NEWSLETTER

Is Generative Artificial Intelligence Effective in Improving Student Outcomes? A Meta-Analysis Based on 39 Experimental and Quasi-Experimental Studies

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THE EMERGING GENERATIVE ARTIFICIAL INTELLIGENCE (GenAI) technology has the potential to become strong technological support for further reform and innovation in education by enriching instructional devices and modalities. Nevertheless, its specific effects on student outcomes remains contentious in academia. This article, using meta-analytical techniques, systematically reviews 39 experimental and quasi-experimental studies (encompassing 60 effect sizes) published before June 2024, aiming to investigate the effect of GenAI use on student outcomes and its moderating factors.

Research Findings:

- Overall, GenAI has a moderate and above positive effect on student outcomes (g = 0.623), indicating it is effective in enhancing educational outcomes.
- Subgroup analysis reveals that variables, such as the discipline, sample size, intervention frequency, and application method have moderating effects on the relationship between GenAI use and student outcomes, while those, including the educational stage, intervention duration, and target user, do not show statistically significant moderating effects. Specifically, (i) GenAI exhibits particularly prominent positive effects in medical education, but with minimal effects in the discipline of information engineering; (ii) as the sample size increases, the effect of GenAI on student outcomes diminishes, with even negative outcomes observed in large-scale instructional settings; (iii) multiple-time GenAI-based interventions were more effective than one-time intervention, yet there are no significant differences in the effect among varying durations of the GenAI-based intervention; (iv) the conversational interactive GenAI application is the most widely adopted and yields the best outcomes among all forms of GenAI applications, including content generation, assessment feedback, and the mixed application; (v) GenAI is applicable at all educational levels and among all user groups in the educational world, despite it being primarily

applied to higher education currently, with students being mostly its direct users.

The study recommends actively promoting the deep integration of GenAI into teaching and learning; emphasizing discipline-specific adaptation to achieve tailored GenAI applications; administering GenAI-assisted teaching to appropriate sizes of learner groups and differentiating teaching strategies; setting a legitimate frequency of GenAI interventions; and enhancing the alignment between GenAI application methods and teaching contexts.

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