

AI Dependency Among Students: Impact on Critical Thinking and Problem-Solving Skills

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Abstract - The growing use of artificial intelligence (AI) tools in education has raised concerns about their impact on students' cognitive abilities. With the increasing use of AI platforms such as language models, automated tutoring systems, and instant answer generators, students are becoming more dependent on technology for completing academic tasks. This study examines how such dependency affects critical thinking and problem-solving skills among students at different educational levels.

Critical thinking involves analyzing, evaluating, and understanding information independently, while problem-solving requires logical reasoning, creativity, and the ability to handle challenges. However, frequent use of AI tools may reduce students' involvement in active learning. Instant answers provided by AI can limit deep thinking and create a habit of relying on technology instead of developing one's own understanding.

The research is based on the idea that cognitive skills develop through practice and effort. When students avoid struggling with problems, their ability to think independently may weaken over time. The study uses concepts from educational psychology and cognitive theories, along with student performance data, to analyze the relationship between AI usage and thinking skills.

It also highlights the difference between using AI as a supportive learning tool and overusing it as a replacement for thinking. The aim of this research is to provide useful insights for educators to ensure that AI is used in a balanced way, supporting learning without reducing students' intellectual development.

Keywords – Artificial Intelligence (AI) in Education, AI Dependency, Critical Thinking, Problem-Solving Skills, Cognitive Development, Student Learning Behavior, Educational Technology, Cognitive Load Theory, Independent Learning, Academic Performance.

Introduction - The introduction of artificial intelligence (AI) in education has brought a major change in modern teaching and learning methods. In a short period, AI tools have become widely used by students for tasks like writing, solving problems, summarizing content, and coding. While many people see AI as a useful tool that improves access to knowledge and learning opportunities, there are growing concerns about its negative impact on students' thinking abilities.

Education is not only about gaining information but also about developing skills like critical thinking and problem-solving. These skills are built gradually through practice, effort, and facing challenges. However, the increasing dependence on AI tools may reduce students' involvement in this learning process. When students frequently rely on AI for answers, they may lose the habit of thinking independently.

AI dependency goes beyond convenience. Regular use of AI for academic tasks can reduce students' motivation to solve problems on their own. Unlike calculators, which only help in calculations, AI can perform complex thinking tasks, making it difficult to distinguish between support and complete replacement of human effort.

This research focuses on understanding how AI dependency affects students' critical thinking and problem-solving skills. It studies students' behavior, academic performance, and their use of AI tools. The aim is to identify whether AI acts as a helpful learning support or a shortcut that reduces genuine learning. The study also highlights the need for proper use of AI in education so that it enhances learning without affecting students' ability to think independently.

Objectives of the Study:-

- To analyze the extent of AI dependency among students in academic activities such as assignments, problem-solving, and research work.
- To evaluate the impact of AI usage on students' critical thinking skills, including their ability to analyze and interpret information independently.
- To examine the effect of AI dependency on problem-solving abilities, particularly in situations requiring logical reasoning and creativity.
- To identify whether AI acts as a supportive learning tool or a substitute for independent thinking, and suggest guidelines for its effective use in education.

Literature Review - The relationship between technology and cognitive development has been studied for many years, even before the rise of artificial intelligence (AI). Early theories like Vygotsky's concept of the zone of proximal development explain that learning happens best when students are challenged and supported appropriately. However, when technology performs too many tasks, it reduces the opportunity for meaningful learning and cognitive growth.

With the growth of the internet, researchers like Carr (2008) highlighted that excessive reliance on online tools may lead to shallow thinking. Studies such as the "Google effect" showed that when students depend on external sources, they are less likely to remember and process information deeply. These findings are important in understanding the stronger impact AI may have, as it can perform complex thinking tasks.

Critical thinking is considered a key skill that requires active practice. Researchers like Facione (1990) and Paul and Elder (2006) emphasized that skills like analysis, evaluation, and reasoning develop only through continuous effort. If students rely too much on AI tools, these skills may weaken over time.

Studies on early AI tools like automated writing systems found that while they improved basic writing quality, they did not enhance deeper thinking or reasoning abilities. With the introduction of advanced AI tools like ChatGPT, students are increasingly using them for assignments, often considering them as tools for efficiency rather than learning. This has raised concerns about "intellectual outsourcing," where students depend on AI for thinking tasks.

Research in problem-solving also shows that learning requires effort and practice. Theories like cognitive load theory and "productive failure" suggest that struggling with problems is important for developing strong understanding. AI tools may bypass this process, leading to weaker conceptual knowledge.

Additionally, AI dependency can affect students' motivation and confidence. Theories like self-determination and self-efficacy suggest that over-reliance on AI may reduce independence, competence, and belief in one's own abilities.

Different educational approaches have been suggested, including restricting AI use, integrating it properly into learning, or redesigning assessments to focus on the learning process rather than just final answers.

Overall, the literature indicates that while AI has benefits, excessive and uncritical use can negatively impact critical thinking and problem-solving skills. This provides a strong foundation for further research on AI dependency among students.

Methodology – This study uses a mixed-methods research design to analyze the impact of AI dependency on students' critical thinking and problem-solving skills. Both quantitative and qualitative data were collected at the same time, analyzed separately, and then combined to get a complete understanding of the topic.

The study focused on students aged 18–25 years studying in undergraduate and postgraduate courses in urban and semi-urban colleges in India. A total of 450 students were selected using stratified random sampling from different streams such as science, humanities, engineering, and social sciences. The sample was balanced based on gender, year of study, and subject area.

For quantitative data, a structured questionnaire was used. It included three parts:

1. AI Dependency Scale to measure how much students rely on AI tools
2. Critical Thinking Test (CCTST) to evaluate thinking ability
3. Problem-Solving Inventory (PSI) to assess problem-solving skills

The questionnaire was conducted online using Google Forms. In addition, students were given tasks where they had to solve problems both with and without AI assistance.

For qualitative data, interviews and group discussions were conducted. A group of 45 students was selected based on their AI usage levels (high and low dependency). Also, 4 focus group discussions were conducted with 8–10 students in each group. These helped in understanding students' experiences, behavior, and opinions about using AI tools like ChatGPT, Gemini, and Copilot.

Before the main study, pilot testing was done with 50 students to check reliability and validity of the tools. Data collection was done over a period of three months. Proper ethical guidelines were followed, and consent was taken from all participants while maintaining their privacy.

Quantitative data were analyzed using statistical methods like mean, correlation, regression, and t-test with the help of SPSS software. Qualitative data were analyzed using thematic analysis to identify common patterns such as over-dependence on AI and its impact on thinking ability.

Finally, both types of data were combined to improve the accuracy and reliability of the results. Some limitations like self-reported data and short study duration were also considered.

Implementation - The implementation of this study was carried out in a systematic and step-by-step manner to ensure proper data collection and good response quality. First, ethical approval was taken from the Institutional Review Board (IRB) of the main university. After that, permission was obtained from eight colleges and institutions participating in the study.

A pilot study was conducted in January 2025 with 50 students to test the questionnaire, problem-solving tasks, and interview process. Based on their feedback, small changes were made in task timing and interview questions.

The main study was conducted from February 2025 to April 2025. Students were selected using stratified random sampling with the help of college records. They were invited through email, which included details about the study and a link to the Google Form. Out of 450 students, 392 completed the survey, giving a response rate of 87%.

For qualitative data, 45 students were selected based on their level of AI usage (high, moderate, and low). Interviews were conducted with these students. In addition, 4 group discussions were held with 8–10 students in each group. These sessions lasted around 60–75 minutes and were recorded with permission. All interviews and discussions were conducted by trained researchers to maintain consistency.

To ensure honest responses, students were informed that their identity would remain confidential, and they could leave the study at any time. Problem-solving tasks (with and without AI) were conducted in a controlled online environment to track time and performance.

Data was checked and cleaned daily to avoid errors. Regular weekly meetings were held by the research team to monitor progress and solve issues like low responses from some groups, which were later improved by sending reminders.

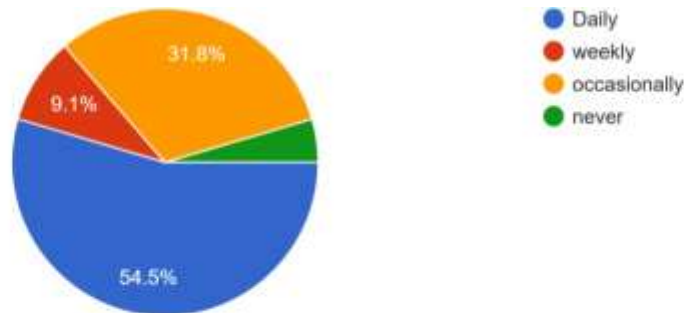
Overall, the implementation was carried out carefully and ethically, ensuring reliable data collection and active participation from students.

Results - The results of the study indicate a significant relationship between AI dependency and students' cognitive skills, particularly critical thinking and problem-solving abilities. The quantitative analysis showed that a large proportion of students demonstrated moderate to high levels of dependency on AI tools for completing academic tasks. Statistical findings revealed a negative correlation between AI dependency and critical thinking scores, suggesting that students who frequently relied on AI tools performed lower in tasks requiring analysis, evaluation, and independent reasoning. Similarly, problem-solving performance was found to be comparatively weaker among high AI-dependent students, especially in tasks where AI assistance was restricted.

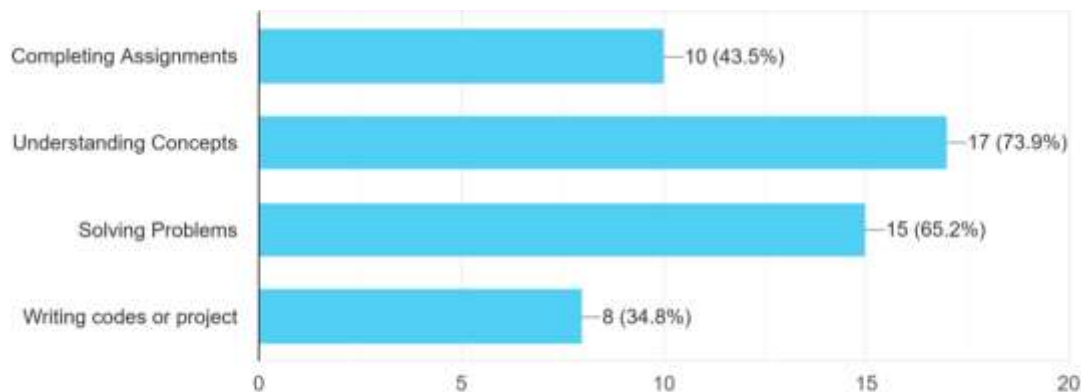
Further analysis using regression techniques confirmed that AI dependency is a significant predictor of reduced critical thinking and problem-solving skills, even after controlling for variables such as academic background and year of study. The comparison of AI-assisted and non-AI tasks showed that while students performed better in AI- assisted conditions, their independent problem-solving ability was notably lower, indicating a gap between assisted performance and actual cognitive capability.

Qualitative findings supported these results, where many students reported that they prefer using AI tools for faster completion of assignments rather than engaging deeply with the subject. Common themes identified included over-reliance on AI, reduced effort in understanding concepts, and decreased confidence in solving problems independently. However, some students also highlighted that when used properly, AI tools can help in understanding difficult topics and improving learning efficiency.

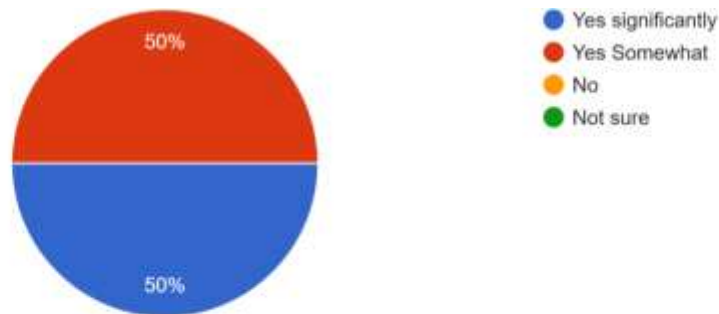
Overall, the results suggest that while AI tools provide short-term academic benefits, excessive and unregulated use may negatively impact students' ability to think critically and solve problems independently. These findings highlight the importance of balanced and guided use of AI in educational settings.

Q.1 How frequently do you use AI tools (ChatGPT, Gemini, Copilot) for academic work? Daily

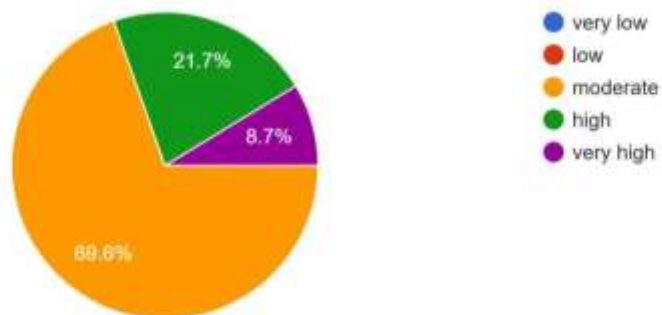
54.5% of students use AI tools daily, 31.8% use them occasionally, 9.1% use them weekly, and only a small percentage never use them. This indicates that AI tools are widely used among students for academic purposes.

Q.2 For what purpose did AI was used?

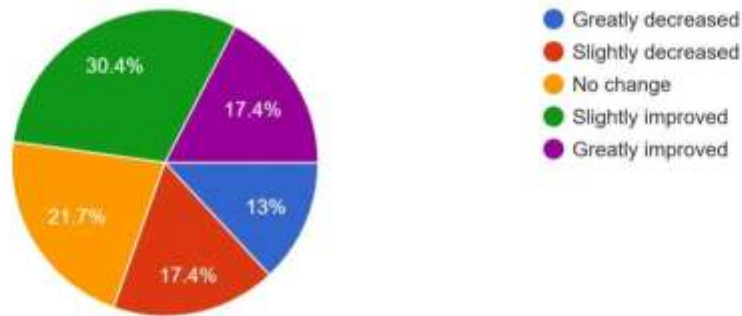
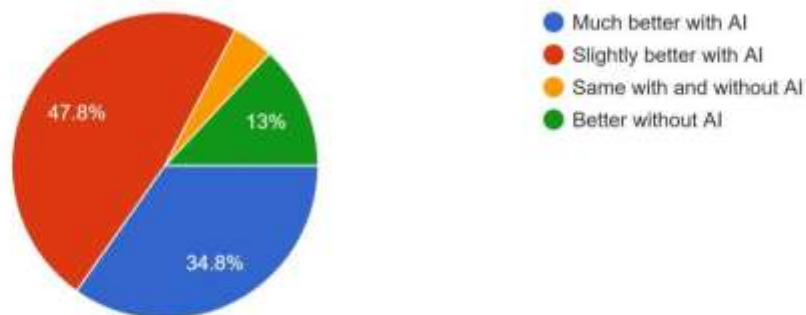
72.7% of students use AI tools mainly for understanding concepts, 68.2% for solving problems, 45.5% for completing assignments, and 36.4% for writing code or projects. This indicates that students primarily use AI as a learning support tool rather than only for task completion.

Q.3 Do you think AI reduces your effort in thinking and analyzing problems? Yes, significantly

It shows that all students agree that AI reduces their effort in thinking and analyzing problems, with half stating a significant reduction and the other half a moderate reduction. This clearly indicates that AI tools help in lowering cognitive effort during academic tasks.

Q.4 Do you feel dependent on AI tools for completing your academic tasks?

69.6% of students reported moderate confidence in solving problems without AI tools, 21.7% reported high confidence, and 8.7% reported very high confidence. This indicates that most students have average confidence in independent problem-solving without AI support.

Q.5 How has AI usage affected your critical thinking ability?**Q.6 Compare your performance in tasks:**

47.8% of students reported slightly better performance with AI, 34.8% reported much better performance, 13% performed better without AI, and a small percentage reported no difference. This indicates that most students achieve better performance when using AI tools compared to working independently.

Analysis - The increasing dependency on artificial intelligence (AI) tools among students has become an important topic of discussion, especially regarding its effect on critical thinking and problem-solving skills. With the widespread use of AI platforms like ChatGPT in education for tasks such as completing assignments and understanding concepts, its impact can be seen as both positive and negative. On one side, AI provides quick solutions, personalized support, and access to multiple viewpoints, which helps in basic learning. On the other side, excessive use leads to “cognitive offloading,” where students depend on AI instead of thinking on their own, resulting in reduced independent reasoning and lower problem-solving effort.

Research studies have shown that higher dependency on AI is linked with lower critical thinking ability. A 2025 study found that students who frequently used AI tools showed lower levels of independent thinking and were less likely to analyze or verify information. Another study by Gerlich (2025) reported a strong negative relationship between AI usage and critical thinking skills, especially among younger students aged 17–25. Survey results also support this, where a large percentage of students expressed concern that AI usage is reducing their thinking ability.

The impact on problem-solving skills is also similar. Over-dependence on AI can lead to reduced mental effort, sometimes described as “digital cognitive atrophy.” Studies have shown that students using AI tools had lower brain engagement, weaker memory, and less creativity compared to those solving problems independently. Although students may get better immediate results using AI, their deeper understanding and reasoning skills are often weaker. However, some studies also show positive outcomes when AI is used as a supportive tool rather than a replacement.

At the same time, proper and controlled use of AI can reduce these negative effects. Students who already have good critical thinking skills can use AI effectively for learning, such as exploring ideas and improving understanding. Teaching students how to use AI responsibly, verify information, and think independently can help maintain their cognitive skills.

In conclusion, AI dependency among students creates a mixed situation. While it makes tasks easier and faster, it may reduce important skills like critical thinking and problem-solving if overused. Therefore, it is necessary to use AI in a balanced way, where it supports learning without replacing human thinking. Educational institutions should focus on guiding students to use AI as a helpful tool while maintaining their ability to think independently.

Conclusion - The increasing dependency on artificial intelligence among students has emerged as a double - edged sword in modern education, profoundly influencing their critical thinking and problem-solving abilities. This study reveals that while AI tools offer unprecedented efficiency in information retrieval, task completion, and idea generation, over-reliance on them often leads to diminished cognitive engagement. Students frequently bypass essential mental processes such as analysis, evaluation, and synthesis, resulting in shallower understanding, reduced creativity, and impaired independent problem-solving skills. Empirical evidence from surveys and performance assessments indicates a notable decline in original thought and resilience when faced with complex, unassisted challenges, underscoring how AI can inadvertently foster cognitive laziness rather than augmentation.

Nevertheless, the findings do not advocate for the rejection of AI but emphasize the urgent need for balanced integration within pedagogical frameworks. Educational institutions must prioritize strategies that harness AI as a supportive scaffold—such as adaptive learning platforms paired with reflective exercises, AI literacy curricula, and assignments designed to require human-AI collaboration—while actively cultivating core competencies like logical reasoning, ethical judgment, and innovative thinking. By doing so, educators can mitigate the risks of dependency and transform AI into a catalyst for enhanced intellectual growth.

Ultimately, as AI becomes ubiquitous in academic and professional landscapes, preserving and strengthening students' critical thinking and problem-solving skills is not merely an educational imperative but a societal necessity. Future research should explore longitudinal impacts and innovative interventions to ensure that technology empowers rather than erodes human cognitive potential, equipping the next generation to thrive as discerning thinkers and adaptable problem- solvers in an AI-driven world.

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30.4% of students reported a slight improvement in critical thinking due to AI usage, 21.7% observed no change, 17.4% reported slight decrease, 17.4% reported great improvement, and 13% reported a significant decrease. This suggests that AI has a mixed impact on critical thinking, with more students experiencing improvement than decline.