

THE IMPACT OF LARGE LANGUAGE MODELS ON COGNITIVE ACTIVITY: EVIDENCE OF COGNITIVE DECLINE AND DEPENDENCY IN EDUCATIONAL CONTEXTS

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Annotation: *This study examines the impact of large language models on cognitive activity in education. It analyzes cognitive decline risks and dependency formation based on literature (2020–2026).*

Key words: *large language models, cognition, education, dependency, cognitive decline, artificial intelligence, learning.*

Abstract: *Large Language Models (LLMs) have become widely integrated into educational environments, transforming how students access and process information. This study investigates their influence on cognitive activity, focusing on whether prolonged use contributes to cognitive decline or dependency. A systematic literature review (2020–2026) was conducted. Findings show that LLMs improve learning efficiency and academic performance, but may reduce independent cognitive effort, critical thinking engagement, and memory retrieval when overused. Evidence of permanent cognitive decline is not confirmed, but behavioral dependency patterns and cognitive offloading are frequently reported. The study concludes that the impact of LLMs depends on the balance between assistance and independent thinking in educational practice.*

Keywords: *large language models, cognition, education, dependency, cognitive decline, artificial intelligence, cognitive offloading, critical thinking.*

INTRODUCTION

Large Language Models (LLMs), such as GPT-based systems, have rapidly transformed modern education by enabling automated text generation, summarization, translation, and problem-solving. Their integration into academic environments has significantly changed traditional learning processes, where students previously relied primarily on independent cognitive effort.

Cognitive activity in education includes memory, reasoning, attention, and problem-solving skills. These processes are essential for deep learning and long-term knowledge retention. However, with the adoption of LLMs, many of these cognitive tasks are increasingly supported or replaced by artificial intelligence systems.

One of the key concerns in recent research is cognitive offloading, which refers to the delegation of mental tasks to external tools. While this can improve efficiency and reduce cognitive load, excessive reliance may weaken internal cognitive processes such as memory retrieval and analytical reasoning [1], [5].

Previous studies suggest a dual effect of LLMs: they enhance productivity and accessibility, but may also reduce the depth of cognitive engagement if used without critical reflection [2], [4]. Therefore, the aim of this study is to analyze the impact of LLMs on cognitive activity in education and evaluate whether their use contributes to cognitive decline or dependency.

METHODS

This study employed a systematic literature review approach to analyze the impact of Large Language Models on cognitive processes in educational settings.

Data Collection

Sources were selected from peer-reviewed journals, conference papers, and institutional reports published between 2020 and 2026. Databases included academic repositories and preprint archives.

Inclusion Criteria

Studies were included if they:

- examined LLMs or generative AI in education,
- addressed cognitive processes (thinking, memory, reasoning),
- were published between 2020–2026,
- were written in English.

Exclusion Criteria

Excluded sources included:

- non-academic publications,
- opinion-based articles without empirical or theoretical support,
- studies unrelated to cognition or education.

Data Analysis

A thematic synthesis approach was used. Extracted data were grouped into three categories:

1. cognitive efficiency and learning enhancement,
2. cognitive offloading and reduced mental effort,
3. dependency formation and behavioral changes.

This approach allowed identification of recurring patterns across different studies.

RESULTS

Cognitive Efficiency and Learning Enhancement

Most studies confirm that LLMs significantly improve learning efficiency. They assist students in writing essays, generating ideas, and summarizing complex materials. As a result, academic performance often improves, particularly in language-based tasks [3], [4].

LLMs also reduce the time required to complete assignments, allowing students to focus more on structure and presentation rather than content generation. This leads to improved productivity and accessibility in education.

Cognitive Offloading and Reduced Mental Effort

A consistent finding across the literature is the increase in cognitive offloading. Students increasingly rely on LLMs for tasks that require reasoning, analysis, and memory retrieval. This reduces the need for active cognitive engagement [1], [5].

Over time, such reliance may weaken internal cognitive skills, particularly in critical thinking and problem-solving. Instead of constructing answers independently, learners may prioritize AI-generated responses.

Dependency and Behavioral Changes

Several studies report emerging dependency patterns. Students may become reluctant to start academic tasks without AI assistance and may trust generated outputs without sufficient evaluation [4], [7].

This behavioral shift indicates a transition from active learning to passive consumption of information. While not universal, such patterns are increasingly observed in digital learning environments.

Cognitive Decline vs Cognitive Reorganization

Importantly, there is no strong empirical evidence of irreversible cognitive decline. Instead, research suggests cognitive reorganization, where cognitive effort shifts from production to evaluation and verification tasks [9].

This means that while certain skills may weaken with overuse, others—such as editing and critical evaluation—may become more prominent.

DISCUSSION

The findings demonstrate that Large Language Models have a complex and dual impact on cognitive activity in education. On one hand, they enhance efficiency, accessibility, and academic performance. On the other hand, they reduce cognitive effort in tasks that require independent thinking.

The concept of cognitive offloading is central to understanding these effects. By transferring cognitive tasks to external systems, learners reduce mental effort. While this can be beneficial for productivity, excessive offloading may limit the development of deep cognitive skills.

A key concern is dependency formation. If students consistently rely on AI-generated answers, they may gradually lose confidence in their own reasoning abilities. However, this outcome is not inevitable and depends heavily on instructional design and usage patterns.

LLMs do not inherently damage cognition. Instead, they act as cognitive tools that can either support or replace thinking processes depending on how they are integrated into learning. When used as scaffolding tools that encourage reflection and analysis, they can enhance learning outcomes. When used as substitutes for thinking, they may reduce cognitive engagement.

Therefore, educational systems must promote balanced use of LLMs, ensuring that students remain actively engaged in reasoning, problem-solving, and critical evaluation.

CONCLUSION

This study demonstrates that Large Language Models significantly influence cognitive activity in education.

They improve learning efficiency and accessibility but may contribute to cognitive offloading and dependency when overused. There is no conclusive evidence of permanent cognitive decline; instead, LLMs appear to reshape cognitive processes.

The overall impact depends on how these technologies are integrated into educational practice, highlighting the importance of balanced and critical use.

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