

From Assistance to Dependence: Investigating the Effects of Generative AI on Student Learning, Retention, and Study Effort

Najeeb Parkar

Department of Information Technology, Mahatma Education Society's Pillai College of Arts, Commerce & Science (Autonomous), New Panvel, Maharashtra, India

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Abstract

Purpose: Generative Artificial Intelligence (GenAI), including tools such as ChatGPT, is increasingly used by university students for explanations, summaries, problem-solving, feedback, and academic support. This paper examines whether such assistance supports learning or may encourage dependence that affects long-term retention and independent thinking. **Methods:** The study uses secondary research and a descriptive synthesis of published experimental studies, randomized controlled trials, systematic reviews, and meta-analyses. No primary data were collected and no new statistical meta-analysis was conducted. **Results:** The reviewed studies generally report positive effects on academic performance and engagement. Reported effect sizes include approximately $g = 0.712$ across 69 experimental studies, Hedges' $g = 0.577$ across 37 studies, and an effect size of approximately 0.804 across 57 studies. However, one randomized controlled study reported 45-day retention of 57.5% for a ChatGPT-assisted group compared with 68.5% for a traditional-learning group. **Conclusion:** GenAI can be a useful learning assistant when students actively use it for explanation, feedback, comparison, and clarification. However, completing tasks efficiently should not be treated as proof of deep or lasting learning. Students should retain opportunities for independent recall, reasoning, analysis, and problem-solving.

Keywords: generative artificial intelligence; ChatGPT; student learning; knowledge retention; cognitive effort; higher-order thinking

1 Introduction

Generative Artificial Intelligence (GenAI) has rapidly become part of modern education. Students use tools such as ChatGPT to understand difficult concepts, summarize information, generate examples, solve problems, and obtain feedback. These tools can provide quick and accessible learning support.

However, completing an academic task successfully with AI assistance does not necessarily mean that a student has developed the same level of understanding independently. This creates an important distinction between task performance and actual learning. Recent research therefore considers not only academic performance but also knowledge retention, cognitive effort, engagement, and higher-order thinking.

The central problem examined in this paper is whether GenAI improves genuine learning or encourages dependence on external assistance. AI may reduce the time and effort required to complete tasks, but some of the mental effort removed may also be the effort required for understanding, remembering, reasoning, and problem-solving.

1.1 Objectives

1. To examine the effect of GenAI on academic performance.
2. To examine its effect on knowledge retention.
3. To understand its effect on cognitive effort.
4. To examine its relationship with student engagement and higher-order thinking.
5. To understand how the method of GenAI use influences learning outcomes.
6. To identify risks associated with excessive dependence on GenAI.

1.2 Research questions

1. Does GenAI improve academic performance?
2. Does GenAI improve long-term knowledge retention?
3. How does GenAI affect students' cognitive effort?
4. Can GenAI support higher-order and critical thinking?
5. How does the way GenAI is used influence learning?
6. What problems can result from excessive dependence on GenAI?

2 Methods

2.1 Research design

This study uses a secondary research design. No survey, interview, questionnaire, experiment, or primary data collection was conducted. Instead, the paper synthesizes findings from existing experimental studies, randomized controlled trials, systematic reviews, and meta-analyses.

2.2 Sources of information

Relevant research was identified through academic sources including ScienceDirect, Springer Nature, Wiley, Nature Portfolio, PubMed/PMC, and Google Scholar. Priority was given to peer-reviewed research and studies reporting quantitative evidence.

2.3 Selection criteria

Studies were included when they examined GenAI or ChatGPT in educational settings, involved students or learning contexts, measured learning-related outcomes, provided empirical evidence or a research synthesis, and were relevant to the research questions. News articles, marketing material, unsupported opinions, duplicate studies, and unrelated research were excluded.

2.4 Data analysis

The selected studies were compared according to research design, number of participants or studies, AI tool, educational context, comparison group, measured outcomes, and main findings. The analysis is a descriptive and comparative synthesis rather than a new statistical meta-analysis. Published effect sizes are reported as presented in the cited studies.

3 Results

The reviewed studies generally indicate positive effects of GenAI on academic performance and engagement, while the evidence concerning long-term retention is less consistent. Table 1 summarizes the main studies reported in the reviewed material.

Table 1. Summary of studies included in the review.

Study	Evidence reported	Main finding
Deng et al. (2025) [1]	69 experimental studies	Positive academic and learning effects
Liu et al. (2025) [2]	37 studies	Positive academic achievement
Chen and Cheung (2025) [3]	57 studies	Positive learning outcomes
Barcaui (2025) [4]	Randomized controlled study; 120 undergraduate students	Lower 45-day retention in the ChatGPT-assisted group than in the traditional-learning group
Heung and Chiu (2025) [5]	17 studies; 1,735 students	Positive student engagement
Wu et al. (2026) [6]	35 studies; 4,193 participants	Overall positive learning effects

3.1 Academic performance

The reviewed meta-analyses report positive effects of GenAI on academic performance. Deng et al. reported an effect size of approximately $g = 0.712$ across 69 experimental studies [1]. Liu et al. reported Hedges' $g = 0.577$ across 37 studies [2], while Chen and Cheung reported an effect size of approximately 0.804 across 57 studies [3]. These findings suggest that GenAI assistance can improve performance on academic tasks. However, improved performance alone does not establish that learning will be retained over time.

3.2 Knowledge retention

Retention results are less consistent than immediate academic performance. Barcaui's randomized controlled study involving 120 undergraduate students reported 45-day retention of 57.5% for the ChatGPT-assisted group and 68.5% for the traditional-learning group [4]. This finding suggests that successful task completion with AI assistance may not always translate into stronger long-term memory. It should be interpreted in the context of the particular study rather than as a universal outcome for all GenAI use.

3.3 Cognitive effort

GenAI can reduce the mental effort required to complete academic tasks, which may be useful when it removes unnecessary difficulty, such as searching for basic information or correcting simple mistakes. However, reasoning, recall, analysis, and problem-solving are also important parts of learning. If AI performs these activities instead of the student, opportunities to practice independent learning may decrease. The key issue is therefore not simply whether AI reduces effort, but which type of effort it reduces.

3.4 Engagement and higher-order thinking

The reviewed evidence indicates that GenAI can support student engagement [5]. It may also support higher-order thinking when students question answers, compare ideas, request explanations, identify weaknesses, and evaluate information. In contrast, simply copying AI-generated answers may reduce independent involvement and critical thinking.

3.5 Role of context

The effectiveness of GenAI may depend on how it is integrated into teaching, the subject being studied, the duration of use, instructional design, and whether students interact actively with AI or depend on it to complete tasks. Overall, the reviewed material provides stronger evidence for immediate academic performance and engagement than for long-term retention.

4 Discussion

The findings suggest that GenAI can provide educational assistance through explanations, feedback, examples, and clarification. However, AI-assisted learning differs from AI-dependent learning. In AI-assisted learning, students first attempt to understand or solve a problem and then use AI to clarify concepts, receive feedback, compare approaches, or obtain additional examples. In AI-dependent learning, students rely on AI to generate answers, perform reasoning, and complete problem-solving with little independent effort.

AI-assisted learning can preserve student involvement, whereas excessive dependence may reduce opportunities for independent recall and problem-solving. The retention result reported by Barcaui [4] illustrates why immediate task performance and long-term learning should be considered separately. Nevertheless, the reviewed studies vary in design, setting, and outcome measures, so the findings should not be interpreted as proving that all AI use reduces retention.

4.1 Recommended learning process

1. Attempt the problem independently.
2. Use GenAI to identify mistakes or explain difficult concepts.
3. Compare the AI response with personal reasoning.
4. Verify important information using reliable sources.
5. Solve the problem or explain the concept again without AI.

This approach allows students to benefit from GenAI while maintaining opportunities to practice independent learning.

5 Limitations

1. The research is based entirely on existing studies and does not contain primary data.
2. The reviewed studies differ in subjects, educational settings, methods, and duration.
3. Evidence concerning long-term retention is more limited than evidence concerning short-term academic performance.
4. GenAI technologies are developing rapidly, so findings may change as tools and educational practices evolve.

5. The study does not conduct a new statistical meta-analysis; published findings are synthesized descriptively.

6 Conclusion

Generative AI has become an important educational technology with the potential to improve academic performance, engagement, and access to learning support. The studies reviewed in this paper generally report positive short-term academic outcomes. However, long-term retention presents a more complex picture. Students may perform well with AI assistance while retaining less information when independent learning effort is reduced.

The educational value of GenAI therefore depends strongly on how it is used. GenAI should be treated as a learning assistant rather than a replacement for student thinking. Students should continue practicing independent recall, reasoning, analysis, problem-solving, and explanation. The central conclusion is that efficiency in completing a task should not be confused with effective learning.

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