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Problem Based Learning Strategy: the Impact on Mathematical Learning Outcomes viewed from Anxiety Levels

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Abstract

This study aims to look at the effect of Problem Based Learning (PBL) Strategy and mathematical anxiety towards mathematics learning outcomes. The method used is the quasi-experiment method with a 2x2 factorial pattern. The data analysis technique is was the two-way analysis of variance (ANAVA) technique. This study discovers that (1) there are differences in mathematics learning outcomes between students who got the Problem Based Learning (PBL) strategy treatment and conventional learning strategies treatment, (2) there are effects of interaction between learning strategies and anxiety on mathematics learning outcomes, (3) there are differences in mathematics learning outcomes of students who have high anxiety level based on the treatments they received, (4) there are differences in mathematics learning outcomes of students who have low anxiety level based on the treatments they received.

Keywords: Problem Based Learning (PBL), Anxiety, Mathematics.

INTRODUCTION

Learning mathematics plays a very important role as a science that utilizes language and as a science that has an accurate nature of solving social problems and supporting knowledge in other fields. Many efforts have been made so that learning outcomes, especially on mathematics subjects, can be increased. The assessment of mathematics learning outcomes is done to find out whether the learning objective been achieved or not. One of the efforts made is applying the right learning strategies. The assumption is based on the selection of appropriate learning strategies for a particular material that strongly supports the learning process and results.

Strategies relate to approaches in delivering material. The strategy must be adjusted to the learning objectives that have been determined (Abell, Appleton, & Hanuscin, 2010). One strategy that can be used in mathematics learning is the Problem Based Learning which is characterized by the use of real-life problems as a focus for students to learn. With the Problem Based Learning, students are expected to get more skills compared to just memorizing. Starting from problem-solving skills, critical-thinking skills, work skills in groups, interpersonal and communication skills, as well as information searching and processing skills. In addition, learning strategies that affect learning outcomes are other factors that cause low mathematics learning outcomes, including factors that exist within students such as their attitudes toward mathematics.

The development of negative thinking in students as a trigger for the emergence of negative impulses on their attitudes toward mathematics subjects. It can cause anxiety that will have an impact on the low learning outcomes in mathematics. The impact of anxiety on mathematics learning causes students to be unsure of the completion of their mathematics

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learning, their lack of desire to solve mathematical learning problems, and their avoidance in taking mathematics lessons.

Based on previous research, the Problem Based Learning (PBL) strategy had been widely applied in learning (Aisida, 2017; Alfi, Sumarmi, & Amirudin, 2016; Amir, 2010; Anggraini & Masykur, 2018; Arifin Handoyo & Arifin, 2016; Choridah, 2013; Farhan & Retnawati, 2014; Fitri, 2011; Kartikasari, Rusdi, & Asyhar, 2016; Maulidiyahwarti, Sumarmi, & Amirudin, 2016; Murniyati & Winarto, 2018; Mustofa, Susilo, & Muhdhar, 2016; Pranawestu, Kharis, & Mariani, 2012; Primartadi, 2012; Saleh, 2013; Syaifulloh, 2016; Tristanti, 2017; Yustianingsih, Syarifuddin, & Yerizon, 2017) The research in improving the mathematics learning outcomes are currently being studied (Arifin Handoyo & Arifin, 2016; Asmawati & Wuryanto, 2014; Asmoro, 2017; Hasanah, 2016; Kristin & Rahayu, 2016; Larasati, 2014; Lusianti, 2013; Maulidiyahwarti et al., 2016; Pratiwi & Santosa, 2013; Primartadi, 2012; Sari, Ridlo, & Utami, 2016; Sarnoko, Ruminiati, &Setyosari, 2016; Sukardi, Susilo, & Zubaidah, 2015; Sumarni & Susanti, 2016; Tafakur & Suyanto, 2015; Taufik Aditia & Muspiroh, 2013; Tyas, 2014; Utami, Hastuti, Yatimah, Padmini, & Arroyan, 2013; Vahlia & Sudarman, 2015; Yulianti, An'nur, & Wati, 2014). However, no research has looked at the effect of Problem Based Learning (PBL) strategy and mathematical anxiety on mathematics learning outcomes. So, the purpose of this study is to look at the effect of Problem Based Learning (PBL) strategy and mathematical anxiety on mathematics learning outcomes.

THE RESEARCH METHODS

The method used in this research is the quasi-experiment method with a 2x2 factorial design. The study was conducted in the seventh grade of Junior High School (SMP) 29 Lampung. The target population of the study was all students of SMP 29 Lampung while the population was students of the seventh-grade class 1 and 2. The sample was 30 students for each class who was randomly chosen to be the member of the experimental class and control class using multi-stage cluster random sampling. The research plan is displayed in the following table:

Table 1. The Design of Treatment by Levels 2 × 2

Anxiety (B)	Learning Strategies	
	Problem Based Learning (PBL) (A1)	Conventional (A2)
High (B1)	A1B1	A2B1
Low (B2)	A1B2	A2B2

To determine the anxiety level of the two classes, a high and low anxiety questionnaire was given. The results of the questionnaire are sorted from high to low. The next stage, the 27% of the highest-ranked students were classified as a group of students who had high anxiety level and 27% of the lowest-ranked students was classified as a group of students who had low anxiety level. The consideration of taking 27% of the students for each high and low anxiety

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groups was based on the determination of the high group and the low group which could be determined between 25% and 33%.

Data Analysis Techniques.

This study employed a two-way analysis of variance (ANAVA) technique. By using this technique, it was intended to determine the significance of the interactions occurred between learning strategies and anxiety towards the mathematics learning outcomes. Two-way ANAVA was used because this research has more than one independent variable. Before hypothetical testing was carried out, the pre-requisite tests were carried out first, namely the normality test and the data homogeneity test.

1. Prerequisite Tests

The normality and data homogeneity test needed to be done. The data normality test was done through the Lilliefors test while the homogeneity test was carried out by the Bartlett test. The tests were conducted to ensure that the data used was actually from the normally distributed data and originates from a homogeneous population.

2. Hypothetical Test

This test was intended to see which interaction effects or simple effects were higher. As for the statistical hypothesis of this research are :

a. Hypothesis 1:

$H_0 : \mu_{A1} \leq \mu_{A2}$

$H_1 : \mu_{A1} > \mu_{A2}$

b. Hypothesis 2:

$H_0 : \mu_{A2B2} \leq \mu_{A2B2}$

$H_1 : \mu_{A2B2} < \mu_{A2B2}$

c. Hypothesis 3:

$H_0 : \mu_{A1B1} \leq \mu_{A2B1}$

$H_1 : \mu_{A1B1} > \mu_{A2B1}$

d. Hypothesis 4 :

H_0 : Interaksi $A \times B = 0$

H_1 : Interaksi $A \times B \neq 0$

THE RESULTS OF THE RESEARCH AND THE DISCUSSION

Table 1. The Description of the Research Data

Anxiety(B)	Learning Strategy (A)		
	Problem based Learning *(PBL)*(A1)	Conventional (A2)	Total
High (B1)	n = 30 SD = 2,43 $\bar{X}$= 20,00	n = 30 SD = 2,63 $\bar{X}$= 12,52	n = 60 SD= 4,74 $\bar{\bar{X}}$= 16,26
Low (B2)	n = 30 SD = 3,50 $\bar{X}$= 12,29	n = 30 SD = 3,14 $\bar{X}$= 15,07	n = 60 SD=3,49 $\bar{\bar{X}}$= 13,68
Total	N = 60 SD = 4,58 $\bar{\bar{X}}$= 16,14	N = 60 SD = 3,69 $\bar{\bar{X}}$ = 13,79	N = 120 SD=4,13 $\bar{\bar{X}}$= 13, 96

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Description:
n : Sample Number
Primary : Standard Deviation
$\overline{X}$: Average Score (Mean)
The two-way variance analysis with interaction (2 x 2 ANAVA) was conducted. With the intention to see the different effects of the treatments, namely the influence of learning strategies and anxiety and their interactions with mathematics learning outcomes as presented in Table 2.

Table 2. Two-way ANAVA toward the Mathematics Learning Outcomes

Source of Variance	Db	Jk	RK = JK/db	F_c=RK/RKD	F_{table}	
					0,05	0,01
Learning Strategy (A)	1	164, 779	164,775	17,10*		
Anxiety (B)	1	201, 207	200,207	22,208*	3,92	6,84
Interaction Factor (AxB)	1	754,406	754,406	82,11*		
In (D)	116	109,640	9,565	-	-	-
Total (T)	119	2260, 954	-	-	-	-

Description:
Db : Degree of freedom of the variance
Jk : The squared total of the source of variance number
RK : The average number of squared sources of variance
RKD : The average number of the squared number in groups
*) Significance
Fc : The value of $F_{critical}$
F_t : The value of F_{table}

First Hypothetical Test

Students' mathematics learning outcomes who learned with Problem Based Learning strategy were higher than the mathematics learning outcomes of the students who learned using conventional strategy. The results of calculations using two-way ANAVA show that $F_c = 17.31$ which is greater than $F_t = 3.92$ at the 0.05 significance level. > F (0.05) (1,116) = 6.84) Likewise, the value of F_c is greater than F_t = 6.84 at the significant level of 0.01 (Fc = 17.31> F (0.01) (1.116) = 6.4. It can be concluded that H_0 was rejected and H_1 was accepted. Thus, the learning outcomes of students that learned using Problem Based Learning strategy was different from the group that learned using conventional strategy.

The analysis was followed by Tukey HSD test with = 60 k = 2 dk = 58 KRD = 9.565 and the calculation of q at the 0.05 and 0.01 significance levels obtained by HSD = 1.118 and HSD = 1.477 mean difference $\mu A_1 =$ 16.15 and $\mu A_2 =$ 13.80 is 2.35> HSD = 1.118 at p <0.05 and 2.35> HSD = 1.477 at p <0.01. Thus, it was concluded that H_0 was rejected and H_1 was accepted. The mathematics learning outcomes of the students who got the PBL treatment were higher than the mathematics learning outcomes of the students who got conventional strategy treatment.

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The Second Hypothetical Test

There was an interaction effect between environmental and neighborhood conditions with the learning strategy on mathematics learning outcomes. Based on the ANAVA test, it was obtained that the value of $F_c = 82.11 > F_c = 3.92$ ($\alpha = 0.05$) and $F_c = 82.11 > 6.84$ ($\alpha = 0.01$), this means that H_0 was rejected and H_1 was accepted (interaction AXB> 0) or ($uA_1 B_1 = 20.00 > uA_2 B_1 = 12.53$) and $uA_1 B_2 = 12.30 < \mu A_2 B_2 = 15.06$). It can be concluded that there was an interaction effect between the application of learning strategies and anxiety on mathematics learning outcomes.

The Third Hypothetical Test

The mathematics learning outcomes of the students who have high anxiety level and were given the PBL treatment was higher than the mathematics learning outcomes of the students who were given the conventional strategy treatment. The results of calculations using two-way ANAVA obtained Fc = 82.11 then F_t= 3.92 with a significance level of 0.05 and 6.84 for the significance level of 0.01. The data indicating that (Fc = 82.11 and F_t= 3.92 (0.01: 1116) = 6.84. This means that H_0 was rejected and H_1 was accepted. Thus, the learning outcome of the students who have a high anxiety level treated with the PBL strategy was different from the learning outcome of students who were treated with the conventional learning strategy.

Furthermore, the Tukey HSD test with n = 30 and k = 2 dk = 58 KRD = 9.565 and calculations at the significance level of 0.05 and 0.01 obtained by HSD = 1.597 and 2.123. The mean that the difference of $\mu A_1 B_1 = 20.00 > \mu A_2 B_1 = 12.53$ is 7.47> HSD = 1.597 (p <0.05) and 7.47> HSD = 2.123 (p <0.01). it can be concluded that H_0 was rejected and H_1 was accepted. Thus, the learning outcome of the students who have a high anxiety level treated with the PBL strategy was higher than the learning outcome of students who were treated with the conventional learning strategy.

The Fourth Hypothetical Test

The learning outcome of the students who have low anxiety level and were treated with PBL strategy was lower than the students who were treated with the conventional learning strategy. Fc = 82.11 then F_t= 3.92 for the significance level of 0.05 and 6.84 for the significance level of 0.01, it turns out that $Fc = 82.11 > F_{t\,(0.05)}$; 1.116 = 3.92 and $Fc = 82.11 > F_t$ (0.01 1.116) = 6.84). This means that H_0 was rejected and H_1 was accepted. It is concluded that the mathematics learning outcome of the students who have low anxiety and were treated with PBL strategy was different from students' mathematics learning outcomes who were treated with conventional strategy.

Furthermore, the Tukey HSD test with n = 30 k = 2 KRD = 9.565 and calculations at the significance level of 0.05 and 0.01 obtained by HSD = 1.597 and 2.123. Mean difference $uA_1 B_2 = 12.30 > uA_2 B_2 = 15.06$ was 2.76> 1.597 (p <0.05) and 2.76,> 2,123 (p <0.01). It means that H_0 was rejected and H_1 was accepted. It can be concluded that the learning outcome of the students with low anxiety level and were treated with PBL strategy is lower than the students who were treated with conventional strategy.

Mathematics is a science that is often found in everyday life. The needs of human life become one of the histories of mathematics. The conveniences obtained from mathematics make life well-fulfilled. One of the important goals of mathematics is to be able to help people

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solve problems in daily life easier. However, many people do not realize the importance of learning mathematics in their daily lives. Generally, mathematical knowledge is obtained from a process involving the abstract cognitive nature, has a primary goal in numbers, and is able to solve problems in everyday life. The understanding of mathematics for elementary school children is learning numbers and forms and measurements in mathematical concepts, understanding the numeracy, reading numbers, operating mathematical numbers, teaching basic concepts, and being the foundation for further education. One of the successes of learning mathematics can be seen from the mathematics learning outcomes.

The primary learning outcomes of mathematics are the ability or mastery possessed by students after learning which can be seen from cognitive, affective, and psychomotor aspects. Assessment of learning outcomes is influenced by factors that are closely related to the educational process such as row, input, interest, and readiness in learning. However, there are components that influence the mathematics learning outcomes, among others: teachers, materials given in educational conventions, forms of communication, household situations and conditions, social environment, economic conditions, and the state of learning the culture.

Learning mathematics itself requires full concentration. This makes students unable to think casually because concentration is heavy mental work. Relaxing conditions are the best conditions for learning mathematics if the learning strategies used are appropriate and relevant to their interests and learning abilities. For those who have high anxiety, their learning outcomes will be lower if the learning strategies used do not match their characteristics since each strategy has certain characteristics with all its strengths and weaknesses.

Some opinions explain that some of the advantages in the application of Problem Based Learning include: (a) Providing opportunities for students to solve problems according to their individual ways or learning styles. By knowing the learning styles of each individual, we are expected to help to adjust to the approach we use in learning. (b) Development of critical thinking skills. (c) Learners are trained to develop ways to discover, question, articulate, explain or describe, consider or make judgments, and make a decision (decision-making). Thus, students apply a work process through a problematic situation that contains problems. Furthermore, the weaknesses in the application of Problem Based Learning include: (a) The Problem Based Learning requires a long time to apply. (b) Need to be supported by books that can be used in learning activities, especially in making questions.

Students who experience anxiety in mathematical learning are called mathematical anxiety. Many factors cause a person's anxiety in mathematical learning including the inability to understand mathematics learning and the development of antipathy in mathematics learning. This impact can cause anxiety in students which can affect the learning outcomes. Students' anxiety can be recognized through three components, namely (1), psychological components in the form of anxiety, nervousness, tension, insecurity, fear, and surprise, (2) physiological components such as palpitations, cold sweat in the palms, the increase of blood pressure, and (3) social in the form of behavior shows by individuals in the form of behavior and sleep disturbance.

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Someone in an anxious condition will not concentrate, consequently, it can reduce their concentration power. Mathematical anxiety is a type of disease that refers to the atmosphere of an unhealthy heart. The worst impact of anxiety can cause a person to be depressed, panic and helpless, nervous, and afraid.

CONCLUSION AND SUGGESTION

Based on the hypothetical test and discussion, it can be concluded that (1) Overall, there are significant differences in student learning outcomes treated with Problem Based Learning (PBL) strategy with students treated with conventional learning strategy, (2) there is an interaction effect of learning strategies with anxiety on mathematics learning outcomes, (3) the mathematics learning outcomes of the students who have high anxiety and were given the Problem Based Learning (PBL) strategy treatment are higher than the learning outcomes of students who are treated with conventional learning strategy, (4) the mathematics learning outcomes of students who have low anxiety and were given the Problem Based Learning (PBL) strategy treatment have no difference compared to the students who are treated with conventional learning strategy. Suggestions that can be given for further research is to be able to examine problems with a wider range and try to use other learning strategies to maximize various aspects of mathematics learning.

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