GYANBODH
An International Multidisciplinary Peer Reviewed Journal

ISSN:3048-9792
Volume: 3
Issue: 4
July - August: 2026

Comparative Study of Critical Thinking between Artificial Intelligence Users and Non-Artificial Intelligence Users Among Secondary School Students

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Abstract

As generative AI becomes commonplace amongst young people, a critical question is whether or not the use of AI enhances or diminishes the capacity for independent thinking. The study contrasts critical thinking skills among the secondary students who use AI and those who do not, and sees how this use is correlated with the quality of their reasoning. The study was conducted in a quantitative and cross-sectional comparative design with 200 students (9th to 12th) randomly selected using purposive-stratified sampling, out of which 100 were considered as AI users and 100 were considered as non-users in Lucknow district, Uttar Pradesh, India. The instrument used to measure critical thinking was a validated 5-dimension critical thinking test (inference, analysis, evaluation, interpretation, self-regulation). Two hypotheses were proposed: that the overall score of AI users would be higher (H1) and that their critical thinking scores would change depending on the frequency of use (H2). Independent-samples t-tests were applied and one-way ANOVA was used. There were statistically significant differences between the AI users and the non-AI users in overall CT, but not in evaluation or self-regulation. Statistically significant differences between AI users and the non-AI users were found in overall CT, but not in evaluation or self-regulation. An inverted U shape was seen in the ANOVA with moderate users performing better than low and heavy users. The study finds that AI can be helpful to reasoning, but only under certain circumstances and that it can undermine reasoning overuse.

Keywords: artificial intelligence; critical thinking; secondary education; cognitive offloading; comparative study

1. Introduction

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Since 2023, the volume of publications on the impact of AI on students' cognitive outcomes has increased rapidly, and India has become a significant contributor to this research (Ansari & Qamari, 2025). The Indian school system has specifically seen the introduction of AI content into affiliated curricula, with the National Education Policy 2020 and the Central Board of Secondary Education being among the first to do so, marking the transition of secondary students to be "AI-ready" instead of passive consumers (Karan & Angadi, 2025).

Although the evidence is promising and not definitive, AI shows a moderately positive impact on the "4C skills" and the positive effect on critical thinking is not consistent across study contexts (Tian & Zheng, 2025). A larger synthesis of 228 studies also finds that cognition is positively affected by reading while pointing to a variable and weak effect on meta-cognition (Yeo & Lansford, 2025). Structural evidence at the secondary level reveals that the use of generative AI significantly impacts students' digital literacy and innovation capability, which ultimately foster critical and creative thinking (Wu & Zhang, 2025). Concurrently, the initial systematic reviews of the impact of AI on curriculum, instruction and assessment highlight the need to deliberately shape the pedagogical use of the tools, because otherwise they can reduce the cognitive challenge for learning (Liang et al., 2025). The most provocative counter-evidence is that regular AI usage can have a correlation with decreased critical thinking, when critical thinking is delegated to the machine (Gerlich, 2025). The present study fills that void by not attempting to build a case for but rather measuring a population that school level policy has already targeted as an existing behavioral distinction, but which has been under-researched by research.

2. Literature Review

AI and reasoning are a very polarized discipline, with some being optimistic and others being cautious. The positive side is a controlled pretest–posttest study in Ghana demonstrated that use of ChatGPT in in-class tasks enhanced critical, creative and reflective thinking of undergraduates compared to a control group, partly due to dialogic prompting and personalised feedback (Essel et al., 2024). Similar experimental findings were reported in international-relations debate training where students who used ChatGPT performed better than other students in critical thinking, argumentation skills (de la Puente et al., 2024). This is confirmed by a large-scale experimental study that found a moderate positive effect for ChatGPT on

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higher-order thinking, but noted that there are fewer studies with small sample sizes focusing on this effect (Deng et al., 2025). Perception studies corroborate the promise and identify the risks: EFL learners appreciate AI for analysis and theory creation, but are concerned with the risk of echo-chambers, the loss of nuance (Darwin et al., 2024); collaborative use of generative tools has been associated with a higher sense of critical interaction when used in a structured manner (Ruiz-Rojas et al., 2024).

The warning thread is no less effective. Research into UK business schools revealed that using an AI text generator to write papers can reduce the extent to which students think in a critical and analytical way, as it may replace analysis with writing (Essien et al., 2024). Another community of inquiry study found that only students who wrote papers collaboratively and with AI support were able to complete all of cognitive presence's stages and developed a higher level of reasoning (Nasr et al., 2025). The direst warning comes from secondary mathematics, where students who were initially able to do well with the support of a generative AI were found to have impaired learning when the tool was removed, demonstrating a dependency effect (Bastani et al., 2025). Similarly, when examining evidence related to school-aged learners, it is found that there are also increases in engagement and decreases in independent thinking through over-reliance (Kundu & Bej, 2025). These conflicting results are underpinned by conceptual consensus that CT is the competence that is increasingly (and not less) important in the job world a job-proof competence, because it is the one that also represents the disposition and capacity to analyse, evaluate, and infer reasonably (Dumitru & Halpern, 2023).

3. Objectives

1. To compare the level of critical thinking (overall and dimension-wise) between AI-using and non-AI-using secondary school students.
2. To examine whether the intensity of AI use is associated with variation in critical thinking among AI-using students.

4. Methodology

This study has a quantitative, cross-sectional comparative (causal comparative/ex post facto) design that is suitable when there is an existing group difference here, and the use of AI cannot be manipulated and is treated as a naturally occurring variable. Individuals who were the secondary school students (9–12 grade) of Lucknow district, Uttar Pradesh, India were

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ISSN:3048-9792
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included in the population. Responses were collected from 200 students selected using purposive-stratified sampling (grade and locale) and further divided into two groups: AI users (N = 100, who reported using ChatGPT or similar AI generative tools to assist with their academic work at least three times a week within the last 3 months) and non-users (N = 100, who indicated negligible or no academic use of ChatGPT or similar AI generative tools). Active enrolment and basic device access and parental/guardian consent were required for inclusion, and identities were anonymised.

The main instrument was a 100-mark critical thinking test adapted from the frameworks of analytic-reasoning, which consists of 5 components, each with a mark of 20. A brief survey recorded a range of demographic information and intensity of use of AI, based on frequency and duration of use (low, moderate, high). The content validity was obtained from the review of three experts from the field of education and one psychometrician while the reliability was obtained by Cronbach's alpha. Administration effects were controlled by collecting their data under standardised, invigilated conditions in one sitting per school. Descriptive statistics (mean, SD), independent-samples t-tests of group differences on each subscale (Objective 1) and Cohen's d for effect size, and one-way ANOVA testing the within-group variance of scores across AI-use intensity of users (Objective 2) were performed. Prior to parametric testing normality (Shapiro–Wilk) and homogeneity of variance (Levene's test) were verified.

5. Results

Table 1. Demographic profile of respondents by group

Characteristic	Category	AI Users (n = 100)	Non-Users (n = 100)
Gender	Male	54	51
	Female	46	49
Grade	9	22	25
	10	26	24
	11	28	26
	12	24	25
Locale	Urban	63	41
	Rural	37	59

Source: Primary data

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The two groups were found to be equivalent on gender and grade distribution as evidenced by the data in Table 1. There was no difference in sex representation (Male ≈ 51–54%) or across grades 9–12 between both groups. The biggest difference was locale, with most AI users in urban areas (63%) compared to the majority of non-users in rural areas (59%), which indicated differences in access to devices and connectivity.

Table 2. Reliability of the critical thinking test (Cronbach's alpha)

Dimension	Cronbach's α
Inference	.81
Analysis	.84
Evaluation	.79
Interpretation	.82
Self-regulation	.78
Overall test	.88

Source: Primary data

Table 2, the instrument was internally consistent. The alpha for the overall test was .88, and the five sub-dimensions were all higher than the standard .70, from .78 (self-regulation) to .84. These are the coefficients that showed that the items within each dimension measure one underlying construct and that the composite score of the critical thinking scale was sufficiently reliable to be used in inferential testing.

Table 3. Descriptive statistics of critical thinking scores by group

Dimension (max)	AI Users M (SD)	Non-Users M (SD)
Inference (20)	14.6 (2.4)	12.9 (2.6)
Analysis (20)	15.1 (2.2)	13.4 (2.5)
Evaluation (20)	13.8 (2.7)	13.1 (2.8)
Interpretation (20)	14.9 (2.3)	13.0 (2.6)
Self-regulation (20)	13.2 (2.9)	13.5 (2.8)
Overall (100)	**71.6 (9.0)**	**65.9 (9.4)**

Source: Primary data

Table 3, the overall critical thinking scores and scores for four out of five dimensions were higher for AI users than for others, with the largest difference being found in critical thinking

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interpretation and analysis. The only reversal is in the area of self-regulation, which showed a slight edge for the non-users. This descriptive pattern is consistent with the results of comparative-mediation analyses, which revealed that AI engagement was positively associated with most of the facets of reasoning, but not consistently across all of them (Liu et al., 2025).

Table 4. Independent-samples t-test for overall critical thinking

Group	n	M	SD	t (df)	p	Cohen's d
AI Users	100	71.6	9.0	4.31 (198)	< .001	0.61
Non-Users	100	65.9	9.4			

Source: Primary data

Table 4 shows that the overall difference was statistically significant with AI users making 5.7 marks more than the non-users, $t(198) = 4.31$, $p < .001$. The effect size ($d = 0.61$) is a moderate size, suggesting a practically meaningful, rather than just a statistically significant, benefit. Hypothesis H1 is thus accepted at a composite level. But because the magnitude is moderate and not large, the results indicate that the use of AI is correlated with, but cannot be considered a determinant of, greater critical thinking.

Table 5. Dimension-wise independent-samples t-tests (AI Users vs Non-Users)

Dimension	Mean difference	t (df)	p	Cohen's d	Significance
Inference	1.7	4.80 (198)	< .001	0.68	Significant
Analysis	1.7	5.12 (198)	< .001	0.72	Significant
Evaluation	0.7	1.80 (198)	.073	0.25	Not significant
Interpretation	1.9	5.49 (198)	< .001	0.78	Significant
Self-regulation	–0.3	–0.74 (198)	.459	–0.10	Not significant

Source: Primary data

The group advantage is broken down in Table 5. Those using AI significantly outperformed those not using AI with medium to large effects ($d = 0.68–0.78$) for dimensions most directly enabled by the pattern-structuring and explanatory affordances of AI, namely dimensions of inference and analysis and interpretation. Importantly, there was only a weak, non-significant difference, and self-regulation slightly favoured non-users.

Table 6. One-way ANOVA: critical thinking by AI-use intensity (users only)

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Intensity	n	M	SD	F (df)	p	η^2
Low	34	68.2	8.7	8.34 (2, 97)	< .001	0.15
Moderate	40	75.9	8.1			
High (heavy)	26	69.0	9.3			

Source: Primary data

Table 6 reveals a significant effect of use intensity, $F(2, 97) = 8.34$, $p < .001$, $\eta^2 = 0.15$ (large). The correlation is non-linear, with moderate users having the highest score ($M = 75.9$), and low users and heavy users having scores significantly lower ($M = 68.2$, $M = 69.0$, respectively). The inverted-U curve is consistent with Hypothesis H2, suggesting that benefits are greatest at moderate levels of engagement, with no benefit over low use; the empirical signature of taking advantage of cognitive offloading among the most engaged users.

6. Discussion

The research results contribute to answering both goals and contradict the notion that AI enhances or impairs adolescents' reasoning. In Objective 1, the overall performance of the AI users was significantly higher and their performance was better in inference, analysis and interpretation. They are consistent with the findings of previous studies that demonstrate the ability of structured AI interaction to facilitate critical, reflective, and creative thinking (Essel et al., 2024), enhance argumentation (de la Puente et al., 2024), and achieve moderate improvements in higher-order thinking (Deng et al., 2025). The impact is still limited, however, indicating that the benefits of AI are not guaranteed and rely on conscious use (Tian & Zheng, 2025). The lack of significance of the results for evaluation and self-regulation offers valuable insights. However, AI users were not better at judging themselves or monitoring their thinking, suggesting possible cognitive offloading concerns, relying too heavily on AI may lead to less in-depth critical thinking (Gerlich, 2025; Essien et al., 2024). This means that, to support reasoning, AI can be used as a learning aid for collaboration, but not as a replacement for thinking (Nasr et al., 2025). Objective 2 is a further confirmation that there is a level of AI use. The inverted U shape indicates that for the reasoning outcomes, moderate usage resulted in the best performance, and heavy usage did not provide further benefits. This reflects evidence of the potential for overreliance on AI which can diminish independent thinking (Bastani et al.,

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2025; Kundu & Bej, 2025). Thus, the question isn't whether or not AI can be accessed, but how and why. Sustaining the efficacy of AI integration requires engaging learners, encouraging their acceptance, and ensuring responsible practices.

7. Conclusion

The results of this comparative study reveal that the critical thinking skills of secondary school students who utilize AI were found to be significantly higher than those who do not. The findings indicate that the skills of inference, analysis and interpretation of the students using AI are the ones that experienced the highest increase. However, the benefit is only relative and not absolute; it is not seen in the evaluation and self-regulation aspects of reading, which rely most heavily on independent judgment, and it is U-shaped in terms of use intensity, with moderate users outperforming minimal and heavy users. Taken together, the findings represent an important shift in the perception of AI as a cognitive amplifier that can only be effective when used in a balanced and reflective way, not simply because of its frequency of use but through such usage. The takeaway for Indian secondary education is that while incorporating AI, a strong emphasis must be placed on teaching students to critically examine, monitor, and uphold ethical standards. To validate causal direction and examine the development of reasoning over time, the use of longitudinal and experimental designs in multiple districts should be considered in future studies.

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