

# VStops: A Thinking Strategy and Visual Representation Approach in Mathematical Word Problem Solving toward Enhancing STEM Literacy

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This study aimed to determine the impact of strategic thinking and visual representation approaches (VStops) on the achievement, conceptual knowledge, metacognitive awareness, awareness of problem-solving strategies, and student attitudes toward mathematical word problem solving among primary school students. The experimental group (N=96) received the VStops approach in teaching and learning of mathematical word problem solving, while the control group (N=97) received the conventional approach. Five instruments were used to collect the data: the achievement test, conceptual knowledge test, metacognitive awareness questionnaire, problem-solving strategies awareness questionnaire, and attitudes toward mathematical word problem-solving questionnaire. Pre and posttest data were analyzed using multivariate analysis of variance (MANOVA) followed by univariate analysis of variance (ANOVA). Overall, the study found that the VStops approach had a positive impact on achievement, conceptual knowledge, metacognitive awareness, awareness of problem-solving strategies, and student attitudes toward mathematical word problem solving.

*Keywords:* mathematical word problems, thinking strategy approach, visual representation approach

## INTRODUCTION

The decline in the number of students pursuing STEM-related studies at the secondary and tertiary levels; and the low performance shown in international studies, such as TIMSS, among Malaysian students is alarming. To become a developed nation, STEM is essential to our educational system. Our country's entire economy revolves around mathematics, science, engineering, accounting, business, transportation, geology, and economics. Therefore, it is the

responsibility of primary educators to inculcate the importance of STEM in the mathematics curriculum. One way is to improve mathematical problem-solving abilities among schoolchildren. This is in accordance with the STEM literacy definition, which states that STEM literacy is the ability to identify and apply concepts and content from science, technology, engineering, and mathematics to understand and solve challenges or problems that cannot be resolved by any one disciplinary approach (Washington STEM Study Group, 2011). The current way of teaching mathematics focuses on drilling and remembering facts and procedures. This method does not encourage thinking and problem-solving capabilities. Most students go into higher levels of learning and become rote learners of mathematics, and do not appreciate the beauty and importance of mathematics in daily life. The acquisition of skills in mathematical word problem solving can be

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### **State of the literature**

- The current method of teaching mathematics focuses on drilling, and remembering facts and procedures.
- Students had difficulties in controlling the mechanisms of self-regulation, which involve metacognitive awareness and cognitive control.
- Although many studies have investigated problem solving in mathematics, there are few studies focusing on the effects of a thinking strategy and visual representation approach on primary schools students.

### **Contribution of this paper to the literature**

- Central to this study is the effectiveness of the thinking strategy and visual representation approach in increasing students' achievement, conceptual knowledge, metacognitive awareness, awareness of problem-solving strategies, and attitudes toward mathematical word problem solving among primary school students.
- A classroom-oriented approach module was developed and implemented as an aid in the teaching and learning of mathematical word problems. The approach was based on thinking strategies and visual representations (VStops).

achieved through effective delivery and by applying complex thinking through systematic and effective awareness of self-regulation. Mathematics educators at all levels should seek to develop the skills of problem solving, reasoning and proof, communication, representation, and connections in their students (NCTM, 2000; 2003). Approaches and strategies in problem-solving skills should not only be directed toward activities of doing, but also be comprehensive and involve the activity of thinking. The need for doing and thinking is because both have an integrated relationship in the domain of knowledge and problem solving (Adeleke, 2007; Cooper & Harries, 2002; Baumert et al., 2010).

According to Fuchs et al. (2008) and Beyer (1988), knowledge of problem solving in mathematics should not only emphasize schematic solutions as a standalone strategy; but should also involve higher-thinking skills that include self-regulated awareness, while applying heuristics to integrate with facts and information. Thus, all aspects of skills, knowledge, awareness, and control of thinking become a prerequisite for productive decision making (Calhoun & Fuchs, 2003; Cennamo & Kalk, 2005; Kapa, 2001; Pugilee, 2001). By building these problem-solving competencies, students will strengthen their conceptual understanding, procedural fluency, strategic competence, productive disposition,

and adaptive reasoning abilities. In addition, student will be able construct new knowledge, make representations, apply heuristics, reflect on actions taken, and improve their attitudes, confidence, perseverance, persistence, exploration and creativity (Agnes, 2002; Hanich et al., 2001; Huat, 2006; Kilpatrick & Swafford, 2002; Leinwand et al., 2007). In view of the importance of problem-solving skills, awareness and control of the thinking process that occurs in the minds of students should be given attention, and focus should be placed on strengthening students' conceptual and strategic knowledge (Jitendra et al., 2007; Reed, 2001; Rittle-Johnson et al., 2001; Snowman & Biehler, 2011).

Solving a mathematical problem is very complex because it involves a multi-step processes through psychological control, verbal processes, comprehension, representations, application of a variety of heuristics, conceptual knowledge, procedural fluency, affective reactions, awareness of cognitive, metacognitive control, and a system of beliefs about mathematics (Goldin & Shteingold, 2001; Hill, 2008; Johnson, 2010). Students' abilities to solve mathematical word problems not only rely on finding the right answer but also involve understanding and mastering more complex strategies such as the ability to plan, monitor, and evaluate. In addition, students should be able to interpret problems in the form of visual representations and reasoning in working memory. Visual representations aim to inspire ideas and allow a deeper understanding of a relationship in problem solving (Knight 2000; Mohd Daud Hamzah 2002; Parkinson & Redmond, 2002; Stylianou, 2002). All these aspects require students to master the knowledge and adopt or have an awareness of metacognitive and cognitive elements in a conscious and organized way (Ayres 2006; Butcher et al., 2006; Mayer 2003).

### **Background of the study**

Student difficulties in controlling the mechanisms of self-regulation, which involve metacognitive awareness and cognitive control is a major problem caused by a lack of attention and interference in their thinking systems. This mechanism is a major obstacle to students during problem-solving tasks (Geary, 2004; Hanich, 2004; Krulik & Rudnick, 1996; Jitendra et al., 2002). Metacognition is used to control all strategies, procedures, and specific skills during the problem-solving process. This notion is in line with the views on cognitive control, in which metacognition is responsible for controlling the success of activities or cognitive strategies used, and monitors all information processed through given responses (Beyer, 1988; Favell, 1976; Pintrich, 2002).

Students' inability to self-regulate and be aware of their thinking processes cause problems during

mathematical problem solving, especially with word problems. Research has found that a majority of students are not able to determine the required information in a problem and then transform it into mathematical sentences, algorithms, representations, operations, and appropriate procedures (Anneke, 2001; Berch & Mazzocco, 2007; Duval, 2002; Grugnetti & Jaquet, 2005; Ismail, 2009; Johnson, 2010; Malmivouri, 2001; Montague et al., 2000; Suhaidah & Mohd Szali, 2009). In addition, students have difficulty associating concepts into mathematical information in a meaningful way and transferring the conceptual aspects into actual solutions to the problems (Kroesbergen & Van Luit, 2002; Nathan et al., 2002; Olive & Steffe, 2002; Thevenot & Oakhill, 2008). Further, they have less awareness and ability to control their thinking to solve problems, particularly in the application of metacognitive and cognitive control elements in doing so. This deficiency gives the impression to students that mathematical word problem-solving skills are difficult to master and they do not have the confidence to solve them (Lerch, 2004; Hagit & Anat, 2010a; Mayer, 2003; Noraini, 2005; Parmjit, 2005).

Due to these issues, solving word problems is difficult, especially considering the inability of students to control their thought processes, and apply concepts and procedures to the problems. To overcome this problem, students need to develop and grow the habits and tendencies that will give meaning to the problems, and allow them to interpret the problems carefully. In addition, to master a repertoire of thinking skills, students must acquire knowledge of specific strategies (Johnson, 2010; Hill et al., 2005; Lager, 2006; Tuohimaa et al., 2008). Thus, based on the literature, a classroom-oriented approach was implemented. The approach was based on thinking strategies and visual representations (VStops). A module was developed (MVStops) as an aid in the teaching and learning of mathematical word problems. The VStops approach was intended to help students master a repertoire of thinking skills; in particular, those involving metacognitive knowledge and cognitive elements, while developing habits and tendencies to give meaning to, and interpret, the problems through effective visual representations. This method was chosen because solving mathematical word problems involves the ability to transfer ideas from a concrete form to a more abstract form, and apply all of the concepts and procedures that have been learned to find the solution to the problem (Alexandra, 2005; DeWindt-King & Goldin, 2003; Faulkenberry, 2003; Presmeg, 2008; Rittle-Johnson & Star, 2007). Three main elements of thinking were incorporated into the VStops approach: control of metacognitive process and cognitive strategies, and the ability to develop visual representations to solve mathematical word problems.

Metacognitive processes include an individual's ability to plan, monitor, evaluate, and control the cognitive strategies that involve understanding the problem, planning a strategy, implementing the strategy, and evaluating the solution during the process of mathematical word problem solving. Students' conceptual knowledge is developed through their cognitive abilities to construct visual representations mentally. The image that emerged as a result of the translation of the word in the problem is a reflection of the visual image in the form of diagrams and modeling to help students understand the concept of the mathematical problem to be solved. Each element interacts with, and has a continuous relationship in, the VStops approach in the teaching and learning of mathematical word problems.

### Purpose of the study

This study aimed to identify the impact of thinking strategy and visual representation (VStops) approaches implemented through MVStops modules (MVStops) on achievement, conceptual knowledge, metacognitive awareness, awareness of problem-solving strategies, and attitudes toward mathematical word problem solving. Making comparisons between a control and experimental group, the objectives of the study were as follows: a) determine the differences in student achievement, b) determine the differences in students' conceptual knowledge, c) determine the differences in students' metacognitive awareness, d) determine the differences in students' problem-solving strategies, and e) determine the differences in students' attitudes toward problem solving.

## RESEARCH METHODOLOGY

### Population and Sampling of the Study

This study used a quasi-experimental pre and posttest nonequivalent control group design. The pretest was used to determine whether there was similarity between groups; this test was also used as a statistical control. The posttest was used to determine the difference between experimental and control groups. The implementation period of this study was 10 weeks. The number of participants involved was 193 students, which consisted of 96 students in the experimental group and 97 in the control group. Sample selection was conducted using two methods: purposive sampling and simple random sampling. In this study, the experimental group was given the strategy thinking and visual representation (VStops) approach through MVStops modules in the teaching and learning of mathematical word problem solving, while the control group received the conventional approach. The

conventional approach refers to a direct approach to teaching and giving explanations using the year five textbook.

### Instrumentation

Five instruments were used in this study. An achievement test was used to measure student achievement in mathematical word problem solving and included 20 items based on the six scoring criteria of the Primary School Achievement Test (UPSR) issued by the Malaysian Examination Board (LPM, 2002). Conceptual knowledge instruments were used to reflect students' knowledge about important concepts in mathematical word problems. Every step of the students' work in the solutions of mathematical word problems was checked and scored based on four grading rubric criteria, and modified and adapted from the *NWREL Mathematics Problem Solving Scoring Guide* (2000) and Schommer-Aikins et al. (2005). The metacognitive awareness questionnaire was used to measure three components of metacognitive awareness in problem solving, planning, monitoring, and evaluation. This instrument measures student knowledge in a set of activities that help regulate cognitive strategies when faced with a problem situation. This instrument was adapted and modified from *State Metacognitive Inventory* (O'Neil & Schacter, 1997), which uses Likert scale ranking. The awareness questionnaire of students' mathematical word problem solving strategies was designed to measure students' knowledge of cognitive strategies that can be observed and generated by students during the problem-solving process (i.e., understanding the problem, planning a strategy, and implementing and reviewing strategies to reach a solution). This instrument is an adaptation and modification of the *Cognitive Strategy Rubric of Mathematical Word Problem Solving* (Ismail, 2009). The questionnaire of students' attitudes toward mathematical word problems was based on the adaptation and modification of the *Student Attitude Questionnaire* derived from the *Mathematical Problem Solving Project* (Charles et al., 1997). This questionnaire measures students' attitudes toward mathematical word problem solving based on self-assessment. Three categories were evaluated (a) willingness to engage in problem solving, (b) persistence in the performance of the problem-solving process, and (c) confidence to solve word problems. Reliabilities of instruments were determined using Cronbach's Alpha coefficients, which yielded 0.76 to 0.89, respectively.

### Procedure for Data Analysis

Two main analyses were used a) descriptive statistical analysis through frequency, percentage, mean, and standard deviation; and (b) inferential statistical analysis using Multivariate Analysis of Variance (MANOVA)

followed by Univariate analysis (ANOVA). An inferential statistical analysis is a statistical analysis involving hypothesis testing where the results are used to make generalizations or descriptions of the population. Data were analyzed using MANOVA followed by ANOVA (significance level of  $p < 0.05$ ). ANOVA was used to determine the specific meaning of each main effect (George & Mallery, 1999).

There are several reasons why MANOVA was used in this study. First, the use of MANOVA can solve the problem of Type I errors and give an overall test score of group differences at a certain alpha value (Hair et al., 1998). Second, MANOVA considers correlations between the dependent variable, thus giving an accurate reflection of the data (George & Mallery, 1999). To determine the overall correlation between the dependent variables, Hair et al. (1998) suggested using Bartlett's Test for Sphericity. Third, the dependent and manipulated variables in this study meet the criteria for MANOVA: five dependent variables or responses and one manipulated variable (Taqi, 1997). Testing was done to meet the assumption of MANOVA. To determine the uniformity of the variance of the two groups, Levene's test was used. Univariate Levene's Test of Equality of Variances Errors of the five variables was not significant ( $p > 0.01$ ). This shows that the variance of the two groups of dependent variables is not different. Bartlett's test of sphericity showed a significant correlation between the dependent variables ( $p < 0.05$ ). Box's M value is greater than  $p > 0.01$ , thus indicating homogeneity of variance covariance between the dependent variables across the independent variables. Analysis of the distribution of scores collectively showed no difference between experimental and control groups.

### RESULTS

This section displays the analysis of the pre and posttests, which measured the impact of the five dependent variables of achievement, conceptual knowledge, metacognitive awareness, awareness of problem-solving strategies, and attitudes toward mathematical word problem solving. Table 1 shows the mean scores and standard deviations for the pre and posttest for the experimental and control groups. For the experimental group, the mean achievement test scores was 36.93, while for the control group, it was 37.56. For scores of conceptual knowledge, the experimental group mean was 17.35, while the control group mean was 18.03. Mean score of metacognitive awareness of the experiment group was 1.77 and the control group mean was 1.80. For the experimental group, scores for the variables of awareness of problem solving was 2.16, while the control group mean was 2.17. For the variables of attitude towards mathematical

**Table 1.** Mean Scores Pretest, Posttest, and the Standard Deviation of the Dependent Variable

Variables	Pretest		Posttest	
	Experimental	Control	Experimental	Control
Achievement test				
Mean	36.93	37.56	75.75	60.32
Standard Deviation	10.32	11.04	11.45	16.02
Conceptual knowledge				
Mean	17.35	18.03	40.48	30.07
Standard Deviation	6.95	6.60	6.69	8.58
Metacognitive awareness				
Mean	1.77	1.80	2.66	2.08
Standard Deviation	0.09	0.10	0.25	0.22
Awareness of problem-solving strategies				
Mean	2.16	2.17	2.64	2.44
Standard Deviation	0.14	0.15	0.24	0.17
Attitudes towards mathematical problem solving				
Mean	1.47	1.45	1.73	1.51
Standard Deviation	0.14	0.14	0.17	0.14

**Table 2.** Results of Multivariate Analysis of Variance (MANOVA) and analysis of variance (ANOVA) for the pretest

Variables	Multivariate F <i>df</i> = 2	Univariate F <i>df</i> =(1,191)	Probability <i>p</i>
Groups	0.99		0.42
Achievement test		0.17	0.69
Conceptual knowledge		0.48	0.49
Metacognitive awareness		3.19	0.08
Awareness of problem-solving strategies		0.17	0.68
Attitudes towards mathematical problem solving		0.83	0.37

**Table 3.** Results of Multivariate Analysis of Variance (MANOVA) and analysis of variance (ANOVA) for the posttest

Variables	Multivariate F <i>df</i> = 2	Univariate F <i>df</i> =(1,191)	Probability <i>p</i>
Effects of approach	92.82		0.00
Achievement test		59.18	0.00
Conceptual knowledge		88.17	0.00
Metacognitive awareness		285.12	0.00
Awareness of problem-solving strategies		43.78	0.00
Attitudes towards mathematical problem solving		88.30	0.00

problem solving, the experimental group showed the mean of 1.47 and for the control group, the mean value was 1.45. Descriptive findings showed that the mean score and standard deviation for all the variables were similar.

### Pretest Analysis

This section discusses the differences between the scores of the experimental group and the control group for the pretest responses. The pretest was administered to ensure that both the experimental and control groups were similar at the beginning of the study. All variables were used in the pretest. The results of MANOVA on

the dependent variable were based on the group as a whole, which indicated no significant main effect of group on the five variables: *Pillai's Trace* =  $F(5, 187) = 0.99$ ,  $p = 0.424$ ,  $p > 0.05$ ,  $\eta^2 = 0.026$ . Bonferroni correction for the five tests ( $\alpha = 0.05/5 = 0.01$ ) was used to determine the association between the dependent and independent variable. Effect size ( $\eta^2$ ; partial eta squared) is reported for each analysis to determine whether there were differences between the two groups on the pretest. Further checks for each dependent variable need to be done (Pallant, 2009). Univariate analysis showed no significant difference between groups in achievement test [ $F(1, 191) = 0.17$ ,  $p = 0.69$ ,  $p > 0.01$ ,  $\eta^2 = 0.001$ ]; conceptual knowledge [ $F(1,$

191) = 0.48,  $p = 0.49$ ,  $p > 0.01$ ,  $\eta^2 = 0.003$ ]; metacognitive awareness [F(1, 191) = 3.19,  $p = 0.08$ ,  $p > 0.01$ ,  $\eta^2 = 0.016$ ]; awareness of problem-solving strategies [F(1, 191) = 0.17,  $p = 0.68$ ,  $p > 0.01$ ,  $\eta^2 = 0.001$ ]; and attitudes toward problem solving [F(1, 191) = 0.83,  $p = 0.37$ ,  $p > 0.01$ ,  $\eta^2 = 0.004$ ] (see Table 2).

The results also yielded no differences in the mean scores of the five variables between the experimental and control groups. This finding means that at the beginning of the study, all the variables were equal.

### Posttest Analysis

The results of the MANOVA showed a significant main effect for approach [Pillai's Trace = F(5, 187) = 92.82,  $p = 0.000$ ,  $p < 0.05$ ,  $\eta^2 = 0.713$ ] for the five dependent variables,  $\eta^2$  value = 0.7, which indicates that the VStops approach had a significant impact on the five dependent variables, with scores of 0.713 or 71.3% on the posttest. According to Cohen (1977, in Stevens 1996), the partial eta squared effect sizes ( $\eta^2$ ) of 0.01 is small, 0.06 is medium, and 0.14 is large. Overall, the results of the analysis showed main effects for the combination of the five dependent variables. The main effects of each dependent variable are identified in Table 3. The results showed a main effect for approach on achievement test scores, conceptual knowledge, metacognitive awareness, awareness of problem-solving strategies, and attitudes toward problem solving. The results were significant for approach on achievement test [F(1, 191) = 59.18,  $p < 0.01$ ,  $\eta^2 = 0.24$ ]; conceptual knowledge, [F(1, 191) = 88.17,  $p < 0.01$ ,  $\eta^2 = 0.32$ ]; metacognitive awareness [F(1, 191) = 285.12,  $p < 0.01$ ,  $\eta^2 = 0.60$ ]; awareness of problem solving strategies [F(1, 191) = 43.78,  $p < 0.01$ ,  $\eta^2 = 0.19$ ]; and attitudes toward problem solving [F(1, 191) = 88.30,  $p < 0.01$ ,  $\eta^2 = 0.32$ ] (see Table 3). From the analysis, the effect sizes were also found to be large for the five independent variables; the value of  $\eta^2$  (eta squared) was between 0.19 to 0.60 (Cohen 1988). According to Kiess (1996), generally, a value of  $\eta^2$  (eta squared) between 0.10 to 0.15 may indicate a strong treatment effect.  $R^2$  also showed that the approach contributed 0.237 (23.7%) to the score on the achievement tests, 0.316 (31.6%) to conceptual knowledge, 0.599 (59.9%) to metacognitive awareness, 0.186 (18.6%) to awareness of problem-solving strategies, and 0.316 (31.6%) to attitudes toward problem solving among students.

### DISCUSSION

Based on the results, the VStops approach is capable of improving student achievement, conceptual knowledge, metacognitive awareness, awareness of problem-solving strategies, and attitudes toward mathematical word problem solving.

### Mathematics achievement

The experimental group performed better than the control group in achievement of students using the VStops approach. The VStops approach is based on the key elements that are extracted from the models of Beyer (1988), Polya (1957), Schoenfeld (1985), Krulik and Rudnick (1996), Stylianou (2002) and Lesh et al. (2003). Each element of control mechanisms—in particular, thinking strategies involving metacognitive and cognitive elements, and construction capabilities through visualization representation—directly assist and influence the achievement of the experimental group of students in solving mathematical word problems compared to the control group. This study also reinforces the model presented by Beyer (1988), which states that solving complex problems in mathematics requires the integration of several elements of the thought process that involves metacognitive and cognitive development in order to achieve effective solutions. This finding is also consistent with the findings of Van Garderen and Montague (2003) and Pape (2004), which show that there is a relationship between the use of the representation problem and problem-solving success.

### Conceptual knowledge

The results also showed significant differences in mean scores of conceptual knowledge of students between the experimental group and the control group. The mean score of the experimental group is greater than the control group. This study found that the concept of knowledge possessed by a student is directly related to students' ability to construct representations of problems. In this study, the ability of students can be detected and measured by a pattern of answers given by students who demonstrate a good knowledge of their concept. The effectiveness of the approach, which incorporated elements of visualization, directly help students to master the concept or at least show a clear conceptual knowledge and obtain the right answer. The finding is in line with the views of Gilbert (2007) and Kozma and Rusell (2007), which state that representation visualization is very important in helping students master the concepts and understand phenomena in their environment. These results are also consistent with the intervention study conducted by Jitendra et al. (2007), Johnson (2010), Rittle-Johnson and Star (2007), De Windt-King and Goldin (2003) and Faulkenberry (2003), which involve intervention through visual and schematic representation.

## Metacognitive awareness

The findings of the study show that there are significant differences in the mean scores of metacognitive awareness in the experimental group compared to the control group mean score. The experimental group students' mean score was significantly higher compared with that of the control group. It coincided with the models presented in this study, such as Beyer (1988), Flavell (1979) and Schoenfeld (1985), who explains that metacognitive processes are one important aspect to ensure that we are in control in problem solving. Through guided steps and constant exposure while performing problem-solving activities, students are aware and able to plan, monitor and evaluate during the problem-solving process. Some studies also show similar findings, such as Demetriou (2000) and Michael (2006), who found that exposure to metacognitive processes have an impact on the success and improvement of students in mathematical problem solving.

## Awareness of problem-solving strategies

The results showed significant differences in mean scores in problem solving awareness among students in the experiment group compared to the control group. The mean scores of students' problem-solving awareness in the experimental group were significantly higher compared to the control group. The steps in the problem-solving approach disclosed in the experimental group is based on measures of problem solving that are extracted from the cognitive model, as presented; namely, Polya (1957), Schoenfeld (1985), Krulik and Rudnick (1996), Visual Analytics Model Stylianou (2002), and Lesh Translation Model et al. (2003). This is in line with the findings of Stylianou and Silver (2004), Fuchs et al. (2008) and Garderen (2006), which state that the basic skills of reading in understanding the problem serve as a starting point to other cognitive strategies. When reading occurs, many other mental activities also occur. This finding is also consistent with previous studies that found that awareness-based approaches to problem-solving strategies to implement coordinated measures will help students develop their thinking through the activities of synthesizing and processing information (Fuchs & Fuchs 2005; Montague & Dietz, 2009).

## Attitudes toward mathematical word problem solving

Overall, results showed a significant difference in mean scores in attitudes of students in the experimental group compared to the control group, with a mean

score of the experimental group being significantly higher than the control group. Differences in attitude of the experimental group compared to the control group are influenced by the effects of the learning acquired by them. Most students at school have difficulty in learning mathematics due to the lack of exposure to the process of problem-solving skills. This finding coincides with the study by Wan Zah (2002) and Arsaythamby (2010), which explained that changes in the behavior of students, particularly in the affective aspects such as attitude, can be changed after students are exposed to something meaningful. The VStops approach gives student the chance to acquire new knowledge, so they are able to apply the knowledge obtained, resulting in a change of behavior and a useful experience, and improvement in student achievement in mathematics problem solving.

## CONCLUSION

The construction of representation in the form of visualization can help students connect with a problem situation and facilitate students' ability to communicate their understanding of that problem. Thus, this study supports the emphasis on improving strategic thinking skills and abilities to build visual representations among students. Every mathematics teacher should take some measures to develop self-control in mathematical word problem solving among students to make this approach a practice of teaching and learning for mathematics problem solving. This approach may develop students' problem solving, reasoning, and critical thinking skills, which are necessary in STEM academic disciplines. It is hoped that student interest toward word problem solving and mathematics will encourage them to further their studies in a STEM-related career.

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