

THE IMPACT OF OVER-RELIANCE ON ARTIFICIAL INTELLIGENCE TOOLS ON STUDENTS' INDEPENDENT THINKING AND CRITICAL THINKING SKILLS IN HIGHER EDUCATION

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Abstract. *The rapid proliferation of artificial intelligence (AI) tools in higher education has raised growing concerns about their potential negative impact on students' cognitive development, particularly independent thinking and critical thinking skills. This study investigates the effects of excessive reliance on AI tools, including ChatGPT, Grammarly, and other generative AI platforms, on the development and maintenance of higher-order cognitive skills among university students. Employing a convergent parallel mixed-methods design, the research collected quantitative data from 312 undergraduate and graduate students across four universities in Uzbekistan through a purpose-designed questionnaire measuring AI usage patterns, cognitive engagement levels, and critical thinking dispositions. Additionally, qualitative data were gathered through semi-structured interviews with 28 purposively selected students and 16 faculty members.*

Keywords: *artificial intelligence, over-reliance, critical thinking, independent thinking, cognitive offloading, higher education, generative AI, ChatGPT, metacognition, Uzbekistan.*

The emergence of generative artificial intelligence tools, most notably OpenAI's ChatGPT, has fundamentally transformed the landscape of higher education. Since its public release in November 2022, ChatGPT and similar large language models have been rapidly adopted by students worldwide for a wide range of academic purposes, including essay writing, problem-solving, research assistance, language practice, and examination preparation. While these tools offer unprecedented convenience and accessibility, a growing body of research suggests that their uncritical and excessive use may have deleterious consequences for students' cognitive development, particularly in the domains of critical thinking and independent reasoning.

Critical thinking, broadly defined as the capacity to analyze, evaluate, synthesize, and create solutions through independent reasoning, represents a cornerstone of higher education and intellectual development. It encompasses the ability to question assumptions, evaluate evidence, recognize logical fallacies, identify biases, and formulate well-reasoned arguments.

Independent thinking, a closely related construct, refers to the capacity to generate original ideas, make autonomous judgments, and solve problems without undue reliance on external authorities or tools. Together, these cognitive competencies form the foundation of academic excellence, professional competence, and informed citizenship.

The concern about AI's impact on these competencies centers on the concept of cognitive offloading, a phenomenon wherein individuals delegate cognitive tasks to external tools rather than engaging their own mental faculties. When students routinely turn to AI for answers, summaries, analyses, and arguments, they may bypass the very cognitive processes through which critical thinking skills are developed and maintained. Research from MIT's Media Lab has demonstrated that students who extensively use AI assistants for writing tasks accumulate what

researchers term "cognitive debt," a measurable decline in the mental effort invested in analytical tasks over time. Similarly, a landmark study from the Wharton School found that generative AI can harm learning by promoting surface-level understanding and reducing the depth of cognitive engagement.

The Uzbekistan higher education context presents a particularly relevant setting for investigating this phenomenon. The country's education system is undergoing rapid digital transformation, with AI tools becoming increasingly accessible to students. However, the pedagogical infrastructure for guiding appropriate AI use, including instructor training, institutional policies, and curricular frameworks, has not kept pace with technology adoption.

This gap creates conditions in which students may adopt AI tools without the metacognitive awareness necessary to use them productively, potentially exacerbating the risk of cognitive dependency.

LITERATURE REVIEW. Cognitive offloading refers to the process of using external tools or resources to reduce the cognitive demands of a task. While this phenomenon predates AI, with calculators and search engines representing earlier forms, generative AI represents a qualitative escalation in both the scope and sophistication of cognitive tasks that can be externalized. Risko and Gilbert (2016) established the theoretical foundations of cognitive offloading, demonstrating that when external tools are available, individuals consistently prefer to offload cognitive effort rather than engage internal mental resources, even when the task is well within their cognitive capacity.

In the context of AI in education, Zhai et al. (2024) conducted a systematic review examining the effects of over-reliance on AI dialogue systems on students' cognitive abilities.

Their analysis revealed that excessive dependence on AI tools was associated with declines in critical thinking, decision-making capacity, and analytical reasoning. Critically, the review identified that students who over-relied on AI often accepted AI-generated content without questioning its accuracy, coherence, or completeness, a behavior pattern that directly contradicts the evaluative orientation central to critical thinking.

Gerlich (2025) provided further empirical evidence through a mixed-methods study of 666 participants, finding that frequent reliance on AI tools negatively affected critical thinking abilities primarily through the mechanism of cognitive offloading. The study revealed a particularly concerning pattern among younger individuals aged 17-25, who exhibited higher AI dependence and correspondingly greater susceptibility to cognitive offloading effects.

Importantly, higher education itself was found to serve as a protective buffer against these effects, suggesting that the educational environment, when properly designed, can mitigate AI-related cognitive risks.

The relationship between AI and critical thinking is not unidirectional. Several researchers have argued that AI tools, when used strategically, can serve as "cognitive mediators" that stimulate processes of analysis, argumentation, and reflection. Vasconcelos and dos Santos (2023) demonstrated that structured interactions with AI chatbots could prompt students to evaluate arguments, identify weaknesses in reasoning, and develop counterarguments, all of which are core components of critical thinking. Similarly, Darwin et al. (2024) found that when students were explicitly instructed to critically evaluate AI-generated content rather than passively accept it, the AI interaction enhanced rather than diminished their analytical capabilities.

However, the weight of current evidence suggests that without deliberate pedagogical intervention, the default pattern of student-AI interaction tends toward uncritical acceptance.

Stadler, Bannert, and Sailer (2024) demonstrated that while large language models reduced mental effort during scientific inquiry tasks, this reduction came at the cost of depth in student analysis. Their study found that students using AI assistants produced work that was superficially adequate but lacked the analytical rigor and original insight characteristic of deep learning. The authors introduced the concept of "cognitive ease at a cost," describing the trade-off between the convenience of AI-assisted work and the cognitive development opportunities foregone.

A Microsoft research study (Lee et al., 2025) focusing on knowledge workers found that higher confidence in generative AI's ability to perform tasks was inversely correlated with critical thinking effort. This finding suggests an attitudinal mechanism underlying over-reliance: as users develop greater trust in AI capabilities, their motivation to invest cognitive effort in independent analysis diminishes. In educational contexts, this trust-effort dynamic is particularly concerning because students, as developing thinkers, may lack the metacognitive awareness to recognize when their critical engagement is declining.

Independent thinking, understood as the capacity for autonomous intellectual engagement, is closely linked to but distinct from critical thinking. While critical thinking emphasizes evaluative processes, independent thinking encompasses the broader capacity for original thought, self-directed inquiry, and intellectual courage. Theoretical frameworks from Dewey (1933), who argued that genuine thinking begins with a felt difficulty that prompts inquiry, through Freire (1970), who emphasized the role of problem-posing education in developing critical consciousness, converge on the principle that cognitive struggle is essential for intellectual growth.

The availability of AI tools that can instantly resolve cognitive difficulties raises fundamental questions about the conditions under which independent thinking develops. Bastani et al. (2024) at the Wharton School conducted a rigorous experimental study demonstrating that students who used generative AI as a learning aid performed worse on subsequent assessments compared to those who studied without AI assistance. The researchers attributed this effect to the removal of productive struggle from the learning process, as students who could immediately access AI-generated solutions had fewer opportunities to develop the persistence, resilience, and problem-solving strategies that characterize independent thinkers.

This study integrates three theoretical perspectives to examine the cognitive impact of AI over-reliance. First, Bloom's Revised Taxonomy provides a framework for understanding the hierarchical nature of cognitive skills, from lower-order processes such as remembering and understanding to higher-order processes such as analyzing, evaluating, and creating. The hypothesis is that AI over-reliance primarily affects the development of higher-order cognitive skills by allowing students to bypass the analytical and evaluative processes that characterize deep learning.

METHODOLOGY. This study employed a convergent parallel mixed-methods design, collecting quantitative and qualitative data simultaneously and integrating findings during interpretation. This design was chosen for its capacity to provide complementary perspectives on the complex cognitive and behavioral phenomena under investigation.

The quantitative strand measured the statistical relationships between AI usage patterns and cognitive skill indicators, while the qualitative strand explored the subjective experiences, motivations, and perceptions that underlie these statistical patterns.

The quantitative phase involved 312 students from four universities in Uzbekistan, including two national universities in Tashkent and two state universities in Bukhara and Samarkand. Stratified random sampling ensured representation across academic levels (undergraduate and graduate), disciplines (humanities, social sciences, STEM, and economics), and year of study. The sample comprised 189 (60.6%) female and 123 (39.4%) male participants, with ages ranging from 18 to 32 years ($M = 22.4$, $SD = 3.1$). All participants reported regular use of at least one AI tool for academic purposes.

For the qualitative phase, 28 students were purposively selected based on their AI usage profiles, representing high-frequency users ($n = 10$), moderate users ($n = 10$), and low-frequency users ($n = 8$). Additionally, 16 faculty members across the four institutions participated in interviews to provide an instructional perspective on observed changes in student cognitive behavior.

Table 1. Participant Demographics ($N = 312$)

Variable	Category	n	%	M (SD)
Gender	Female	189	60.6	-
	Male	123	39.4	-
Age (years)	18-21	148	47.4	22.4 (3.1)
	22-25	112	35.9	-
	26-32	52	16.7	-
Academic Level	Undergraduate	224	71.8	-
	Graduate	88	28.2	-
Discipline	Humanities	86	27.6	-
	Social Sciences	78	25.0	-
	STEM	84	26.9	-
	Economics	64	20.5	-
AI Usage Frequency	Daily	124	39.7	-
	Several/week	118	37.8	-
	Occasionally	70	22.5	-

Three validated instruments were adapted and combined into a comprehensive questionnaire. The AI Usage Patterns Scale (AUPS), developed for this study based on existing technology use scales, measured the frequency, purpose, and nature of AI tool engagement across 15 items. The Critical Thinking Disposition Inventory (CTDI), adapted from Facione et al.'s (1995) California Critical Thinking Disposition Inventory, assessed seven dimensions of critical thinking disposition: truth-seeking, open-mindedness, analyticity, systematicity, self-confidence in reasoning, inquisitiveness, and cognitive maturity (28 items).

The Independent Problem-Solving Self-Efficacy Scale (IPSES), adapted from Bandura's (1997) self-efficacy scales, measured students' confidence in their ability to solve academic problems without external assistance (10 items). Additionally, a Metacognitive Awareness Inventory (MAI), based on Schraw and Dennison's (1994) instrument, assessed students' knowledge and regulation of their own cognitive processes (12 items). All scales used 5-point Likert-type response formats. Cronbach's alpha coefficients for the four scales were .89, .92, .87, and .91 respectively.

The semi-structured interview protocol comprised 18 questions organized around four thematic areas: AI usage patterns and motivations, perceived cognitive effects, changes in academic behavior, and strategies for balanced AI engagement. Interviews lasted 45-65 minutes and were conducted in the language preferred by participants.

RESULTS. Descriptive analysis revealed that 77.5% of participants used AI tools at least several times per week, with 39.7% reporting daily use. ChatGPT was the most commonly used tool (91.3%), followed by Grammarly (67.4%), Google Bard/Gemini (48.1%), and DeepSeek (29.5%). The primary purposes for AI use were: completing written assignments (84.6%), translating and paraphrasing (76.9%), finding information for research tasks (71.2%), solving mathematical and logical problems (54.5%), and preparing for examinations (43.3%).

A critical finding was that 62.8% of participants reported frequently accepting AI-generated content with minimal or no modification, while only 18.3% reported consistently evaluating and substantially revising AI output before incorporating it into their work. This pattern of uncritical acceptance represents a key behavioral indicator of over-reliance.

Table 2. Correlation Matrix for Key Variables (N = 312)

Variable	1	2	3	4
1. AI Usage Frequency	1.00			
2. Critical Thinking Disposition	-.47**	1.00		
3. Problem-Solving Self-Efficacy	-.39**	.64**	1.00	
4. Metacognitive Awareness	-.42**	.71**	.58**	1.00

Note. ** $p < .001$

All three cognitive variables showed significant negative correlations with AI usage frequency. The strongest negative correlation was observed between AI usage and critical thinking disposition ($r = -.47, p < .001$), followed by metacognitive awareness ($r = -.42, p < .001$) and independent problem-solving self-efficacy ($r = -.39, p < .001$). Among the critical thinking sub-dimensions, truth-seeking ($r = -.51, p < .001$) and analyticity ($r = -.49, p < .001$) showed the strongest negative associations with high-frequency AI use.

5. DISCUSSION

The findings of this study contribute to the growing body of evidence that excessive reliance on AI tools poses a measurable risk to the development and maintenance of critical thinking and independent thinking skills in higher education. The significant negative correlations between AI usage frequency and all three cognitive variables, together with the SEM results identifying cognitive offloading as the primary mediating mechanism, provide empirical support for the theoretical concerns that have been articulated in recent literature.

The cognitive offloading pathway identified in this study aligns with and extends the findings of Gerlich (2025) and Zhai et al. (2024). When students habitually delegate analytical and evaluative tasks to AI systems, they progressively disengage from the effortful cognitive processes through which critical thinking competencies are developed. From the perspective of Bloom's Taxonomy, AI over-reliance appears to concentrate student cognitive activity at the lower levels of the hierarchy, specifically remembering and understanding AI-generated content, while higher-order processes of analyzing, evaluating, and creating are increasingly outsourced to the AI system.

CONCLUSION. This study has provided comprehensive empirical evidence that over-reliance on AI tools poses significant risks to the development of critical thinking and independent thinking skills among higher education students in Uzbekistan. Through structural equation modeling, the study identified cognitive offloading and diminished metacognitive awareness as the primary mechanisms through which excessive AI use undermines higher-order cognitive development. The qualitative findings enriched this picture by revealing the subjective experiences of diminished analytical effort, eroded intellectual confidence, dependency formation, loss of deep learning engagement, and atrophied argumentation skills.

However, the identification of strategic AI users who maintain robust critical thinking despite frequent AI engagement provides grounds for cautious optimism. The critical difference lies not in whether AI is used but in how it is used. When students approach AI as a critical dialogue partner rather than an answer generator, and when they maintain preliminary independent thinking before consulting AI, the technology can complement rather than compromise cognitive development. This finding shifts the educational imperative from restricting AI access to developing the metacognitive and critical dispositions that enable productive engagement.

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