

Impact of Generative AI on Student Learning and Creativity

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Abstract - Generative Artificial Intelligence (GenAI) has rapidly become part of modern educational environments, providing students with tools for text generation, problem solving, coding assistance, summarization, translation, brainstorming, and personalized learning support.

Applications such as ChatGPT, Gemini and other generative systems can provide immediate explanations and academic assistance. However, increasing dependence on these technologies raises concerns about independent learning, critical thinking, creativity and academic integrity. This paper examines the impact of Generative AI on student learning and creativity through a review of existing research. The study focuses on personalized learning, academic performance, higher-order thinking, creative problem-solving, AI dependency and responsible use. Existing research indicates that GenAI can positively influence academic achievement, higher-order thinking, motivation and student engagement, although outcomes vary according to educational context and instructional design. At the same time, research has identified concerns regarding cognitive offloading, overdependence, inaccurate information, originality and academic integrity. Therefore, the educational impact of GenAI depends not only on the technology itself but also on how it is used and guided. The paper argues that GenAI should be used as a learning assistant rather than a replacement for students' intellectual effort.

Key Words: Generative AI, Student Learning, Creativity, Critical Thinking, AI Dependency, Academic Integrity.

1. INTRODUCTION

Generative Artificial Intelligence is a form of artificial intelligence capable of producing new content in response to user instructions. Unlike conventional educational software that mainly provides predefined information, GenAI can generate text, explanations, summaries, computer programs, questions, images and other forms of

content. Tools such as ChatGPT, Gemini and other generative systems have become increasingly accessible to students.

The rapid availability of these technologies has changed the way students approach academic activities. Students can use GenAI to understand difficult concepts, obtain alternative explanations, summarize study material, generate practice questions, improve writing, debug computer programs and develop project ideas. These capabilities can make learning more accessible, interactive and personalized.

However, the educational value of GenAI cannot be measured only by the quality or speed of the final academic output. The process through which students acquire knowledge, solve problems and develop their own ideas is equally important. A student may produce a high-quality assignment with extensive AI assistance without fully understanding the content.

An important concern is cognitive dependency on GenAI. When students repeatedly ask AI to solve problems, formulate arguments or generate ideas before attempting these activities independently, AI may become a substitute for cognitive effort rather than a learning assistant. This creates an important distinction between AI-assisted performance and genuine independent learning.

Therefore, the impact of GenAI should be examined across learning outcomes, independent learning, critical thinking, creativity, motivation, confidence, ethical reasoning and academic integrity. The central focus is not only what students produce with GenAI, but also what happens to students' own learning and creative processes when AI becomes a regular part of academic work.

2. OBJECTIVES OF THE STUDY

2.1 To examine the role of GenAI in improving students' understanding of academic concepts.

2.2 To study the role of GenAI in personalized learning and immediate feedback.

2.3 To examine the influence of GenAI on critical thinking and problem-solving.

2.4 To investigate the effect of GenAI on student creativity and idea generation.

2.5 To examine the possibility of AI dependency among students.

2.6 To distinguish between AI-assisted creativity and independently generated creativity.

2.7 To identify challenges related to misinformation and academic integrity.

2.8 To examine the role of teachers in responsible GenAI integration.

3. RESEARCH METHODOLOGY

This study follows a literature-based research approach. Existing research articles, systematic reviews and meta-analyses related to Generative AI, ChatGPT, student learning, creativity, critical thinking and academic integrity were examined. The literature was organized around learning outcomes, personalized learning, student engagement, creativity, critical thinking, AI dependency, independent learning and responsible AI use.

The purpose of the methodology is to examine both the benefits and limitations of GenAI rather than considering only its effect on academic performance. Recent evidence includes experimental studies, systematic reviews and meta-analyses. Deng et al. reviewed 69 experimental studies and reported positive effects of ChatGPT on academic performance, affective-motivational states and higher-order thinking, while also noting methodological limitations [2]. Chen and Cheung synthesized 57 studies and 97 estimates and reported positive effects on several university learning outcomes, while finding no statistically significant effect on metacognition in their analysis [1].

4. GENERATIVE AI IN EDUCATION

The integration of GenAI into education has created opportunities for students to interact with learning materials in new ways. Students can use AI as a virtual tutor, writing assistant, programming assistant, brainstorming partner and source of practice questions.

4.1 Personalized Learning

Students have different levels of knowledge and different learning speeds. GenAI can provide explanations

according to an individual's needs. A beginner can ask for a simple explanation, while an advanced student can request a technical explanation with examples. This flexibility can support personalized learning.

4.2 Immediate Feedback

GenAI can provide immediate responses to questions and can help students identify possible mistakes in writing, programming or problem-solving. Immediate feedback can help students recognize weaknesses while they are learning. However, AI-generated feedback must be verified because AI systems may provide incorrect information.

4.3 Programming and Technical Learning

GenAI is particularly relevant to computer science education. Students can ask AI to explain programming concepts, identify errors, explain algorithms or suggest alternative coding approaches. However, students should understand generated code rather than simply copying it. The ability to explain and modify the code remains an important part of technical learning.

4.4 Student Engagement

GenAI can make learning more interactive because students can ask questions and receive immediate responses. A 2025 systematic review and meta-analysis of 17 empirical studies involving 1,735 students found a medium effect on overall engagement in ChatGPT-based learning and identified personalized tutoring, programming and technical assistance, and content generation and collaboration as important roles [6]. The review also identified over-reliance as a potential risk.



Fig. 1. Generative AI applications that can support student learning.

5. IMPACT OF GENERATIVE AI ON STUDENT LEARNING

5.1 Academic Achievement

Research has reported positive effects of GenAI on several learning outcomes. Chen and Cheung reported positive effects on academic achievement and higher-order thinking among university students [1]. Deng et al. similarly found that ChatGPT interventions improved academic performance and higher-order thinking propensities [2]. However, improved academic performance does not automatically prove deeper independent learning. Assessments should also determine whether students can independently explain and apply what they have learned.

5.2 Higher-Order Thinking

Higher-order thinking involves analyzing, evaluating and applying information. GenAI can provide students with different solutions that they can compare and evaluate. For example, a student can ask AI for two approaches to a problem and then identify the strengths and weaknesses of each approach. This can encourage analytical thinking when the student performs the evaluation rather than simply accepting the AI response.

5.3 Motivation and Engagement

GenAI can make academic interaction more immediate and personalized. A 2025 meta-analysis reported positive effects of GenAI on student motivation and engagement across diverse educational settings, while also identifying subject category, learning strategy and context as factors that can influence outcomes [7]. Therefore, AI may contribute to engagement, but it should complement rather than replace teachers, classroom activities and independent study.

6. IMPACT OF GENERATIVE AI ON STUDENT CREATIVITY

Creativity involves generating, developing and evaluating ideas. GenAI can influence creativity in both supportive and challenging ways. Its ability to produce multiple ideas quickly makes it useful for brainstorming, but the same feature can create dependence if students stop generating ideas independently.

6.1 Brainstorming and Idea Generation

One useful application of GenAI is brainstorming. A student working on a project can ask AI to suggest several possible topics or approaches. The student can then evaluate the suggestions and develop a suitable idea. In this situation, AI acts as a starting point for creative

exploration, while the student remains responsible for selecting and developing the final idea.

6.2 Creative Problem-Solving

GenAI can generate alternative solutions to a problem. A productive process can be represented as Problem → AI Suggestions → Student Evaluation → Modification → Final Solution. The evaluation and modification stages are important because they require the student to contribute independent reasoning.

6.3 Independent Creativity

A major concern is that students may become dependent on AI-generated ideas. If students always ask AI for ideas before attempting to generate their own, they may have fewer opportunities to practice independent creative thinking. Habib et al. examined student creativity using the Alternative Uses Task and measured flexibility, fluency, elaboration and originality. Their findings support a careful approach because AI may support creative thinking while also having negative effects on creativity and creative confidence [3].



Fig. 2. Potential benefits of GenAI in education.

7. AI DEPENDENCY AND CRITICAL THINKING

AI dependency occurs when students increasingly rely on AI to perform tasks that they could otherwise attempt themselves. Excessive dependence may reduce opportunities to practice independent problem-solving, critical evaluation and writing. Two different learning processes can be considered: independent learning follows Problem → Think → Attempt → Evaluate → Correct, whereas AI-dependent learning may follow Problem → Ask AI → Receive Answer → Copy → Submit.

GenAI can nevertheless support critical thinking when students are asked to question AI-generated content. Teachers can provide an AI-generated answer and ask students to identify errors, verify information and produce a corrected response. Liu and Zhong's systematic review emphasizes that instructional guidance and pedagogical scaffolding are important for integrating GenAI into student learning [4].

8. CHALLENGES OF GENERATIVE AI

8.1 Inaccurate Information

GenAI can sometimes generate information that is incorrect but appears convincing. Students should therefore verify important information using reliable academic sources rather than treating an AI response as automatically correct.

8.2 Academic Integrity

Students may use AI to generate essays, assignments, programming code or examination answers. If such work is submitted as entirely their own, it can create academic-integrity concerns. Institutions should establish clear rules about acceptable and unacceptable AI use.

8.3 Reduced Independent Thinking

Excessive AI use may reduce opportunities for students to practice reasoning and problem-solving independently. The issue is particularly important when AI performs the central intellectual task instead of providing support.

8.4 Privacy and Data Security

Students may enter personal, academic or confidential information into AI systems. UNESCO recommends a human-centred approach to GenAI in education, including attention to data privacy, ethical validation and appropriate safeguards [5].

9. RESPONSIBLE USE OF GENERATIVE AI

GenAI should be used as a learning assistant rather than a replacement for student thinking. Responsible use requires students to remain active participants in the learning process. A useful framework is Think → Ask → Verify → Improve → Create.

9.1 Think

Students should first attempt to understand the problem independently. This preserves the opportunity to develop reasoning and recall skills.

9.2 Ask

Students can use GenAI when additional explanation, examples, feedback or alternative approaches are required.

9.3 Verify

AI-generated information should be checked against reliable sources. This is particularly important for

academic research, factual claims, references and technical information.

9.4 Improve

Students should correct errors, compare alternatives and modify AI suggestions rather than copying them directly.

9.5 Create

The final work should reflect the student's own understanding, reasoning and creativity. AI can support the process, but the student should remain responsible for the final academic contribution.

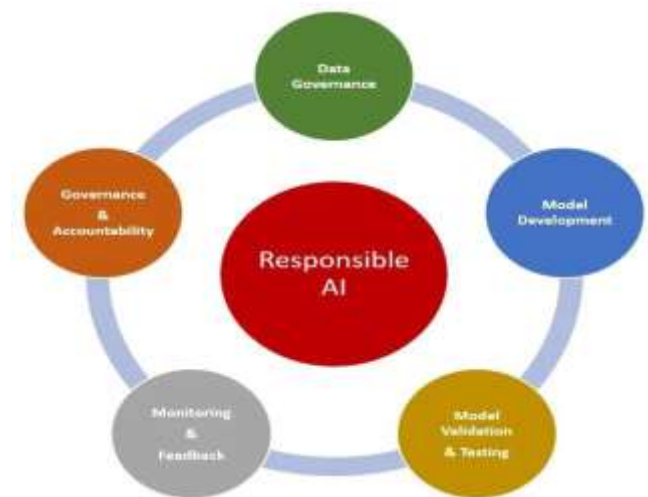


Fig. 3. Responsible GenAI learning cycle: Think, Ask, Verify, Improve and Create.

10. RESEARCH GAP

Existing research provides evidence that GenAI can improve several learning outcomes, but important questions remain. Many studies focus on academic performance or student attitudes toward AI. Less attention is given to the relationship between academic learning, independent thinking and creativity as interconnected outcomes. Another important issue is the difference between producing a high-quality output with AI and actually developing the skills required to produce that output independently.

There is also a need for more research examining how frequency of AI use, academic discipline, teacher guidance and AI literacy influence outcomes. Future studies should therefore investigate not only whether GenAI improves academic results but also whether students continue to develop independent thinking, creativity and critical reasoning.

11. DISCUSSION

The findings show that Generative Artificial Intelligence (GenAI) can influence student learning in both positive and challenging ways. Tools based on GenAI can support learners by offering personalized explanations, providing quick feedback, assisting with idea generation, helping with programming-related tasks, and making additional learning materials available. Previous research has also identified potential improvements in areas such as academic performance, higher-order thinking, student motivation, and engagement.

At the same time, the educational value of GenAI largely depends on the manner in which students and teachers incorporate these tools into the learning process. When AI is used without appropriate guidance, students may become overly dependent on generated responses and may spend less time working through problems independently. Similar considerations apply to creativity. Although GenAI can expose students to new perspectives, possible ideas, and alternative approaches, meaningful learning still requires students to develop, assess, modify, and communicate their own ideas. Thus, GenAI is more appropriately viewed as a learning aid rather than a replacement for students' intellectual participation.

The main educational concern is therefore not whether GenAI should be permitted in student learning, but how its use can support learning without taking over tasks that students need to perform themselves. Appropriate teacher supervision, development of AI literacy, verification of AI-generated information, and assessment activities that require students to explain their reasoning and apply concepts independently can help address this issue. Such practices can allow students to benefit from GenAI while retaining responsibility for their own learning and intellectual development.

12. CONCLUSION

Generative Artificial Intelligence is changing the way students learn, solve problems and develop ideas. It provides useful opportunities for personalized learning, immediate feedback, brainstorming, programming assistance, writing support and creative problem-solving. Studies conducted across different educational settings suggest that the use of GenAI may contribute to improvements in various dimensions of students' learning. Meta-analytic evidence has reported positive effects on academic achievement, higher-order thinking, motivation and engagement, although the size of these effects varies according to educational context and instructional design [1,2,6,7].

At the same time, excessive dependence on AI may reduce opportunities for students to practice independent

reasoning and creativity. Other concerns include inaccurate information, academic-integrity problems and privacy. Therefore, the educational value of GenAI should not be judged only by the quality of AI-assisted outputs. The development of students' own understanding, critical thinking, creativity and learning ownership is equally important.

GenAI should be used as a supportive learning and creative tool rather than a substitute for student intellectual effort. Students should first think about a problem, use AI when appropriate, verify the information, improve the suggestions and finally produce their own work. The future of AI-assisted education should focus on human-AI collaboration, where technology supports learning while students remain responsible for reasoning, creativity, evaluation and decision-making.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my research guide and faculty members for their valuable guidance, constructive suggestions and continuous encouragement throughout the preparation of this research paper. I am also grateful to my institution for providing the academic environment and resources required for this work. Finally, I would like to thank my family and friends for their constant support and encouragement.

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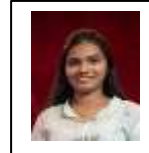
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