Аңдатпа.** Жоғары білім беру саласында жасанды интеллект (ЖИ) технологияларының қарқынды енгізілуі ғылыми қызығушылықтың артуына алып келді. Сонымен қатар, бұл оқытушылар арасында алаңдаушылық туғызды. Қолданыстағы зерттеулер негізінен технологиялық тиімділікке немесе академиялық адалдыққа төнетін қауіптерге назар аударса, ЖИ-ді студенттердің когнитивтік белсенділігін төмендетпей, оқытуды қолдау үшін педагогикалық тұрғыда қалай тиімді біріктіруге болатынын қарастыратын зерттеулер аз.

Бұл зерттеуде ЖИ-ге негізделген оқыту, білім беру технологиялары және жоғары білім салаларындағы рецензияланған ғылыми еңбектер аналитикалық және теориялық тәсіл арқылы жүйеленді. Жұмыста ЖИ-ді адам ойлауын алмастыратын құрал емес, когнитивтік құрал ретінде қарастыратын педагогикалық модель ұсынылады.

Ұсынылған модель ЖИ-ді педагогикада өзара байланысты үш негізгі функция арқылы әрекет ететін когнитивтік құрал ретінде сипаттайды: скэффолдинг, когнитивтік қолдау және рефлексия. Бұл функциялар конструктивистік және әлеуметтік-мәдени оқыту теорияларына негізделген логикалық құрылымға біріктірілген. Жоғары білім беруде ЖИ-ді этикалық тұрғыда енгізуге арналған логикалық және практикалық тұрғыдан тиімді модель ұсына отырып, зерттеу ЖИ-ге негізделген оқыту тәжірибесін дамытуға үлес қосады.

**Түйін сөздер:** Білім берудегі жасанды интеллект, жасанды интеллектпен басқарылатын құралдар, когнитивті құрал, педагогикалық қолдау, сыни ойлау, когнитивті құрал

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# КОНЦЕПТУАЛЬНАЯ ОСНОВА ИСПОЛЬЗОВАНИЯ ИИ ИНСТРУМЕНТОВ КАК КОГНИТИВНОГО ИНСТРУМЕНТА В ВЫСШЕМ ОБРАЗОВАНИИ

**Аннотация.** Быстрое внедрение технологий ИИ в высшее образование вызвало растущий научный интерес. В то же время это вызвало опасения среди преподавателей. В то время как существующие исследования в основном акцентируют внимание на технологической эффективности или рисках академической честности, меньше исследований посвящено тому, как ИИ может быть педагогически интегрирован для поддержки обучения без подрыва когнитивной вовлеченности студентов.

В данном исследовании осуществляется синтез рецензируемой литературы в области обучения с использованием ИИ, образовательных технологий и высшего образования на основе аналитического и теоретического подхода. В работе предлагается педагогическая модель, в которой ИИ рассматривается как когнитивный инструмент, а не как замена человеческого мышления.

Предложенная модель описывает ИИ как когнитивный инструмент, функционирующий через три взаимосвязанные педагогические функции: скэффолдинг, когнитивную поддержку и рефлексию. Эти функции интегрированы в логическую структуру, основанную на конструктивистских и социокультурных теориях обучения. Предлагая логически обоснованную и практически применимую модель этичной интеграции ИИ в высшем образовании, исследование вносит вклад в развитие педагогических подходов с использованием ИИ.

**Ключевые слова:** ИИ в образовании, инструменты на основе ИИ, когнитивный инструмент, педагогическая поддержка, критическое мышление, когнитивный инструмент

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