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Cognitive Offloading in AI-Assisted Learning: A Study of Its Psychological Effects on Memory, Critical Thinking, and Problem-Solving Skills

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Abstract: Artificial intelligence (AI) has revolutionized the current educational landscape, making personalized learning, intelligent tutoring systems, and adaptive education possible. It has also been used increasingly for cognitive offloading, for learners to use Artificial Intelligence (AI) tools to assist them with memory, reasoning and problem-solving. The goal of this study is to shed light on the psychological impact of cognitive offloading in the context of AI-supported learning, specifically on memory retention, critical thinking, and problem-solving abilities. A complete narrative study process was carried out based on journal articles, books and conference studies published from 2020 to 2026. Relevant studies were identified through the use of established search strategies and inclusion/exclusion criteria. The results show that AI-assisted learning enhances personalised teaching, reduces cognitive load, increases learning efficiency and leads to academic achievement. "Over-reliance on AI could diminish memory recall, executive functions, analytical thinking, and problem-solving skills. Psychological effects vary based on learners' digital skills, educational context, task complexity, and extent of AI use. Longitudinal and cross-cultural empirical investigations are needed in the future to evaluate long-term cognitive effects and to establish evidence-based ethical guidelines for optimal AI integration in education.

Keywords: Cognitive Offloading, Artificial Intelligence, AI-Assisted Learning, Critical Thinking, Problem-Solving Skills.

1. Introduction

Artificial intelligence is being incorporated at a rapid pace into higher education, evolving from an auxiliary tool to an integral part of academic efforts. In many professions, students have easy access to tools that can generate text, summarise complex content, solve organised and unstructured problems, and support decision-making (Pitti, R. 2020). These inventions have opened up huge potential. Artificial intelligence can boost efficiency, enable tailored learning, and lower barriers to accessing information. Students can swallow vast amounts of information in bite-sized portions, get feedback directly and can dissect and explore several understandings of challenging concepts. Offering such assistance may help to boost a few students' confidence and remove their mental burden (Mir, M. M., et al., 2026). The emergence of AI tools like ChatGPT, Gemini, and Microsoft Copilot that can generate content, explain complex topics, provide tailored feedback, and support real-time decisions is further driving this change, especially in educational settings. Although the earlier generations of education technologies have primarily served to access information, the use of current systems of artificial intelligence is increasingly involved in the cognitive process of learners, thus transforming the way knowledge is acquired, processed and applied in higher education institutions.

Although conceptual advances in the way AI is incorporated into the learning process and how effective it is in making learning activities more efficient have been remarkable, there is relatively limited study on the long-term cognitive costs and psychological consequences of the use of AI (Gayed et al., 2022). With this approach one can really investigate the potential of AI to improve or disrupt the learning process, guaranteeing that the use of AI maximises the learning potential and preserves the necessary cognitive functions. However, the increasing use of AI-powered learning also has sparked a valuable academic discussion. While the use of AI can enhance learning efficiency by offering support in reducing cognitive load and providing personalized feedback and guidance, there have been concerns about the potential long-term effects of over-reliance on intelligent

technologies on learners' cognitive engagement, intellectual autonomy, and higher-order thinking skills. This controversy has diverted focus from the efficacy of AI to the impact that it has on the psychological and cognitive long-term effects. Cognitive offloading is the use of external resources for completing cognitive tasks. AI tools make things easier but reduce possibilities for active recall and problem solving which are crucial to cognitive development (Akgun, M., et al., 2024).

AI enhanced learning has revolutionized education by enhancing cognitive offloading, memory, critical thinking, and problem-solving skills. It has progressed from basic digital materials to sophisticated systems that provide personalised teaching, real-time feedback and adaptive support. Education has been influenced by technology since its inception. It has impacted curriculum and curriculum delivery, the design of the learning environment by the educators and the relationship between students and learning environment (Barua, P. D., et al., 2022). Technology is merely a facilitator to enrich the entire learning experience. EDU 4.0 and Web 4.0 have developed symbiotically and the evolution of digital technologies and their integration in education can be evaluated by looking into EDU 4.0 and Web 4.0. The technological advancement has impacted on the wide uptake, and use, of digital technologies and has transformed the trajectory and influence of EDU 4.0 and Web 4.0 in our daily life (Purba, S. W. D., et al., 2025). With such a lively learning atmosphere, AI tools that support learning have emerged as one of the biggest game-changers since they no longer just provide information but can also assist in reasoning, problem-solving, and decision-making. As a result, AI is becoming more than just an instructional technology, it's a cognitive partner. AI is currently the most transformative phenomenon in the field of EdTech, especially in the realm of learning analytics, intelligent tutoring systems, automatic assessment, and generative systems. One of the big things AI is good at is predicting educational outcomes, so early interventions can be made (Nadeem, S. 2025). As AI tools become more capable of completing complex mental tasks, though, it also gives rise to the issue of how well students are still encouraged to remember, analyze, and solve problems on their own.

Cognitive offloading refers to the use of external instruments to reduce the cognitive load on a person's working memory. This may free up brain resources, but it may also lead to less cognitive engagement and less skill development. With artificial intelligence (AI) tools being widely available and delivering instant solutions and ready-made information, there may be a lack of motivation for people to engage in the cognitive processes that are necessary for critical thinking (Sachdeva, C. 2023). The availability of information from search engines may impact memory ability and the tendency to digest information deeply. Cognitive offloading is the externalisation of cognitive processes, often via tools or external agents, such as notes or calculators or digital technology such as AI, to reduce cognitive load. Cognitive offloading can increase efficiency by freeing up cognitive resources, but this does not mean that engagement with the work decreases (Guo, Y., & Ye, Q. 2026).

Offloading mechanisms, such as external memory aides, electronic devices, and social networks, help individuals manage tasks and information without overloading their working memory. Things like doing calculations, looking up facts and making decisions can be done by electronic devices, especially those that are AI-powered (Grinschgl, S., 2020). AI-assisted learning supports by providing a customised learning experience and clear, contextualised, and accurate feedback that clarifies the expectations. Artificial Intelligence has opened up instructional approaches and educational endeavours. AI can make use of machine learning methods, neural networks and natural language processing for adaptive and interactive feedback (Chen, J., et al., 2022). It would seem that the AI has opened a new round of learning objectives, besides the academic ones. It affects the learners' emotions and hence it affects their moods, engagement and tenacity in their language acquisition process (Alangari, T. S. 2025). AI-enhanced learning is shown to impact various psychological factors, such as motivation, cognitive load, memory retention, critical thinking, problem-solving, self-efficacy, self-regulated learning, cognitive offloading, decision-making, and metacognitive awareness (Khan et al., 2025).

While there has been significant study development in AI-assisted learning, the literature has concentrated on the adoption of AI and the learning outcomes, but there has been comparatively little literature on the psychological impact of AI-induced cognitive offloading when it comes to memory, critical thinking, and problem-solving processes. To this end, the current study attempts to put together the available literature in a balanced way to give an overview of these cognitive implications and to suggest directions for the responsible use of AI in higher education in the future. Here, are the objectives of the study.

1. How cognitive offloading through AI-assisted learning does tools influence learners' memory retention and knowledge acquisition?
2. What are the reported effects of AI-assisted cognitive offloading on learners' critical thinking and problem-solving skills across different educational contexts?
3. What theoretical perspectives and knowledge gaps emerge from the existing literature on cognitive offloading in AI-assisted learning, and what implications do they have for future educational research and practice?

2. Understanding Cognitive Offloading in AI-Assisted Learning

The swift adoption of artificial intelligence (AI) in the educational landscape has shifted cognitive offloading from a foundational approach of supporting memory to a core component of learning with AI.Cognitive offloading, which was once a memory-support strategy, has become a central part of AI-assisted learning as AI has rapidly integrated into the field. Unlike the previous generations of educational technologies that merely help learners access information, modern AI technologies actively engage learners' cognitive processes by retrieving information, fostering ideas, solving problems, and helping with decision making. This has made AI more of a cognitive companion to the learner than a tool to aid their learning and knowledge processing and application. This has led to a renewed academic interest in understanding how cognitive offloading works when learning takes place in an educational setting where students are now engaging with AI tools to execute processes and tasks previously held to require memory, analysis, and independent problem-solving.

While AI learning tools enhance learning efficiency, personalisation, and cognitive support, they also raise critical questions regarding the future of cognitive learning in the era of smart devices. Therefore, a holistic perspective on the conceptual foundations, evolution and educational impact of cognitive offloading in the context of AI-supported learning is important. It has evolved from using external memory aids such as notes, calculators and search engines to the more advanced use of generative AI tools which can provide cognitive assistance in real time. This shift has transformed the learning environment, making AI not just a source of information but also a key enabler of learning. Meanwhile, one critical distinction is arising between the concept of cognitive offloading, which involves shifting cognitive tasks to external technologies, and cognitive support in which AI supports the thinking process of learners rather than replaces it. Based on this, this section will address the definition and development of cognitive offloading, as well as the role of AI in cognitive offloading for learning, and critically differentiate between cognitive offloading and cognitive support, laying the groundwork for psychological impacts on memory, critical thinking, and problem-solving.

3. Theoretical Perspectives

The psychological implications of cognitive offloading in AI-enhanced education can be explored and analyzed using well-developed theories in the fields of learning and cognition, which examine how people process information, engage with external cognitive tools, and manage their thinking. Theories of education and cognition have informed the study of the impact of AI on learning by providing a conceptual basis for exploring how AI impacts on learners' cognitive engagement and learning outcomes. Recent studies indicate that while AI can assist with learning efficiency and help alleviate cognitive load, there are concerns that overreliance on AI

systems could hinder independent thinking and memory retention, as well as undermine higher-order cognitive functions (Purba et al., 2025; Jose et al., 2025).

There are several complementary theories that can be useful in understanding these changes in cognition. In addition, the Extended Mind Theory and Distributed Cognition Theory interpret AI as an external cognitive tool that enables learners' thought processes to go beyond what they can think on their own (Clark & Chalmers, 1998; Hutchins, 1995); while Cognitive Load Theory explains how AI can optimize learning by eliminating unnecessary mental effort (Lam et al., 2018). Moreover, two theories—Self-Regulated Learning Theory and Metacognitive Theory—have highlighted that the educational effect of AI relies on the students' capacity to plan, monitor, and evaluate their learning process; that is, whether AI technologies inhibit or facilitate active cognitive involvement (Flavell, 1979; Zimmerman, 2002).The next sections explore these theoretical approaches, providing a conceptual grounding for the impact of cognitive offloading with AI on memory, critical thinking, problem solving, and learning performance. This study combines basic theories with up-to-date AI study to establish a framework for understanding the psychological impact of AI-enhanced education.

4. Study of Literature

4.1. Cognitive Offloading and Memory in AI-Assisted Learning

Xu, C., et al., (2026) demonstrated that the psychological effects of AI-assisted learning were not confined to learners' cognitive performance, but also affected their motivation, confidence, self-regulation, and metacognitive awareness. The evidence examined indicated that standard artificial intelligence improved engagement through adaptive feedback, personal coaching, and timely learning assistance, which in turn enhanced students' confidence and academic participation. In the meantime, the learners remained merely dependent upon the solutions that were provided by AI (artificial intelligence), reducing their inclination to think, to consider, and to take decisions on their own, which had negative consequences on learner's

cognitive autonomy.

Gerlich, M. (2025) signified that the cognitive offloading is the idea that using cognitive offloading aids in the development of productivity and reducing cognitive stress, but can also have impacts on the development of cognitive skills and critical thinking. Being dependent on outside resources can cause deterioration in what someone else would consider their basic abilities that include memory retention and critical thinking.

Jose, B., et al., (2025) signified that instead of using AI, it was the discussion and interaction between AI and the Learner as co-regulation of working memory that became the focus. Summarized the area of learning in which AI can help, and the area in which it can hurt (based on explanation of Transfer appropriate training (TAT) from Cognitive Load Theory, retrieval practice, and metacognition).

Stöhr, C., et al., (2024) articulated that there is no scientific data on the influence of the rapid uptake of AI-supported learning tools in higher education on deep cognition and learning processes, which have altered the pattern of the undergraduate academic experience. Abstract This study explores the effect of AI-based learning tools on students' metacognition, cognitive offloading, individualised learning, and critical thinking in Sri Lanka.

Danry, V. M. (2023) stated that the artificial intelligence (AI) is a powerful technology in all spheres, able to learn, determine and solve issues. The idea of artificial intelligence started in the 1950's when scientists tried to make robots that could do occupations that usually required human intelligence to do them. Early artificial intelligence systems relied on rules and symbolic thinking, but were limited by processing power and data availability. The 1990s and 2000s witnessed a boom in machine learning, where computers learn to detect patterns and improve at a task with practice.

Biermann, O. C. (2022) stated that the higher Education teachers are both excited and concerned about the possibility that artificial intelligence (AI) technology can provide an educational experience for undergraduates that is custom-made on an unprecedented scale. Generative artificial intelligence (AI) tools provide many options for undergraduate students to adapt the learning experience, however there are concerns about their probable harmful effects on students' critical thinking skills.

Onani, S. (2020) articulated the problematic trend that has the potential to have negative consequences for the future of technology use and cognition. Cognitive offloading may be seen as a useful mechanism of cognitive load management which improves productivity. It meant that educators needed to enable children to engage in meaningful, ethical uses of AI by asking their students the right questions, giving them the autonomous space to work together and develop their own reflections, yet still ensuring that technology would not hinder the learning process.

4.2. AI-Assisted Learning and Critical Thinking

Maiti, A. (2026) demonstrated that the EdTech has gone beyond digitising textbooks or online content to personalising learning, anticipating learner needs, supporting educators with intelligent tools and creating engaging settings that address motivational and cognitive barriers. This shift is a fundamental movement from seeing technology as an add-on to pedagogy to seeing it as an integral part of the design, experience, assessment and governance of learning. The study stated that the Mastering critical thinking enabled students to improve their communication skills by spotting biases, creating strong arguments, understanding different perspectives, and responding accurately and efficiently.

Melisa, R., et al., (2025) signified that the critical thinking represented the ability to pose and resolve questions, dissect arguments, evaluate the trustworthiness of sources, reach logical and well-supported conclusions, comprehend situations, and re-examine past decisions. Therefore, communication became more focused and effective, enabling children to structure and express their ideas clearly and logically. Artificial intelligence-assisted education involved the use of artificial intelligence technology to enhance the educational experience. AI utilised personalised learning paths to analyse student data and customised teaching to meet individual needs.

Çela, E., et al., (2024) examined the probable adverse effects of AI-assisted learning on crucial cognitive capacities such as critical thinking and problem-solving within the Albanian education system. A quantitative methodology was employed to gather data on the experience and impression of AI-assisted learning through a survey conducted with 53 students in a private educational institution in Albania. The results did not show a significant difference in critical thinking skills between students who had used artificial intelligence (AI) tools before and those who had not.

Namjoo, F., et al., (2023) signified the role of AI in higher education evolved rapidly, touching upon the methods of instruction, the design of learning journeys, and providing cognitive support.AI seized higher education and gave it a vastly renewed face and form in everything from the delivery of instruction to the creation of paths of learning, and even in the provision of cognitive support to students. Universities rapidly adopted AI-powered learning tools, such as intelligent tutoring systems, adaptive feedback systems, and AI-enabled content development, and actively studied how these technologies might enhance student learning and academic performance.

Kim, J., et al., (2022) considered language learning and stated that the motivation proved to be the essential element that was inherently connected to language proficiency, because without it, learning could not take place. As AI became more interwoven into daily life, it was important to understand the attitudes and feelings of people who employed AI for language acquisition. Most experts agreed that emotions were an intrinsic part of the learning process, perhaps even the foundation of it. The acquisition of foreign languages influenced learners and caused them to experience a variety of emotional responses, both positive and negative.

Kooli, C., et al., (2020) demonstrated that the AI provided benefits by alleviating extraneous external costs, simplifying complex activities, and focusing on schema development. The pain stemmed from using insufficiently long durations or poorly stated output that overloaded working memory or inhibited the retrieval of knowledge. This had been increased by artificial intelligence systems that aimed to prioritise the correct answer over the cognitive work involved in reaching it, pushing learners from knowledge to answer generation.

4.3. Psychological Effects on Problem-Solving Skills and Learning Outcomes

Hoang, N. H. (2026) articulated the psychological consequences of AI-assisted learning, which had both positive and negative aspects. The use of AI was balanced to promote critical thinking, self-regulation, and long-lasting information retention. Neglecting the affective dimension of AI-assisted L2 learning prevented a coherent knowledge foundation from being built and constrained the evidence-based guidance that educators needed to implement differentiated instructional strategies appropriate to learner profiles. The development of chatbot technology aimed to maximise its positive impact on the psychological well-being and cognitive development of its users.

Wan, Y., et al., (2025) studied the effects of technology, which became more and more integrated into educational environments, on important psychological aspects and cognitive skills of students. The study emphasised the possibilities of chatbots to enhance academic processes, provided customised learning experiences, and acted as gateways to educational materials. However, it also raised concerns about the ethical use of these technologies. The study highlighted study that showed regular and satisfying interactions with chatbots increased students' self-efficacy and engagement.

Khoa, B. T., et al., (2024) articulated that the motivation impacts every element of our everyday lives, whether it's personal, academic or professional. Motivation is, by definition, a mechanism by which organisms initiate and sustain goal directed activities. The effectiveness of learning depends on the intrinsic motivation of the learners, which is the main driving force for attaining personal goals. Therefore, motivation is of critical importance in learning new knowledge. However, the impact of AI-assisted language acquisition on these dimensions remained unclear due to a lack of study that particularly investigated this link.

Şenocak, S. Ü., et al., (2023) identified the use of AI improved self-efficacy and self-esteem, suggesting that there was a relationship between the use of AI and psychological outcomes. AI-assisted learning promoted an interactive contact with learners, providing a low-pressure setting through simulations that mimicked conversational scenarios. This method increased self-efficacy and self-esteem as learners received instant feedback to improve their skills.

Tursynkulova, E., et al., (2023) elaborated that the learning was an active process. Knowledge was actively constructed rather than passively received, invented rather than discovered. It was personal, socially cognitive, and socially produced. Learning involved engagement with the outside world. A single student responded to complex global concerns through deep understanding. The convergence of education, training, and technology innovation enabled sustainable employment, social empowerment, and social cognition, leading to sustainable education.

Munir, F., et al., (2021) discovered that the employment of artificial intelligence (AI) tools had a positive connection with perceptions of academic success and assignment effectiveness, indicating that AI had improved those aspects of the educational experience. Intelligent tutoring systems offered individualised assistance and feedback, while adaptive learning platforms adapted to the progress of children and provided immediate suggestions. Artificial intelligence automated grading and assessment systems, leaving educators time to provide individualised feedback. Results indicated a statistically significant negative relationship between the use of AI tools for assignments and students' problem-solving skills, implying that over-reliance on AI had inhibited the development of independent problem-solving skills.

Bruijniks, S. J., et al., (2020) indicated that chatbots could increase self-efficacy experimentally and had indirect effects on health-related self-efficacy. Another factor assessed was critical thinking, and results were mixed. A few studies indicated that chatbots have a positive potential to encourage critical thinking, and some demonstrated limitations or contingent effects. The study explored the different effects of chatbots and artificial intelligence in educational contexts. It analysed the impact of contemporary technology, which was progressively introduced into educational environments, on fundamental psychological parameters and cognitive capacities of students.

5. Psychological Effects of Cognitive Offloading

The integration of AI in the field of education has revolutionized the way learning takes place, allowing students to free up mental space from tasks like information retrieval, content creation, and decision-making. This cognitive offloading can help lower cognitive load and increase learning efficiency, but there are many debates about the long-term psychological effects. While there may be benefits for the use of AI in enhancing learning, the potential downside is that overusing AI could impede memory retention, independent thinking, critical thinking, and metacognition (Gerlich, 2025; Jose et al., 2025).

Existing studies does not provide a clear-cut positive or negative answer to whether cognitive offloading is generally a good or bad thing. Rather, the psychological impact seems to be influenced by a variety of factors, such as the prior experiences of learners, the extent of their cognitive engagement, the frequency of their interaction with AI, the complexity of the tasks, and the instructional design. These variations suggest that AI functions as a cognitive aid when it complements active learning but may hinder cognitive development when it replaces independent mental effort. Accordingly, the following sections critically synthesise the literature on the influence of cognitive offloading on memory, critical thinking, problem-solving skills, and metacognitive processes.

6. Factors Influencing Cognitive Offloading

The cognitive and psychological impact of AI-mediated cognitive offloading depends on more than just the use of AI; it is influenced by several interacting factors. Previous studies indicate that learner-related factors, such as previous knowledge, digital literacy, self-regulation, motivation, and cognitive ability, have effects on learners' engagement with AI technologies and on their need for external cognitive support. Likewise, whether AI acts as a cognitive support system that improves learning or creates unnecessary relying on AI (Sweller, 1988; Clark & Chalmers, 1998; Gerlich, 2025), ultimately depends on the design and functionality of AI systems, including accuracy, transparency, explainability, personalization, and feedback quality.

In addition to characteristics of the learner and the technology, the outcomes of cognitive offloading depend on what factors are at play in the context. Whether AI facilitates or supplants independent thinking depends on the complexity of learning tasks, how instruction is structured, how teachers interact with students, assessment methods, and the educational context. AI is best used to support or augment the thinking processes of a learner, not replace them, especially when performing tasks that involve critical thinking, creativity, and complex problem-solving. Thus, comprehending these concurrent factors is vital in designing educational approaches that leverage the advantages of AI-driven learning without compromising on the risks of over-reliance on AI tools (Jose et al., 2025; Mir et al., 2026).

7. Towards a Balanced Model of AI-Assisted Learning

The existing literature shows that artificial intelligence has a more complex educational impact, and how it is used in the learning process has a significant impact on it. The cognitive offloading effect that AI tools have on learning can increase learning efficiency by relieving cognitive overload, providing personalised feedback, and assisting with problem-solving, but there are potential drawbacks to relying on AI tools entirely: they can lead to

less retention of information, a decrease in critical thinking, reduced metacognitive awareness, and less independent reasoning (Gerlich, 2025; Jose et al., 2025; Sweller, 1988). The extremes of these outcomes suggest both extreme approaches – using only AI and using no AI – are not optimal strategies in learning. But, to get the maximum learning outcomes and ensure learning is preserved, a balance of human thinking and AI is required.

With this in mind, the idea of a balanced approach to learning that leverages AI as a cognitive partner is put forward, instead of replacing human thinking. In this model, AI facilitates adaptive guidance, individualised feedback, and cognitive scaffolding, whilst learners are still in control of retrieval practice, analytical thinking, reflection, and independent decision making. Meanwhile, teachers can design learning tasks that enable students to learn how to think critically, comprehend the ethical implications of using AI, to manage their own learning and/or to engage in higher-order thinking (Clark & Chalmers, 1998; Flavell, 1979; Zimmerman, 2002). This cooperative engagement not only enhances learning but also bolsters learners' cognitive agency with the strength of AI.

The proposed model provides a conceptual framework for the responsible application of AI in education, seeking to strike a balance between the use of AI and active cognitive engagement. It provides actionable advice for curriculum design, instructional strategies, and education policies, and lays the groundwork for future empirical study of sustainable human–AI collaboration. Last, a balance in cognitive offloading may positively impact learning outcomes without sacrificing memory, critical thinking, problem solving and metacognition – essential skills for lifelong learning and informed decision making.

8. Educational Implications of Cognitive Offloading

This study shows that artificial intelligence presents great opportunities to improve the way education is practiced, if it is used as a cognitive support and not as an alternative to human thinking. AI can enhance personalized teaching, offer adaptive feedback, minimize overloading the brain, and enable self-regulated learning. However, these benefits can only be achieved when "learning practices" support learners in critically analysing, interpreting and using information produced by AI, rather than using AI-generated responses. Teachers should therefore have the ability to apply it to pedagogies which facilitate retrieval practice, critical thinking, reflection and self-directed problem solving. The study also has implications for curriculum developers, education institutions and policy makers. Considering the potential for AI to transform learning, the need to equip learners with both technical proficiency and cognitive abilities is crucial, and AI literacy, ethical usage of AI, and responsible cognitive offloading are key concepts that should be embedded in current curricula. In addition, assessment should focus on analytical thinking, creativity and on real problem-solving instead of on information retrieval. These strategies can help to enhance the learning value that AI brings while maintaining learners' critical thinking and ability to continue their education.

9. Challenges and Limitations

Despite its educational benefits, AI-assisted cognitive offloading presents important challenges. Overuse of AI can result in diminished memory, critical thinking, problem-solving, and metacognitive skills, along with issues like algorithmic bias, misinformation, plagiarism, privacy, and accessibility. Moreover, literature is restricted to cross-sectional studies, studies concentrating on higher education, and absence of standardised instruments to measure cognitive offloading. The challenges will need to be tackled through in-depth study and responsible use of AI to enhance learning and not replace it.

10. Future Directions

Longitudinal and experimental studies should be used in future research to study the long term impacts of cognitive offloading in AI-based learning. The study may be conducted within different educational contexts, develop common metrics for cognitive offloading, and explore the relationship between AI literacy, explainable

AI, and human-AI collaboration. This type of study will aid in the creation of evidence-based education practices that enhance learning and retention of critical cognitive skills.

11. Conclusion

AI is changing the way education is taught, allowing for personalized learning, adaptive feedback, and effective cognitive support. The results suggest that using cognitive offloading can help improve learning efficiency and decrease cognitive load; however, overreliance on AI could result in reduced memory retention, critical thinking, problem-solving abilities, and metacognitive engagement. The outcomes are influenced by the learner characteristics, design of instruction, complexity of tasks, and the use of AI in learning environments. Overall, AI is a thinking partner, not a thinking replacement. Responsible use of AI, with human interaction in learning, and a balance between human and AI must be encouraged for best learning outcomes, and continued development of higher order thinking skills, which are essential for lifelong learning, academic achievement and responsible use of technology.

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