

Learning geometry from goal-free problems: alone or together with friends?

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Learning in small-group has been promoted at school since presumably it could foster student's achievement as well as collaboration skills. This study investigated an instructional design that is effective for collaborative learning based on a cognitive load theory. Previous research indicated that goal-free problems improved individual learning. In the current research, goal-free problems were examined for collaborative learning. It was predicted that (1) Goal-free problems would facilitate learning better than goal-given problems; (2) Collaboration would facilitate learning better than alone; and (3) Goal-free problems would improve collaborative learning.

The first experiment was conducted in authentic mathematics classrooms employing a factorial design: 2 groupings (collaborative vs. individual) x 2 problem-type (goal-free vs. goal-given problems). Four consecutive phases were involved: introductory, acquisition, retention test and transfer test. The participant was a hundred and eleven seventh graders (Age average: 12.8 y.o.) from Indonesian school that used the same curriculum and the students had equivalence mathematics competence. The learning materials, Geometry theorems on angle measurement, were novice to the participant. The finding of transfer scores supported the first hypothesis that students who learned by goal-free problems had significantly higher transfer scores than those given the goal-given problems. The second and third hypotheses were not confirmed. Instead, it was found that individual learners scored significantly higher in the transfer test than the collaborative learners. Moreover, while studying during acquisition phase, participants were also asked to rate their cognitive load using the 9-point questionnaire. Interestingly, it was found that the students in goal-free approach experienced significantly higher cognitive load than in goal-given approach, and individuals experienced significantly higher cognitive load than collaborative learners. This cognitive load rating was also collected during tests however no-significant differences between groups were indicated. It is reported that no pattern of interaction effects was found either on test scores or cognitive load rating.

These hypothesis were re-examined using the same experimental design. A number of 136 eight graders (Age average: 14.01 y.o.) from Indonesian school participated and were asked to study a new material about triangle similarity theorems. The results repeated the first experiment results. The retention and transfer scores of students who learned from goal-free problems were significantly better than the goal-given (confirming hypothesis one). Similarly, hypotheses two and three were not proven. It was also found that individual learners were significantly better than the collaborative learners. No interaction effects showed. Repeated results on the cognitive load rating during acquisition phase were also indicated that students in goal-free problems reported higher score than those in goal-given problems. It might be said that goal-free problems could be an effective approach for either individuals or collaborative learning, although it might cause heavy cognitive load during acquisition.