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A Meta-Analysis Review of the Effects of Project-Based Learning on Critical Thinking in Educational Systems

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ABSTRACT

Objective: This study aimed to determine the overall effect size of project-based learning (PBL) on the development of critical thinking and to examine its effectiveness across different educational levels through a systematic meta-analytic approach.

Method: The present research employed a quantitative meta-analysis conducted in accordance with the PRISMA guidelines. A total of 17 experimental and quasi-experimental studies published between 2019 and 2025 were selected based on predefined inclusion and exclusion criteria. The pooled effect size was calculated using Hedges's g under a random-effects model (REML). Study heterogeneity was assessed using the Q statistic and the I^2 index, and subgroup analyses were performed based on educational level Publication bias was examined using Egger's and Begg's tests as well as the trim-and-fill method.

Results: The results indicated that project-based learning had a positive and statistically significant effect on critical thinking (g = 0.92, 95% CI: 0.83 to 1.01), representing a moderate-to-large effect size. Overall heterogeneity was low and non-significant (I^2 = 0%), although substantial heterogeneity was observed in certain subgroups, particularly at the university level. Subgroup analyses revealed variations in effect sizes across educational levels; however, these differences were not statistically significant. Tests for publication bias provided no conclusive evidence of serious bias, and the trim-and-fill analysis did not alter the overall effect size.

Conclusions: The findings support project-based learning as an effective, evidence-based instructional approach for enhancing critical thinking within educational systems. Nevertheless, given the limited number of eligible studies and variations in conceptualization and contextual factors, the generalizability of the results should be interpreted with caution. Further high-quality experimental research across diverse educational and cultural contexts is recommended.

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