Vol.9 No.2 (2026)

Journal of Applied Learning & Teaching

ISSN: 2591-801X

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Content Available at: **https://jalt.open-publishing.org/index.php/jalt/index**

ChatGPT and DeepSeek in higher education: Comparing two contrasting Generative AI models and their implications for student learning

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Keywords

ChatGPT;
DeepSeek;
Generative Artificial Intelligence;
Higher Education.

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Article Info

Received 28 August 2025
Received in revised form 21 April 2026
Accepted 30 April 2026
Available online 22 June 2026

DOI: https://doi.org/10.37074/jalt.2026.9.2.5

Abstract

Artificial intelligence (AI) tools such as ChatGPT and DeepSeek are becoming more common in higher education. These tools can support teaching and learning in many ways, including generating study materials, helping with coding, offering feedback, and creating personalised content. ChatGPT is widely used because it produces fast and creative responses, making it useful for general academic support. However, it sometimes gives incorrect or shallow answers, which can reduce academic quality if not carefully reviewed. On the other hand, DeepSeek R1 is a powerful open-source model that is good at complex reasoning and solving advanced problems, especially in technical fields. But it raises concerns about data security, national regulations, and uneven access across countries. This paper compares ChatGPT and DeepSeek in terms of performance, educational use, and ethical risks. It discusses how these tools can both help and harm student learning and critical thinking. The main question is whether these AI models improve learning or create too much dependency among students. By studying their benefits and challenges, this research gives useful insights for teachers, students, and policymakers on the future of AI in education. It also suggests ways to use AI tools in a more balanced and responsible way in academic settings.

Introduction

The emergence of artificial intelligence (AI) technologies, particularly ChatGPT and DeepSeek, two contrasting generative AI (GenAI) models, has precipitated significant transformations within higher education, yielding both challenges and opportunities (Rasul et al., 2024; Swift, 2025). The increasing complexity of the educational landscape is accentuated by the recent introduction of the DeepSeek R1 reasoning model, which presents novel capabilities for data analysis and synthesis (DeepSeek-AI et al., 2025). Experts posit that ChatGPT and DeepSeek, although differing in their operational logic, can function as complementary tools that enhance pedagogical innovation (Young, n.d.).

The application of these AI technologies in higher education is relevant to curriculum design, instructional strategies, personalised learning, innovative assessment practices, and educational efficiency while also raising ethical concerns such as bias, the digital divide, data privacy, and environmental impact (Rasul et al., 2024; Francis et al., 2025; Popenici et al., 2023). Among AI tools, ChatGPT excels at producing varied, engaging content, including exam questions, lesson plans, programming help, feedback, and streamlined assessments (Rajabi et al., 2024). To remain current, it is also important to note that OpenAI recently released GPT-5, a long-awaited milestone that enhances reasoning and multimodal capabilities. The free version of ChatGPT continues to run on GPT-3.5, while the Plus (paid) plan provides access to GPT-4/4o, and a Pro tier extends to GPT-5, offering users differentiated access to model capabilities. Nevertheless, a critical analysis of ChatGPT's limitations is also highlighted, particularly its susceptibility to inaccuracies and the simplification of complex scholarly concepts, which necessitates comprehensive human review to uphold academic integrity (Rasul et al., 2024; Rajabi et al., 2024).

DeepSeek R1, on the other hand, is an open-source large language model (LLM) developed by a Chinese AI company named DeepSeek. It has demonstrated strong performance in complex reasoning tasks while being significantly more cost-effective than leading Western AI models (Gibney, 2025b). Its accessibility has led to its integration into higher education, where institutions explore its potential for personalised learning, research support, and automated assessment; however, concerns about data security and AI governance remain (Tutella, 2025; The Daily, 2025). While Case Western Reserve University in the U.S. has adopted a controlled approach by hosting DeepSeek R1 on secure servers, Australian universities, including the University of Adelaide and UNSW, have restricted its use due to national security risks (The Australian, 2025). These differing approaches highlight the ongoing debate about balancing AI innovation with ethical considerations, content restrictions, and institutional compliance with regulatory policies (The Australian, 2025; The Daily, 2025).

An analysis of the two cases presented above underscores the ethical implications of AI integration into academic settings while recognising their tangible benefits. Although both ChatGPT and DeepSeek represent significant advancements in AI-driven education, they differ notably in implementation, accessibility, and institutional reception.

A comparative analysis of ChatGPT and DeepSeek remains highly valuable in this context, especially given the proliferation of LLMs and the growing number of benchmarking studies. These two models represent distinct technological, institutional, and epistemic frameworks rather than mere interchangeable chatbots. ChatGPT continues to serve as the predominant reference point in higher education and discussions surrounding academic integrity, influencing policy, assessment redesign, and institutional responses more than any other model (An et al., 2025; Balalle & Pannilage, 2025; Dabis & Csáki, 2024; Rasul et al., 2024; Xia et al., 2024).

In contrast, DeepSeek is not merely another LLM; it introduces a fundamentally different configuration through its open-source architecture, lower cost, capacity for local deployment, optimisation for Chinese language use, and its heightened relevance in data-sensitive educational and clinical contexts. This makes DeepSeek particularly pertinent for inquiries about adoption, trust, and governance (Ju et al., 2026; Wang & Long, 2025). However, DeepSeek also raises unique concerns related to semantic censorship, transparency, and ideological filtering, issues that are often overlooked in standard performance-based comparisons (Qiu et al., 2026).

This is precisely why comparing these two models is theoretically more robust than simply adding another generic LLM comparison: It allows scholars to explore whether variations in learning support, trust, readability, risks to criti-

-cal thinking, policy implications, and evidentiary reliability stem solely from model performance or are influenced by the broader political and governance frameworks in which these models are developed and implemented.

Therefore, this paper systematically investigates the intersection of AI, pedagogy, and cognitive development by comparing the functionalities and applications of DeepSeek and ChatGPT. By assessing their impact on student learning behaviours, we aim to determine whether they enhance the educational experience or foster an over-reliance that may hinder intellectual growth. Ultimately, we aim to generate insights that will inform future practices and policies regarding AI integration in higher education, culminating in the following research question: How do the differing implementations and functionalities of ChatGPT and DeepSeek impact student learning outcomes and intellectual development in academic environments?

The paper is structured as follows. The next section provides a general literature review on the role of AI in student learning. This is followed by a comparative analysis of ChatGPT and DeepSeek. The following section highlights the benefits of AI in higher education. After that, the study discusses the risks associated with the use of AI, including a direct comparison between ChatGPT and DeepSeek. The next section proposes solutions to address the challenges of AI integration in higher education. The final section concludes the study with suggestions for future research agendas.

The role of AI in student learning in higher education

The integration of AI in higher education has had a profound impact on student learning, particularly following the introduction of ChatGPT in 2022 (Rasul et al., 2024). This transformative tool has improved student engagement by providing research support and enhancing writing efficiency, in addition to facilitating personalised learning, predictive analytics, automated assessment, and adaptive systems, among various other benefits (Bond et al., 2024). Rajabi et al. (2024) emphasise the necessity of establishing clear institutional guidelines that advocate for the advantages of AI while fostering critical thinking and originality among students. To ethically address these concerns, the authors stress the importance of students learning to differentiate between the beneficial use of AI as an aid in their learning processes and over-reliance that may impede their cognitive development. This shift could ultimately transform learning patterns in higher education (Rajabi et al., 2024; Rudolph et al., 2025). AI in higher education enhances personalised learning, student engagement, and automated assessments; however, it also presents challenges to academic integrity through plagiarism and diminished critical thinking (Rasul et al., 2024). The authors asserted that mitigating risks requires institutional promotion of AI literacy, educator training, and ethical policies that align innovation with responsible AI application in educational contexts.

AI is transforming various aspects of higher education, especially in assessment methods and personalised learning. More recently, ChatGPT introduced its Deep Research function, which autonomously conducts multi-step web analysis and produces reports with citations. This capability offers students and faculty a tool for more reliable inquiry and evidence-based academic exploration, complementing its existing generative functions. Xia et al. (2024) highlight that GenAI enables automated assessments that not only promote self-regulated learning but also foster academic integrity and offer real-time feedback. Despite these benefits, concerns about academic misconduct and excessive reliance on AI-based evaluations call for a careful balance between human oversight and automated grading processes. AI allows for adaptive learning by tailoring educational content to meet each student's individual needs, creating a more personalised and engaging learning environment (Bond et al., 2024; Xia et al., 2024). While this shift enhances both accessibility and educational efficiency, it requires educators to develop competencies in AI literacy to address ethical concerns, including bias and data privacy risks (Bond et al., 2024; Rudolph et al., 2023b). Khan et al. (2025) stress that AI-driven innovations can reduce energy consumption, streamline administrative processes, and improve the long-term sustainability of educational institutions. Additionally, AI enables predictive analytics for student retention, helping universities identify at-risk students and implement timely interventions to boost academic performance (Khan et al., 2025).

Nonetheless, the ethical dimensions of AI cannot be ignored. As Francis et al. (2025) argue, AI-driven decision-making must be transparent, equitable, and free of algorithmic bias. The adoption of AI in higher education offers

both advantages and ethical challenges that warrant careful examination. AI technologies, such as GenAI, adaptive learning systems, and predictive analytics, improve personalised education, streamline assessment processes, and aid decision-making. However, these advancements also give rise to significant ethical issues concerning academic integrity, data privacy, algorithmic bias, and the digital divide (Francis et al., 2025). The misuse of AI for plagiarism, contract cheating, and automated content generation jeopardises the authenticity of student work and the credibility of academic qualifications, highlighting the need for ethical AI frameworks (Balalle & Pannilage, 2025). Moreover, algorithmic bias in AI-assisted grading and admissions systems can lead to unfair outcomes, especially for marginalised student groups (Khan et al., 2025).

To ensure the ethical implementation of AI, higher education institutions (HEIs) must establish clear policies and governance structures that promote transparency, fairness, and accountability in AI-driven processes (Bond et al., 2024). This includes data privacy protections, as AI tools often collect and analyse vast amounts of data, raising concerns about informed consent, security breaches, and misuse of personal information (Rasul et al., 2024). Furthermore, accessibility disparities, where students from disadvantaged backgrounds have limited access to AI-powered learning tools, risk widening the digital divide (Khan et al., 2025). Consequently, a balanced approach is essential, integrating AI literacy training, ethical AI policies, and interdisciplinary collaboration, to ensure that AI enhances education without compromising academic integrity or social equity (Francis et al., 2025).

Although research into the impact of AI on higher education is fairly new, it has developed at an exponential rate within the last few years. Comparative studies of ChatGPT and DeepSeek have only appeared in the literature starting in 2025. Nonetheless, the research is categorised into three themes:

- Integration of AI into higher education: This is a consistent theme highlighting the ongoing interest in exploring and refining AI tools for better educational outcomes.
- Generative AI in language learning: This is a rising theme focused on harnessing the power of AI in supporting language learning.
- Student perceptions of AI in higher education: This is a novel theme that is emerging in tandem with the newly available data. The integration of AI would not be effective without an understanding of the students' perceptions.

Basic technical differences between DeepSeek and ChatGPT

At a foundational level, both ChatGPT and DeepSeek are categorised as "Large Language Models" (LLMs) (Jiang et al., 2025). ChatGPT employs a dense transformer model enhanced by "reinforcement learning from human feedback" (RLHF), which enables it to generate fluent and contextually relevant conversational outputs (Hakam et al., 2024). In contrast, DeepSeek uses a "Mixture-of-Experts" (MoE) architecture that activates only the necessary parameters for specific tasks, thereby improving computational efficiency, particularly in domain-specific applications such as finance, healthcare, and education (Rahman et al., 2025).

DeepSeek R1 excels in advanced reasoning for numerical methods and operator learning, achieving high accuracy in complex tasks; however, it experiences slower reasoning times and occasional implementation bugs. ChatGPT o3-mini-high prioritises computational efficiency and delivers reliable code with minimal errors in scientific machine-learning tasks, making it more adaptable for a broader range of applications, even if it has slightly lower performance in specialised scenarios (Jiang et al., 2025). As noted by Manik (2025), DeepSeek is particularly advantageous for developers focused on algorithmic or correctness-centric tasks. In contrast, ChatGPT serves as a robust general-purpose tool that provides cleaner code and slightly better stylistic practices. Table 1 provides a summary of the studies comparing DeepSeek and ChatGPT in terms of purpose, methodology, and key findings.

Benefits of AI in higher education

Enhanced learning experience

Table 1. Comparison studies on DeepSeek vs. ChatGPT.

Reference	Purpose	Method	Key Findings
Jiang et al., 2025	The study compares reasoning-focused models (e.g., ChatGPT-3.5-turbo, DeepSeek R1, Claude 3 Sonnet) with general-purpose models (e.g., ChatGPT-4, DeepSeek V3, Claude 3 Sonnet) in their ability to select suitable neural network architectures and numerical methods for complex ML and scientific tasks.	Each model was tested with identical prompts in a controlled setting, focusing on solution correctness, reasoning quality, and implementation fidelity.	Reasoning models significantly outperform non-reasoning models in scientific computing and ML tasks. ChatGPT o3-mini-high responds much faster to prompts than others, including DeepSeek R1.
AlAfnan, 2025	The study compares ChatGPT and DeepSeek in terms of business writing, composition, and communication tasks.	The AI-generated content was evaluated by three experts for adaptability, coherence, persuasiveness, clarity, and grammatical correctness.	ChatGPT outperformed DeepSeek in tone modulation, audience adaptation, and dynamic content production, making it more effective for creative and persuasive communication. In contrast, DeepSeek excelled in grammatical accuracy, factual consistency, and structural clarity, making it better suited for formal, standardised writing.
Wang et al., 2025	This study compares the feasibility of using LLMs to automate computational fluid dynamics (CFD) tasks in OpenFOAM through OpenFOAMGPT, with a focus on performance, stability, and cost-effectiveness.	Four LLMs, i.e., OpenAI GPT-4o and o1, Qwen2.5-Max and DeepSeek V3, were compared in zero-shot steering scenarios in standard CFD cases to evaluate their ability to create valid solver configurations, set parameters, and run simulations without retrieval-augmented support.	ChatGPT (GPT-4o and o1) demonstrated strong reasoning and reliable simulation setup generation despite high token costs. Qwen 2.5-Max offers similar capabilities at a lower cost, while DeepSeek V3 has shown moderate success but suffers from output instability and limitations in complex situations.

Table 1. Comparison studies on DeepSeek vs. ChatGPT. (cont.)

Reference	Purpose	Method	Key Findings
Albuhairy & Al-Garaady, 2025	This study compares the effectiveness of DeepSeek and ChatGPT in detecting and diagnosing errors in second language (L2) acquisition among South Asian Arabic learners.	Using error analysis on non-native Arabic sentences, the models were evaluated for their ability to detect morphological, syntactic, and semantic inaccuracies, with a focus on L1 (first language) transfer effects and the depth of reasoning.	DeepSeek outperformed ChatGPT in context-sensitive error detection, particularly in identifying word order transfer errors resulting from L1 influence. However, both models needed fine-tuned prompts to detect subtle semantic and sociolinguistic errors, while ChatGPT provided more instructive and pedagogically relevant feedback.
Shakya et al., 2025	This study compares the performance of ChatGPT o3-mini and DeepSeek-R1 in solving competitive programming problems from Codeforces.	Twenty-nine tasks, varying in difficulty levels (easy, medium, and hard), were defined to evaluate both models in terms of solution accuracy, memory usage, and runtime efficiency.	Both models demonstrated similar performance on easy problems, but ChatGPT o3-mini significantly outperformed DeepSeek-R1 on intermediate tasks, achieving a 54.5% success rate compared to 18.1% for DeepSeek-R1. However, both struggled with complex tasks, highlighting the limitations of LLMs in addressing complex programming challenges.
Manik, 2025	This study compares the Python code generation capabilities of ChatGPT o1 and DeepSeek R1, focusing on accuracy, code quality, and efficiency.	Using online judge coding competitions, models were evaluated on decision accuracy (up to three trials), code quality (Flake8/Pylint scores), and runtime and memory efficiency.	DeepSeek R1 achieved higher accuracy, especially on algorithmic problems, often passing on the first try, while ChatGPT o1 showed better code compactness and slightly faster performance. Both models showed comparable efficiency and offered different trade-offs for developers choosing AI coding tools.
Mondillo et al., 2025	This study compares the diagnostic accuracy and clinical reasoning performance of DeepSeek-R1 and ChatGPT o1 in paediatric decision support using the MedQA dataset.	Both models answered 500 multiple-choice paediatrics questions from MedQA under controlled conditions, and their responses were analysed using accuracy measures, Cohen's Kappa, and statistical tests.	ChatGPT o1 achieved significantly higher diagnostic accuracy (92.8%) than DeepSeek-R1 (87.0%) by leveraging structured chain-of-thought reasoning. Despite the lower accuracy, DeepSeek-R1 offered greater adaptability and accessibility, demonstrating potential value in low-resource clinical settings and mass use.

Table 1. Comparison studies on DeepSeek vs. ChatGPT. (cont.)

Reference	Purpose	Method	Key Findings
Aridan et al., 2025	The study compares post-launch public interest in DeepSeek and ChatGPT using Google Trends data from Indonesia and the Philippines.	A quantitative analysis of temporal and regional Google Trends data was conducted to assess public engagement patterns and levels of interest in both AI tools.	ChatGPT has seen consistently higher public interest due to its global reach, multilingual support, and strong integration into education and workspaces. DeepSeek has shown occasional increases, primarily in academic and niche communities.
Chowdhury et al., 2025	This paper compares DeepSeek and ChatGPT, focusing on their architecture, performance, ethical implications, and practical applicability.	Using standard Natural Language Processing (NLP) benchmarks, empirical tests, and a literature review, the models were evaluated for language understanding, reasoning, code generation, response accuracy, bias, transparency, and deployment scalability.	DeepSeek demonstrates superior adaptability and performance on specialised NLP tasks by leveraging domain-driven optimisation and scalable architecture. ChatGPT excels in conversational AI with advanced RLHF training, but both models still face challenges in reducing bias and ensuring ethical transparency.

Academic staff use ChatGPT for assignment and assessment design, student supervision, curriculum development, and lesson planning, where it aids in automating grading, generating assessment questions, and providing feedback, enhancing efficiency in education delivery (Rasul et al., 2023; Rasul et al., 2024). According to Rasul et al. (2023), ChatGPT enhances the higher education learning experience by enabling adaptive, personalised, and constructivist approaches. It delivers customised content and feedback based on learners' prior knowledge, fostering engagement and deeper understanding. Through interactive conversations, the tool promotes self-directed, discovery-based learning, encouraging students to explore and question actively. By scaffolding learning effectively, it supports higher-order thinking and addresses just-in-time needs. Ultimately, ChatGPT transforms passive instruction into dynamic, student-centred engagement aligned with constructivist learning principles. ChatGPT improves learning and teaching by generating customised educational content, summarising academic texts, and assisting with writing in multiple languages. It helps students and educators by reducing workloads through drafting and editing while engaging with complex topics. With strong performance on standardised exams and potential in curriculum development, ChatGPT also enhances accessibility and learner support through its real-time responsiveness (Rudolph et al., 2023a).

DeepSeek goes beyond the capabilities of ChatGPT by providing enhanced learning experiences in higher education. It delivers transparent, step-by-step reasoning that emulates human tutoring, making complex subjects more accessible for students (Wang, 2024). Its integration into university curricula, such as at Shenzhen and Zhejiang Universities, promotes the development of AI literacy and critical thinking through hands-on interaction with advanced models (Reuters, 2025). Educators gain access to cost-effective AI tools that enable them to create personalised and engaging learning experiences. DeepSeek's structured outputs encourage more profound understanding and self-directed learning, aligning with contemporary, student-centred pedagogies (Milvus, n.d.). DeepSeek AI enhances the learning experience for university students by promoting personalised, inquiry-based, and constructivist approaches. Acting as an intelligent assistant, it provides contextual explanations, summarises complex content, and offers real-time feedback tailored to individual research goals. This interactivity fosters exploration and critical thinking, leading to deeper engagement and cognitive development. Additionally, DeepSeek supports students within their "Zone of Proximal Development," bridging understanding gaps while maintaining autonomy and facilitating interdisciplinary collaboration and reflective academic practice (Cui, 2025).

DeepSeek R1, in particular, enhances learning by providing students with accessible and adaptable AI-driven support across various areas, fostering a deeper learning experience. According to Swift (2025), its open-source nature enables institutions to integrate AI tools without being tied to proprietary models like ChatGPT, creating a more flexible educational environment. By leveraging DeepSeek R1, educators can personalise learning experiences, enhance critical thinking through AI-assisted problem-solving, and help students refine their analytical skills. The transparent reasoning sequences provided by DeepSeek R1, which offer a step-by-step outline of the logic involved, primarily facilitated this. This fosters a well-thought-out and informed critical thinking process, allowing learners to grasp the nuances of critical thinking and develop logical and analytical solutions to the problems they encounter. This method equips learners with essential problem-solving skills. Additionally, its adaptability ensures that universities remain technologically responsive, prioritising pedagogical effectiveness over specific AI models (Swift, 2025). Ultimately, this approach enhances student engagement and academic outcomes.

Personalisation and accessibility

GenAI is revolutionising higher education by enhancing personalisation and accessibility, making learning more adaptive and inclusive. AI-powered tutoring systems like MATHia and Khanmigo provide real-time, personalised feedback, while adaptive learning platforms adjust content based on students' progress (Carnegie Learning, n.d.; C-

-astro et al., 2023). AI automates assessments, refines learning materials, and tailors academic pathways to align with career goals (Dempere et al., 2023; Khan & Okahana, 2024). Accessibility is also improving through AI-driven technologies, such as speech-to-text tools for students with disabilities and real-time translation for non-native speakers, expanding access to education globally (Floridi et al., 2018; Yanes et al., 2020). AI-powered chatbots streamline student support, offering instant academic and administrative guidance (Lucien & Park, 2024). However, ethical concerns such as algorithmic bias, data privacy, and over-reliance on AI must be addressed to ensure fairness and responsible use (Akgun & Greenhow, 2021; Robert, 2024). Through strategic integration, AI holds the potential to reshape higher education by offering tailored, effective, and equitable educational experiences, equipping students to thrive in a future increasingly shaped by AI advancements (Rasul et al., 2024).

While both DeepSeek and ChatGPT can personalise their service, DeepSeek has an additional advantage due to its open-source option. This allows users to customise the freely downloadable model with all the algorithmic equations. Users can modify the model to perform tasks and train it to meet their requirements with a high level of accuracy. DeepSeek enhances personalised learning by adapting content, assessments, and activities to individual students' cognitive profiles and preferences (Zhai, 2025). Using advanced reasoning and retrieval-augmented generation, it offers tailored, context-sensitive support, which has been shown to boost student engagement, motivation, and academic performance. Educators benefit from insights that facilitate targeted interventions and reduce their workload. As an open-source model, DeepSeek promotes transparency and responsible AI use, advancing equity and inclusivity in education by making personalised learning accessible in diverse, under-resourced environments (Zhai, 2025). DeepSeek is becoming a significant tool in personalised learning, providing educators with the capability to customise instruction, automate assessments, and engage students with interactive content. Its advanced reasoning and open-source features promote critical thinking by enabling learners to follow the AI's transparent problem-solving approach (Wang, 2024).

In contrast to DeepSeek, ChatGPT is not open-source, as OpenAI retains proprietary control to mitigate risks associated with misuse and misinformation (OpenAI Developer Community, 2023). Although GPT models like ChatGPT are highly advanced and capable of delivering accurate outputs across a wide range of general tasks, they fall short in terms of extensive personalisation features (OpenAI, 2023). Nevertheless, the platform's strength lies in its accessibility to a vast and diverse array of knowledge domains, making it a valuable resource for general inquiries and productivity support for students and educators in higher education. Additionally, effective, prompt engineering allows users to steer GPT models towards greater levels of personalisation. For instance, educators can craft prompts that direct ChatGPT to function as a course coach for first-year online MBA students grappling with time management, offering suggestions for weekly planning strategies, motivational techniques, and reflection prompts. This method provides tailored guidance that aligns with the user's specific context (Khan, 2023).

Efficiency and productivity

Researchers have raised concerns about the over-reliance on AI and its potential negative impact on students' problem-solving and critical thinking skills (Rasul et al., 2024). They also noted that ChatGPT is a valuable resource for language learning, coding assistance, personalized education, and writing support. It offers services such as grammar correction, translation, and AI-driven tutoring, which can enhance academic performance. This tool not only promotes efficiency and productivity but also allows students and academics to focus their time and energy on more advanced learning and applications that require higher-order critical thinking skills. Consequently, it does not compromise the development of these skills and facilitates the mastery of foundational competencies through more efficient and effective routines.

According to Kerimbayev et al. (2024), GenAI models such as GPT-4 and DeepSeek have shown significant promise in enhancing student efficiency and productivity in higher education. These tools support the creation of personalised learning content, automate feedback, and improve student engagement through interactive content generation. For instance, GPT-4 and DeepSeek contributed to a 20–25% improvement in student comprehension, indicating their effectiveness in supporting both cognitive and behavioural aspects of learning. Additionally, these models ease instructors' workloads by automating routine tasks such as assignment creation and assessment feedback (Kerimbayev et al., 2024).

DeepSeek provides benefits to academics in improving efficiency and productivity alongside students (Zhai, 2025). Educators can access valuable insights from a large amount of educational data that is already stored in the system, which helps them use effective teaching strategies and develop creative curricula (Rasul et al., 2024). For example, teachers can quickly identify common misunderstandings among students, customise learning support to address each misunderstanding, and create activities that address gaps in understanding. Additionally, pilot studies in schools using similar AI tools have shown that these tools can reduce teachers' workloads and improve teaching effectiveness (Zhai, 2025). Similar benefits can be achieved in higher education by saving the time and energy of educators and students. They have gained access to the DeepSeek models, which are customisable to meet their specific needs since they are open-sourced. This technology facilitates and supports deep reasoning, as highlighted in recent literature (Yang, 2025).

Research

Integrating advanced AI tools such as ChatGPT and DeepSeek significantly enhances research activities within higher education by academics and students, ultimately leading to more efficient and effective academic inquiry. According to Gibney (2025a), various AI systems are pivotal in transforming research practices in this sector. Notably, OpenAI's o3 enables complex reasoning and detailed problem analysis, which are essential skills for conducting thorough academic research. This capability allows scholars to engage deeply with intricate issues relevant to their fields.

Although DeepSeek's direct influence on academic and practical research is constrained in numerous studies, its attributes, such as high accuracy and robust reasoning capabilities, suggest a noteworthy potential for application within research contexts. For instance, Hu et al. (2025) conducted a comparative analysis testing DeepSeek-V3 against a standardised medical examination set. Their findings revealed that DeepSeek achieved an overall accuracy of 72%, surpassing ChatGPT-3.5, which scored only 55.6%. This performance indicates that DeepSeek excels in knowledge retrieval across various question types and subspecialties. Nonetheless, the study pointed out that DeepSeek may still have limitations in addressing higher-order and complex reasoning tasks, indicating areas needing further development. Additionally, DeepSeek is beneficial for higher education researchers, as it synthesises information from a multitude of sources, streamlining the often labour-intensive process of conducting literature reviews (Gibney, 2025a). This efficiency not only saves time but also enhances the quality of research outputs, allowing academics to build on existing knowledge more effectively.

Tuyen et al. (2025) acknowledge ChatGPT as both a significant phenomenon and a disruptor of research methodologies within the field of tourism and hospitality research. They emphasise that ChatGPT has the potential to revolutionise idea generation, enhance research methodologies, and improve data analysis techniques. Feng et al. (2025) describe ChatGPT as a versatile research assistant in the field of finance. It proves particularly beneficial for tasks such as coding support, textual analysis, model derivation, literature reviews, translation, and even chart interpretation. The authors express an optimistic view of the productivity enhancements ChatGPT can bring; however, they highlight potential concerns, including hallucinations, confirmation bias, and visual misinterpretations, underscoring the need for ongoing human validation. Emerging evidence suggests that DeepSeek's value in research extends beyond mere answer accuracy; it also excels at facilitating information-rich, clinically relevant, and methodologically sound knowledge work across various applied fields, including healthcare. Notably, in the domain of mental health education, DeepSeek has produced the highest proportion of highly comprehensive responses to common questions regarding depression. This highlights its particular significance in contexts where both explanatory depth and thoroughness are essential, even if this advantage may reduce readability for general users (You et al., 2026).

For example, in urology, the contributions of DeepSeek seem to be more qualitative than strictly technical. Although it reportedly did not demonstrate significant superiority over ChatGPT-4.0 in terms of reliability, DeepSeek produced higher-quality and more readable responses. This suggests that its value in research extends beyond mere data analysis to encompass the communicative aspects of knowledge delivery, including accessibility and a focus on patient-centred approaches (Cao et al., 2025). In the field of oral pathology, DeepSeek-V3 has demonstrated remarkable potential as a pre-diagnostic research assistant, surpassing the performance of ChatGPT-4o in most clinical scenarios. Furthermore, it generates significantly fewer fabricated references, emphasising the importance of citation credibility as a key criterion for assessing the utility of LLMs in medical research, rather than treating it as a secondary concern (Kaygisiz & Teke, 2025). Taken together, these studies position DeepSeek as a potentially valuable research support tool, not only because it can retrieve and organise domain knowledge, but because it appears capable of sustaining qualities central to serious scholarly and clinical inquiry, including comprehensiveness, interpretive usefulness, communicative clarity, and source credibility.

GPT-4 and ChatGPT can efficiently create scholarly materials, including abstracts, literature reviews, and research drafts, thereby reducing researchers' initial workload and allowing them to focus more on critical analysis and creativity (Qadhi et al., 2024). These tools also enhance literature analysis by quickly identifying trends and citation patterns across large datasets (Kerimbayev et al., 2024). As previously shown, GenAI supports personalised learning by adapting educational resources to diverse learner needs, thereby improving comprehension and engagement (Kerimbayev et al., 2024). Despite ethical challenges, the responsible use of GenAI offers significant opportunities to enhance the quality and productivity of academic research (Qadhi et al., 2024; Kerimbayev et al., 2024). We will discuss the ethical changes in the next section of the paper.

Risks of AI dependency in higher education

Academic integrity and ethical concerns

Recent literature indicates that concerns surrounding academic integrity related to AI tools like ChatGPT and DeepSeek are no longer viewed solely as a narrow issue of plagiarism. Instead, they are recognised as a broader crisis affecting authorship, originality, authenticity, and the validity of learning. While the integration of AI tools such as DeepSeek and ChatGPT in higher education presents transformative opportunities, it also introduces significant challenges to maintaining academic integrity. As students increasingly use GenAI to complete their assignments, ethical issues surrounding plagiarism and the authenticity of their work have come to the forefront (Rasul et al., 2024; Batista et al., 2024). Key concerns include the risk of plagiarism, diminished authenticity of student submissions, and an escalating reliance on AI-generated content, which ultimately undermines critical thinking and original scholarship (Rasul et al., 2024; Batista et al., 2024).

In the context of higher education writing, ChatGPT blurs the line between a student's original intellectual contributions and AI-assisted production. It can engage throughout the entire composing process, ranging from brainstorming and outlining to revising and refining, often in iterative ways that are challenging to identify and even more difficult to interpret from a pedagogical perspective (Wang, 2024). This challenge is complicated by the undeclared use of AI. Students may not disclose their use of AI assistance, not only due to dishonest intentions, but also because of fear of repercussions, unclear policies, peer acceptance, and inconsistent enforcement. These factors undermine transparency and erode trust in assessment systems (Gonsalves, 2024). Conceptual and review-based analyses underscore this shift by positing that ChatGPT not only jeopardises the integrity of submitted work but also calls into question the validity of assessments themselves. This concern arises when the use of AI disguises

dependence, misrepresents genuine competence, or displaces students' own reasoning and scholarly voice (Rasul et al., 2024; Koo, 2025).

The ethical landscape surrounding artificial intelligence applications in educational and research contexts is increasingly complex, highlighting a duality of concerns associated with technologies such as ChatGPT and DeepSeek. The literature underscores a spectrum of risks linked with ChatGPT, including hallucinations, misinformation, and issues related to privacy and data security. These challenges extend to biases and fairness, with implications for critical thinking and human judgment being jeopardised in favour of over-reliance on AI. Such ethical dilemmas also manifest in research-writing environments, contributing to educational inequity, questionable citation practices, and the potential erosion of scholarly integrity. Without robust governance through AI literacy, transparency, and institutional policies, the integrity of academic efforts may be compromised (Tuyen et al., 2025; Cheng et al., 2025).

Conversely, research on DeepSeek, while narrower, reveals an equally pressing ethical profile characterised by concerns about evidentiary reliability and authority in clinical domains. For instance, while DeepSeek-V3 has been shown to outperform ChatGPT-4.0 diagnostically in oral pathology, both systems produced fabricated or redundant citations, indicating that source credibility remains a primary issue within evidence-based frameworks (Kaygisiz & Teke, 2025). Similarly, in urology, despite DeepSeek's apparent advantages in readability and response quality, both AI models fell short on ethical sufficiency, lacking robust documentation and the ability to provide authoritative, contextually grounded advice (Cao et al., 2025).

Decline of critical thinking

AI tools, such as DeepSeek and ChatGPT, offer convenience and efficiency but pose significant risks to the development of critical thinking in higher education. As Rasul et al. (2024) highlight, these tools enable students to produce polished assignments with minimal cognitive effort, undermining the deep engagement necessary for critical thought. This overreliance can lead to reductions in attention span, memory retention, and analytical skills, ultimately weakening intellectual growth. Salih et al. (2025) further argue that the ability of ChatGPT to deliver seemingly coherent responses may result in students accepting information uncritically, promoting surface learning where they fail to adequately assess, question, and synthesise ideas, which are core components of critical thinking. Similarly, Combrinck and Loubser (2025) found that students whose work contained a higher proportion of AI-detected content often exhibited a lack of genuine engagement with their learning, as demonstrated by superficial or absent reflections on their use of AI tools.

Additionally, while Habib et al. (2024) illustrate that ChatGPT can enhance creativity, it simultaneously undermines students' confidence in their ideation skills, which are crucial for problem-solving and critical thinking. This decline in creative autonomy threatens to foster dependence on AI rather than promoting original thought.

Recent scholarship increasingly suggests that the degradation of critical thinking skills associated with ChatGPT poses a substantial structural risk to educational paradigms, rather than a marginal consequence. Within the context of university education, ChatGPT poses a risk of supplanting the very cognitive competencies that academic learning endeavours to nurture, such as interpretation, synthesis, argument construction, evaluation, and reflective judgment. The scholarly examination of AI-supported writing suggests that students habitually employ ChatGPT from the inception to the conclusion of the writing process, including idea development and subsequent revisions, thereby introducing a notable concern regarding the potential transfer of intellectual labour from the student to the computational tool (Wang, 2024).

The evidence surrounding DeepSeek is less extensive, yet it highlights a concerning, albeit subtler, trajectory of critical decline. Unlike ChatGPT, which often faces criticism for facilitating shortcuts, DeepSeek poses a different risk: It may undermine critical thought through its persuasive overconfidence. In medical contexts, DeepSeek frequently generates outputs that are more readable, structured, and seemingly reasoned than those produced by ChatGPT. This fluency can enhance user trust and diminish critical scrutiny of the response itself (Cao et al., 2025). However, this apparent clarity is misleading. Research indicates that DeepSeek can still deliver under-referenced, c-

-onceal underlying epistemic weaknesses (Cao et al., 2025; Kaygisiz & Teke, 2025). Consequently, while ChatGPT endangers critical thinking by rendering it seem optional, DeepSeek jeopardises it by presenting flawed reasoning as credible. The more polished the AI's output, the greater the risk that students or professionals will accept it uncritically. Collectively, the literature implies that both systems can erode critical thinking, albeit through distinct mechanisms: ChatGPT through cognitive offloading, and DeepSeek through epistemic seduction.

Erosion of deep learning

GenAI tools like ChatGPT and DeepSeek are reshaping higher education; however, their uncritical use can hinder deep learning. These tools often promote surface-level engagement, allowing students to bypass crucial cognitive processes such as synthesis, analysis, and evaluation (Reiter et al., 2025). For instance, in programming education, frequent reliance on AI chatbots has been found to negatively correlate with academic performance, as students tend to depend on these tools for solutions without grasping the underlying logic (Lepp & Kaimre, 2025).

The literature indicates that the erosion of learning linked to ChatGPT is more thoroughly theorised and empirically documented than that linked to DeepSeek, although both systems raise significant concerns about diminishing intellectual effort. In higher education, ChatGPT frequently faces criticism for shifting students from active knowledge construction to passive answer acquisition. Its ability to generate ideas, structure arguments, revise prose, and even simulate explanations can inadvertently eliminate the cognitive struggle essential for genuine learning. Research on AI-assisted writing reveals that students often use ChatGPT not merely to support their work but to bypass challenging stages of thinking, creating a conflict between efficiency and true understanding (Wang, 2024). Broader reviews echo similar warnings, suggesting that habitual reliance on GenAI can undermine independent effort, diminish metacognitive engagement, and weaken critical and reflective capacities if students start to view AI output as a shortcut rather than an invitation for inquiry (Rasul et al., 2024; Bond et al., 2024; Francis et al., 2025). More concerning, empirical evidence from programming education shows that frequent use of AI chatbots correlates negatively with academic performance, implying that convenience may come at the expense of lasting conceptual learning (Lepp & Kaimre, 2025).

In contrast, the existing literature on DeepSeek has yet to directly address the issue of learning erosion in higher education; however, it does highlight a subtler yet potentially equally serious concern. DeepSeek often yields more readable, better-structured, and seemingly more reasoned responses than ChatGPT, particularly in clinical comparisons (Cao et al., 2025). This superficial strength may inadvertently amplify epistemic dependence rather than diminish it. While ChatGPT may lead students to outsource their effort, DeepSeek may encourage them to outsource their judgment. Research in oral pathology and urology indicates that, despite DeepSeek's appearances of coherence and helpfulness, it can still produce responses that are weakly evidenced, insufficiently referenced, or partially unreliable (Cao et al., 2025; Kaygisiz & Teke, 2025). The pedagogical risk is that enhanced fluency creates an illusion of trustworthiness, which can deter learners from critically interrogating evidence, questioning assumptions, or engaging in thorough verification. Collectively, the literature reveals a stark contrast: ChatGPT primarily erodes learning through cognitive offloading, whereas DeepSeek threatens learning through fostering persuasive overconfidence and uncritical acceptance. Both tools pose risks to learning, albeit through different mechanisms.

In summary, both ChatGPT and DeepSeek promise significant benefits for higher education, but both tools face valid challenges that may hinder their full potential. Table 2 highlights some of the key differences paving the way for addressing the challenge of balancing the use of AI in academia.

Addressing the challenge: Balancing AI use in academia

AI as a learning aid, not a substitute

To effectively integrate GenAI tools like ChatGPT and DeepSeek into educational practices, it is crucial to position them as complementary resources rather than substitutes for traditional learning methods. These tools can enhan-

-ce the educational experience by providing personalised support, facilitating research, and encouraging critical thinking (Al-Sharafi et al., 2023). However, students should be encouraged to use these technologies to supplement their understanding and cognitive skills rather than relying on them exclusively. Educators should focus on guiding students in leveraging these AI tools to foster engagement and deepen knowledge, emphasising the importance of maintaining their intellectual independence. By promoting the idea that AI can serve as a helpful resource in the learning process, providing insights or clarifying concepts, students can benefit from the advantages of technology while still developing essential skills such as deep analysis, innovation, creativity, problem-solving, and critical thinking skills (Gibreel & Arpaci, 2025).

Table 2. Summary comparative table.

Factor	**ChatGPT**	**DeepSeek**
Primary current use	Language learning and programming support	Language learning and educational quality assessment
Main strengths	Prompt feedback, interactive learning, personalised support	Better conversational capabilities, reported better accuracy, cost-effectiveness, and stronger predictive analytics
Main challenges	Over-reliance by learners, academic dishonesty, ethical concerns, accuracy issues	Scalability, lack of and need for more transparent models
Integration alternatives	Supplementary tool in enhancing traditional methods	Deep learning-based models used for quality assessment, personalised learning
Student perspective	Effective but requires supervision for improved accuracy	Generally preferred for language learning due to better support and accuracy

In higher education, the most significant pedagogical value of AI tools lies in their support functions, such as brainstorming, providing formative feedback, clarification, and assisting with revision, as long as students continue to engage in the core intellectual work themselves (Kim et al., 2025; Sousa & Cardoso, 2025). This distinction is vital, as the literature cautions that when ChatGPT begins to replace tasks like interpretation, argument construction, or problem-solving, it shifts from being a tool that supports learning to one that potentially undermines it. Empirical evidence from programming education underscores this point: While AI tools can be helpful for assistance, an increased reliance on chatbots has been negatively correlated with academic performance, indicating that uncritical dependence may weaken lasting understanding rather than enhance it (Lepp & Kaimre, 2025). Similarly, classroom experiences have shown that ChatGPT enhances understanding and retention only when accompanied by substantial instructor oversight, validation mechanisms, and structured guidance; in essence, it functions most effectively as a scaffold rather than as an independent tutor (Trindade et al., 2025).

While empirical evidence from educational contexts regarding DeepSeek is not extensive, it does align with a comparable fundamental concept. In comparison to ChatGPT, DeepSeek often delivers responses that are more easily understood, complete, and ostensibly well-reasoned, thereby offering potential value as a supplementary resource for explanations (Cao et al., 2025). Conversely, empirical studies suggest that DeepSeek's generated content might be deficient in its sourcing or completeness of documentation. Thus, it cannot be regarded as a substitute for the judgment of experts or the verification by learners (Cao et al., 2025). Ultimately, scholarly sources uniformly assert that the educational validity of AI tools, such as ChatGPT or DeepSeek, is contingent upon their ability to foster human intellect, economise cognitive resources, and maintain rigorous human oversight.

Teaching AI literacy

As previously discussed, understanding when to use GenAI and when not to, as well as how to leverage it in conjunction with human creativity, is a critical skill that must be taught and developed in students. These competencies are integral to the graduate attributes of universities. Acquiring these skills and literacies is essential for successfully navigating a future increasingly influenced by GenAI and general AI tools, which continue to gain prominence. Many mundane tasks that require basic cognitive functions can be efficiently delegated to tools like ChatGPT and DeepSeek. In contrast, more creative and innovative challenges, particularly those involved in addressing complex problems, should remain the domain of humans. This approach will enhance human decision-making and problem-solving abilities in the future. Therefore, university curricula should evolve to teach these skills within the context of using these tools rather than completely replacing human cognitive activities.

Literature positions AI literacy as essential to the responsible educational use of both ChatGPT and DeepSeek. For ChatGPT, AI literacy is framed as more than technical familiarity; it includes understanding AI's capabilities, limits, ethical risks, and the need to question outputs rather than merely accept them (Xia et al., 2024; He et al., 2024). Students and educators, therefore, require explicit training in critical evaluation, disclosure, and balanced use so that ChatGPT supports, rather than replaces, thinking (Rasul et al., 2024; Sousa & Cardoso, 2025). For DeepSeek, direct literacy research is limited, but comparative studies imply that users need equally strong verification literacy because readable, confident answers may still be weakly referenced or under-documented (Cao et al., 2025; Kaygisiz & Teke, 2025).

One real-life example of leveraging ChatGPT and Deepseek, among other GenAI tools, alongside human creativity, is found in the realm of marketing and advertising. These skills can be integrated into university curricula for these subjects, enabling students to train in utilising GenAI tools to develop a foundational understanding of the market and industry. This knowledge can then be applied within their own company's context or a case study, drawing from their personal experiences. This approach fosters the development of marketing skills, demonstrating how effectively this information can enhance creative thinking to emotionally connect with customers and create products and services that resonate with the target market, ultimately leading to greater satisfaction and delight. While GenAI tools provide essential background information and research, human skills and creativity combine these insights to fulfil innate human needs.

Policy and governance

Recent literature indicates that the policy and governance surrounding GenAI are more developed for ChatGPT compared to DeepSeek. However, both technologies present important governance considerations for universities and other institutions. In the realm of higher education, the governance related to ChatGPT is evolving to focus on key areas such as transparent disclosure, course-specific guidance, academic integrity, privacy protection, assessment redesign, and the promotion of AI literacy. This represents a significant shift towards more adaptable, coordinated governance models rather than implementing blanket bans, fostering a more constructive approach to integrating AI in educational settings (An et al., 2025; Dabis & Csáki, 2024).

Universities are increasingly shifting from outright bans on ChatGPT and GenAI to governance models that emphasise course-level transparency, academic integrity, staff guidance, privacy protections, and the promotion of AI literacy (Dai et al., 2024; Ullah et al., 2024; An et al., 2025). Research indicates that effective governance hinges on

clear policies, tailored guidance for stakeholders, and adaptable assessment redesign, rather than relying solely on prohibitions (Dabis & Csáki, 2024; Gupta & Nyamapfene, 2025). In contrast, the existing literature offers limited direct evidence on university policies specifically related to DeepSeek; instead, its governance implications are primarily inferred from concerns about evidentiary reliability, inadequate referencing, and issues of authority (Cao et al., 2025; Kaygisiz & Teke, 2025). Although not directly associated with the higher education sector, Qiu et al. (2026) demonstrate that DeepSeek engages in semantic-level censorship, in which politically sensitive content is acknowledged in its internal reasoning yet omitted or softened in the final outputs. This underscores the necessity for systematic auditing, transparency, and external oversight of such models. The implications of DeepSeek's semantic-level censorship are significant for university governance, particularly regarding how institutions address and handle sensitive topics and politically charged issues within their frameworks.

Universities must establish clear guidelines regarding the use of ChatGPT and Deepseek, for that matter, any GenAI tools in academic work. These policies should address acceptable applications, ethical considerations, and potential disciplinary actions for misuse of the system. This is critical in conjunction with the need to develop GenAI literacy and promote appropriate use. Given the rapid advancements in efficiency and expertise afforded by these tools, higher education students must acquire the essential skills expected of them in academic institutions. Skills such as deep learning, critical thinking, creative problem-solving, effective decision-making, and advanced technical capabilities are foundational to higher education. The integration of AI tools should not compromise the development of these skills.

Conclusion and research agenda

This paper explored the use and application of GenAI tools such as DeepSeek and ChatGPT within higher education, presenting a complex interplay of benefits and challenges. Both tools have shown the potential to enhance student engagement and learning outcomes through tailored support and innovative educational approaches. However, their distinct functionalities and implementation practices also raise significant ethical concerns, including potential over-reliance, data privacy, and the risk of diminishing critical thinking among students.

The paper suggests that the GenAI landscape is experiencing rapid advancements with the emergence of new tools, such as DeepSeek, which introduce open-source technology that creates vast and limitless opportunities within the field. The higher education sector, like other industries worldwide, has benefited from these developments but is also facing their negative impacts. Furthermore, it is incumbent upon the higher education sector to equip students with the new skills required in light of these technologies and to educate them on the ethical and responsible use of these tools. Therefore, it is crucial to carefully develop policies and guidelines regarding skills development to ensure that the new generation can use these valuable tools effectively and responsibly.

Future research agendas in AI and higher education should prioritise longitudinal studies to assess the long-term effects on student learning and engagement. The comparative effectiveness of AI tools, such as DeepSeek and ChatGPT, should be investigated across diverse contexts and industries. Ethical frameworks for AI use must be developed to address issues like data privacy and bias. Additionally, research should explore innovative curriculum designs that foster critical thinking and originality, as well as AI-driven assessment practices, faculty training, and student attitudes towards AI. Cross-cultural comparisons and new pedagogical models integrating AI can further enhance understanding and optimise their responsible integration into education.

As a final thought, the authors believe that while completely AI-enabled higher education solutions may not be on the immediate horizon, the potential for virtual AI universities and transformative educational institutions is bright. These innovations can redefine conventional roles, such as teaching, research, curriculum development, educational training, and tutoring, taking these functions to new heights. A compelling future lies in blended learning environments that harmoniously unite virtual and physical modes, guided by passionate educators who harness GenAI tools to elevate educational effectiveness. These institutions need to embrace and collaborate with these technologies, paving the way for a revolutionary approach to education that thoroughly assesses learning outcomes across various subjects and courses.

References

Akgun, S., & Greenhow, C. (2021). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI and Ethics*, *2*(3), 431-440. https://doi.org/10.1007/s43681-021-00096-7

AlAfnan, M. A. (2025). DeepSeek vs. ChatGPT: A comparative evaluation of AI tools in composition, business writing, and communication tasks. *Journal of Artificial Intelligence and Technology, 5*, 202-210. https://doi.org/10.37965/jait.2025.0740

Albuhairy, M. M., & Algaraady, J. (2025). DeepSeek vs. ChatGPT: Comparative efficacy in reasoning for adults' second language acquisition analysis. *Humanities and Educational Sciences Journal, 44*, 864-883. https://doi.org/10.55074/hesj.vi44.1313

Al-Sharafi, M. A., Al-Emran, M., Arpaci, I., A. Iahad, N., AlQudah, A. A., Iranmanesh, M., & Al-Qaysi, N. (2023). Generation Z use of artificial intelligence products and its impact on environmental sustainability: A cross-cultural comparison. *Computers in Human Behavior,* 143, 107708. https://doi.org/10.1016/j.chb.2023.107708.

An, Y., Yu, J. H., & James, S. (2025). Investigating the higher education institutions' guidelines and policies regarding the use of generative AI in teaching, learning, research, and administration. *International Journal of Educational Technology in Higher Education*, *22*(10). https://doi.org/10.1186/s41239-025-00507-3

Aridan, M., Irwandani, Villarama, J. A., & Fuente, A. V. D. (2025). Post-launch public interest in DeepSeek vs. ChatGPT: A comparative Google trends analysis in Indonesia and the Philippines. *Blockchain, Artificial Intelligence, and Future Research, 1*(1), 1-12. https://doi.org/10.70211/bafr.v1i1.166

Balalle, H., & Pannilage, S. (2025). Reassessing academic integrity in the age of AI: A systematic literature review on AI and academic integrity. *Social Sciences & Humanities Open*, *11*, 101299. https://doi.org/10.1016/j.ssaho.2025.101299

Batista, J., Mesquita, A., & Carnaz, G. (2024). Generative AI and higher education: Trends, challenges, and future directions from a systematic literature review. *Information*, *15*(11), 676. https://doi.org/10.3390/info15110676

Bond, M., Khosravi, H., De Laat, M., Bergdahl, N., Negrea, V., Oxley, E., Pham, P., Chong, S. W., & Siemens, G. (2024). A meta systematic review of artificial intelligence in higher education: A call for increased ethics, collaboration, and rigour. *International Journal of Educational Technology in Higher Education*, *21*(4), 1-41. https://doi.org/10.1186/s41239-023-00436-z

Cao, H., Hao, C., Zhang, T., Zheng, X., Gao, Z., Wu, J., Gan, L., Liu, Y., Zeng, X., & Wang, W. (2025). Battle of the artificial intelligence: A comprehensive comparative analysis of DeepSeek and ChatGPT for urinary incontinence-related questions. *Frontiers in Public Health*, *13*, 1605908. https://doi.org/10.3389/fpubh.2025.1605908

Carnegie Learning. (n.d.). *MATHia: The 1-to-1 math coach that makes your life easier*. Accessed from https://www.carnegielearning.com/solutions/math/mathia/

Castro, E., Sinha, S., & Moran, C. (2023, December 18). *How artificial intelligence can personalize education*. IEEE Spectrum. https://spectrum.ieee.org/how-ai-can-personalize-education

Cheng, D., Li, M., & Lee, T. (2025). Leveraging ChatGPT for research writing: An exploration of ESL graduate students' practices. *Computers and Composition*, *76*, 102934. https://doi.org/10.1016/j.compcom.2025.102934

Chowdhury, M. N. U. R., Haque, A., & Ahmed, I. (2025). *DeepSeek vs. ChatGPT: A comparative analysis of performance, efficiency, and ethical AI considerations*. TechRxiv. https://doi.org/10.36227/techrxiv.173929663.35290537/v1

Combrinck, C., & Loubser, N. (2025). Student self-reflection as a tool for managing GenAI use in large class assessment. *Discover Education*, *4*(72). https://doi.org/10.1007/s44217-025-00461-2

Cui, J. (2025). The impact of general artificial intelligence on university students' research and technological innovation: A case study of DeepSeek AI and ChatGPT. *The Educational Review*. http://dx.doi.org/10.2139/ssrn.5179907

Dabis, A., & Csáki, C. (2024). AI and ethics: Investigating the first policy responses of higher education institutions to the challenge of generative AI. *Humanities and Social Sciences Communications*, *11*(1), 1-13. https://doi.org/10.1057/s41599-024-03526-z

Dai, Y., Lai, S., Lim, C. P., & Liu, A. (2024). University policies on generative AI in Asia: Promising practices, gaps, and future directions. *Journal of Asian Public Policy*. Advance online publication. https://doi.org/10.1080/17516234.2024.2379070

DeepSeek-AI, Guo, D., Yang, D., Zhang, H., Song, J., Zhang, R., Xu, R., Zhu, Q., Ma, S., Wang, P., Bi, X., Zhang, X., Yu, X., Wu, Y., Wu, Z. F., Gou, Z., Shao, Z., Li, Z., Gao, Z., ... He, Y. (2025). *Deepseek-r1: Incentivizing reasoning capability in LLMs via reinforcement learning*. arXiv. https://doi.org/10.48550/arXiv.2501.12948

Dempere, J., Modugu, K., Hesham, A., & Ramasamy, L. K. (2023). The impact of ChatGPT on higher education. *Frontiers in Education*, *8*, 1-13. https://doi.org/10.3389/feduc.2023.1206936

Feng, Z., Hu, G., Li, B., & Wang, J. (2025). Unleashing the power of ChatGPT in finance research: Opportunities and challenges. *Financial Innovation*, *11*, 93. https://doi.org/10.1186/s40854-025-00770-3

Floridi, L., Cowls, J., Beltrametti, M., Chatila, R., Chazerand, P., Dignum, V., Luetge, C., Madelin, R., Pagallo, U., Rossi, F., Schafer, B., Valcke, P., & Vayena, E. (2018). AI4People—An ethical framework for a good AI society: Opportunities, risks, principles, and recommendations. *Minds and Machines*, *28*, 689-707. https://doi.org/10.1007/s11023-018-9482-5

Francis, N. J., Jones, S., & Smith, D. P. (2025). Generative AI in higher education: Balancing innovation and integrity. *British Journal of Biomedical Science*, *81*, 14048. https://doi.org/10.3389/bjbs.2024.14048

Gibney, E. (2025a, February 17). *What are the best AI tools for research*? Nature. https://www.nature.com/articles/d41586-025-00437-0

Gibney, E. (2025b). China's cheap, open AI model DeepSeek thrills scientists. *Nature, 638*(8049), 13–14. https://doi.org/10.1038/d41586-025-00229-6

Gibreel, O., & Arpaci, I. (2025). *Development and validation of the prompt engineering competence scale (PECS)*. Information Development. https://doi.org/10.1177/02666669251336455

Gonsalves, C. (2024). Addressing student non-compliance in AI use declarations: Implications for academic integrity and assessment in higher education. *Assessment & Evaluation in Higher Education*, *50*(4), 592-606. https://doi.org/10.1080/02602938.2024.2415654

Gupta, V., & Nyamapfene, A. (2025). Generative AI in universities: Practices at UCL and other institutions, and the path forward. *Internet Reference Services Quarterly*, *29*(1), 131-151. https://doi.org/10.1080/10875301.2025.2453461

Habib, S., Vogel, T., Anli, X., & Thorne, E. (2024). How does generative artificial intelligence impact student creativity?. *Journal of Creativity*, *34*(1), 100072. https://doi.org/10.1016/j.yjoc.2023.100072

Hakam, H. T., Prill, R., Korte, L., Lovreković, B., Ostojić, M., Ramadanov, N., & Muehlensiepen, F. (2024). Human-written vs AI-generated texts in orthopedic academic literature: Comparative qualitative analysis. *JMIR Formative Research*, *8*(1), e52164. https://doi.org/10.2196/52164

He, A. J., Zhang, Z., Anand, P., & McMinn, S. (2024). Embracing generative artificial intelligence tools in higher education: A survey study at the Hong Kong University of Science and Technology. *Journal of Asian Public Policy*, *18*(2), 352-376. https://doi.org/10.1080/17516234.2024.2447195

Hu, N., Luo, Y., & Lei, P. (2025). Evaluation of AI models for radiology exam preparation: DeepSeek vs. ChatGPT-3.5. *Medical Education Online*, *30*(1), 2589679. https://doi.org/10.1080/10872981.2025.2589679

Jiang, Q., Gao, Z., & Karniadakis, G. E. (2025). DeepSeek vs. ChatGPT vs. Claude: A comparative study for scientific computing and scientific machine learning tasks. *Theoretical and Applied Mechanics Letters*, *15*(3), 100583. https://doi.org/10.1016/j.taml.2025.100583

Ju, Y., Li, J., Zhang, X., Wu, M., Pang, X., Li, Z., Wang, J., Li, J., Zhang, Y., & Dai, X. (2026). The impact of DeepSeek's perceived interactivity on medical students' self-directed learning ability. *Scientific Reports*, *16*, 3695. https://doi.org/10.1038/s41598-025-33780-3

Kaygisiz, Ö. F., & Teke, M. T. (2025). Can DeepSeek and ChatGPT be used in the diagnosis of oral pathologies? *BMC Oral Health*, *25*, 638. https://doi.org/10.1186/s12903-025-06034-x

Kerimbayev, N., Menlibay, Z., Garvanova, M., Djaparova, S., & Jotsov, V. (2024, October 10-12). *A comparative analysis of generative AI models for improving learning process in higher education* [Paper presentation]. 2024 International Conference Automatics and Informatics (ICAI), Varna, Bulgaria. https://doi.org/10.1109/ICAI63388.2024.10851491

Khan, F. (2023, May 24). *Prompt engineering complete guide*. Medium. https://medium.com/@fareedkhandev/prompt-engineering-complete-guide-2968776f0431

Khan, S., Mazhar, T., Shahzad, T., Khan, M. A., Rehman, A. U., Saeed, M. M., & Hamam, H. (2025). Harnessing AI for sustainable higher education: Ethical considerations, operational efficiency, and future directions. *Discover Sustainability*, *6*(1), 23. https://doi.org/10.1007/s43621-025-00809-6

Khan, S., & Okahana, H. (2024, May 6). *Empowering higher education with artificial intelligence*. Higher Ed Dive. https://www.highereddive.com/spons/empowering-higher-education-with-artificial-intelligence/714549/

Kim, J., Yu, S., Detrick, R., & Li, N. (2025). Exploring students' perspectives on generative AI-assisted academic writing. *Education and Information Technologies*, *30*(1), 1265-1300. https://doi.org/10.1007/s10639-024-12878-7

Koo, M. (2025). ChatGPT research: A bibliometric analysis based on the Web of Science from 2023 to June 2024. *Knowledge*, *5*(1), 4. https://doi.org/10.3390/knowledge5010004

Lepp, M., & Kaimre, J. (2025). Does generative AI help in learning programming: Students' perceptions, reported use and relation to performance. *Computers in Human Behavior Reports*, *18*, 100642. https://doi.org/10.1016/j.chbr.2025.100642

Lucien, R., & Park, S. (2024). Design and development of an advising chatbot as a student support intervention in a university system. *TechTrends*, *68*(1), 79-90. https://doi.org/10.1007/s11528-023-00898-y

Manik, M. M. H. (2025). *ChatGPT vs. DeepSeek: A comparative study on AI-based code generation*. arXiv. https://doi.org/10.48550/arXiv.2502.18467

Milvus. (n.d.). *How does DeepSeek engage with academic institutions?*. Accessed from https://milvus.io/ai-quick-reference/how-does-deepseek-engage-with-academic-institutions

Mondillo, G., Colosimo, S., Perrotta, A., Frattolillo, V., & Masino, M. (2025). *Comparative evaluation of advanced AI reasoning models in pediatric clinical decision support: ChatGPT O1 vs. DeepSeek-R1*. MedRxiv. https://doi.org/10.1101/2025.01.27.25321169

OpenAI. (2023, November 6). *Introducing GPTs*. Accessed from https://openai.com/index/introducing-gpts/

OpenAI Developer Community. (2023, April). *Why isn't ChatGPT open-source?*. Accessed from https://community.openai.com/t/why-isnt-chatgpt-open-source/166126

Popenici, S., Rudolph, J., Tan, S., & Tan, S. (2023). A critical perspective on generative AI and learning futures: An interview with Stefan Popenici. *Journal of Applied Learning and Teaching*, *6*(2), 311-331. https://doi.org/10.37074/jalt.2023.6.2.5

Qadhi, S. M., Alduais, A., Chaaban, Y., & Khraisheh, M. (2024). Generative AI, research ethics, and higher education research: Insights from a scientometric analysis. *Information*, *15*(6), 325. https://doi.org/10.3390/info15060325

Qiu, P., Zhou, S., & Ferrara, E. (2026). Information suppression in large language models: Auditing, quantifying, and characterizing censorship in DeepSeek. *Information Sciences*, *724*, 122702. https://doi.org/10.1016/j.ins.2025.122702

Rahman, A., Mahir, S. H., Tashrif, M. T. A., Aishi, A. A., Karim, M. A., Kundu, D., Debnath, T., Moududi, M. A. A., & Eidmum, M. D. (2025). *Comparative analysis based on DeepSeek, ChatGPT, and Google Gemini: Features, techniques, performance, future prospects*. arXiv. https://doi.org/10.48550/arXiv.2503.04783

Rajabi, P., Taghipour, P., Cukierman, D., & Doleck, T. (2024). Unleashing ChatGPT's impact in higher education: Student and faculty perspectives. *Computers in Human Behavior: Artificial Humans*, *2*(2), 100090. https://doi.org/10.1016/j.chbah.2024.100090

Rasul, T., Nair, S., Kalendra, D., Balaji, M. S., de Oliveira Santini, F., Ladeira, W. J., Rather, R. A., Yasin, N., Rodriguez, R. V., Kokkalis, P., Murad, W., & Hossain, M. U. (2024). Enhancing academic integrity among students in GenAI era: A holistic framework. *The International Journal of Management Education*, *22*(3), 101041. https://doi.org/10.1016/j.ijme.2024.101041

Rasul, T., Nair, S., Kalendra, D., Robin, M., de Oliveira Santini, F., Ladeira, W. J., Sun, M., Day, I., Rather, R. A., & Heathcote, L. (2023). The role of ChatGPT in higher education: Benefits, challenges, and future research directions. *Journal of Applied Learning and Teaching*, *6*(1), 41-56. https://doi.org/10.37074/jalt.2023.6.1.29

Reiter, L., Jörling, M., Fuchs, C., & Böhm, R. (2025). Student (Mis) use of generative AI tools for university-related tasks. *International Journal of Human–Computer Interaction*, *41*(19), 12390-12403. https://doi.org/10.1080/10447318.2025.2462083

Reuters. (2025, February 21). *Chinese universities launch DeepSeek courses to capitalise on AI boom*. https://www.reuters.com/technology/artificial-intelligence/chinese-universities-launch-deepseek-courses-capitalise-ai-boom-2025-02-21/#:~:text=HONG%20KONG%2C%20Feb%2021%20(Reuters,China%20and%20garnered%20widespread%20attention

Robert, J. (2024, February 26). *2024 EDUCAUSE AI landscape study: Policies and procedures*. EDUCAUSE. https://www.educause.edu/ecar/research-publications/2024/2024-educause-ai-landscape-study/policies-and-procedures

Rudolph, J., Ismail, F., Tan, S., & Seah, P. (2025). Don't believe the hype. AI myths and the need for a critical approach in higher education. *Journal of Applied Learning and Teaching*, *8*(1), 6-27. https://doi.org/10.37074/jalt.2025.8.1.1

Rudolph, J., Tan, S., & Aspland, T. (2023a). Personal digital assistant or job killer? Generative AI and the teaching profession in higher education. *Journal of Applied Learning and Teaching*, *6*(2), 7-16. https://doi.org/10.37074/jalt.2023.6.2.1

Rudolph, J., Tan, S., & Tan, S. (2023b). War of the chatbots: Bard, Bing Chat, ChatGPT, Ernie and beyond: The new AI gold rush and its impact on higher education. *Journal of Applied Learning and Teaching*, *6*(1), 364-389. https://doi.org/10.37074/jalt.2023.6.1.23

Salih, S., Husain, O., Hamdan, M., Abdelsalam, S., Elshafie, H., & Motwakel, A. (2025). Transforming education with AI: A systematic review of ChatGPT's role in learning, academic practices, and institutional adoption. *Results in Engineering*, *25*, 103837. https://doi.org/10.1016/j.rineng.2024.103837

Shakya, R., Vadiee, F., & Khalil, M. (2025). *A showdown of ChatGPT vs DeepSeek in solving programming tasks*. arXiv. https://doi.org/10.48550/arXiv.2503.13549

Sousa, A. E., & Cardoso, P. (2025). Use of generative AI by higher education students. *Electronics*, *14*(7), 1258. https://doi.org/10.3390/electronics14071258

Swift, B. (2025, February 21). *DeepSeek and shallow moats: What does it mean for higher education?*. Times Higher Education. https://www.timeshighereducation.com/campus/DeepSeek-and-shallow-moats-what-does-it-mean-higher-education

The Australian. (2025). *Top university bans Chinese AI app DeepSeek, another strongly encourages staff not to use it*. https://www.theaustralian.com.au/higher-education/top-university-bans-chinese-ai-app-DeepSeek-another-strongly-encourages-staff-not-to-use-it/news-story/6ea8d1d01f7a76914afc676037aacbeb

The Daily. (2025, February 12). *Exploring AI safely: Using DeepSeek R1 at CWRU*. Case Western Reserve University. https://thedaily.case.edu/exploring-ai-safely-using-DeepSeek-r1-at-cwru

Trindade, M. A. M., Edirisinghe, G. S., & Luo, L. (2025). Teaching mathematical concepts in management with generative artificial intelligence: The power of human oversight in AI-driven learning. *The International Journal of Management Education*, *23*(2), 101104. https://doi.org/10.1016/j.ijme.2024.101104

Tutella, F. (2025, January 30). *Q&A: DeepSeek AI assistant and the future of AI in education*. PennState. https://www.psu.edu/news/research/story/qa-DeepSeek-ai-assistant-and-future-ai

Tuyen, Q. D., Vo-Thanh, T., Nghi, N. H., Phuong, B. T., & Bao, B. T. T. (2025). Research on ChatGPT in tourism and hospitality: A systematic review and future directions. *International Journal of Hospitality Management*, *13*1, 104287. https://doi.org/10.1016/j.ijhm.2025.104287

Ullah, M., Bin Naeem, S., & Kamel Boulos, M. N. (2024). Assessing the guidelines on the use of generative artificial intelligence tools in universities: A survey of the world's top 50 universities. *Big Data and Cognitive Computing*, *8*(12), 194. https://doi.org/10.3390/bdcc8120194

Wang, S. (2024, March 10). *Beyond the black box: How DeepSeek could transform higher education*. Times Higher Education. https://www.timeshigheredhaucation.com/campus/beyond-black-box-how-DeepSeek-could-transform-higher-education

Wang, T., & Long, Y. (2025). Understanding Chinese university students' continued learning intentions with DeepSeek: An integrated TAM-SOR model. *Acta Psychologica*, *261*, 105904. https://doi.org/10.1016/j.actpsy.2025.105904

Wang, W., Xu, R., Feng, J., Zhang, Q., & Chu, X. (2025). *A status quo investigation of large language models towards cost-effective CFD automation with OpenFOAMGPT: ChatGPT vs. Qwen vs. DeepSeek*. arXiv. https://doi.org/10.48550/arXiv.2504.02888

Xia, Q., Weng, X., Ouyang, F., Lin, T. J., & Chiu, T. K. (2024). A scoping review on how generative artificial intelligence transforms assessment in higher education. *International Journal of Educational Technology in Higher Education*, *21*(1). https://doi.org/10.1186/s41239-024-00468-z

Yanes, N., Mostafa, A. M., Ezz, M., & Almuayqil, S. N. (2020). A machine learning-based recommender system for improving students learning experiences. *IEEE Access*, *8*, 201218-201235. https://doi.org/10.1109/ACCESS.2020.3036336

Yang, Z. (2025, January 25). *How Chinese AI startup DeepSeek made a model that rivals OpenAI*. Wired. https://www.wired.com/story/deepseek-china-model-ai/

You, Q., Luo, Y., Chen, Z., Song, X., Wang, F., Wen, S., Ding, Q., & Chen, J. (2026). How large language model responds to common depression questions: A comparative analysis of ChatGPT-4.0, DeepSeek, Google Gemini and Perplexity. *Nurse Education in Practice*, *90*, 104668. https://doi.org/10.1016/j.nepr.2025.104668

Young, N. (n.d.). *DeepSeek vs. ChatGPT: Which AI will define the future?*. Teachfloor. https://www.teachfloor.com/blog/deepseek-vs-chatgpt

Zhai, X. (2025). *DeepSeek: Transforming the foundations of education*. Preprints. https://doi.org/10.20944/preprints202503.1776.v1