WHEN AI DOES THE THINKING: AI TOOL DEPENDENCY, COGNITIVE OFFLOADING, AND CRITICAL THINKING SELF-EFFICACY IN INDIAN HIGHER EDUCATION, A CONCEPTUAL FRAMEWORK

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ABSTRACT

Purpose: This paper examines the cognitive consequences of habitual AI tool dependency among university students in India. Specifically, it investigates how AI tool usage frequency leads to AI dependency, how dependency reduces critical thinking self-efficacy through the mediating mechanism of cognitive offloading, and how AI literacy and AI risk awareness may moderate these relationships.

Design and Methodology: This is a conceptual paper. A theoretical framework is developed by integrating three established theories: Cognitive Load Theory (Sweller, 1988), Cognitive Offloading Theory (Risko and Gilbert, 2016), and the Technology Acceptance Model (Davis, 1989). The framework is supported by a critical synthesis of five published empirical studies.

Findings: Six theoretically grounded hypotheses are proposed. The framework identifies cognitive offloading tendency as the mediating mechanism through which AI dependency reduces critical thinking self-efficacy. AI literacy and AI risk awareness are introduced as moderating variables. A moderated mediation hypothesis is developed following Preacher, Rucker and Hayes (2007).

Originality and Value: To the best of the researcher's knowledge, no published study has tested this integrated framework among university students in India. This paper contributes a theoretically grounded model and identifies two trainable protective factors that may inform evidence-based AI governance in Indian higher education.

Keywords: *AI dependency; cognitive offloading; critical thinking self-efficacy; generative AI; higher education; AI literacy; AI risk awareness; Cognitive Load Theory; Technology Acceptance Model; India*

1. INTRODUCTION

AI tools have been rapidly adopted across various sectors around the globe, and the education system is one of the sectors that has been most significantly transformed. With this rapid adoption, AI tools have entered educational institutions and classrooms, transforming the way students interact with their studies.

According to a global survey conducted by the Digital Education Council (2024), which covered sixteen countries and included 3,839 students, 86 percent of students are now using AI tools for academic purposes. Among these tools, ChatGPT was found to be the most widely used, cited by

66 percent of respondents. In India, the adoption has been even faster. AICTE declared 2025 as the Year of Artificial Intelligence and is integrating AI tools across 14,000 schools, colleges, and universities, serving approximately 40 million students (AICTE, 2025).

Students are increasingly delegating academic tasks to AI tools, writing assignments, summarising readings, and generating ideas, rather than engaging in these cognitive activities independently. As they delegate tasks that are intended to develop their cognitive capabilities, they stop practising the associated skills. Over time, as these skills are not exercised, the ability to think independently and critically may gradually weaken.

As this rapid adoption is taking place, one important question remains underexplored. While AI tools clearly offer productivity and learning support benefits, what are the cognitive consequences of habitual AI tool dependency for students' critical thinking ability? Educational institutions are fundamentally intended to develop the critical thinking capacity of students. The question of what habitual AI dependency does to that capacity is important and has received insufficient empirical attention, particularly in the Indian higher education context.

Five empirical studies published in 2025 provide converging evidence on this question. Gerlich (2025) surveyed 666 participants in the United Kingdom and found a strong negative correlation between AI usage frequency and critical thinking scores ($r = -0.68$). Lee, Sarkar, Tankelevitch, Drosos, Rintel, Banks and Wilson (2025) found that AI confidence negatively correlated with critical thinking enaction among 319 knowledge workers (beta = -0.69, $p < 0.001$). Yang, Xu and colleagues (2025) found that AI dependency significantly increased cognitive inertia among 1,032 Chinese university students (beta = 0.570, $p < 0.001$). Bastani, Bastani, Sungu, Ge, Kabakci and Mariman (2025) demonstrated experimentally that students with unrestricted AI access performed 17 percent worse on unassisted examinations. Zhang, Li and colleagues (2025) confirmed similar findings among 580 Chinese students, with cognitive fatigue as a mediating variable. All five studies point in the same direction: AI dependency is negatively associated with critical thinking ability. However, none of these studies was conducted in India.

India has a different socio-cultural and educational context from the UK, Turkey, and China. Indian higher education is traditionally examination-focused, with limited formal integration of critical thinking in curricula. AI tools are being adopted rapidly across Indian institutions without established regulatory frameworks governing their cognitive consequences. To the best of the researcher's knowledge, no published empirical study has tested the relationship between AI dependency and critical thinking self-efficacy among Indian university students. This paper addresses that gap.

This paper proposes a theoretical framework explaining how AI tool usage frequency leads to AI dependency, and how dependency affects critical thinking self-efficacy through cognitive offloading as a mediating variable. Two moderating variables, AI literacy and AI risk awareness,

are identified as potential protective factors. Six theoretically grounded hypotheses are developed, and a moderated mediation model is proposed following Preacher, Rucker and Hayes (2007). The framework will be tested empirically in a subsequent quantitative study.

The remainder of this paper is structured as follows. Section 2 reviews the relevant empirical and theoretical literature. Section 3 presents the integrated theoretical framework and proposed research model. Section 4 develops the research hypotheses. Section 5 discusses theoretical, policy, and practical implications. Section 6 concludes the paper.

2. LITERATURE REVIEW

2.1 AI Dependency: Definition and Conceptualization

AI dependency, in the academic context, refers to a pattern of excessive and habitual reliance on AI tools for completing academic tasks, to the extent that students experience difficulty, anxiety, or an inability to function effectively without them (Morales-Garcia, Sairitupa-Sanchez, Morales-Garcia and Morales-Garcia, 2024). This is conceptually distinct from self-regulated AI use, in which students employ AI tools as a supplement to their own independent cognitive effort rather than as a substitute for it.

A self-regulated student uses AI tools to a limited extent, maintains control over their usage, and is able to function independently when AI tools are unavailable. A dependent student, by contrast, finds it difficult, anxious, or impossible to complete academic tasks without AI assistance. The critical distinction lies in the degree to which the student retains independent cognitive functioning.

Morales-Garcia et al. (2024) developed and validated the Dependency on AI Scale (DAI Scale) among university students in Peru, identifying three dimensions of dependency: behavioural, emotional, and cognitive. These instruments provide a psychometric basis for measuring AI dependency as a multidimensional latent construct.

The Technology Acceptance Model (TAM; Davis, 1989) provides a theoretical explanation for how AI dependency develops. TAM proposes that perceived usefulness and perceived ease of use drive technology adoption. Generative AI tools score highly on both dimensions for academic tasks. Without deliberate self-regulation, repeated adoption becomes habitual, and habitual usage transitions into dependency. Yang et al. (2025) confirmed empirically that AI usage frequency significantly predicted AI dependency among university students.

2.2 Cognitive Offloading as a Mediating Mechanism

Cognitive offloading refers to the use of physical or digital tools to reduce the cognitive demands placed on the internal processing system (Risko and Gilbert, 2016). While cognitive offloading is adaptive in everyday contexts, writing a list to reduce memory demands, for example, the concern

in the AI context is that students habitually offload higher-order academic cognitive tasks, constructing arguments, analysing evidence, generating ideas, and reasoning through complex problems, to AI tools. As these tasks are delegated rather than practised independently, the associated cognitive capabilities may weaken over time through disuse.

Cognitive Load Theory (Sweller, 1988; Sweller, van Merrienboer and Paas, 2019) provides the theoretical mechanism. The theory distinguishes germane cognitive load, the productive effort that supports schema formation and long-term skill development, from extraneous load, which does not contribute to learning. When AI tools consistently perform cognitive tasks on behalf of students, the germane cognitive load that would otherwise drive schema formation is reduced. Over time, without schema formation, critical thinking skills may fail to develop or may weaken through inactivity.

Empirical support for this mediating mechanism is growing. Zhai, Wibowo and Li (2024) conducted a systematic review and found that over-reliance on AI dialogue systems was associated with declines in higher-order cognitive abilities, including critical thinking. Zhang et al. (2025) confirmed cognitive fatigue as a mediating variable in the AI dependency to critical thinking relationship among 580 Chinese university students. Yang et al. (2025) identified cognitive inertia, the tendency to cease engaging in original thinking, as a consequence of AI dependency among 1,032 Chinese students.

2.3 AI Literacy and AI Risk Awareness as Protective Moderators

Not all students who use AI tools frequently develop dependency. Individual differences in AI literacy and AI risk awareness may function as protective moderating factors that reduce the negative effects of AI dependency on critical thinking.

AI literacy is defined as the knowledge, skills, and attitudes that enable individuals to understand how AI tools work, evaluate AI-generated content critically, and use AI tools responsibly (Wang, Rau and Yuan, 2022). Wang et al. (2022) developed and validated the Artificial Intelligence Literacy Scale (AILS) among university students, identifying four dimensions: awareness, usage, evaluation, and ethics. Students with higher AI literacy do not accept AI output uncritically, they evaluate it, question it, and supplement it with their own thinking. This critical engagement makes them less likely to develop habitual dependency even when they use AI tools frequently.

AI risk awareness, as conceptualised in this paper, refers to a student's awareness of the specific cognitive risks associated with excessive AI tool dependency, particularly the risk of reduced independent thinking and critical thinking capacity over time. Students who are aware of these risks are more motivated to maintain deliberate cognitive engagement even when AI tools are available, preserving the habit of independent thinking. Gerlich (2025) noted that awareness of AI

tool limitations was associated with more self-regulated usage patterns, providing empirical support for the protective role of risk awareness.

2.4 Research Gap

The five studies reviewed confirm a consistent negative association between AI tool dependency and critical thinking outcomes. However, all five were conducted outside India. India has distinctive features that may intensify the cognitive consequences of AI dependency: a long tradition of examination-focused pedagogy with limited formal integration of critical thinking in curricula; rapid AI adoption without institutional guidance or regulatory frameworks; and an absence of published empirical studies establishing the cognitive consequences of AI dependency among Indian students.

Furthermore, no published study has proposed or tested an integrated structural model incorporating mediation, moderation, and moderated mediation simultaneously in this context. This paper addresses both gaps by proposing a theoretically grounded integrated framework for testing in Indian higher education.

3. THEORETICAL FRAMEWORK AND PROPOSED RESEARCH MODEL

3.1 Technology Acceptance Model

The Technology Acceptance Model (TAM; Davis, 1989) explains how and why people adopt and continue using technology. TAM proposes that perceived usefulness and perceived ease of use are the primary antecedents of technology acceptance. For generative AI tools, students clearly perceive both high usefulness and ease of use in academic tasks. Without deliberate self-regulation, this repeated adoption becomes habitual, and habitual usage transitions into dependency. In the Indian higher education context, where examination pressure is high and cognitive shortcuts are attractive, the transition from use to dependency may be particularly rapid. TAM is used in this framework to explain H1 (how GenAI usage frequency leads to AI dependency) and H4 (how AI literacy moderates this relationship). Students with higher AI literacy evaluate the perceived usefulness of AI tools more critically, making them less likely to adopt AI tools in an uncritical and habitual manner (Wang et al., 2022).

3.2 Cognitive Load Theory

Cognitive Load Theory (CLT; Sweller, 1988; Sweller et al., 2019) explains why AI dependency may reduce critical thinking self-efficacy. CLT proposes that schema formation, the cognitive process through which students develop expertise and complex skills such as critical thinking, requires effortful cognitive engagement, specifically germane cognitive load. When AI tools consistently perform cognitive tasks on behalf of students, this productive effort is removed, and

schema formation may be impaired. In the Indian context, where rote learning is prevalent and critical thinking is not systematically cultivated, the added removal of cognitive effort through AI dependency may compound existing limitations. Students with higher AI risk awareness are hypothesised to maintain deliberate cognitive effort even when AI tools are available, preserving the conditions for schema formation. CLT is used to explain H2, H3, H5, and H6.

3.3 Cognitive Offloading Theory

Cognitive Offloading Theory (Risko and Gilbert, 2016) explains the mediating mechanism through which AI dependency affects critical thinking. The theory proposes that habitual delegation of cognitive tasks to external tools reduces internal processing. In the AI context, students who are dependent on AI tools habitually offload reasoning, analytical, and argumentative tasks. They stop practising these skills independently. Over time, as these skills are not exercised, they weaken through disuse. In Indian universities, where assessments often permit AI tool access without guidelines on appropriate use, the risk of habitual offloading without awareness is particularly acute. This is the mediating mechanism proposed in H3 of this framework.

3.4 Proposed Research Model

The proposed research model integrates the three theoretical frameworks above. GenAI usage frequency positively predicts AI dependency (H1, grounded in TAM). AI dependency negatively affects critical thinking self-efficacy directly (H2, grounded in CLT) and indirectly through cognitive offloading tendency as a mediating variable (H3, grounded in Cognitive Offloading Theory). AI literacy moderates the H1 relationship (H4, grounded in TAM). AI risk awareness moderates the H2 relationship (H5, grounded in CLT) and also moderates the indirect H3 pathway, the moderated mediation hypothesis (H6, grounded in CLT and Cognitive Offloading Theory).

4. RESEARCH HYPOTHESES

H1: GenAI Usage Frequency and AI Dependency

Frequent usage of AI tools for academic tasks, when not accompanied by deliberate self-regulation, is expected to transition into habitual dependency over time. As students use AI tools for writing, summarising, problem-solving, and reasoning on a regular basis, their reliance on these tools increases and their confidence in completing the same tasks independently may diminish. Yang et al. (2025) confirmed this relationship empirically among 1,032 Chinese university students. TAM explains it theoretically, repeated adoption driven by perceived usefulness and ease of use becomes habitual without effortful self-regulation. Therefore:

H1: GenAI tool usage frequency is positively associated with AI dependency among university students.

H2: AI Dependency and Critical Thinking Self-Efficacy

Critical thinking self-efficacy refers to a student's confidence in their own ability to engage in critical thinking independently, including analysing arguments, evaluating evidence, forming independent opinions, and reasoning without external assistance. Habitual AI dependency may reduce this self-efficacy over time, as students increasingly rely on AI rather than developing and exercising their own cognitive capabilities. Gerlich (2025) found $r = -0.68$ between AI usage and critical thinking scores. Lee et al. (2025) found beta = -0.69 ($p < 0.001$) for the relationship between AI confidence and critical thinking enaction. CLT explains this theoretically, AI dependency reduces the germane cognitive load that drives schema formation. Therefore:

H2: AI dependency is negatively associated with critical thinking self-efficacy among university students.

H3: Cognitive Offloading as Mediating Variable

The relationship between AI dependency and reduced critical thinking self-efficacy is not proposed to be direct alone. Rather, cognitive offloading tendency is proposed as the mediating mechanism. When students are dependent on AI tools, they habitually offload cognitive tasks, summarising, reasoning, arguing, and analysing, to AI rather than engaging with these tasks independently. Over time, as they stop practising these skills themselves, their critical thinking self-efficacy declines. Cognitive Offloading Theory (Risko and Gilbert, 2016) provides the theoretical foundation for this mechanism. Zhang et al. (2025) confirmed a similar mediated pathway in the Chinese context. Therefore:

H3: Cognitive offloading tendency mediates the relationship between AI dependency and critical thinking self-efficacy.

H4: AI Literacy as Moderating Variable

Students with higher AI literacy, the knowledge, skills, and attitudes to understand AI, evaluate AI outputs critically, and use AI responsibly (Wang et al., 2022), are less likely to develop habitual dependency even when they use AI tools frequently. Their literacy enables them to evaluate AI outputs rather than accepting them uncritically, reducing the risk of habitual dependency formation. Within TAM, AI literacy functions as a boundary condition: students with higher AI literacy apply more critical evaluation of perceived usefulness, moderating the H1 relationship. Therefore:

H4: AI literacy moderates H1, such that the positive effect of GenAI usage frequency on AI dependency is weaker for students with higher AI literacy.

H5: AI Risk Awareness as Moderating Variable

Students who are aware of the cognitive risks associated with AI dependency, specifically, the risk of reduced independent thinking and critical thinking capacity, are more likely to engage in deliberate self-regulation of their AI usage. This awareness motivates students to maintain independent cognitive engagement even when AI tools are available, thereby reducing the negative effect of dependency on critical thinking self-efficacy. Gerlich (2025) noted that awareness of AI tool limitations was associated with more self-regulated usage. CLT supports this: risk awareness helps students preserve germane cognitive load. Therefore:

H5: AI risk awareness moderates H2, such that the negative effect of AI dependency on critical thinking self-efficacy is smaller for students with higher AI risk awareness.

H6: Moderated Mediation

H6 extends the moderation proposed in H5 to the indirect pathway. It is proposed that AI risk awareness moderates not only the direct H2 relationship but also the H3 indirect pathway, the cognitive offloading mechanism itself. Students with higher AI risk awareness are not only less directly affected by the negative consequences of dependency; they are also less likely to engage in automatic cognitive offloading in the first place. This means that the mediating mechanism through which AI dependency reduces critical thinking, the H3 pathway, is weaker for students with higher AI risk awareness. This moderated mediation hypothesis follows the framework established by Preacher, Rucker and Hayes (2007). Therefore:

H6: The indirect effect of AI dependency on critical thinking self-efficacy through cognitive offloading tendency is moderated by AI risk awareness, such that the indirect effect is weaker for students with higher AI risk awareness (moderated mediation).

Table 1: Summary of Research Hypotheses

Hypothesis	Statement	Theoretical Basis	Direction
H1	GenAI usage frequency is positively associated with AI dependency.	TAM, Davis (1989)	Positive (+)
H2	AI dependency is negatively associated with critical thinking self-efficacy.	CLT, Sweller (1988)	Negative (-)
H3 (Mediation)	Cognitive offloading mediates the AI dependency to critical thinking SE relationship.	Risko and Gilbert (2016)	Indirect (-)

H4 (Moderation)	AI literacy moderates H1, the positive effect is weaker for students with higher AI literacy.	TAM; Wang et al. (2022)	Buffering
H5 (Moderation)	AI risk awareness moderates H2, the negative effect is smaller for students with higher AI risk awareness.	CLT; Gerlich (2025)	Buffering
H6 (Mod. Med.)	The indirect H3 effect is moderated by AI risk awareness, weaker for students with higher AI risk awareness.	Preacher et al. (2007)	Conditional Indirect

Source: Developed by the author. CLT = Cognitive Load Theory; SE = Self-Efficacy; Mod. Med. = Moderated Mediation.

5. IMPLICATIONS AND CONTRIBUTIONS

5.1 Theoretical Contributions

This paper makes four theoretical contributions. First, to the best of the researcher's knowledge, it proposes an integrated conceptual model connecting GenAI usage frequency, AI dependency, cognitive offloading tendency, and critical thinking self-efficacy in a single framework, a combination that has not been previously tested in the Indian higher education context. Second, it introduces AI literacy and AI risk awareness as theoretically grounded moderating variables with distinct theoretical bases: AI literacy within TAM and AI risk awareness within CLT. Both are trainable competencies rather than fixed personal traits. Third, the moderated mediation model (H6) proposes that AI risk awareness may weaken not only the direct negative effect of dependency but also the cognitive offloading mechanism itself, a theoretically novel contribution to the AI dependency literature. Fourth, it extends existing research from Western and East Asian contexts to Indian higher education, where distinctive pedagogical and regulatory features may amplify the proposed effects.

5.2 Policy and Educational Implications

For AICTE and UGC, this paper provides a theoretical basis for developing evidence-based AI governance guidelines before further large-scale AI integration in Indian higher education. India is integrating AI tools across approximately 40 million students without a comprehensive cognitive

risk evidence base (AICTE, 2025). The proposed framework suggests that AI literacy should be a prerequisite rather than an afterthought in AI integration policy.

For university educators, the key implication is to design assessments that preserve independent cognitive engagement alongside AI-permitted tasks. Students should be given regular practice in unassisted tasks, writing, arguing, and analysing without AI tools, so that the associated cognitive schemas continue to be exercised. Student-facing communications that raise awareness of the cognitive risks of AI dependency may also activate the self-regulatory mechanisms proposed in H5 and H6.

5.3 Proposed Methodology for Empirical Validation

This framework will be tested empirically using a quantitative cross-sectional survey design. Data will be collected from graduate, postgraduate, MPhil, and PhD students enrolled at higher education institutions in Hyderabad, India, who actively use generative AI tools for academic purposes. A target sample of 350 respondents will be recruited using purposive and snowball sampling, consistent with the minimum sample size derived from the indicator count (Hair, Black, Babin and Anderson, 2014).

AI dependency will be measured using items adapted from Morales-Garcia et al. (2024). Critical thinking self-efficacy will be measured using items adapted from Sosu (2013) and Fu, Lin, Hwang and Zhang (2023). Cognitive offloading tendency will be measured using items adapted from Risko and Gilbert (2016). AI literacy will be measured using the Artificial Intelligence Literacy Scale developed by Wang et al. (2022). AI risk awareness items will be developed and subjected to content validity review prior to data collection, with a Content Validity Ratio threshold of 0.62 (Lawshe, 1975).

Analysis will proceed in stages: confirmatory factor analysis using IBM AMOS v26, with fit criteria of CFI greater than or equal to 0.95, TLI greater than or equal to 0.95, RMSEA less than or equal to 0.08, and SRMR less than or equal to 0.08 (Hair et al., 2014); structural equation modelling for H1 and H2; bootstrapped mediation analysis using PROCESS macro v4 for H3 (Hayes, 2018); moderation analysis for H4 and H5; and moderated mediation analysis using PROCESS macro v4 Model 14 for H6 (Preacher, Rucker and Hayes, 2007).

6. CONCLUSION

This paper began with an important but underexplored question: when students habitually delegate their cognitive tasks to AI tools, what are the consequences for their own critical thinking ability? Based on a review of five published empirical studies and three established theoretical frameworks, the proposed answer is that habitual AI dependency may reduce critical thinking self-efficacy through the mechanism of cognitive offloading.

Six theoretically grounded hypotheses were proposed. H1 and H2 address the core direct relationships. H3 introduces cognitive offloading tendency as the mediating mechanism. H4 and H5 introduce AI literacy and AI risk awareness as protective moderating variables. H6 proposes a moderated mediation model in which AI risk awareness weakens the cognitive offloading mechanism itself.

Several limitations of this paper should be noted. As a conceptual paper, all proposed hypotheses require empirical validation. This paper does not claim that AI tool usage is inherently harmful, AI tools clearly offer significant productivity and learning support benefits. The concern is specifically about habitual, unregulated dependency that substitutes for independent cognitive effort.

Future research should empirically validate this framework among Indian university students using SEM, conduct longitudinal studies to track critical thinking development over time, and experimentally test whether AI literacy and AI risk awareness training effectively reduce AI dependency and improve critical thinking outcomes.

The central argument of this paper is not that students should cease using AI tools. It is that how students engage with AI tools, with self-regulation, critical evaluation, and awareness of cognitive risks, matters considerably for their long-term cognitive development. Educational institutions and policymakers have a role in ensuring that AI tools augment rather than replace independent human thinking.

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