NEWSLETTER

Effects of Problem-based Learning on Student Problem-solving Skills

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TO explore the effect of problem-based learning on student problem-solving skills, this study conducted a meta-analysis of 34 experimental or quasi-experimental studies in China and other countries and tried to answer the following questions: 1) Compared with traditional teaching methods, does problem-based learning affect student problem-solving skills more significantly? 2) In problem-based learning, how do the education levels, teaching periods, disciplines, teaching settings, and assessment tools impact student problem-solving skills?

The results of the study:

The random effect model is used to aggregate the effect indicators, and the combined effect size of problem-based learning on student problem-solving skills is 0.66, the 95% confidence interval is 0.46 - 0.87, and $p < 0.05$, indicating that the research has reached a statistically significant level, and that the overall effect of problem-based learning on student problem-solving skills is at a moderately high level.

Detailed analyses:

As students at different education levels have different cognitive characteristics, this study analyzes four groups of students from elementary school, junior secondary school, senior secondary school, and university, and finds that the combined effect size is 0.47, 0.84, 1.27, and 0.45 for elementary school, junior secondary school, senior secondary school, and university students respectively. The combined effect values at different education levels are all positive, indicating that problem-based learning has a positive impact on students at all stages. The effect is the most significant on senior secondary school students, and weaker on elementary school and university students and above.

In terms of education periods, the effect size is 0.62, 1.01, and 0.59 for 0-2 months, 2-4 months, and more than 4 months respectively. Problem-based learning has a positive effect on student's problem-solving skills in all the three periods. The effect is most remarkable when the education period is

controlled in 2-4 months, and the effect is relatively weak in 0-2 months or for more than 4 months.

From the perspective of disciplines, the effect size is 1.18 for Mathematics, 1.05 for Nursing, 0.78 for Chemistry, 0.76 for Sports, 0.57 for Physics, 0.51 for Science, 0.48 for Robots, 0.28 for Education, and 0.42 for others, indicating that problem-based learning has the most significant positive effect in mathematics, physics, chemistry, nursing, and sports, while its effect in education and other subjects is relatively weak.

This study involves three types of teaching settings, that is, ordinary classrooms, laboratories, mixed indoor and outdoor locations. The combined effect size is 0.72 in ordinary classrooms, the 0.44 in laboratories, and 0.67 in mixed indoor and outdoor locations. It shows that the implementation of problem-based learning in ordinary classrooms has the greatest positive effect on students' problem-solving skills.

From the perspective of assessment tools, the study divides the literature sample into three categories by questionnaire method, self-diagnostic tests, and teacher-made objective assessments. The effect size is 0.91, 0.38 and 0.82 respectively. A student problem-solving skill has nothing to do with assessment tools, but the results obtained by different assessment tools differ.

Based on analysis results, the research puts forward the following suggestions: i) Design problem-based learning according to students' cognitive characteristics at different education levels. ii) Optimize the application of problem-based learning in various disciplines, iii) Incorporate virtual technology and diversify the teaching settings. iv) Integrate multiple assessment methods and tools.

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