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# What Neuropsychology Says about Mathematical Word Problem Solving: Contribution of Executive Function in Educational Setting

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***Abstract***

The literature study was aim to describe the important role of neuropsychology in relation with the process of learning mathematical word problem. In this case, the involvement basic components of executive function (EF) which is consist of working memory, inhibition control, and shifting. The components of EF play an important role in higher order cognitive process to solve mathematics word problem, i.e. reasoning, planning, monitoring and problem solving. Implication for further study will consider basic components of EF capacity to design explicit instruction to improve mathematics word problem solving ability in the classroom.

**Keywords:** neuropsychology, executive function, mathematical word problem solving, metacognitive, explicit instruction

## 1. INTRODUCTION

Neuropsychology plays an important role in mathematical learning difficulty (Newcombe et al., 2009; von Aster, 2000), particularly, mathematical word problem solving. Previous study reported that area prefrontal cortex of human brain involved in reasoning (Bunge, Wendelker, Badre, & Wagner, 2005), problem solving and other higher order cognitive process (de Souza, et al., 2014). Using multi-step strategy of Mathematical word problem consist of reading text carefully, paraphrasing. It was more difficult than mathematics without word problem (Hoogland, Pepin, de Koning, Baker, & Gravemeijer, 2018), therefore mathematical word problem need higher order cognitive process to solving it (Fuchs, Gilbert, Seethaler, & Martin, 2017; Wang, Fuchs, & Fuchs, 2016).

Executive function (EF) lies in prefrontal cortex (PFC) of the brain which is as cognitive control function. EF is a neuropsychology construct that consist of three basic cognitive skills with namely: working memory, inhibition control and shifting/cognitive flexibility (Diamond, 2012; Friedman & Miyake, 2016). Three components of EF are essentials to build higher order cognitive process in academic domain, especially, using strategy to solve mathematical word problem (Fung & Swanson, 2017; Viterbori, Traverso, & Usai, 2017). Previous study was reporting that learning mathematical difficult due to low capacity in working memory (capacity to hold information and manipulation it) (Swanson, Zhang, & Jerman, 2008); inhibitory control (control unexpected response (Brookman-Byrne, Mareschal, Tolmie & Dumontheil, 2018); and shifting/cognitive flexibility (using procedural strategy) (DeCaro, 2016).

This study literature was aim to describe what is executive function's contribution toward mathematical word problem solving. Working memory, inhibitory control and shifting are lower cognitive process than planning and problem solving. Three of components EF are equal each other (Miyake, et al., 2000) and play an important role to multi-step strategy of mathematical word problem solving. In the other side, planning, monitoring and procedural are components in using strategy to solve mathematical word problem (van Velzen, 2016). In other words, how to solve mathematical word

 

problem depend on working memory, inhibitory control and shifting flexibility. Few researches reported that using three of components EF concurrently to solve mathematical word problem (Abreu-Mendoza, Chamorro, Garcia-Barrera, & Matte, 2018; Wang, Georgiou, Li, & Tavouktsoglou, 2018). Especially, experimental research in educational setting is not considering components EF as a covariate between multi-step strategy training and mathematical word problem solving ability. Previous research, only using working memory as covariate between solving strategy training and mathematical word problem solving ability (Swanson, 2015; 2014; Swanson, Lussier, & Orosco, 2013; 2015; Swanson, Moran, & Fung, 2014).

## 2. DISCUSSION

Current study literature is describing an important role of Executive Functions (EF) toward mathematical word problem solving. Three components of EF that consist of working memory, inhibition control and shifting are indirect contributing to three main components of mathematics, i.e. knowledge of fact, concept and procedural skills (Cragg & Gilmore, 2013) and direct influence to mathematics achievement (Bull & Lee, 2014; Mulder, Verhagen, Van der Ven, Slot, & Laseman, 2017; St John, Dawson, & Estes, 2018). The influence inhibitory control to mathematical word problems to inhibit unexpected or wrong respon, for example *"Tono has 25 marbels. She has more 5 marbels than Joko has. How many marbels does Joko have?"*. Previous research was reporting that the use of relational term "more than" in the text is not addition (Lubin, et al., 2016). Students with low inhibitory control capacity understand it as additional, then it is wrong response.

Using strategy to solve mathematical word problem is different without words for student's mathematics learning difficulty. In this case, to solve mathematical word problem using multi-steps strategy or named explicit instruction. Explicit instruction is a strategy teaching metacognitive based mathematical word problems for students learning difficulty (Babakhani, 2011; Powell & Fuchs, 2018). In educational setting, students were trained by metacognitive strategy to planning and monitoring their cognitive process (Panahandeh & Asl, 2014; Papleontiou-louca, 2003). Neuropsychology or cognitive neuroscience perspective describe that monitoring and planning are as higher level cognitive (García-Madruga, Gómez-Veiga, & Vila, 2016) than working memory, inhibitory control and shifting. In other words, three basic EF components facilitate children's metacognitive in mathematics learning.

Further experimental research in educational psychology will consider to design explicit instruction to improve mathematical word problem solving. The explicit instruction design should consider individual differences in executive functions (EF) capacity.

## 3. CONCLUSION

Executive function capacity will determine metacognitive ability in student's mathematics learning difficult. In the other side, teaching metacognitive based strategy can encourage independent learner to solve mathematical word problem.

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