

Teaching science problem solving: An overview of experimental work

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Abstract

The traditional approach to teaching science problem solving is having the students work individually on a large number of problems. This approach has long been overtaken by research suggesting and testing other methods, which are expected to be more effective. To get an overview of the characteristics of good and innovative problem-solving teaching strategies, we performed an analysis of a number of articles published between 1985 and 1995 in high-standard international journals, describing experimental research into the effectiveness of a wide variety of teaching strategies for science problem solving. To characterize the teaching strategies found, we used a model of the capacities needed for effective science problem solving, composed of a knowledge base and a skills base. The relations between the cognitive capacities required by the experimental or control treatments and those of the model were specified and used as independent variables. Other independent variables were learning conditions such as feedback and group work. As a dependent variable we used standardized learning effects. We identified 22 articles describing 40 experiments that met the standards we deemed necessary for a meta-analysis. These experiments were analyzed both with quantitative (correlational) methods and with a systematic qualitative method. A few of the independent variables were found to characterize effective strategies for teaching science problem solving. Effective treatments all gave attention to the structure and function (the schemata) of the knowledge base, whereas attention to knowledge of strategy and the practice of problem solving turned out to have little effect. As for learning conditions, both providing the learners with guidelines and criteria they can use in judging their own problem-solving process and products, and providing immediate feedback to them were found to be important prerequisites for the acquisition of problem-solving skills. Group work did not lead to positive effects unless combined with other variables, such as guidelines and feedback.

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