

**A new kind of cognitive tool:
Generative AI and the future of critical and creative thinking in education**

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Abstract

Since the 2022 release of ChatGPT, students have increasingly embraced the use of generative artificial intelligence (AI) in their schoolwork. These tools threaten to fuel misinformation and plagiarism; however, we contend that a deeper concern lies in how students' use of generative AI could affect their cognitive development. Students can now offload tasks to generative AI that, if completed independently, would require them to build and exercise higher-order cognitive abilities (i.e., critical and creative thinking). Thus, we argue that repeated cognitive offloading through generative AI could hinder the development of students' fundamental skills and undermine the core aims of educational institutions. We begin by comparing generative AI to two other cognitive tools – calculators and navigation systems – and explaining how the nature of work AI can perform differs from the nature of work that can be offloaded to these prior technologies. We then examine how the use of generative AI could impede the development of higher-order cognitive abilities in three educational use cases: essay writing, idea generation, and explanation of complex concepts. Lastly, we offer practical recommendations for educators concerning generative AI's role in education. We suggest that educators delay students' use of generative AI as a cognitive tool for complex tasks until the later stages of their schooling. At the same time, we note that educators could design activities that require students to interact with generative AI as a dialogue partner that asks questions, offers varied perspectives, and challenges assumptions – with potential to support, rather than hinder, students' cognitive development.

Introduction

In November 2022, OpenAI released its user-friendly chatbot, ChatGPT, to the general public. ChatGPT immediately went viral, surprising users with its ability to generate human-like textual responses to simple prompts (Rudolph et al., 2023a; Verma & Lerman, 2022). Within two months of its launch, the chatbot had amassed 100 million monthly active users, surpassing TikTok as the fastest-growing app in history (Hu, 2023). In the wake of ChatGPT's viral success, major tech companies around the world began to promote their own artificial intelligence (AI) chatbots: for instance, in March 2023, Alphabet publicly released Bard (now succeeded by Google Gemini), and China's Baidu unveiled Ernie (Rudolph et al., 2023b). These chatbots are examples of generative AI, a type of machine learning where systems are trained on massive information sets and produce content – including text, computer code, images, video, and audio – in response to user prompts (Office of the Privacy Commissioner of Canada, 2023).

ChatGPT's arrival was met with mixed reactions from journalists and scholars. A common point of contention was the role and impact of generative AI in education. In the days following ChatGPT's release, headlines proclaimed that "the college essay [was] dead" (Marche, 2022) and that the chatbot marked "the end of high-school English" (Herman, 2022). Fear spread that ChatGPT would fuel an explosion in cheating, with students turning to the tool for the almost instantaneous production of human-like text (Criddle & Staton, 2022; Meckler & Verma, 2022; Rudolph et al., 2023a). Other articles framed the effects of generative AI in education in more neutral or optimistic terms, stating that it could "change the way students learn" (Farooqui, 2022), offer "a powerful tool for education if used correctly" (Williams, 2022), and even "make education fairer" by helping students who speak English as a second language or who are unfamiliar with academic writing to better express themselves (Stacey, 2022). The common thread across much of this discourse was that generative AI tools like ChatGPT would be widely adopted by students and transform learning.

Recent research shows that students have indeed embraced the use of generative AI tools in their schoolwork. A 2025 UK-based survey found that undergraduate student use of AI had "surged in the last year, with almost all students (92%) now using AI in some form, up from 66% in 2024, and some 88% having used GenAI for assessments, up from 53% in 2024" (Freeman, 2025, p. 1). Similarly, a report published in October 2025 found that the majority (73%) of Canadian students surveyed use generative AI in their schoolwork, a sharp increase from 59% in the previous year (KPMG Canada, 2025). Significant proportions stated that they use AI to generate ideas (62%), summarize publicly available information (39%), and write essays or reports (36%), with 45% admitting that "their 'first instinct' is to use AI when they get an assignment instead of writing the first draft themselves" (KPMG Canada, 2025). In some cases, student use of generative AI has been actively encouraged by the companies behind these products: most notably, OpenAI made the premium version of ChatGPT free to American and Canadian college students during the spring 2025 exam season (DiBenedetto, 2025).

Students' use of generative AI tools like ChatGPT offers clear opportunities to promote learning. For example, generative AI could provide personalized, on-demand learning experiences tailored to a student's individual pace (Fuchs, 2023; Lo et al., 2024; Yang, 2024). These tools could also automate mundane, laborious tasks, allowing students to devote their time and attention to more complex cognitive work (Baek et al., 2024; Kovanovic & Marrone, 2025). At the same time, however, the use of generative AI in education raises obvious challenges for student learning. Much attention has focused on the tendency for generative AI to produce inaccurate but plausible-sounding statements known as *hallucinations* (Currie, 2023) and the corresponding need to train students to critically evaluate AI outputs (Kenedy, 2024; Larson et al., 2024; Steele, 2023). Additionally, a possible surge in plagiarism – as students pass off AI-produced text as their own work, in some cases tweaking the content to evade the likelihood of detection – continues to alarm educators (Cotton et al., 2024; Currie, 2023; Forrester, 2025).

While misinformation and plagiarism are obvious issues, we contend that a deeper, more foundational concern lies in how students' use of generative AI could affect the development of higher-order cognitive abilities, such as critical and creative thinking. In simple terms, critical thinking involves processes of assessing or judging, and creativity involves processes of making or producing (Paul & Elder, 2006). These types of thinking occupy the highest levels of Bloom's (1956) taxonomy of educational objectives: the *analysis*, *synthesis*, and *evaluation* of information and ideas (with synthesis renamed *create* in Krathwohl's [2002] revised version of the taxonomy). Critical and creative thinking are essential for independent decision-making and

complex problem-solving in individuals' professional and personal lives (Bailin, 1987; Snyder & Snyder, 2008). In addition, these skills – especially critical thinking – are not innate; rather, they must be learned through instruction and practice (Fasko, 2001; Snyder & Snyder, 2008; Siegel, 2005), and their development is often recognized as a central educational goal (Hitchcock, 2022; World Economic Forum, 2017).

Students can now offload tasks to generative AI that, if completed independently, would require them to build and exercise these higher-order cognitive abilities. Thus, we argue that repeated cognitive offloading through generative AI could hinder the development of students' fundamental skills and undermine the core aims of educational institutions. We begin this paper by comparing generative AI to other types of tools used to offload cognitive tasks: calculators and navigation systems. We explain how generative AI – while resembling these earlier technologies in some respects – nonetheless represents a significant departure due to fundamental differences in the nature of work that it can perform. We then examine how the use of generative AI can impede the development of higher-order cognitive abilities in three educational use cases: essay writing, idea generation, and explanation of complex concepts. While the first example is generally viewed as detrimental to students' learning and sometimes constitutes cheating or academic misconduct (Forrester, 2025), the second and third examples are often perceived as “appropriate” or “responsible” uses of generative AI by students (Barrett & Pack, 2023; Freeman, 2025; Lee et al., 2024b; Sidoti et al., 2025) and may be explicitly allowed or encouraged in educational institutions' AI guidelines (e.g., The Ohio State University, n.d.). We show how these seemingly appropriate uses also require careful attention, since the types of cognitive abilities required for generating ideas or understanding a complex topic independently of generative AI assistance may be the exact kinds of abilities that educators aim to develop in their students. Lastly, we offer practical recommendations for educators looking to integrate generative AI use in their classrooms while simultaneously protecting the development of students' critical and creative thinking skills.

Generative AI: A new kind of cognitive tool

Cognitive offloading refers to the delegation of tasks – including memory retention, decision-making, and information retrieval – to external tools to reduce cognitive demand (Fan et al., 2025; Gerlich, 2025; Risko & Gilbert, 2016). Examples of cognitive offloading include using a calculator to complete basic arithmetic when solving a math problem (Hembree & Dessart, 1986; Risko & Gilbert, 2016), relying on a navigation system to identify routes and to provide real-time navigation instructions when driving (Fenech et al., 2010; Hamilton & Yao, 2018), and storing friends' phone numbers on a smartphone (Hamilton & Yao, 2018). Offloading onto external tools can free up cognitive resources for other activities – including higher-order thinking (Gerlich, 2025) – with the potential for enhanced performance across many domains (Risko & Gilbert, 2016). For instance, using a navigation app such as Google Maps while driving can free up the cognitive resources normally allocated to paying attention to directional signs and could possibly allow drivers to focus more fully on traffic (Wahn et al., 2023).

Clearly, cognitive offloading to external devices is not a new phenomenon. However, we contend that offloading through generative AI poses a unique threat to students' cognitive development and the core goals of educational institutions. Calculators and navigation systems exemplify different models of how computational labour can be divided between humans and cognitive tools: we can offload minor, routine tasks (as in the case of the calculator), or we can offload more complex and cognitively demanding tasks (as in the case of navigation systems)

(Heersmink, 2024). These tools also show how repeated offloading could have a detrimental impact on the acquisition and maintenance of the specific cognitive abilities that would be required to perform the tasks independently. In these examples, the cognitive abilities at risk of being weakened through disuse (or simply never developing) range from the ability to perform basic arithmetic operations (mentally or by pen-and-paper) – a simple skill that would fall at the lowest end of Bloom’s (1956) taxonomy – to navigation ability, a more complex and multifaceted skill that includes environmental knowledge and self-reported sense of direction. In some respects, generative AI resembles calculators and navigation systems; however, it differs in the nature of work it can perform, and the corresponding skills that individuals may lose, or fail to develop, as a result of repeated cognitive offloading.

Cognitive offloading through calculators and navigation systems

A prime example of an external tool used in education to complete tasks and reduce students’ cognitive demand is the calculator. Although calculators have become ubiquitous in math education today, these tools were the subject of much debate when they began to enter classrooms in the 1970s and 1980s. Proponents of calculator use in education argued that the tools would allow students to offload rote tasks (i.e., basic arithmetic), thereby freeing up cognitive resources to solve more complicated and relevant math problems (Fiske, 1975; Rowe, 1986.) From this perspective, calculator use represents the first division of computational labour between humans and cognitive tools described by Heersmink (2024): it performs a minor, routine task within a larger cognitive task, allowing students to focus their attention more fully on the work that requires higher-order thinking.

Calculators were also met with resistance from some educators. A *Mathematics Teacher* magazine survey conducted in the mid-1970s found that the majority (72%) of respondents “opposed equipping seventh graders with calculators” (Crow et al., 2024). A common concern was that the devices would become a “crutch” and erode students’ basic arithmetical skills as they repeatedly outsourced tasks that, in the absence of calculators, would be practiced mentally or by pen-and-paper (Crow et al., 2024; Fiske, 1975; Rowe, 1986). Some suggest that reliance on calculators could worsen students’ ability to perform arithmetic (Sternberg, 2024), although there is a lack of empirical evidence to support this claim. However, the weakened cognitive ability – the ability to complete basic arithmetic operations – would likely occupy the lowest level of Bloom’s (1956) taxonomy of educational objectives. We can understand the use of calculators by students as involving a trade-off: a potential weakening of basic arithmetical skills in exchange for the chance to allocate more time and attention to solving complex math problems, and to thereby develop higher-order cognitive abilities. Given that education generally aims to support the higher levels of Bloom’s (1956) taxonomy, this trade-off appears reasonable, which may explain why calculators overcame early resistance to become an integral part of contemporary math education (Rudolph et al., 2023a).

As another tool for cognitive offloading, navigation systems provide an interesting point of comparison. By identifying routes and providing real-time navigation instructions, these systems offload the complex and cognitively demanding task of navigation. Use of navigation systems falls under the second model of the division of computational labour between humans and cognitive tools identified by Heersmink (2024): the cognitive tool performs most (or all) of the larger cognitive task, rather than a minor, routine component. The most obvious benefit of navigation systems is that they allow people to navigate to a location more quickly and effectively than if they relied on verbal instructions or paper maps. Studies generally show that

GPS use enhances wayfinding performance when this performance is measured at a behavioural level (e.g., speed, distance traveled, and navigation errors; Miola et al., 2024).

At the same time, repeated use of navigation systems could hinder the acquisition or maintenance of the cognitive skills that would be required to navigate an environment in the absence of the device. Navigation ability – defined as “people’s ability to navigate an environment and manage spatial relationships among the objects within it” (Miola et al., 2024, p. 1) – is a multi-faceted construct comprised of various cognitive functions (e.g., mental imagery, planning, problem-solving, and decision-making) and components (e.g., environmental knowledge, wayfinding, and sense of direction) (Miola et al., 2024). In a systematic literature review, Miola et al. (2024) found that GPS use was negatively associated with navigation ability – particularly environmental knowledge and self-reported sense of direction – “indicating that the more individuals rely on GPS to reach destinations, the more poorly they perceive their navigation skills and the poorer is their knowledge of the environment” (p. 11). This relationship between GPS use and navigation ability is bidirectional: those with “poorer ability to learn spatial information and form environmental knowledge tend to use assisted navigation systems more frequently in daily life, thus weakening their navigation abilities” (Miola et al., 2024, p. 11). Thus, as with calculators, the use of navigation systems involves a trade-off between benefits (i.e., reaching a destination more quickly, with fewer navigation errors) and downsides (i.e., a potential weakening of, or failure to develop, navigation abilities). Importantly, however, this trade-off carries more significant consequences in the case of navigation systems compared to calculators. For one, complex cognitive functions related to navigation are at risk of erosion, rather than rote arithmetical skills. Moreover, unlike students who typically learn how to complete basic arithmetic operations before receiving permission to offload this work to calculators, new generations of drivers who repeatedly use navigation systems might fail to *ever* develop their navigation ability.

Comparing generative AI to other cognitive tools

As a tool for cognitive offloading, generative AI shares some similarities with calculators and navigation systems. Like calculators, generative AI can perform rote tasks, potentially freeing up cognitive resources for more complex work that requires higher-order thinking (Black & Tomlinson, 2025; Essien et al., 2024; Heersmink, 2024; Wiederhold, 2025). To return to the first division of labour outlined by Heersmink (2024), generative AI is capable of performing routine work that constitutes a minor component of a larger cognitive task. For example, generative AI can proofread a document, allowing writers to focus on the overall structure and substance of their work rather than precise spelling (Black & Tomlinson, 2025; Heersmink, 2024). This idea – that generative AI, like calculators, can automate rote tasks and allow students to allocate time and attention to more important work – is at the heart of many current arguments in favour of allowing students to use generative AI. Some authors explicitly point to parallels between “the great calculator debate” (Rowe, 1986) in the 1970s and 1980s and contemporary discourse concerning the use of AI in education, suggesting that generative AI, like calculators, will overcome initial resistance from educators and eventually be accepted as a tool that can enhance student learning (Crow et al., 2024; Kovanovic & Marrone, 2025; Villasenor, 2023). In 2024, OpenAI CEO Sam Altman explicitly called ChatGPT “a calculator for words” (Warner, 2024). At the same time, as with calculators, it is possible that repeated use of generative AI for rote tasks could erode associated skills. For example, AI-performed proofreading could worsen, or at least prevent the improvement of, students’ spelling, mirroring the potential effects of spell

checkers and autocorrect. Keeping in mind the key goals of education, however, the benefits of outsourcing proofreading to generative AI (e.g., more time devoted to the development of students' higher-order cognitive abilities) may outweigh the risk of a possible decline in students' spelling.

The calculator analogy fails when we consider that, while generative AI can indeed automate rote tasks, its capacities also far exceed this kind of work. Like navigation systems, generative AI is also capable of performing more complex, cognitively demanding tasks. These types of tasks fall under the second model described by Heersmink (2024), where most or all parts of an activity are completed by a cognitive tool. For instance, in response to a simple prompt, generative AI can produce an essay that synthesizes information and ideas from various sources. Human labour in this task is relegated to comparatively minor, simple actions, such as “engineering” the prompt and checking the work for errors (Heersmink, 2024). As with navigation systems, the most obvious benefit of this division of labour is enhanced performance (at least when considering speed): generative AI can produce a long piece of writing in a fraction of the time that it would require someone to perform the task independently, which would involve the laborious process of generating ideas, developing an outline, composing a first draft, and revising their work. Indeed, the possibility of generative AI increasing productivity is frequently cited as one of its greatest benefits (Al Naqbi et al., 2024; Altman, 2025). Here, again, a clear trade-off emerges: enhanced productivity at the expense of developing or sustaining cognitive abilities that would be required to complete the task in the absence of the AI tool.

We can see that generative AI has the capacity to perform both minor, routine tasks (like calculators) as well as more complex, cognitively demanding tasks (like navigation systems). In this way, generative AI might appear to largely resemble the cognitive tools that preceded it, representing the latest in a long series of technologies used to complete tasks, reduce cognitive demand, and enhance performance. However, generative AI differs from other cognitive tools in the nature of the work that it can automate. The fundamental difference that separates generative AI from other cognitive tools is its capacity to perform complex cognitive tasks that, if performed independently, would require us to exercise higher-order cognitive abilities, including critical and creative thinking. Research on cognitive skill acquisition, including the development of critical thinking, shows that practice is key to acquiring these skills (Bensley & Spero, 2014; Snyder & Snyder, 2008; van Gelder, 2001), and offloading complex cognitive work to generative AI could preclude this necessary practice. Thus, repeated cognitive offloading through generative AI could impede the acquisition and maintenance of skills fundamental for problem-solving, decision-making, and autonomy.

Higher-order cognitive abilities: Key skills at risk from repeated offloading of complex cognitive tasks to generative AI

Bloom's (1956) taxonomy presents a hierarchy of cognitive abilities moving from lower-order skills – such as basic recall – to higher-order skills, including analysis, synthesis, and evaluation. In his revised version of Bloom's taxonomy, Krathwohl (2002) replaced *synthesis* with *create* – defined as “[p]utting elements together to form a novel, coherent whole or make an original product” (p. 215) – and moved this ability to the top of the hierarchy, thereby emphasizing “innovation and originality as key educational goals” (Lubbe et al., 2025, p. 17593). The taxonomy's higher-order cognitive abilities are closely related to critical and creative thinking. Critical thinking, for example, is generally defined as people's ability to analyze, synthesize, and evaluate information to form reasoned and independent judgments

(Gerlich, 2025; Kenedy, 2024; Lubbe et al., 2025); it involves processes of assessing or judging (Paul & Elder, 2006). On the other hand, creative thinking involves the generation of ideas that are original (i.e., novel, surprising, and uncommon) and appropriate (i.e., feasible, practical solutions to a problem) (Lee & Chung, 2024); it involves processes of making or producing (Paul & Elder, 2006). In practice, critical and creative thinking are closely intertwined, if not inseparable. For instance, determining the best creative solution to a problem from a list of ideas naturally requires critical judgment, and thinking critically about problems often involves use of the imagination (Bailin, 1987; Bailin et al., 1999; Paul & Elder, 2006). As Paul and Elder (2006) note, “[w]hen engaged in high-quality thought, the mind must simultaneously produce and assess, generate and judge the products it fabricates” (p. 34).

Higher-order cognitive abilities carry obvious value. According to recent World Economic Forum (2020; 2023; 2025) reports, critical and creative thinking are among the skills most valued by employers. In one’s professional as well as personal life, these skills are essential for making independent decisions and solving complex problems (Bailin, 1987; Snyder & Snyder, 2008). Focusing specifically on critical thinking, some authors claim that its major goal is autonomy: the ability to judge and act “independently of external constraint, in accordance with [one’s] own reasoned appraisal of the matter at hand” (Siegel, 2005, p. 357) and to be “very hard to fool – by others, by [oneself], and, to a degree, by circumstances” (McPhee & Cox, 2025, p. 190). Moreover, these skills – especially critical thinking – are not innate. They must be developed through instruction and practice (Fasko, 2001; Snyder & Snyder, 2008; Siegel, 2005).

Given the value of these skills and the need for them to be formally taught and practiced, it is not surprising that they are commonly identified as key educational outcomes (Hitchcock, 2022; World Economic Forum, 2017). In education as well as work-related contexts, some have expressed concern that reliance on AI could erode existing cognitive abilities – a phenomenon that has been variously called *skill decay* (Macnamara et al., 2024), *deskilling* (Melumad & Yun, 2025; Shukla et al., 2025), and *skill atrophy* (Fan et al., 2025). However, a deeper risk lies in the fact that, if students repeatedly offload tasks to generative AI, they may miss the opportunity to *acquire* skills like critical and creative thinking in the first place. Just as the ubiquity of navigation systems naturally reduces the need for younger generations to develop their navigation ability, the instant accessibility of generative AI for current and future generations of students could reduce their need to develop higher-order cognitive skills.

Repeated cognitive offloading through generative AI and reduced higher-order cognitive abilities: Preliminary evidence for a link

While nascent, some research has begun to provide evidence for a relationship between repeated cognitive offloading through generative AI and reduced higher-order cognitive abilities. For example, Gerlich (2025) established a “significant negative correlation between frequent AI tool usage and critical thinking abilities” (p. 1) with increased cognitive offloading as a mediating factor. Several participants reported relying heavily on AI tools for cognitive tasks and expressed concerns about lost opportunities to engage in this work independently; as one put it, “[t]he more I use AI, the less I feel the need to problem-solve on my own. It’s like I’m losing my ability to think critically” (Gerlich, 2025, p. 20). Along similar lines, a study by Kosmyna et al. (2025) determined that receiving generative AI assistance while writing essays could carry a significant cognitive cost. Participants were assigned to one of three experimental groups (i.e., LLM [large language model] group, Search Engine group, or Brain-only group) and instructed to write an essay four times over the course of several months. Recording participants’ brain

activity during these sessions using electroencephalography (EEG), Kosmyna et al. (2025) found that “[b]rain connectivity systematically scaled down with the amount of external support: the Brain-only group exhibited the strongest, widest-ranging networks, Search Engine group showed intermediate engagement, and LLM assistance elicited the weakest overall coupling” (p. 2). Moreover, the LLM group’s participants struggled to quote from their essays written minutes prior, exhibited “a fragmented and conflicted sense of authorship” (p. 138), and “produced statistically homogenous essays within each topic” (p. 133), suggesting that they may have failed to engage deeply with the topics or critically evaluate the LLM’s output. The researchers conclude that the LLM group’s performance reflects the concept of *cognitive debt*, a condition where “repeated reliance on external systems like LLMs replaces the effortful cognitive processes required for independent thinking” (p. 141).

How Generative AI undermines the development of higher-order cognitive abilities: Examining three educational use cases

To illustrate how generative AI use can undermine the development of students’ higher-order cognitive abilities, we focus on three educational use cases and identify the skills that would be required to complete these tasks independently. A distinction can be drawn between the first task (essay writing) and the latter two (idea generation and explaining complex concepts). Using generative AI to offload most or all of the work involved in writing an essay is widely regarded as cheating or academic misconduct (Forrester, 2025), and students tend to perceive this use of AI as inappropriate (Lee et al., 2024b; Sidoti et al., 2025). On the other hand, using generative AI to produce ideas or explain topics by summarizing various sources or a longer text are sometimes permitted in educational institutions’ AI guidelines (e.g., The Ohio State University, n.d.; The University of Sydney, n.d.). Not surprisingly, students often believe these activities are appropriate and report engaging in them frequently (Barrett & Pack, 2023; Common Sense, 2024; Freeman, 2025; KPMG Canada, 2025; Lee et al., 2024b; Sidoti et al., 2025). However, a closer consideration of the skills that would be required to complete these tasks in the absence of generative AI complicates the notion that AI-assisted idea generation or explanations support (or at least do not interfere with) student learning and cognitive development.

Essay writing: An inappropriate use

Although relying on generative AI to write essays typically constitutes cheating and is acknowledged as inappropriate by students, surveys and media accounts reveal that many students do in fact use generative AI for this purpose (Freeman, 2025; KPMG Canada, 2025; Walsh, 2025). For example, one recent study found that over a third (36%) of Canadian students surveyed reported using generative AI tools to write essays and reports (KPMG Canada, 2025); meanwhile, almost a fifth (18%) of undergraduate students in a UK-based survey stated that they use AI-generated and edited text in their assignments (Freeman, 2025). This uptake may be explained, in part, by a lack of meaningful consequences. LLMs like ChatGPT can produce text virtually indistinguishable from human writing, and it is challenging – if not impossible – for educators to prove that an assignment is AI-generated, even if they suspect that this is the case (Forrester, 2025; Lo et al., 2024; Wiederhold, 2025). But the uptake may also arise from a failure among students to understand the cognitive purpose of writing, and what might be lost when this work is outsourced to generative AI.

Offloading most or all of the effort involved in writing an essay to a tool like ChatGPT falls within the second division of labour outlined by Heersmink (2024), where the larger, more complex cognitive work is outsourced to generative AI and human contributions are minimal and routine. A typical workflow begins with a student entering a prompt into ChatGPT outlining an essay's basic parameters, such as topic, intended audience, style, and word count. Within seconds of submitting this prompt, the student copy-and-pastes a complete AI-generated essay draft into a word processor and starts to fact-check, dutifully removing any hallucinated references. As an added precaution, the student then processes the essay through "humanizing" software to evade detection (Ayub et al., 2024). Here, the complex cognitive work – the actual writing of the essay – has been offloaded to generative AI, while the student performs rote tasks that require minimal cognitive effort. Of course, generative AI can also be deployed in the essay writing process in more nuanced ways, raising the question of where appropriate use ends and academic misconduct begins. A less egregious version, where a student may in fact feel that they have used AI as a tool for collaboration rather than cheating, could involve the student asking ChatGPT to generate an essay draft based on their own preliminary ideas, which the student then edits to reflect their writing style before submission. In this case, the student might feel reassured by the knowledge that the ideas are their own and simply view ChatGPT as a cure for writer's block.

To understand exactly how generative AI use could impede students' cognitive growth, we need to uncover the kinds of cognitive skills demanded by independent essay writing. Many have observed that the writing process is uniquely well-suited to supporting the development of higher-order cognitive abilities (e.g., Emig, 1977; Hunt, 2010; Mintz, 2021, 2025). Writing is not simply an external storage medium for pre-existing thoughts (Menary, 2007). Rather, written sentences are external and enduring "vehicles of thought" (Menary, 2007, p. 622) that can be manipulated, on paper or other media, in ways that are not possible in our heads (Heersmink, 2024; Menary, 2007; Oatley & Djikic, 2008). As Menary (2007) puts it, written sentences enable "manipulations, transformations, reorderings, comparisons and deletions of text that are not available to neural processes" (p. 629). For example, after externalizing our own thought by writing it down, we can reread it, evaluate it, and choose to manipulate it accordingly: through revision and refinement, movement to another paragraph, or removal (Menary, 2007; Oatley & Djikic, 2008). In this way, writing supports the emergence of thoughts and insights that would be difficult, if not impossible, to otherwise achieve (Heersmink, 2024; Hunt, 2010; Mintz, 2021; Oatley & Djikic, 2008). While we could hypothetically compose a paper without external media, the kinds of manipulations that writing affords "are not easily, if ever, achieved in the head" (Menary, 2007, p. 629), meaning that the style and content of a paper will differ depending on whether it is developed in our heads or through writing (Menary, 2007).

We can see how writing – understood as the manipulation of external "vehicles of thought" – involves processes of assessing and judging, as well as making and producing, that characterize critical and creative thought (Paul & Elder, 2006). Viewing writing as a cognitive process that gives rise to new forms of thinking (Heersmink, 2024), rather than the externalization and storage of pre-existing thoughts, may explain why some perceive writing assignments as so crucial to developing students' higher-order cognitive abilities, especially critical thinking (Emig, 1977; Mintz, 2021, 2025; Royer, 2024). For example, Emig (1977) characterizes writing as "a unique mode of learning – not merely valuable, not merely special, but unique" (p. 122) that builds students' skills in analysis and synthesis; Mintz (2021) similarly suggests that writing is "the most nuanced and sophisticated way to order, analyze, apply and synthesize information." From this point of view, calls to replace "old-fashioned" pen-and-paper

essays with AI-assisted written work (Villasenor, 2025; Warner, 2024) or to simply deprioritize written assignments as an assessment method (Rudolph et al., 2023a) appear to misunderstand the cognitive value of the writing process, possibly perceiving writing as a means to simply record and transmit pre-formulated thoughts.

Extensive use of generative AI during the writing process could disrupt a unique mode of thinking marked by both criticality and creativity. From a cognitive perspective, there may be no substantial difference between a student committing a clear act of academic misconduct (i.e., simply entering a prompt and fact-checking the AI-generated product) or arguably “collaborating” with an AI tool (i.e., entering preliminary ideas and stylistically editing an AI-generated draft). In both cases, the cognitive skills that the student would exercise by engaging in the independent writing process – externalizing their own thoughts on a medium, manipulating those thoughts, and thereby generating new insights – are bypassed, or only invoked to a limited degree. Even if the student articulates their own ideas that are then used to prompt ChatGPT to write a draft, they skip the crucial stage of manipulating and transforming their externalized thoughts and producing new insights – in other words, they miss the opportunity to “use imperfect drafts as portals of discovery” (Oatley & Djikic, 2008, p. 13). Thus, beyond the performance of simple rote tasks, heavy AI use in the writing process appears to short-circuit critical and creative thinking.

Idea generation and explanations: Appropriate uses?

Other uses of generative AI in educational settings are deemed acceptable or even encouraged, sometimes accompanied by the assumption that schools should train students to work with AI to prepare them for careers where these tools will be ubiquitous (Tseng & Warschauer, 2023; Vázquez-Parra et al., 2024). As mentioned, students widely perceive AI use for idea generation and explaining complex concepts to be appropriate uses of the technology (Barrett & Pack, 2023; Freeman, 2025; Lee et al., 2024b; Sidoti et al., 2025), and the guidelines of some educational institutions may permit these kinds of uses (e.g., The Ohio State University, n.d.; The University of Sydney, n.d.). There are obvious practical challenges to implementing and enforcing these guidelines (Forrester, 2025). However, even assuming that it is possible to police students’ behaviour – forcing them to restrict their use of generative AI to specific, seemingly narrow tasks – a deeper problem remains. The implications of the “permissible” offloading of some tasks (i.e., idea generation and explaining concepts by summarizing various sources or longer-form texts) may curtail the development of higher-order cognitive abilities that would be required to complete these tasks independently.

Idea generation

On the surface, student use of generative AI for idea generation – such as brainstorming a list of potential topics for an essay – might appear to support creativity, or at least not actively harm students’ cognitive growth (Essien et al., 2024; Gonsalves, 2024; Tossell et al., 2024). According to one study, about half of young people report using AI for this purpose (Common Sense, 2024), and teachers and students alike consider use of generative AI in the early stages of the writing process, including brainstorming, to be more acceptable than in later stages (Barrett & Pack, 2023). Research examining the impact of generative AI use on participants’ creative outputs shows that these tools allow people to produce ideas judged to be more creative than those that are produced without AI assistance (Anderson et al., 2024; Habib et al., 2024; Lee & Chung, 2024; Liu et al., 2024). A popular assumption is that generative AI can provide a

“‘springboard’ for the human mind” (Doshi & Hauser, 2024, p. 1). For instance, based on student self-reports, the author of one study concluded that use of ChatGPT by MSc Marketing students in their coursework supported the highest level of Bloom’s revised taxonomy (i.e., creating), with generative AI serving as “catalysts for creative thinking, enabling students to expand beyond their conventional ideas, experiment with novel solutions, and refine innovative concepts” (Gonsalves, 2024, p. 8). In this context, generative AI tools serve as “co-creators” that transform “how students engage with cognitive tasks” (Gonsalves, 2024, p. 11).

The appropriateness of AI assistance in idea generation becomes harder to defend when we consider the cognitive abilities that this task would demand in the absence of AI. Independent idea generation involves creative thinking, or the capacity to produce ideas that are both original and appropriate (Lee & Chung, 2024), and exercises like brainstorming are believed to be ways to practice and strengthen creative abilities (Fasko, 2001). It follows that offloading this work to generative AI could impede the development of students’ innate creative thinking skills, and this lack of growth could, in turn, make it difficult for students to “collaborate” or “co-create” effectively with AI (i.e., evaluate and build upon an AI tool’s initial suggestions to produce genuinely innovative work).

Some evidence that generative AI use may hinder the acquisition and maintenance of students’ creative thinking skills lies in the fact that people who receive AI assistance when completing idea generation tasks consistently produce less diverse outcomes than their counterparts who work alone – even though their AI-assisted work is judged, in some respects, to be more creative (Anderson et al., 2024; Liu et al., 2024; Meincke et al., 2025). Generative AI outputs are infamously homogeneous: as a technology that exhibits “a significant narrowing of model output diversity relative to available training data for a given task,” LLMs have been said to promote a *generative monoculture* (Wu et al., 2024, p. 1). In experiments, the homogeneity of AI-assisted ideas could possibly indicate that participants are failing to engage in creative thinking to expand on AI outputs, complicating the rosy view that these outputs serve as a natural springboard for further idea development.

This concern is corroborated by participants’ self-reported experiences in creative task studies. A common sentiment is that AI-assisted idea generation leads participants to exert little cognitive effort, since the AI does the “thinking” for them (Anderson et al., 2024; Habib et al., 2024). A student in one experiment observed that it felt like ChatGPT was giving them “an easy way out” and not allowing them “to think on [their] own as much” (Habib et al., 2024, p. 4). Anderson et al. (2024) suggest that “[f]or at least some users, the apparent completeness of ChatGPT responses resulted in users feeling disengaged from the process of idea generation” (p. 420); one participant stated that “‘ChatGPT allowed [them] to turn [their] brain off’ and did ‘the heavy lifting’ during ideation” (p. 420). While LLMs like ChatGPT might rapidly produce “relatively obvious possibilities” that users would otherwise have failed (or taken longer) to consider, these systems do not appear to help users generate “truly original ideas” (Anderson et al., 2024, p. 422). For those who have developed their capacity for creative thinking, this failure to expand on AI-generated ideas may be due to a lack of motivation. On the other hand, students – who have not necessarily acquired these creative abilities – may lack the cognitive *capacity* to build on the AI-generated ideas in the first place, and repeated use of AI for idea generation may exacerbate the problem by continually interfering with the development of these skills.

Explaining complex concepts

A recurring theme in the literature is the potential for generative AI tools to explain complex concepts by summarizing numerous sources or longer-form texts, potentially freeing up students' cognitive resources for more advanced activities. According to one recent survey of undergraduate students, using AI to "explain concepts" remains its "most popular function, with 58% of students using it for this purpose, up from 36% in 2024" (Freeman, 2025, p. 3). By making it easier for students to "grasp foundational concepts," AI tools are assumed to enable them to "explore advanced topics with confidence" (Crow et al., 2024). In Gonsalves' (2024) study, MSc Marketing students reported using AI to simplify complex concepts into "clear, digestible explanations, creating accessible starting points for deeper learning" (p. 7). Black and Tomlinson (2025) similarly found that university students reported "using AI to enhance and synthesize their existing understandings of conceptual connections," which were then utilized to "write their own interpretations of the material" (p. 5).

The prevailing issue raised regarding AI explanations is the potential for hallucinations: claims that are inaccurate but sound plausible, delivered in the authoritative, self-assured tone characteristic of generative AI (Currie, 2023; Steele, 2023). This is a valid concern, but its dominance in discussions of generative AI use among students obscures a more foundational problem related to relying on AI tools to simplify and summarize complex information. As with essay writing and idea generation, we need to identify the cognitive skills that would be required to understand a complex concept in the absence of short, easily digestible AI summaries. One approach would be to effortfully analyze, synthesize, and evaluate information from various sources, as when one conducts a Google search and navigates through several websites to learn about a topic (Melumad & Yun, 2025). Another approach to understanding a complex concept is to engage in *deep reading* of a longer-form text such as a print book (Weber, 2024; Wolf, 2010).

To focus specifically on the second example – which arguably calls on our higher-order cognitive abilities to a greater extent than synthesizing information from a Google search – deep reading refers to "engaging with a text in a thoughtful, critical, and reflective way such that the reader is able to make inferences from what they've read" (Sangha et al., 2023). Drawing from the work of literacy scholar Maryanne Wolf, Weber (2024) notes that deep reading is "more than decoding or comprehending solely for meaning making" (p. 63); it "encompasses the acts of close reading and performing critical analysis, as well as generating 'novel' thoughts and ideas as a product of contemplating what one has read, and even as the result of epiphany" (p. 63). In this way, like effortful engagement in the writing process, deep reading calls on critical (i.e., assessing and judging) and creative (i.e., making and producing) processes (Paul & Elder, 2006). Its defining features include slow, sustained attention and immersion in the world of a book (Weber, 2024). Moreover, deep reading is a practice that must be intentionally engaged in, rather than an ability automatically possessed and exercised by all readers (Weber, 2024; Wolf, 2010).

The shift away from deep reading to *skim reading* – quickly browsing a text, or series of short texts, to gain the gist of their messages – has been underway since the advent of screens, the internet, and social media (Delgado et al., 2018; Kovač & van der Weel, 2018). However, the marginalization of deep reading could further accelerate with generative AI's capacity to summarize dense, long-form texts in seconds, as well as its tendency to automatically organize its responses into short paragraphs and bullet points – a style optimized for skimming and scanning. This stylistic approach may also align with the characteristics of explanations considered satisfying: for example, experiments have shown that "people prefer answers and explanations that are simple, broad, reductive, and quantitative" (Messeri & Crockett, 2024, p.

52). It is not that skim reading carries no utility; in many ways, skimming is a necessary and natural response to the vast volume of information we encounter daily online. Rather, the concern is that repeated skimming, particularly by students, could supplant engagement in deep reading and hamper the development of the higher-order cognitive skills that this sophisticated reading practice requires – skills that were already in decline pre-ChatGPT. Addressing the problem over a decade ago, Wolf (2010) stated that the “plasticity” of the brain’s reading circuit means that it “can be fully fashioned over time and fully implemented when we read, or it can be short-circuited – either early on in its formation period or later, after its formation, in the execution of only part of its potentially available cognitive resources” (p. 8).

It is possible that short generative AI explanations could provide a starting point for deeper learning, as some have argued (e.g., Crow et al., 2024; Gonsalves, 2024); a simple summary in plain language could make diving into a longer-form print book or article less daunting. However, this line of reasoning assumes that students have already acquired the ability to engage in the cognitively demanding work of deep reading, with its requirement for sustained attention and a critical mindset. As with idea generation, for students, the issue may not be a lack of motivation so much as a lack of cognitive *capacity* to perform deep reading, and this problem will be exacerbated if consuming information through short AI summaries becomes the norm.

Protecting the development of students’ higher-order cognitive abilities in the age of AI: Practical recommendations

If generative AI can perform complex cognitive tasks that would normally demand the use of higher-cognitive abilities, how can we integrate AI into education while protecting the development of critical and creative thinking skills? We acknowledge that current trends, especially in the US and China, advocate for early AI exposure in education (Burleigh, 2025; OpenAI, 2025; The White House, 2025). We also recognize the value of training students to work with and use AI to prepare for their future careers. Nonetheless, we make the case that students’ use of generative AI to assist in complex, cognitively demanding work should be delayed until the later stages of their education – and even then, limited in its application. We recommend this delay and limitation of students’ generative AI use in complex tasks for three reasons: (1) to ensure that young students acquire fundamental cognitive skills; (2) to allow students’ cognitive development to be accurately assessed and measured; and, (3) to create conditions where students will be able to collaborate effectively with generative AI, since they will possess the fundamental skills needed to do so. Given the easy accessibility of generative AI tools like ChatGPT outside of the classroom, this delay and limitation may require more assessments to be completed in-person under supervision; however, an in-depth discussion of how assessment methods might change is beyond the scope of this paper. Finally, we acknowledge that there is potential to build students’ higher-order cognitive abilities through generative AI use, although these positive outcomes appear to depend on using AI as a *dialogue partner* (i.e., for providing alternative perspectives and challenging students’ views) rather than as a *cognitive tool* (i.e., for offloading cognitive work, as has been extensively discussed in this paper).

Ensuring young students acquire fundamental cognitive skills

The first reason to delay AI generative use for complex cognitive tasks is to ensure that students – especially younger students – acquire higher-order cognitive abilities. Rote tasks that involve skills at the lower levels of Bloom’s (1956) taxonomy (e.g., recall), and that students

have already learned to perform independently, are less risky to offload. To return to the example of the calculator, once students have grasped the ability to perform arithmetic mentally or by pen-and-paper, outsourcing this routine and tedious work to a calculator frees up cognitive resources to tackle more complex and realistic math problems. Similarly, assuming that students possess a solid foundation in spelling, using generative AI to complete the routine work of proofreading an essay could allow them to focus more fully on evaluating and revising the writing's structure and substance.

Educators need to be much more cautious about allowing students to offload tasks that, completed independently, would require critical and creative thinking. Repeatedly outsourcing this kind of work to generative AI could not only erode these fundamental skills through disuse – as in skill decay – but hinder students' acquisition of these abilities in the first place. Unlike in the case of skill decay, where individuals may be aware of a deterioration of their prior skills if they cease to perform a task (Macnamara et al., 2024), students who never develop certain cognitive abilities may have no conception of what has been “lost” (Sternberg, 2024). In addition, children's brains are more malleable or “plastic” than adults' (Johnston et al., 2009). As a result, “the effects of intensive learning in school, exposure to a second language or practice in athletics has a much greater impact on children than adults” (Johnston et al., 2009, p. 2). If children miss the opportunity to develop fundamental cognitive skills due to overreliance on AI offloading, these abilities may be much more difficult for them to acquire as they mature.

Allowing students' cognitive development to be accurately assessed and measured

The second reason to delay students' use of generative AI for complex cognitive tasks – and to ensure that, even after AI's introduction, some work continues to be completed in its absence – is to allow students' cognitive development to be accurately assessed and measured. It is possible that enhanced academic performance achieved through AI assistance could be mistaken for evidence that students' actual cognitive abilities have improved (Macnamara et al., 2024). Put another way, *products* (e.g., AI outputs) could be confused with *processes* (e.g., the skills a student would need to invoke to perform the task independently) (Runco, 2023).

Several studies have shown that generative AI use can increase the quality of students' writing (Fan et al., 2025; Marzuki et al., 2023; Yang et al., 2025). It is reasonable to expect that use of an AI tool that produces grammatically correct, mostly coherent text would improve writing quality, especially among younger students; after all, in one study, entirely AI-generated essays received high scores at a university level (Yeadon et al., 2023). However, enhanced essay quality with AI use tells us nothing about students' cognitive growth. From a cognitive perspective, the purpose of assigning essays is not to assess whether students can competently record and transmit information through a written product: it is to require them to engage in the writing process and, in doing so, build their capacity to think critically and creatively.

A parallel can be drawn with generative AI use in idea generation. Across studies, AI-assisted products are consistently rated as more creative than those produced independently (Anderson et al., 2024; Habib et al., 2024; Lee & Chung, 2024; Liu et al., 2024). Putting aside other relevant factors – such as the apparent absence of “incubation periods,” where people “process ideas unconsciously before arriving at innovative solutions” (Shukla et al., 2025, pp. 5-6), in these experiments – the enhanced AI outputs tell us very little, if anything, about participants' innate creative thinking abilities. In fact, the homogeneity of the AI-assisted outputs may indicate that the tools' instant generation of seemingly complete ideas, based on patterns detected in vast volumes of training data, makes participants less inclined (or able) to produce

truly innovative work. Again, in an educational context, a student discovering an idea through generative AI that contains some markers of creativity cannot be mistaken for actual cognitive growth; creative products should not be confused with creative processes.

To further complicate the situation, it is not only that enhanced academic performance through generative AI use cannot be taken as evidence of cognitive growth: increased performance with AI might be correlated with *reduced* cognitive development. For example, we can assume that a student who composes an essay alone and receives a lower grade than a student who composes an essay with AI assistance may nonetheless have developed their critical and creative thinking skills to a much greater degree than the higher-scoring student. Educational institutions that permit and encourage generative AI use among students may inadvertently create an environment where students who offload complex cognitive work to AI receive immediate, concrete rewards (i.e., higher grades) while suffering invisible long-term consequences (i.e., failure to acquire critical and creative thinking skills). Ironically, in this environment, students who work independently may be penalized in the short term while building skills essential for complex problem-solving, independent decision-making, and autonomy – in other words, the exact kinds of cognitive abilities that are central to the aims of education.

Creating conditions where students will be able to collaborate effectively with AI

A final reason to delay and limit students' use of generative AI for complex cognitive tasks is to create conditions where students will be able to collaborate effectively with these tools. One of the assumptions underlying educational guidelines that permit students' use of generative AI for non-rote cognitive tasks, such as idea generation, appears to be that students will critically evaluate and build upon AI outputs in a process of collaboration or co-creation. This belief seems to reflect a third division of human and machine labour apart from those mentioned by Heersmink (2024), where both parties make a substantial contribution to a complex, cognitively demanding task, and the allocation of labour is determined by each party's complementary strengths (best captured by the concept of *hybrid intelligence*; Akata et al., 2020). From this point of view, human-AI teams could not only outperform humans working alone (i.e., *human augmentation*) but also surpass what could be achieved by humans *or* AI working alone (i.e., *human-AI synergy*) (Vaccaro et al., 2024). The problem is that, in order to collaborate effectively with generative AI on complex tasks, students must *already* possess foundational skills in critical and creative thinking.

For instance, using rapidly generated AI ideas as a springboard for further idea development, or simply identifying the most original and appropriate idea from an AI-generated list, presumably requires students to already possess a critical and creative mindset. This may explain, in part, why the students in Gonsalves' (2024) study – who were “mainly high-achieving, fully engaged” (p. 13) MSc Marketing students – were reportedly able to use generative AI tools to “expand beyond conventional ideas, experiment with novel solutions, and refine innovative concepts” (p. 8). Whether generative AI truly supports human creativity remains an open question (Doshi & Hauser, 2024; Runco, 2023; Sternberg, 2024), but it is reasonable to expect that people will be more capable of “co-creating” with AI, and even achieving human-AI synergy, when they are independently creative thinkers and can bring their unique cognitive strengths to the task at hand. In a work context, some have suggested that AI is an especially powerful tool for experts because they have the capacity to critically engage with AI outputs (Azaria et al., 2024). Still, more research is needed to investigate whether, and under what conditions, collaboration with AI yields positive outcomes: a recent systematic literature

review and meta-analysis found that, “on average, human-AI combinations performed significantly worse than the best of humans or AI alone” (Vaccaro et al., 2024, p. 2293).

Even assuming that it is possible to collaborate effectively with generative AI, this kind of work still carries the risk of skill decay, since repeated disuse of certain cognitive skills – like repeated disuse of muscle groups through a lack of physical activity – follows the principle of “use it or lose it” (Sternberg, 2024). A helpful example can be found in the field of aviation. Some research suggests that automated assistance may cause cognitive skill decay in pilots, with those who spend more time flying with automation support performing worse when the automation is unavailable or irrelevant (Macnamara et al., 2024). In 2022, the US Federal Aviation Administration “recommended that pilots periodically use their manual skills for the majority of flights” following “a rise in near misses and other evidence that pilots’ manual skills were declining” (Macnamara et al., 2024, p. 3). Interestingly, “higher levels of skill decay are associated with tasks that require greater cognitive effort and fewer physical demands [...] as opposed to tasks that primarily rely on physical abilities with minimal cognitive processing” (Macnamara et al., 2024, p. 3). This line of work suggests that higher-order cognitive abilities like critical and creative thinking are especially vulnerable to erosion through repeated generative AI offloading, and that individuals who can perform complex cognitive tasks independently should continue to practice these tasks in the absence of AI to retain core skills. In a work context, independent practice could mitigate the risk of *AI lock-in*, where increased outsourcing of tasks to AI leads to skill decay and ultimately “leaves businesses vulnerable if AI systems fail or deliver poor results” (Chandrasekaran, 2025). In an educational context, including in later stages of schooling like higher education, independent practice – such as the requirement for students to complete many activities without AI assistance – could similarly avoid AI-driven skill decay and related problems, such as *cognitive lock-in* (i.e., dependency on AI tools for cognitive processes and tasks; Hansen, 2024).

From cognitive tool to dialogue partner: A possible path to developing students’ higher-order cognitive abilities through generative AI use

To this point, we have almost exclusively focused on the use of generative AI as a *cognitive tool* capable of offloading rote as well as complex cognitive tasks through content generation (Zhao et al., 2025). This focus has been driven by students’ self-reported usage habits (e.g., Freeman, 2025; KPMG Canada, 2025) as well as the unique cognitive risks posed by repeatedly outsourcing complex work – such as essay writing, idea generation, and summarization or synthesis of information – to generative AI. However, educators could design activities that require students to use generative AI as a *dialogue partner* that asks relevant questions, provides varied perspectives, and challenges their assumptions (e.g., Borge et al., 2024; Chen et al., 2025; Tang & Putra, 2025; Zhao et al., 2025). Generative AI tools like ChatGPT can be instructed to interact with students in specific ways; for example, users can enter a prompt before or during a conversation that requests certain response styles (Borge et al., 2024) or create a customized chatbot with tools offered by AI companies (OpenAI, n.d.; Tang & Putra, 2025). Activities that involve back-and-forth dialogue with generative AI might help students view the technology as an engaging partner rather than an “all-knowing oracle” (Helal et al., 2025, p. 7) or “authoritative knowledge provider” (Tang & Putra, 2025, p. 2), and this shift in perspective may promote students’ critical thinking (Helal et al., 2025).

As an example, an AI dialogue partner could be prompted or customized to interact with students in ways designed to build their argumentation skills. Sharples (2023) proposed the idea

of ChatGPT serving as a “Socratic opponent” (p. 163) for students in an argument. For instance, students could pose a contentious question to ChatGPT, reflect on its response, and challenge it to clarify or defend its stance (Sharples, 2023). Borge et al. (2024) similarly suggest that students could practice argumentation strategies with a chatbot and then prompt the chatbot to skim the conversation transcript and evaluate the quality of the interaction. Putting these ideas into practice, Lee et al. (2024a) developed a debate education application utilizing ChatGPT (“DEBO”) and allowed undergraduate university students to use the tool to prepare for a debate. DEBO – which can debate with users and then evaluate the performance of both the user and the program itself – reportedly enhanced students’ divergent thinking “by providing a variety of ideas from different perspectives” (Lee et al., 2024a, p. 329). Using OpenAI’s “My GPTs” feature, Tang and Putra (2025) instructed a chatbot to behave like a science teacher and “engage in dialogic interaction” (p. 4) with high school students. When designing the chatbot, the researchers provided a definition of dialogic interaction (e.g., “...thoughtful, reciprocal exchanges where multiple perspectives are explored, fostering critical thinking and deeper understanding...” [p. 4]) as well as further instructional steps stipulating how the chatbot should ask and respond to questions. High school students who interacted with the chatbot “were engaged in reflective thought processes that required them to consider alternative viewpoints, defend their reasoning, propose creative solutions, and engage in evidence-based argumentation” (Tang & Putra, 2025, p. 10).

While using generative AI as a dialogue partner carries great potential to support learning and cognitive development, complications remain. For one, generative AI is known to be sycophantic (Sharma et al., 2023). In a role-playing exercise with ChatGPT, Borge et al. (2024) noticed that the chatbot tended to “agree with and expand ideas rather than disagree and provide counterarguments” (p. 494), requiring the user to recognize this sycophancy and explicitly prompt ChatGPT to offer multiple perspectives. Lee et al. (2024a) similarly found that, even though their chatbot was designed to act as a debate partner, it struggled to maintain “consistent responses that effectively counter-argued the position of the opposing party” (p. 329) across multiple exchanges. As has been extensively discussed and documented in the literature, generative AI tools are also prone to hallucinations (Borge et al., 2024). These limitations highlight the need for students to *already* possess some capacity for critical and creative thought when interacting with generative AI as a dialogue partner. For instance, Borge et al. (2024) note that the quality of interactions depends on users’ “creativity, knowledge, awareness, and regulation of ongoing processes”; “they must “know what questions to ask and how to guide [the] inquiry” (p. 505). The need to evaluate the quality and accuracy of AI outputs also calls on users’ critical thinking abilities (Lee et al., 2024a; Tang & Putra, 2025; Zhao et al., 2025). Notably, therefore, these limitations (i.e., AI sycophancy and hallucinations) could provide opportunities for students to practice and further develop their existing critical and creative thinking skills. As with other forms of human-AI collaboration, to best capitalize on generative AI’s potential as a dialogue partner, educators may wish to delay the introduction of these kinds of interactive activities until students have acquired foundational abilities.

Conclusion

Tools for cognitive offloading have long existed. In math education, students use calculators to perform rote arithmetic. In everyday wayfinding, drivers use navigation systems to find routes and access real-time navigation instructions. However, generative AI is a new kind of cognitive tool. Unlike calculators, navigation systems, or virtually any other technology that

preceded it, generative AI can outsource complex cognitive tasks that, if performed independently, would require us to build and exercise higher-order cognitive abilities like critical and creative thinking.

In this way, repeated offloading through generative AI poses a unique threat to the development of students' fundamental skills and the core aims to educational institutions. While discussions of generative AI use in education tend to centre on concerns over hallucinations and plagiarism, we argue that the failure to acquire higher-order cognitive abilities through repeated AI offloading represents a deeper, more foundational problem. Unfortunately, this problem has no clear solution. Popular approaches to integrating generative AI into education – such as guidelines that outline “appropriate” student uses – are not only difficult to enforce but may unwittingly encourage uses that hinder students' acquisition of critical and creative thinking skills.

We recommend that educators delay students' use of generative AI to assist in complex cognitive tasks until the later stages of their education and ensure that many of these activities continue to be completed in the absence of AI. Our reasons for this recommendation are threefold. First, this approach would protect younger students' acquisition of fundamental cognitive skills that are among the most important goals of education. Second, this approach would allow educators to accurately assess and measure students' cognitive development, since improvements in academic performance with AI assistance would not be mistaken for evidence of enhanced cognitive abilities. Finally, this approach would create the conditions for students to collaborate effectively with generative AI tools, as this kind of collaboration depends on students already possessing a critical and creative mindset. We conclude by distinguishing between generative AI as a *cognitive tool* for offloading work and generative AI as a *dialogue partner* designed to interact with users in specific ways. While student use of generative AI for cognitive offloading is fraught with risks, designing activities where students interact with AI tools that ask questions, offer alternative perspectives, and challenge views could support, rather than hinder, students' cognitive development.

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