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MBCL and Interactive E-Module: Do They Work Well Together for Student's Math Problem Solving Skill?

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Abstract— Lack of mathematical knowledge and metacognitive skills results in low mathematical problem solving ability. The purpose of this study was to determine the effectiveness of metacognitive-based contextual learning model (MBCL) combined with interactive e-module on mathematical problem solving ability of junior high school students. This research is a quantitative research with quasi-experiment design. Two classes were selected as experimental and control classes through random sampling technique. The experimental class was treated with MBCL model assisted by interactive e-module and the control class was treated with conventional learning model. Data were collected through mathematical problem solving tests (pre-test and post-test) and student response questionnaires. The research data were analyzed using independent sample t-test after the prerequisite tests, namely normality and homogeneity tests. The results of the independent sample t-test test showed that the tcount value was greater than the ttable (2.249>1.679). This means that the mathematical problem solving ability of students taught with the MBCL model assisted by interactive e-modules is better than students taught with conventional models.

Keywords— Contextual; E-module; Metacognitive; Problem Solving.

1. INTRODUCTION

Mathematical problem solving ability is one of the six standards of mathematics learning process in schools [1]. Therefore, students need to have good mathematical problem solving skills to support the success of learning mathematics at school. Problem solving is an attempt to get out of a difficulty in order to achieve a goal that cannot be achieved immediately [2]. Mathematical problem solving is the process of solving mathematical problems involving various cognitive skills and actions.

Mathematical problem solving ability determines the success and achievement of student learning. However, the facts show that the mathematical problem solving ability of students in Indonesia is still low. The low mathematical problem solving ability is partly due to the lack of mathematical knowledge and metacognitive skills [3]-[5]. Metacognition is a high-level thinking process that involves a person's active control over cognitive processes to understand and control their own learning [6].

Metacognition plays an important role in supporting student success, because students who successfully use metacognitive abilities are able to diagnose and correct problems, and find the best way to strengthen the knowledge they have learned [7]. Conversely, students who experience metacognitive failure tend to be less able to solve math problems because they experience redflags in the problem solving process [8]-[11]. Metacognitive failure gets worse when students experience math anxiety. Students with excessive levels of math anxiety tend to

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experience redflags since the initial phase of problem solving and even in almost every phase of problem solving [12]. Therefore, teachers need to apply effective and fun learning models and media to develop metacognitive skills to improve students' mathematical problem solving ability.

One of the learning models that can be used is the metacognitive-based contextual learning (MBCL) model. MBCL model is a learning model that integrates contextual-based learning (CBL) with metacognitive instruction. Learning with metacognitive instruction is able to encourage students' creative problem solving ability and metacognitive skills significantly [13], [14]. In addition, metacognitive strategy instruction has a significant positive impact on students' metacognitive awareness [15]. Meanwhile, learning with CBL is student-centered learning and bridges students' real life into the learning environment to gain knowledge and practical experience [16]. Learning with CBL is able to develop students' conceptual understanding, critical thinking ability, and practical skills in solving problems [17], [18]. Therefore, CBL combined with metacognitive instruction or encouragement is able to develop students' conceptual understanding and ability to organize their own learning [19].

In theory, the MBCL model is an integration between context-based learning and metacognitive instruction [13], [19]-[21]. The MBCL model places students in active learning activities. In general, there are five syntaxes in MBCL; 1) explore prior knowledge; 2) provide contextual problems; 3) recognize and solve problems; 4) present results; and (5) reflect on the learning process [16]. In practice, the teacher acts as a facilitator who guides students to use MBCL in solving problems both in learning, daily life and in students' personal responsibility for learning [19], [22]. Whereas in metacognitive learning, students learn in small groups to reason mathematically and formulate and answer metacognitive questions [20], [23]. Thus, MBCL not only emphasizes on how to build new knowledge, but also makes students aware of learning and developing their abilities in order to use the right strategies in learning and solving problems [20], [24].

The success of the learning process does not only depend on the learning model used, but also depends on the learning media. The learning media used should be able to attract students' attention and be able to facilitate students to understand the material taught more easily. Learning media, including in electronic form, aims to help or facilitate students so that learning becomes more effective [25].

Along with the times that have entered the digital economy era, all activities and needs are designed to be easier and completely digital, including learning media. One form of learning media that can be used as an alternative today is an interactive digital module or e-module. Digital modules, both those used with synchronous and asynchronous approaches, have proven to have a significant effect on students' mathematical abilities [26]. Meanwhile, learning with digital modules or interactive e-modules can make students more interested in the learning process than learning only by reading and listening to explanations [27]. The use of interactive e-modules in learning also supports student learning independence [28], [29], so that students become more active in the learning process.

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Based on what has been described, the MBCL model can be combined with interactive e-modules and used as an effort to deal with low mathematical problem solving skills, especially in junior high school students. Therefore, previously it was necessary to test whether the use of the MBCL model combined with interactive e-modules was effective on the mathematical problem solving skills of junior high school students. Thus, the purpose of this study is to determine how the effectiveness of the MBCL model combined with interactive e-modules on problem solving skills.

2. RESEARCH METHODS

Quantitative research type with quasi experimental design method was used in this study. The quasi experiment design in this study used a pretest-posttest nonequivalent control group design as in Table 1.

Tabel 1. Research Design [30]

Group	Pre-test	Treatment	Post-test
Control	O1	X	O2
Experiment	O1	Y	O2

O1 : Pre-test score of control and experiment group;

X : Conventional model;

Y : MBCL model with an interactive e-module;

O2 : Post-test score of control and experiment group.

Both groups (experimental and control) were given a pre-test to determine the initial ability of the research sample. Then proceed with giving different treatments, in this case the learning model and media. After learning by using different models and media for two meetings, both groups were given a post-test to measure the extent of students' mathematical problem solving skills and how to measure how effective the MBCL model combined with interactive e-modules is on students' mathematical problem solving skills.

The population in this study were all Class VIII junior high school students in one of Pamekasan City in 2023/2024. The research sample consisted of 2 classes, namely the experimental group and the control group selected by random sampling technique. Data in this study were collected through student response questionnaires and math problem solving tests.

The student response questionnaire instrument was used to see students' responses to learning, both in learning using the MBCL model assisted by interactive e-modules and learning with conventional models. The mathematical problem solving test instrument was used to measure the level of students' mathematical problem solving ability, both before and after treatment.

The math problem solving test questions consisted of pre-test and post-test questions which were prepared based on Polya's mathematical problem solving ability indicators. The indicators of mathematical problem solving ability on the test questions are described in Table 2.

Tabel 2. Polya's Mathematical Problem Solving Ability Indicators [2].

Mathematical Problem Solving Satge	Indicator
Understanding the problem	Able to find the information contained in the problem and the information asked in the problem.
Devising a plan	Able to determine the steps that need to be taken to solve the problem and the reasons.
Carrying out the plan	Able to solve the problem with the steps that have been determined.
Reflecting on the solution	Able to check the correctness of the results obtained from each step taken in solving the problem.

The data from the math problem solving test results in this study were carried out with two data analysis tests, namely the pre-test and post-test data analysis tests. Before conducting the data analysis test of the test results, the prerequisite analysis test was carried out which included normality test and homogeneity test. Furthermore, the data analysis test of pre-test results and hypothesis testing of post-test results data were carried out. The normality test in this study used the Kolmogorov Smirnov test. While the homogeneity test in this study used the one-way ANOVA test through Levene's test with the help of SPSS 26 software. Hypothesis testing in this study used a two-party independent sample t-test test to hypothesize the difference in the means of the experimental group and the control group. Meanwhile, to find out which average is better between the experimental group and the control group using the independent sample t-test.

Data from student response questionnaires were analyzed by calculating the percentage value of student responses with the formula and criteria as shown in Table 3.

Percentage of student response:

$$P = \frac{\text{total score obtained}}{\text{maximum score}} \times 100\%$$

Tabel 3. Student Response Criteria

Persentase	Kriteria
$85\% < P \leq 100\%$	Very Positive
$75\% < P \leq 85\%$	Positive
$65\% < P \leq 75\%$	Moderately Positive
$55\% < P \leq 65\%$	Less Positive
$P \leq 55\%$	Not Positive

Learning with the MBCL model assisted by interactive e-modules can be said to be effective if it meets three criteria, namely 1) the average student response in the experimental class reaches positive or very positive criteria

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and is more than the average student response of the control group, and 2) the average mathematical problem solving ability in the experimental group is better than the average control group.

3. RESULT AND DISCUSSION

The research data were processed through several stages, starting with the prerequisite test of students' pre-test results, namely the normality and homogeneity tests. Normality and homogeneity tests on the pre-test were carried out to determine whether the data on the results of students' initial abilities were normally distributed and homogeneous. The results of the pre-test normality test can be seen in Table 4.

Table 4. Test of Normality

	Group	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Pretest Score	Pretest Control	,164	23	,112	,942	23	,200
	Pretest Experiment	,136	24	,200*	,967	24	,602
***. This is a lower bound of the true significance.**							
a. Lilliefors Significance Correction							

Based on Table 4, it can be seen that the significance value in the control group is 0.112 (>0.05) and the significance value in the experimental group is 0.200 (>0.05). This shows that the pre-test data is normally distributed, both in the control group and in the experimental group. The results of the pre-test homogeneity test are presented in Table 5.

Table 5. Test of Homogeinity of Variance

		Levene Statistic	df1	df2	Sig.
Pretest Score	Based on Mean	,190	1	45	,665
	Based on Median	,096	1	45	,758
	Based on Median and with adjusted df	,096	1	44,996	,758
	Based on trimmed mean	,161	1	45	,690

Based on Table 5, the pre-test significance value is 0.665 (>0.05), meaning that the pre-test data is homogeneous. After testing the normality and homogeneity of the pre-test, then proceed to test the results of the post-test. Before testing the hypothesis with an independent sample t-test to determine the average difference between the control and experimental groups, the normality and homogeneity tests were first carried out on the post-test data. The results of the post-test normality and homogeneity tests are presented in Tables 6 and 7.

Table 6. Test of Normality

	Group	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Posttest Score	Posttest Control	,145	23	,200*	,930	23	,107

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	Posttest Experiment	,142	24	,200*	,958	24	,401
***. This is a lower bound of the true significance.**							
a. Lilliefors Significance Correction							

Table 7. Test of Homogeinity of Variance

		Levene Statistic	df1	df2	Sig.
Posttest Score	Based on Mean	2,029	1	45	,161
	Based on Median	1,756	1	45	,192
	Based on Median and with adjusted df	1,756	1	44,613	,192
	Based on trimmed mean	2,000	1	45	,164

Based on Table 6, it can be seen that the significance value in the control group is 0.200 (>0.05) and the significance value in the experimental group is 0.200 (>0.05). This shows that the post-test data is normally distributed, both in the control group and in the experimental group. While in Table 7 the significance value of the post-test results is 0.161 (>005), which means that the post-test data is homogeneous.

After the prerequisite test in the form of normality test and homogeneity test on the post-test data is carried out, then proceed with hypothesis testing using a two-sided independent sample t-test to determine the average difference between classes taught using the metacognitive-based contextual learning model assisted by interactive e-modules (experiment group) and classes taught using conventional models (control group). The results of the independent sample t-test are presented in Tables 8 and 9.

Table 8. Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Posttest Score	Posttest Control	23	56,04	16,910	3,526
	Posttest Experiment	24	66,33	14,403	2,940

Table 9. Result of Independent Sample t-test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper

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Posttest Score	Equal variances assumed	2,029	,161	2,249	45	,029	10,290	4,575	1,075	19,504
	Equal variances not assumed			2,241	43,235	,030	10,290	4,591	1,033	19,547

Based on Table 8, the average post-test result of the control group is 56.04 and the average of the experimental group is 66.33.

Statistically, there is an average difference between the control group and the experimental group. These results show that the average post-test results of the experimental group are higher than the control group. In Table 9, it is known that the significance value is 0.029 (<0.05).

This means that Ha is accepted and H0 is rejected. In other words, there is a significant difference between the ability to solve mathematical problems in classes taught using the MBCL model assisted by interactive e-modules and classes taught using conventional models. The mean difference between the two classes is 10.290.

The results of the one-sided independent sample t-test using manual calculation with df 45 and 5% significance, obtained a tcount value of 2.249 (also shown in Table 9). While the ttable value at df 45 and 5% significance is 1.679. Thus the tcount is more than the ttable (2.249>1.679).

This means that H0 is rejected and Ha is accepted. That is, the mathematical problem solving ability of students taught using the MBCL model assisted by interactive e-modules is better than students taught using conventional models.

Therefore, it can be said that the Metacognitive-Based Contextual Learning (MBCL) model assisted by interactive e-modules has met the criteria for effectiveness on the mathematical problem solving skills of junior high school students.

The results of student response questionnaires in the experimental group and control group are presented as Figure 1 and Figure 2. Based on Figure 1, it is known that the majority of student responses to learning with conventional models are not positive.

More than 50% of students in the control class gave moderately positive and not positive responses to learning with conventional models.

While Figure 2 shows that almost 90% of students in the experimental class gave positive and very positive responses to learning with the MBCL model assisted by interactive e-modules.

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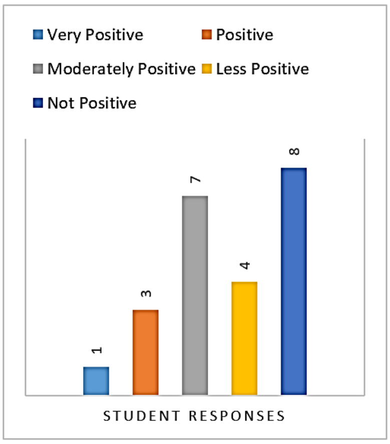

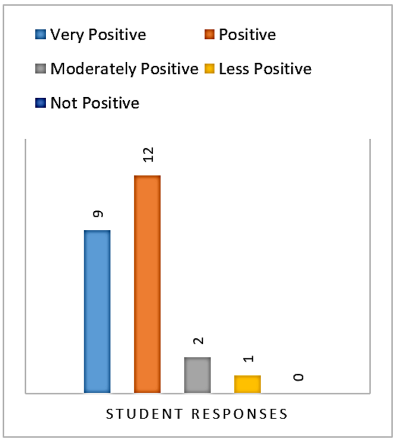

Figure 1 **Figure 2**

Figure 1. Student's Respon (Control Group) | Figure 2. Student's Respon (Eksperiment Group)

The MBCL learning model is proven to help improve students' mathematical problem solving skills. This is because the MBCL learning model integrates contextual learning with metacognitive strategy instruction [16]. During the learning process using the MBCL model, students are given contextual problems that are closely related to their daily lives. Thus, students can think more critically and practically in solving the given problems because the problems are not far from students' lives or experiences. It is in line that contextual learning is able to develop students' critical and practical thinking skills when solving mathematical problems [31]. In addition, contextual learning is also able to improve students' metacognitive ability [19]. The improvement of metacognitive ability can help students optimize their performance in mathematical problem solving through effective utilization of their metacognitive aspects [14], [32].

The use of interactive e-modules in learning with the MBCL model also contributes to students' problem solving skills. The use of electronic learning media, such as digital modules, can improve students' math skills [26]. This is because the use of digital modules, especially interactive ones, is proven to increase students' interest in learning [33]. A sense of interest in the learning process tends to be able to improve students' ability to learn mathematics, including mathematical problem solving. This is in line with the results of research that the use of interactive e-modules can develop students' mathematical competencies [26]-[28].

4. CONCLUSION AND LIMITATIONS

This study examines the effectiveness of metacognitive-based contextual learning (MBCL) model combined with interactive e-module on mathematical problem solving skills of junior high school students. After two lessons using the MBCL model and interactive e-module media, students showed better mathematical problem solving skills and gave more positive responses to learning than students taught using conventional learning models. Therefore, for further research we recommend the application of the MBCL model and interactive e-module to a wider range of uses.

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