



Cognitive Dependency On Generative Ai Tools And Its Impact On Student Learning Behaviour

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Abstract - The increasing presence of generative artificial intelligence (AI) in educational settings is transforming the way students engage with learning. Tools powered by AI are making information more accessible, enabling quicker completion of academic tasks, and offering personalized support tailored to individual needs. While these benefits are undeniable, there is a growing concern that continuous dependence on such technologies may gradually reduce students' active cognitive involvement in the learning process. This study explores how the use of generative AI tools influences student learning behaviour, particularly focusing on critical thinking and problem-solving skills. To gain a comprehensive understanding, a mixed-method approach was adopted, combining survey responses with a comparative evaluation of tasks completed with and without AI assistance. The results suggest that although AI enhances efficiency and convenience, overreliance on these tools can limit deeper cognitive engagement and independent reasoning. The findings emphasize the importance of mindful and balanced use of generative AI in education, ensuring that technological support complements rather than replaces essential learning processes.

Keywords - Artificial Intelligence, Cognitive Dependency, Learning Behavior, Generative AI, Critical Thinking, Academic Performance

1. INTRODUCTION

Recent advancements in artificial intelligence have brought noticeable changes to modern educational practices, reshaping how students access information and approach academic work. Among these developments, generative AI tools—designed to produce written content, provide explanations, and assist in problem-solving—have become increasingly integrated into everyday learning activities (Holmes et al., 2022). These tools are not only widely accessible but are also influencing the pace, style, and independence of student learning.

The integration of such technologies has introduced a shift from traditional learning methods toward more technology-assisted approaches. Students can now generate essays, solve complex problems, and receive instant feedback with minimal effort. This convenience has the potential to reduce barriers to learning, particularly for students who require

additional support or personalized guidance. At the same time, it raises important questions about how learning is being experienced—whether students are actively engaging with knowledge or simply consuming ready-made outputs.

Despite these advantages, the growing use of generative AI has raised important concerns regarding its long-term impact on cognitive development. One key issue is cognitive dependency, which refers to the tendency to rely on external tools or systems for tasks that would typically require active mental effort (Risko & Gilbert, 2016). When students repeatedly depend on AI-generated responses, there is a possibility that essential cognitive processes—such as reasoning, reflection, and problem-solving—may be underutilized over time.

In addition, the ease of accessing AI-generated solutions may alter students' motivation to engage deeply with learning materials. Instead of exploring



multiple perspectives or developing original ideas, learners may become inclined toward quick answers and surface-level understanding. This shift can influence not only academic performance but also the development of long-term intellectual skills that are critical for higher education and professional environments.

As generative AI continues to gain prominence in academic settings, it becomes essential to examine how its use shapes student learning behaviour. Understanding whether these tools act as supportive learning aids or as substitutes for cognitive effort is crucial. Therefore, this study seeks to explore the relationship between generative AI usage and cognitive engagement in a structured and evidence-based manner, with particular attention to critical thinking and problem-solving abilities.

II. LITERATURE REVIEW

The role of artificial intelligence in education has been widely examined, with numerous studies highlighting its potential to enhance learning experiences. AI-based systems have been shown to support personalized learning by adapting content to individual student needs, providing real-time feedback, and improving accessibility for learners with diverse abilities (Luckin et al., 2016). These technologies have also contributed to increased efficiency in academic tasks, enabling students to manage their workload more effectively and access information with greater ease.

However, alongside these benefits, several concerns have emerged regarding the impact of AI on the quality of learning. Researchers have pointed out issues such as reduced originality, increased dependency on automated systems, and challenges related to academic integrity (Selwyn, 2019). There is also evidence suggesting that excessive reliance on digital tools can lead to more superficial engagement with learning materials, where students prioritize quick completion over deep understanding.

A central concept within this discussion is cognitive offloading, which refers to the practice of delegating mental processes to external tools in order to reduce cognitive effort (Risko & Gilbert, 2016). While cognitive offloading can be beneficial in certain contexts—such as reducing memory load or improving efficiency—overuse may limit the development of critical cognitive skills. In educational settings, this raises concerns about whether students are actively processing information or merely relying on external systems to perform cognitive tasks.

The emergence of generative AI introduces a more complex dimension to this issue. Unlike earlier educational technologies, generative AI systems are capable of producing human-like responses, simulating reasoning, and generating complete solutions to academic problems. This capability blurs the boundary between assistance and substitution, as students may begin to depend on AI not just for support but for the entire cognitive process.

Although the implications of AI in education have been widely discussed, there remains limited empirical research specifically examining the long-term cognitive effects of generative AI usage. Most existing studies focus on general AI tools or short-term outcomes, leaving a gap in understanding how continuous exposure to generative systems influences learning behaviour over time. This lack of focused research highlights the need for further investigation, which the present study aims to address.

III. PROBLEM STATEMENT

The rapid adoption of generative artificial intelligence tools in academic environments has significantly transformed the way students approach learning tasks. While these tools offer convenience and efficiency, their increasing use has raised concerns regarding declining cognitive engagement and reduced independence in learning. Students may rely on AI-generated outputs rather than actively engaging in critical thinking, analysis, and problem-solving processes.



Despite the widespread integration of generative AI in education, there is a lack of sufficient empirical evidence examining how such dependency influences student learning behaviour over time. In particular, limited research has focused on the extent to which reliance on AI affects the development of essential intellectual skills, including critical thinking, creativity, and independent reasoning.

This gap in understanding creates uncertainty about whether generative AI serves as a supportive educational tool or contributes to cognitive dependency among learners. Therefore, it is necessary to systematically investigate the relationship between AI usage and cognitive engagement to ensure that the benefits of technology do not come at the cost of meaningful learning outcomes.

IV. OBJECTIVES OF THE STUDY

The present study is designed to achieve the following objectives:

1. **To examine the extent of student dependency on generative AI tools** in academic activities.
2. **To analyze the impact of generative AI usage on critical thinking abilities** among students.
3. **To evaluate the influence of AI-assisted learning on problem-solving skills** and independent reasoning.
4. **To identify behavioral changes in learning patterns** resulting from frequent use of generative AI tools.
5. **To propose strategies for the effective and balanced integration of generative AI** in educational environments.

V. RESEARCH METHODOLOGY

5.1 Research Design

This study adopts a mixed-method research design, combining both quantitative and qualitative approaches to provide a comprehensive understanding of student learning behaviour in the context of generative AI usage. The quantitative component focuses on identifying patterns, relationships, and measurable impacts of AI usage on cognitive skills,

while the qualitative component aims to capture deeper insights into student experiences, attitudes, and behavioural changes. This combination enhances the reliability and validity of the findings by allowing data triangulation.

5.2 Data Collection Methods

Primary data for the study were collected using two main techniques:

(a) Structured Questionnaire

A structured questionnaire was designed and distributed among students to gather quantitative data. The questionnaire included multiple sections such as:

- Frequency of generative AI tool usage
- Level of dependency on AI tools
- Self-assessment of critical thinking and problem-solving abilities
- Perceived impact of AI on learning behaviour

Responses were collected using a Likert scale (e.g., Strongly Agree to Strongly Disagree) to ensure consistency and ease of analysis.

(b) Comparative Experimental Task

In addition to survey data, a controlled comparative experiment was conducted. Participants were asked to complete similar problem-solving tasks under two conditions:

1. With AI Assistance
2. Without AI Assistance

The purpose of this experiment was to observe differences in:

- Task completion time
- Accuracy of responses
- Depth of reasoning and explanation

This method helped in directly assessing the impact of AI usage on cognitive engagement.

5.3 Sample Selection

The study sample consisted of 100 students aged between 18 and 25 years, selected using a convenience sampling method from various educational institutions. Participants included students from both:

- Technical disciplines (e.g., engineering, computer science)



- Non-technical disciplines (e.g., arts, commerce)
This diversity was intentionally included to ensure a broader representation of learning behaviours and varying levels of exposure to AI technologies.

5.4 Data Analysis Techniques

The collected data were analyzed using both quantitative and qualitative techniques:

(a) Quantitative Analysis

- Percentage distribution was used to analyze survey responses
 - Comparative averages were calculated to evaluate differences between AI-assisted and independent tasks
 - Data were interpreted using simple statistical methods for clarity and reliability
- #### (b) Qualitative Analysis
- Observational insights from the experimental tasks were recorded
 - Patterns in student behaviour, engagement levels, and reliance on AI were identified
 - Responses were interpreted to understand underlying attitudes toward AI usage

Table 1: Research Method Overview

Component	Description
Research Design	Mixed-method (Quantitative + Qualitative)
Data Collection	Questionnaire + Experimental Task
Sample Size	100 Students
Age Group	18-25 years
Sampling Method	Convenience Sampling
Analysis Tools	Percentage, Average Comparison

VI. RESULT AND ANALYSIS

6.1 Usage Trends of Generative AI Tools

The analysis of survey responses indicates a high level of adoption of generative AI tools among students. A significant proportion of participants reported using AI regularly as part of their academic workflow.

- 78% of students reported regular use of generative AI tools
 - 52% indicated reliance on AI for completing assignments
 - 34% used AI primarily for understanding concepts
- These findings suggest that while AI is widely used, its primary application is task-oriented rather than concept-driven learning.

Table 2 : AI Usage Patterns

Usage Category	Percentage of Students
Regular AI Usage	78%
Assignment Completion	52%
Concept Understanding	34%

6.2 Problem-Solving Performance

A comparative analysis between AI-assisted and independent task completion revealed notable differences in performance and learning outcomes. Students using AI tools were able to complete tasks more quickly, highlighting increased efficiency. However, those who completed tasks independently demonstrated a deeper understanding of underlying concepts and showed better retention of information. This indicates that while AI enhances speed and convenience, it may not contribute equally to conceptual clarity and long-term learning.

Table 3: AI-Assisted vs Independent Performance

Parameter	AI-Assisted Tasks	Independent Tasks
Completion Time	Faster	Slower
Accuracy	High	Moderate
Conceptual Understanding	Lower	Higher
Retention Level	Lower	Higher

6.3 Cognitive Engagement

The study also examined the level of cognitive engagement among students using generative AI tools.



The results suggest a decline in active mental involvement among frequent users.

- **60%** of respondents reported reduced analytical engagement when using AI
- **45%** admitted to using AI-generated answers without fully understanding the content

These findings indicate a tendency toward passive learning, where students rely on outputs rather than actively processing information.

Table 4 : Cognitive Engagement Indicators

Indicator	Percentage
Reduced Analytical Engagement	60%
Use Without Full Understanding	45%

6.4 Behavioral Observations

Qualitative observations from the experimental tasks revealed several consistent behavioural patterns among students:

- A preference for quick and direct answers rather than in-depth exploration
- Reduced persistence when encountering complex or unfamiliar problems
- Increased dependence on automated solutions for task completion

These patterns suggest that frequent use of generative AI tools may gradually influence learning habits, shifting them toward efficiency-driven rather than effort-driven approaches.

Overall, the results indicate that while generative AI tools significantly improve efficiency and accessibility, their excessive use may reduce cognitive engagement and weaken independent learning behaviours. This supports the study’s hypothesis that overreliance on AI can impact critical thinking and problem-solving abilities.

VII. DISCUSSION

The findings of this study reveal a significant relationship between the use of generative AI tools and changes in student learning behaviour. While these

tools improve efficiency and accessibility, they also introduce challenges related to cognitive engagement and independent thinking. The results align with existing literature and highlight both the benefits and risks associated with AI integration in education.

Key Discussion Insights

- **Efficiency vs Cognitive Depth**
The study confirms that generative AI tools significantly reduce task completion time. This supports earlier findings (Luckin et al., 2016), which emphasize AI’s role in improving learning efficiency. However, this efficiency often comes at the cost of reduced conceptual understanding and depth of learning.
- **Cognitive Offloading and Dependency**
The tendency of students to rely on AI for problem-solving reflects the concept of cognitive offloading (Risko & Gilbert, 2016). Over time, this may lead to cognitive dependency, where learners depend on AI systems instead of engaging in active thinking.
- **Reduced Critical Thinking**
The decline in analytical engagement observed in the results supports concerns raised by Selwyn (2019). Students who frequently use AI-generated responses may bypass critical evaluation, leading to weaker reasoning and problem-solving skills.
- **Shift in Learning Behaviour**
Behavioral patterns such as preference for quick answers, reduced persistence, and increased reliance on automation indicate a shift toward surface-level learning. This suggests that AI tools may influence not only performance but also learning habits.
- **Conditional Benefits of AI**
Despite the concerns, the study also highlights that AI is not inherently harmful. When used selectively—for guidance, clarification, or support—it can enhance learning without replacing cognitive effort.
- **Role of Educators and Integration Strategy**
The impact of AI largely depends on how it is integrated into educational practices. Proper guidance, structured usage, and awareness can prevent overreliance and promote balanced learning.



Overall, the discussion suggests that generative AI acts as a **double-edged tool**—enhancing efficiency while posing risks to cognitive development if used excessively. Therefore, its role in education should be carefully managed to ensure that it supports, rather than substitutes, active learning.

VIII. BENEFITS OF AI INTEGRATION

The integration of generative artificial intelligence in educational settings offers several significant advantages that enhance the overall learning experience. These benefits contribute to improved accessibility, efficiency, and personalized support for students.

Key Benefits :

- **Immediate Access to Information**
Generative AI tools provide instant access to relevant academic content, enabling students to quickly retrieve explanations, summaries, and solutions. This reduces the time spent searching for information and supports faster learning.
- **Increased Efficiency in Task Completion**
AI-assisted tools help students complete assignments, projects, and problem-solving tasks more efficiently. This allows learners to manage their academic workload more effectively.
- **Personalized Learning Support**
AI systems can adapt responses based on individual learning needs, offering customized explanations and guidance. This is particularly beneficial for students who require additional support or alternative learning approaches.
- **Assistance with Complex Problems**
Generative AI tools can break down difficult concepts and provide step-by-step guidance, helping students understand unfamiliar or challenging topics more easily.
While these benefits highlight the potential of AI in education, they must be balanced with mindful usage to avoid overdependence and reduced cognitive engagement.

IX LIMITATIONS OF COGNITIVE DEPENDENCY

The increasing reliance on generative AI tools in educational contexts may introduce several cognitive and academic limitations. While these tools offer convenience, excessive dependence can negatively influence essential learning processes and intellectual development.

Key Limitations :

- **Decline in Independent Thinking**
Continuous use of AI-generated solutions may reduce students' ability to think critically and solve problems independently. Over time, learners may rely on ready-made answers instead of engaging in analytical reasoning.
- **Overdependence on External Systems**
Frequent reliance on AI tools can lead to cognitive dependency, where students depend on external systems to perform tasks that would otherwise require mental effort. This may weaken self-reliance and confidence in one's own abilities.
- **Reduced Originality and Creativity**
The use of AI-generated content may limit students' ability to produce original ideas. When learners depend heavily on automated outputs, creativity and individual expression may gradually decline.
- **Shallow Understanding of Concepts**
AI-assisted learning may encourage surface-level engagement, where students focus on obtaining answers rather than understanding underlying concepts. This can affect long-term retention and deep learning.

These limitations highlight the need for a balanced approach to AI usage, ensuring that technological support enhances learning without replacing essential cognitive processes.

X. RECOMMENDATION

Based on the findings of this study, several measures are proposed to ensure the effective and responsible



use of generative AI tools in educational settings. These recommendations aim to balance the benefits of AI with the need to maintain cognitive engagement and independent learning.

Key Recommendations :

- **Promote a Balanced Learning Approach**
Students should be encouraged to use AI tools as supportive aids rather than substitutes for independent thinking. A combination of AI assistance and self-driven effort can help maintain cognitive development.
- **Develop Institutional Guidelines and Policies**
Educational institutions should establish clear policies regarding the acceptable use of generative AI in academic work. These guidelines can help prevent misuse and ensure ethical practices.
- **Encourage Critical Evaluation of AI Outputs**
Students should be trained to critically assess AI-generated content instead of accepting it at face value. This will strengthen analytical skills and reduce passive learning habits.
- **Design Cognitively Engaging Learning Activities**
Educators should create assignments and tasks that require analysis, reflection, and problem-solving, making it difficult to rely solely on AI-generated responses.
- **Increase Awareness of Cognitive Risks**
Awareness programs should be conducted to educate students about the potential risks of overdependence on AI, including its impact on creativity, critical thinking, and long-term learning.
Implementing these recommendations can help ensure that generative AI serves as a constructive educational tool, supporting learning while preserving essential cognitive skills.

X. FUTURE SCOPE

The rapid evolution of generative artificial intelligence in education opens several avenues for further research. While the present study provides initial insights, there remains significant scope for deeper investigation into the long-term implications of AI usage in learning environments.

Areas for Future Research :

- **Long-Term Cognitive Impact**
Future studies can examine the long-term effects of sustained AI usage on cognitive development, particularly focusing on critical thinking, memory retention, and problem-solving abilities over extended periods.
- **Comparative Analysis Across Educational Levels**
Research can be conducted across different educational stages—such as school, undergraduate, and postgraduate levels—to understand how AI dependency varies with age, academic maturity, and learning context.
- **Development of AI Systems that Encourage Active Learning**
There is scope for designing AI tools that promote engagement, inquiry-based learning, and critical thinking rather than simply providing direct answers. Such systems could guide students through the reasoning process instead of replacing it.
- **Integration of Ethical AI Practices in Education**
Future research can explore the incorporation of ethical guidelines and responsible AI usage into academic curricula, ensuring that students are aware of both the benefits and risks associated with these technologies.

Exploring these areas will contribute to a more balanced and informed integration of generative AI in education, ensuring that technological advancement aligns with meaningful learning outcomes.

XII. CONCLUSION

Generative artificial intelligence has brought a transformative shift in the educational landscape, reshaping how students access information and approach academic tasks. While these tools offer clear advantages in terms of efficiency, accessibility, and personalized support, they also introduce important challenges related to cognitive engagement and independent learning.

The findings of this study indicate that excessive reliance on generative AI can lead to reduced



analytical thinking, lower cognitive involvement, and a decline in essential intellectual skills such as problem-solving and critical reasoning. At the same time, the results highlight that these outcomes are not unavoidable. When used thoughtfully and in moderation, AI tools can act as valuable learning aids that support understanding and enhance academic performance.

Ultimately, the impact of generative AI in education depends on how it is integrated into learning practices. A balanced approach—where technology complements rather than replaces cognitive effort—is essential to ensure that students continue to develop the skills necessary for meaningful and long-term learning. Therefore, educators, institutions, and students must work together to promote responsible AI usage that fosters both efficiency and intellectual growth.

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