
Newsletter

How Generative Artificial Intelligence Promotes the Cultivation of Higher-Order Thinking Skills: A Systematic Review of 68 Empirical Studies

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HIGHER-ORDER thinking skills (HOTSs) are necessitated in advanced cognitive activities, including creative thinking, problem solving, critical thinking, and more. HOTSs cultivation in education has garnered wide attention in academia. Generative artificial intelligence (GenAI), with its features of multimodal generation, personalized interaction, and expanded support, has the potential to open new pathways for fostering higher-order thinking. Nevertheless, its misuse could lead to technology dependence, hindering deeper cognitive development in learners. How to effectively leverage GenAI to promote the cultivation of HOTSs has become a salient subject in current educational research and practice. This study is a systematic review of high-quality empirical research on the subject conducted in China and other countries since November 2022, aiming to find answers to key questions such as “Which HOTSs can GenAI help foster in learners?”, “How does it foster them?” and “What are the outcomes of GenAI use?”, with the goal of providing theoretical and practical insights for cultivating top-notch innovative talents.

Research Findings:

- Existing research mainly focuses on GenAI use in six teaching scenarios: writing, disciplinary instruction, programming, spoken dialogue, reading, and artistic creation. Platforms used include established large language models, self-developed large models, and educational agents.
- Critical thinking, creative thinking, and problem solving are the three primary HOTSs fostered in GenAI application, followed by self-regulation and human-machine collaboration abilities.
- GenAI fosters the learners’ HOTSs through GenAI-based structured task-driven models and open-ended inquiry models, where it acts as a “teaching assistant” or “learning companion.”
- Most studies included in the review corroborate the positive effects of GenAI application on the development of HOTSs like problem

solving and computational thinking, but its effects on creative thinking ability remains inconclusive.

The study suggests that future research should:

(i) Adopt novel learning analytics techniques, such as epistemic network analysis and behavioral sequence analysis, to reveal the underlying mechanisms by which GenAI fosters specific HOTSs.

(ii) Develop generative human-machine collaborative teaching and learning models. Based on theories such as generative teaching and the Socratic method, activity sequences, including “stimulation – task – dialogue – transfer – evaluation,” could be designed to form workable and transferable instructional models.

(iii) Enhance multimodal process data mining. Facial expression, eye-tracking, EEG, and other multimodal data could be integrated into traditional assessment methods to fully track the development of HOTSs, particularly the formation patterns of creative thinking ability.

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