



Technium.

50/2023



The 7th International Conference on Social Sciences
Organized by Faculty of Social Science
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The Effectiveness of Dynamic Assessment Strategies in Solving Math Word Problems Using Cultural context

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ABSTRACT

Math word problems are relevant to the cultural context, making it easier for students to gain meaning. However, the potential of students is different in solving math word problems. Dynamic assessment strategies can be a solution to differences in student learning potential. This study aimed to analyze the effectiveness of dynamic assessment strategies in solving math word problems using cultural contexts. This research was conducted on junior high school students with an experimental design. The sample selection was done by cluster random, namely the control and experimental classes. Data analysis using t-test and Cohen test. The findings of this study indicate that dynamic assessment strategies can foster students' word problem-solving abilities with learning potential scores in the high category. Students in the experimental class could solve word problems better than the control class. Meanwhile, the effect size of the dynamic assessment strategy is in the high category. This research recommends that teachers use dynamic assessment to maximize students' potential in solving math word problems.

Keywords: *Cultural Context, Dynamic Assessment, Size Effect, Word Problems.*

1. INTRODUCTION

Math word problems are links between mathematical concepts and real-world situations expressed in sentences [1], [2]. Word problems aim to provide insight to students to position mathematics as a solution to problems they might face [3]. However, various research results state that students experience serious challenges in solving math word problems and understanding texts [4]–[7].

Meanwhile, the cultural conditions in the student's environment can be the context of math word problems as an effort to find solutions to everyday problems [8]. Word problems in a cultural context can assist students find meaning in mathematics [9]. Issues arising from cultural activities allow students to recognize problems more easily in developing solutions [10]. Conversely, problems not connected to the cultural context and student environment will eliminate the challenge of solving word problems due to decontextualization. However, teaching-related math word problems require intervention strategies to assist students solve problems effectively [11]. The intervention strategy that can be carried out is to integrate assessment in learning according to the talents

and potential of students, which is called dynamic assessment [12], [13].

Dynamic assessment is a strategy that integrates the principles of assessment with the learning process to optimize success in learning [12]. Teachers can better recognize students' potential through dynamic assessment strategies [14]. Dynamic assessment is a way to teach with feedback during testing [15]. The basic principles of dynamic assessment come from Vygotsky's theory of student learning development. According to Vygotsky [14], each student may need assistance to complete tasks at different levels. Students are divided into four stages of development i.e., Firstly, students who can solve problems without needing assistance. Secondly, students who make mistakes but know these mistakes and solve problems with a little assistance. Thirdly, students who have been unable to solve problems without assistance. Fourthly, students who cannot solve problems even if they get assistance.

Various research results show that dynamic assessment acts as an intervention that assists teachers develop their ability to solve math word problems [14], [16], [17]. Furthermore, culture reflects students' initial knowledge before getting to know the school environment. Therefore, culture is an appropriate

context for teaching math word problems. In line with that, the research questions are (1) how is the score of students' learning potential through dynamic assessment strategies? (2) how is the comparison of student's potentiality to solve math word problems with cultural contexts using dynamic assessment strategies? (3) how is the effectiveness of the dynamic assessment strategy in solving students' math word problems?

2. METHODS

This research was conducted on seventh-grade junior high school students aged 11-13. This study used an experimental design pretest-posttest control group design for three face-to-face meetings. Two classes are selected by cluster random sampling representing the control and experimental classes. There were 31 students in the experimental class and 28 students in the control class. The control class uses direct teacher-centered learning, while the experimental class uses a dynamic assessment strategy. Dynamic assessment instructions use three stages, namely; (1) pretest, students complete word problems without assistance, (2) mediation, students receive some assistance in the form of instructions to succeed in achieving the expected solution; and (3) posttest, students complete word problems after mediation. The research instrument was in the form of a word problem test on integer material. Math word problems include cultural activities of coastal communities. Data analysis uses a learning potential score (LPS) = $(2 \times \text{mediation score} - \text{actual score}) / \text{maximum score}$ [18]. Learning potential is divided into three categories, namely, high if $LPS \geq 1$, moderate if $0.71 \leq LPS < 1$, and low if $LPS < 0.71$. Meanwhile, to compare students' ability to solve math word problems in the experimental and control classes, an independent sample t-test was used. The effect size of the dynamic assessment strategy uses the Cohen test $ES = \frac{\bar{x}_1 - \bar{x}_2}{s}$, s as is the combined standard deviation. The effect size criterion is said to be high if $ES > 0.75$, moderate if $0.4 < ES \leq 0.75$, and low if $ES \leq 0.4$.

3. RESULTS

3.1. Student learning potential scores

Students provide answers through a pencil and paper test format, which can be completed flexibly. When students receive assignment results, they receive assistance with instructions until they can solve word problems correctly. The amount of work done is a benchmark for the level of assistance students need. The more trials are carried out until the correct answer indicates that the student needs more assistance and the mediation score is lower. For students' ability to solve word problems before mediation, thirteen needed

simpler problems, nine needed more assistance, six needed a little assistance, and three could solve word problems without assistance. After mediation, students experience a transformation (growth) in their ability to solve word problems. All students could solve word problems with details of four needing much assistance, seventeen needing little assistance, and ten without assistance. LPS transformation of students' ability to solve word problems through dynamic assessment can be seen in Figure 1.

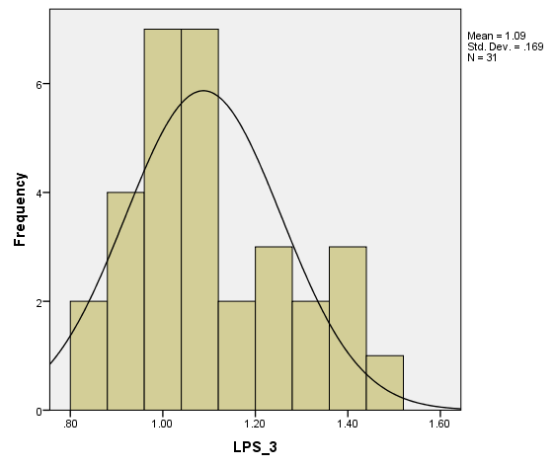


Figure 1 Distribution of learning potential scores

Students learning potential scores in solving word problems are between 0.8 to 1.55. The ability of students to solve word problems is very diverse. The longer tail of the curve on the right side indicates that most students complete the task better after meditation. The average LPS is 1.09, indicating that student learning growth is high.

3.2. Comparison of ability to solve math word problems

A comparative test of the ability to solve math word problems was carried out by the difference between the pretest and posttest results expressed by the normalized gain score. The gain score indicates a change in the ability to solve students' math word problems after learning in both the experimental and control classes. The differences in pretest and posttest scores in the experimental class clustered more around the average value. Gain scores in the experimental class spread from 0.24 to 0.76. Meanwhile, gain scores in the control class clustered more to the left of the average value with a distribution between 0.14 to 0.70. The average gain score in the experimental class was 0.48 with a standard deviation of 0.14, while the average gain score in the control class was 0.38 with a standard deviation of 0.17. The ability of students to solve math word problems in the experimental class has an average gain score greater than that of the control class.

Differences in the ability to solve students' math word problems in the experimental and control classes can be seen from the minimum and maximum scores obtained from the post-test results. The range and standard deviation in the control class are greater than in the experimental class, indicating that the data distribution in the control class is more varied than in the experimental class. Conversely, the experimental class's mean, median, and mode values are greater than the control class. The data in the experimental class is higher than the control class. An average comparison test was conducted using the independent sample t-test to prove this conjecture. However, first, the normality post-test data was analyzed, the results of which are shown in Table 1.

Table 1. Normality test

Group	Kolmogorov-smirnov		Conclusion
	Value	Sig.	
Experiment	0.094	0.200	Normal
Control	0.141	0.164	Normal

It appears that the post-test data for both the experimental class and the control class have a normal distribution, which means that the independent sample t-test can be used, as shown in Table 2.

Table 2. Independent sample t-test

	Value	Sig.	Conclusion
Homogeneous test	3.49	0.067	Homogen
t-test	2.41	0.02	Ho rejected

The results of the t-test show the value of Sig. $0.02 < 0.05$ with t count = 2.41, which means students in the experimental class are better at solving math word problems than students in the control class.

3.3. The effect size of solving word problems through dynamic assessment strategies

The student's ability to solve word problems in the experimental and control classes differed significantly. However, these differences needed to be tested for their effectiveness. Noted that $n_1 = 31$, $n_2 = 28$, $SD_1^2 = 8.25$, $SD_2^2 = 10.79$ therefore obtained $s = 6.59$. Meanwhile, $\bar{x}_1 = 73.42$, and $\bar{x}_2 = 67.43$ so obtained $ES = 0.91$. Therefore, the dynamic assessment strategy affects the ability to solve math word problems in the high category. Thus, applying a dynamic assessment strategy measures the effectiveness of the ability to solve math word problems using a cultural context.

4. DISCUSSION

The findings show that students still depend on symbols, numbers, and quantitative representations. Students need more help in relating problems to cultural contexts. Agree with opinion Dooren *et al* [1] about the

types of mistakes, students solve math word problems due to a lack of sensitivity in involving realistic situations. Realistic context-appropriate word problems require habituation through practice to improve students' ability to analyze any information [8]. The ability to solve students' word problems is determined by the Zone of Proximal Development (ZPD) at different levels. Differences in ZPD areas can be influenced by activities, experiences, culture, language, and other symbols of knowledge that exist in society [19]. Findings about differences in ZPD are in line with the recommendations *Institute of Education Sciences* [10] which states that training students to solve word problems is by demonstrating various solving strategies, giving various word problems, and monitoring the solving process being carried out.

Students with problems in the ability to interpret mathematical symbols, language, and communication fluency greatly affect the accuracy of students solving word problems [20]. Students who experience reading problems are very vulnerable in solving math word problems. Applying dynamic assessment strategies is an effective means of supporting the development of student learning potential. This finding is in line with the results of the study Fuchs [14] regarding feedback that helps students develop according to their learning potential in solving math word problems at different levels. Teachers can provide step-by-step assistance and introduce strategies that lead students to move toward solutions. Dynamic assessment is an important part that facilitates students to grow in solving math word problems. Students receive assistance at each level with a quantitative value as a benchmark for the score of the development of learning potential [21].

4. CONCLUSION

Dynamic assessment strategies provide opportunities for students to learn at their potential. Students experience growth in learning potential during mediation from the pretest to the posttest. Students can solve math word problems using cultural contexts through dynamic assessment strategies better than students with traditional strategies. The effect size of the dynamic assessment strategy is in the high category in growing students' ability to solve math word problems. However, the limitations of exploration related to the cultural context of the word problem model in this study can be a gap for future studies. The contribution of the findings to students' math word problem-solving abilities can be a recommendation for teachers to implement dynamic assessment in the classroom.

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