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ScienceDirect

Procedia - Social and Behavioral Sciences 217 (2016) 169 – 176

Procedia
Social and Behavioral Sciences

Future Academy®'s Multidisciplinary Conference

Predicting Algebra Achievement: Cognitive and Meta-cognitive Aspects

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Abstract

Click here and insert your abstract text. One of the most important goals of mathematics learning is to enhance students' mathematical achievement and also develop skills in mathematics problem solving. The purposes of this study were to consider: How well algebra problem solving performance, meta-cognitive strategies, and cognitive strategies (IVs) predict students' mathematical achievement (DV)? How much variance in mathematical achievement score can be explained by scores of algebra problem solving performance, meta-cognitive strategies, and cognitive strategies? Which is the best predictor of mathematical achievement: algebra problem solving performance, meta-cognitive strategies, or cognitive strategies? The subjects of this study were selected from first year mathematics students who took Algebra course in a public university in Malaysia. The Cognitive Strategy Questionnaire comprises of 18 items, was used to assess the students' specific cognitive strategy for solving the given Algebra problems. Algebra problem solving performance was measured using a test includes routine and non-routine problems, based on the covered topics in the course. The results indicated that there is no significant correlation between independent variables (Algebra problem solving performance, meta-cognitive strategies, deep cognition and shallow cognition). ALGPS and overall meta-cognition are two independent variables which make a strong and significant unique contribution to the prediction of mathematical achievement as a dependent variable, when the explained variance is controlled by all other variables in the model (Beta=0.686, $p<0.05$), (Beta=0.157, $p<0.05$). The value of R square is 0.546 which is indicating 54.6 percent of the variance in the mathematical achievement as independent variable is explained by the model of regression (which includes the variance of algebra problem solving performance, meta-cognitive awareness, deep cognitive strategies and shallow cognitive strategies). The F Change shows the relationship between the set of IVs and the DV is significantly large [$F(4,83)=24.914$, $p<0.0005$]. The answer of the first question of research is: 54.6 percent of the variance in the mathematical achievement as independent variable is explained by the model of regression (which includes the variance of algebra problem solving performance, meta-cognitive awareness, deep cognitive strategies and shallow cognitive strategies). The answer of the second question of research is: among these four variables, ALGPS makes the largest unique contribution, although overall meta-cognition also made a statistically significant contribution.

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Peer-review under responsibility of Future Academy® Cognitive Trading
doi:10.1016/j.sbspro.2016.02.054

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Peer-review under responsibility of Future Academy® Cognitive Trading

Keywords: Cognitive strategies; Metacognitive strategies; Algebra problem solving performance; Mathematical achievement;

1. Introduction

Problem solving is considered as a higher order domain of inquiry (Derry et all, 1993). In some situations problem solving regards to a strategy which is used for developing the reasoning skills of learners as it involves research to identify problems, analyses of various perspectives on the problem, evaluation of the merit of the different perspectives, and synthesis of findings (Hiebert, 1997). In problem solving the cognitive abilities are essential to success in any scientific or professional field (Schoenfeld, 1985). Two kinds of effective strategies in successful of problem solving are cognitive strategies and meta-cognitive strategies that are as learning strategies.

Learning strategies are an individual's approach to a task which affects how a student organizes and uses a set of skills to learn content or to accomplish a particular task more effectively and efficiently either in or out of school (Schumaker& Deshler, 1984). Many researchers have mentioned, a lot of learning strategies such as cognitive learning strategies are offered for mathematics learning. Students are able to employ two types of learning strategies for learning new things: cognitive and meta-cognitive processes. Furthermore, cognitive strategies consisting of rehearsal, elaboration and finally organization help students to encode, organize and retrieve new information. As detailed by some researchers these strategies are classified into surface cognitive strategies and deep cognitive strategies. Surface cognitive strategies involve the repetitive rehearsal and rote memorization of information, which help to encode new information into short-term memory, mainly through reading the course material over and over again. On the other hand, deep cognitive strategies refer to elaborating, organizing and critical thinking, and they challenge the reality of information encountered and attempting to integrate new information with past knowledge and experience, which facilitate long-term retention of the target information, for example making an outline of important concepts after a learning session.

There are some studies which have examined the link between performance goals and the use of deep cognitive strategies in college students. These studies results showed performance goals are consistently unrelated to student's use of deep cognitive strategies. Wolters (2004) indicated that performance approach goals were positively related to the use of deep cognitive strategies. In several studies it was reported that performance goals are positively related to students' use of surface cognitive strategies (Elliot et al. 1999). The results of some studies, which have investigated the relationship between performance goals and using of deep cognitive strategies among college students, indicated that performance goals and use of deep cognitive strategies by students were consistently distinct. Also according to Dart, Burnett, Purdie, Campbell and Smith (2000) using of surface cognitive strategy is related to highlighting on formal achievement.

The other strategy of learning that is meta-cognitive strategy includes self-questioning and self-checking techniques and also consisting of planning, monitoring and regulation which help individuals to control and execute their learning processes. Monitoring enables students to be awarded of comprehension in order to follow their plan to successfully solve their problem. Planning helps the students to analyze the problem and it involves a variety of suitable strategies that affect performance. At the end, the process evaluation of the problem solution helps the student to judge the answer and to process for obtaining the answer and they can re-evaluate their goal and deduction. Flavell introduced the concept of meta-cognition as a concept of intelligent structuring and storage of input, of intelligent search and retrieval operations, and of intelligent monitoring and knowledge of these storage and retrieval operations - a kind of 'meta- memory' (Flavell, 1971 p. 277). Dunning, Johnson, Ehrlinger and Kruger (2003), mentioned Meta-cognition is important in learning and also it is a strong predictor of academic achievement seeing that students with good meta-cognition have good academic performance compared to students with poor meta-cognition. There are many studies have focused on the relationship between meta-cognition and learning

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