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THE INFLUENCE OF PROBLEM BASED LEARNING MODELS ON CRITICAL THINKING ABILITY IN TWO VARIABLELINEAR EQUATION SYSTEMS AS SEEN FROM LEARNING STYLE

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Abstract:

The purpose of this study was to determine the influence of problem based learning models on critical thinking ability in two variable linear equation systems as seen from learning style. This research was a quantitative research using*Factorial Design*. This research was conducted on class VIII students of SMPN 2 Sugio. The sampling technique in this study was*Purposive Sampling*, with VIIIA class as the experimental class and VIIIB class as the control class, each of which has 32 students. Data collection techniques in this study used tests of critical thinking ability and learning style questionnaires. The data analysis technique used is descriptive quantitative. The results showed that the application of the learning model*Problem Based Learning* effect on the ability to think critically both students with visual, auditory, and kinesthetic learning styles in the matter of two variable linear equation systems. Results*pretest* students with a visual learning style show an average value of 57 which increases as seen from the value*posttest* that is 91.41. Results*pretest* students with an auditory learning style show an average value of 53.3, which increases as seen from the value*posttest* that is 90.6. Students with kinesthetic learning styles, results*pretest* showed an average value of 59.1, then experienced an increase as seen from the value*posttest* that is 90.7.PBL learning model influences students' critical thinking ability, learning style has a significant effect on critical thinking ability, critical thinking ability is more influenced by the PBL learning model than learning style.

Keywords: *Problem Based Learning, Critical Thinking Ability, Two Variable Linear Equation Systems, Learning Style*

INTRODUCTION

As time advances, quality and superior human resources are urgently needed. Through education, the government seeks to improve the quality of human resources. The quality of a country's education needs to be improved by developing the quality of education, both in terms of learning objectives, timeliness, and providing learning that is meaningful and not monotonous. One of the educational sciences that is important for improving the quality of human resources is mathematics. In essence, mathematics is a science that plays an important role in everyday life because mathematics is used in almost every science and technology. Therefore mathematics underlies science and technology. This is in line with Septiani & Zanthy's (2019) statement that mathematics does not depend on other subjects. In reality, there are still problems or problems faced by students in studying mathematics. Such as students who experience difficulties in learning mathematics, are slow in completing assignments, and have unsatisfactory learning achievements.

Based on the results of interviews that researchers conducted with several class VIII students at SMP Negeri 2 Sugio, it was found that there were students who experienced difficulties in learning. Students who more easily understand what the

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teacher writes complain of difficulty when the teacher asks not to write while the teacher is explaining. Meanwhile, students who enjoy learning by listening to what theteacher explains tend to be more active in asking questions and find it easier to understand the lesson. Meanwhile, students who learn more easily by trying or practicing directly what they are learning experience difficulty learning when the learning they apply only focuses on the teacher. Where the teacher only explains the material without giving students the opportunity to try or practice the material being studied. This shows that students do not have the freedom to learn according to their own learning style. The consequences that arise from students who do not have the freedom to learn with their learning style are that students will have difficulty learning so that students cannot develop their thinking abilities.

Critical thinking ability is one of the thinking ability that is very important for students to have (Nurlaeli, Noornia, & Wiraningsih, 2018). Critical thinking ability are expected to be able to overcome various difficulties faced by students in learning mathematics and be able to solve various mathematical problems so that correct answers are obtained and conclusions are in accordance with the facts.

From the results of interviews conducted by researchers with class VIII mathematics teachers at SMP Negeri 2 Sugio, information can be obtained that students' critical thinking ability are still relatively low. This was proven when students were given a test that presented a problem, it turned out that there were still many students who found it difficult to understand the question instructions. When faced with a contextual or real problem, the average student cannot convert it into an appropriate mathematical form or model. Apart from that, there are still students who are less precise in using methods or strategies in working on essay questions and are less careful in the calculation process, as well as students' lack of ability to understand the lesson.

Based on the results of research conducted by Nuryanti, Zubaidah, & Diantoro (2018), it shows that the critical thinking ability of class VIII students are still low. This is evidenced by the low average percentage achievement for category B, which is only 40.46%. The results of research conducted by Karim & Normaya (2015) stated that junior high school students' critical thinking ability were still not fully developed and were relatively low. Students' low critical thinking ability are caused by learning that is still teacher-centered and a lack of training students' critical thinking ability.

One alternative learning model that is appropriate for training critical thinking ability is to use the Problem Based Learning (PBL) learning model. The Problem Based Learning learning model is a learning model where students are focused on trying and attempting to solve problems using several stages of the scientific method using all the knowledge they have or from other sources with the aim of encouraging students to develop their abilities so that students are able to learn knowledge related to this problem (Syamsidah & Suryani, 2018).

In its application, the PBL learning model directs students to real problems as a learning context. This learning model provides an understanding that in learning students are faced with a problem, it is hoped that by solving this problem students will learn more basic thinking ability (Husnidar, Ikhsan, & Rizal, 2014).

The material two variable linear equation systems is one of the materials discussed and studied by class VIII SMP students (Napitupulu et al., 2022). The

position of two variable linear equation systems material listed in the 2013 curriculum is as initial knowledge or prerequisite material for studying subsequent material such as three variable linear equation systems material (Maryani & Setiawan, 2021). As stated by Sari & Lestari (2020), two variable linear equation systems material is a continuation of the one variable linear equation system material and is a prerequisite material for studying three variable linear equation systems material.

Some students apparently still have difficulty with this material. Liberna (2015) in his research stated that the results of his interviews with junior high school students showed that the mathematics learning material that was still considered difficult and not easily mastered by students was system of linear equations in two variables material. In their research, Maryani & Setiawan (2021) also stated that the test results with junior high school students showed that there were still many students who had difficulty solving system of linear equations in two variables questions and were less than optimal. From the results of this research, it turns out that the cause is that students still have difficulty understanding the two variable linear equation system concept, changing story problems into mathematical form, using methods to determine the two variable linear equation system solution set and students still having difficulty understanding two variable linear equation system supporting material.

Based on the problems above, researchers are interested in conducting research with the title "The Influence of Problem Based Learning Models on Critical Thinking Ability in Two Variables Linear Equation Systems as Seen from Learning Style".

RESEARCH METHODS

This research was an experimental research using Factorial design. Observations were carried out in two classes, namely the experimental class and the control class. In the experimental class was applied learning using a problem based learning, while in the control class was applied learning using conventional learning. In accordance with the hypothesis to be tested, this research was designed with a 2×3 factorial version.

This research was conducted in the even semester of the 2022-2023 academic year at SMP Negeri 2 Sugio, Lamongan. The population in this study were all students in class VIII of SMP Negeri 2 Sugio. The sampling technique in this research was purposive sampling. The samples selected were class VIII A and class VIII B, where there were 32 students in both classes.

The instruments used in this research consisted of test and non-test instruments. The test instrument used a test in the form of essay questions with a total of 5 questions. The types of pretest and posttest questions are equivalent. The scope of the test material is about systems of linear equations in two variables. The test instrument used in this research is a test to measure students' critical thinking ability. The purpose of the test is given in the form of a description because it is expected to be able to measure indicators of critical thinking ability, namely indicators according to Hutabarat et al. (2019), namely as follows: (1) Interpretation, namely understanding the issues in question by interpreting known information and asking related questions. (2) Analysis, namely identifying the relationship between several statements, questions and concepts given in the problem which is demonstrated by creating an appropriate mathematical model and providing an explanation that is appropriate to the problem.

(3) Evaluation, namely the ability to choose the right way to solve problems and carry out calculations accurately and completely. (4) inference, namely drawing valid conclusions. Before the test instrument was used, the researcher conducted a trial first. The data obtained from the trial results are then tested for validity, reliability, level of difficulty and distinguishing power to prove that the test instrument used is appropriate. The following are the results of the validation of the test instrument.

Table 1. Test Validity Value

Question Item	Pearson Correlation	Interpretation
1	0,82	Very High
2	0,82	Very High
3	0,91	Very High
4	0,85	Very High
5	0,69	High

Table 2. Reliability Test

Reliability Statistic	Posttest		Interpretation
	Cronbach's Alpha	N of Items	
	.936	5	Very High

Based on calculations, the Cronbach Alpha pretest and posttest values were greater than 0.60. Therefore, it can be concluded that the reliability of the Pretest and Posttest of critical thinking ability has high reliability or reliability.

Table 3. Difficulty Level Test

Question Item	Difficulty Level	Interpretation
1	0,539	Medium
2	0,426	Medium
3	0,485	Medium
4	0,317	Medium
5	0,471	Medium

Based on Table 3, it can be concluded that each pretest question item used as a research instrument has a medium level of difficulty.

Table 4. Differentiating Power Test

No.	Differentiating Power	Interpretation
1	0,824	Very Good
2	0,837	Very Good
3	0,986	Very Good
4	0,918	Very Good
5	0,665	Very Good

Each question item meets the requirements and can be used for research because it has been declared valid, reliable, meets the moderate criteria and has excellent differentiating power. Learning style questionnaires using the Guttman scale.The data analysis techniques in this research consist of validity questionnaire data analysis techniques, learning style questionnaire results data, and test result data. Analysis of test result data in this research used the N Gain test, a prerequisite test consisting of a normality test and a homogeneity test, as well as hypothesis testing using the TWO WAY Anova test.

RESULTS AND DISCUSSION

The data obtained in this research are data from the pretest, posttest and learning style questionnaire. From the pretest and posttest results, the increase in each student's critical thinking ability can be seen from the N Gain value. The N Gain value was carried out to determine the increase in critical thinking ability of individual students in the experimental and control classes. After testing N Gain, the learning style tendencies of experimental class and control class students were grouped based on the results of the distribution of learning style questionnaires.

Table 5. Mean and Standard Deviation of Pretest, Posttest, and N Gain

Learning Style	Statistic	Problem Based Learning				Conventional Learning			
		Pretest	Postest	N Gain	N	Pretest	Postest	N Gain	N
Visual	$\bar{x}$	57	91,41	0,79	12	54,36	83,82	0,64	11
	s	13,16	3,260	0,05		5.39	2.639	0,04	
Auditory	$\bar{x}$	53,3	90,6	0,80	10	49,77	82.08	0,64	13
	s	11.38	4.351	0,05		5.13	3.883	0,05	
Kinesthetic	$\bar{x}$	59,1	90,7	0,76	10	56,38	83,3	0,60	8
	s	13.42	2.869	0,09		14.57	4,373	0,06	
Total	$\bar{x}$	169,4	272,71	2,35	32	160,51	249,2	1,88	32
	s	37,96	10,48	0,19		15,09	10,88	0,15	

From Table 5 it shows that in the problem based learning the dominant learning style is the visual learning style with 12 students, while the auditory and kinesthetic

learning styles each consist of 10 students. In the control class, the dominant learning style is the auditory learning style, with 13 students, while the visual learning style only consists of 11 students and the kinesthetic learning style consists of 8 students.

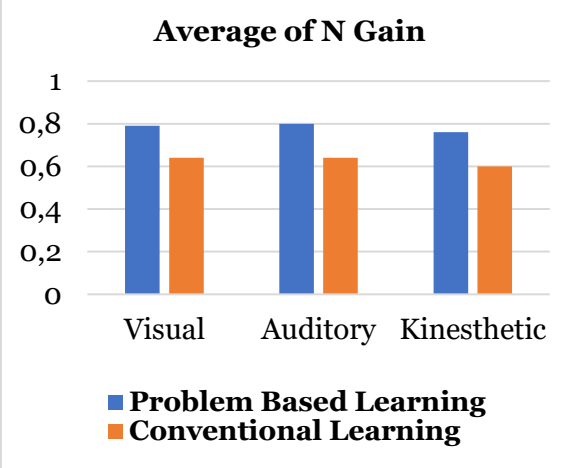

Figure 1. Average of N Gain

Based on Figure 1, the average value of N Gain for students with a visual learning style in the experimental class is 0.79, while in the control class it is 0.64. The average N Gain value obtained by students with an auditory learning style in the experimental class was 0.80, while in the control class it was 0.64. The average N Gain value for students with a kinesthetic learning style in the experimental class was 0.76 and in the control class was 0.60. From this presentation it was found that in the experimental class, students with a visual learning style got an average score of N Gain in the high category, students with an auditory learning style got an average score of N Gain in the high category, and students with a kinesthetic learning style got an average score. -average N Gain in the high category. In the control class, students with a visual learning style got an average N Gain score in the medium category, students with a medium auditory learning style, and students with a kinesthetic learning style got an average N Gain score in the medium category. So it can be concluded that in the learning process, students in the experimental class experienced an increase in results in the high category, and students in the control class experienced an increase in results in the medium category.

The inferential statistical analysis in this research used the Two Way ANOVA test. Before carrying out the analysis, it is necessary to carry out prerequisite tests, namely the data normality test and data homogeneity test first. Testing was carried out with the help of IMB SPSS version 22.

Table 6. N-gain Normality Test Results Critical Thinking Ability

Statistic	PBL	CL
N	32	32
Shapiro Wilk	0.931	0.935
Sig	0.080	0.100
H_0	diterima	diterima

H_0: Data is normally distributed
H_1: Data is not normally distributed

The decision making criteria for the normality test using Kolmogorov-Smirnov is that data is said to be normally distributed when the Sig value is> 0.05. From the results of the data calculations seen in the Shapiro Wilk column, the results show a significance value of more than 0.05, both Problem Based Learning and Convensional Learning. So it can be concluded that the data used for the Problem Based Learning and Convensional Learning are normally distributed.

This hypothesis testing is used to determine the significant influence of implementing the Problem Based Learning learning model. In this research, the hypothesis was tested using Two Ways Anova.

Table 7. Two Way Anova Test Result

Test of Between Subjects Effects					
Dependent Variabel: Learning Outcomes					
Source	Type III Sum of squares	df	Mean Square	F	Sig.
Corrected Model	1360.765[a]	5	272,153	0,780	0,000
Intercept	188411,528	1	188411,528	540,023	0,000
Learning Model	578,777	1	578,777	1,659	0,003
Learning Style	365,06	2	182,530	0,523	0,000
Learning Model *Learning Style	466,988	2	233,494	0,669	0,174
Error	15002,5	43	348,895		
Total	264225	49			
Corrected Total	16363,265	48			
a. R Square= 0,083 (Adjusted R Squared = -0,023)					

PBL Learning Model Influences Critical Thinking Ability

The data used to test the hypothesis is data N gain score is obtained from the difference between final ability (posttest) and initial ability initial (pretest) experimental class and control class. Testing The hypothesis in this research is:

H_0 : The PBL learning model has no effect on critical thinking ability
H_1: The PBL learning model has effect on critical thinking ability

The basis for making decisions based on significance values is as follows:

If the significant value is > 0.05 then H_0 is accepted
If the significant value is < 0.05 then H_0 is rejected

The results of data analysis using two-way Anova show thatThe PBL learning model has a significant effect on students' critical thinking ability.The analysis results for the essay test show the sig value. 0.003, so the sig value. < 0.05. There isdifference in mean critical thinking abilitybetween the experimental class and the control class.It can be decided that in this experiment H_0 is rejected and H_1 is acceptedresearch result. The results of this analysis show the PBL learning modelinfluences students' critical thinking ability.

Learning Style Influences Critical Thinking Ability

Hypothesis testing in this research is:

H_0 : Learning style has no effect on critical thinking ability

H_1: Learning style has effect on critical thinking ability

The basis for making decisions based on significance values is as follows:

If the significant value is > 0.05 then H_0 is accepted

If the significant value is < 0.05 then H_0 is rejected

The results of data analysis using two-way ANOVA show that learning style has a significant effect on critical thinking ability. This is demonstratedwith the results of the analysis it is known that the sig value. 0.000, so the sig value <0.05. Can be takenthe decision in this experiment H_0 was rejected and H_1 was accepted as the research result.

Interaction between PBL Learning and Learning Styleon Critical Thinking Ability

Hypothesis testing in this research is:

H_0 : There is no interaction between the PBL learning model and learning styleon critical thinking ability

H_1: There is interaction between the PBL learning model and learning styleon critical thinking ability

The basis for making decisions based on significance values is as follows:

If the significant value is > 0.05 then H_0 is accepted

If the significant value is < 0.05 then H_0 is rejected

The results of analysis using two-way Anova show that the modelPBL learning and learning styles do not interact significantly withcritical thinking ability. This is indicated by the sig value. 0.174, so (sig. value >0.005).Thus it can be concluded that in this experiment H_0 was accepted and H_1 rejected as a result of research.Based on the results of the analysis, it can be stated that the PBL learning modelwith learning style does not interact significantly with the resultscritical thinking ability. This means differences in critical thinking ability between experimental classesand control is more influenced by the PBL learning model than learning style.

CONCLUSION

Based on the research results, data analysis, and discussion, it can be concluded that:

1. In the experimental class with 32 respondents, 12 students with a dominant visual learning style, 10 students with a dominant auditory learning style, and 10 students with a dominant kinesthetic learning style. Meanwhile, 32 respondents in the control class had 11 students with a dominant visual learning style, 13 students with a dominant auditory learning style, and 8 students with a dominant kinesthetic learning style. So, the total number of respondents was 64 students, consisting of 23

students with a visual learning style, 23 students with an auditory learning style, and 18 students with a kinesthetic learning style.

2. The average pretest and posttest scores for critical thinking ability obtained by students in the experimental class, which consists of students with learning styles, visual auditory and kinesthetic, are higher than the average pretest and posttest scores for critical thinking ability obtained by students in the control class. Where, in the learning process the experimental class applies the Problem Based Learning learning model, while the control class applies the conventional learning model, namely a learning model centered on the teacher as the main role in the learning process. This shows that the application of the Problem Based Learning learning model has more influence on students' critical thinking ability than conventional learning models.
3. PBL learning model influences students' critical thinking ability,learning style has a significant effect on critical thinking ability, critical thinking ability is more influenced by the PBL learning model than learning style.

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