



## THE INFLUENCE OF THE IMPLEMENTATION OF PROBLEM-BASED LEARNING AND STEM ON THE HOTS ABILITY OF HIGH SCHOOL'S STUDENTS IN SURABAYA

**Amalia Chamidah<sup>1</sup>, Suhartono<sup>2</sup>**

<sup>1,2</sup> *Pendidikan Matematika, FBS, Universitas Wijaya Kusuma Surabaya*

[amaliachamidah\\_fbs@uwks.ac.id](mailto:amaliachamidah_fbs@uwks.ac.id)

### Abstrak

Pembelajaran berdasarkan masalah (PBL) merupakan salah satu model pembelajaran inovatif yang memberikan kesempatan belajar pada peserta didik untuk terlibat langsung dalam proses belajar yang melibatkan dunia nyata. Penelitian ini bertujuan mengetahui signifikansi penerapan PBL berbasis STEM terhadap kemampuan HOTS pada peserta didik SMA Hang Tuah 4 Surabaya. Sampel penelitian ini adalah 17 peserta didik kelas X SMA Hang Tuah 4 Surabaya tahun pelajaran 2021-2022. Data dikumpulkan melalui tes dan dokumentasi yang dilakukan peneliti bersama dengan guru matematika pada saat mengajarkan SPLDV. Data dianalisis menggunakan SPSS 25.0 for windows. Hasilnya adalah penerapan PBL berbasis STEM berpengaruh pada kemampuan HOTS peserta didik di SMA Hang Tuah 4 Surabaya. Untuk itu, direkomendasikan bagi guru matematika untuk menerapkan PBL berbasis STEM untuk membiasakan peserta didik berfikir HOTS.

**Kata kunci:** PBL; STEM; HOTS

### Abstract

Problem-based learning (PBL) is one of the innovative learning models that provides learning opportunities for students to be directly involved in learning processes the real life reality. This study to determine the significance of the application of STEM-based PBL on the HOTS ability of Hang Tuah 4 High School students Surabaya. The sample of this research is 17 students of class X SMA Hang Tuah 4 Surabaya in the academic year 2021-2022. Data were collected through tests and documentation conducted by the researcher together with the mathematics teacher when teaching SPLDV. Data were analyzed using SPSS 25.0 for windows. The result is that the application of STEM-based PBL has an influence on the HOTS ability of students at Hang Tuah 4 High School Surabaya. For this reason, it is recommended for mathematics teachers to apply STEM-based PBL to familiarize students with HOTS thinking.

**Keywords:** PBL; STEM; HOTS

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## INTRODUCTION

The change in the 2013 curriculum to an “Merdeka” curriculum requires a change in the learning paradigm in the classroom. The demands developed to deal with an independent curriculum are the application of a project-based learning model (PjBL) and a problem-based learning model (PBL). The two learning models are closely related as the implementation of the problems developed by the teacher (Mayasari & Adawiyah, 2015).

PBL is an innovative learning model that provides learning opportunities for students to be directly involved in the learning process that involves the real world (Yamin & Maisah, 2012). This is because PBL is based on constructivist theory where students can construct their knowledge based on prepared problems. Through group discussions, students can interact with each other to get solutions to the problem situations presented. PBL can train students in critical thinking in solving problems given by the teacher.

Associated with innovative learning, STEM is present in being integrated in every learning in the classroom. STEM is a learning approach that integrates the fields of science, technology, engineering, and mathematics into a single unit to construct the knowledge and abilities of students (Rivai et al., 2018). The combination of PBL and STEM, it is hoped that it can be a reference for teachers in order to teach higher order thinking skills (HOTS) to their students.

Many researches on PBL involving STEM have been carried out (Mayasari & Adawiyah, 2015; Cahyaningsih & Roektingroem, 2018; Rivai et al., 2018; Amelia, 2019; Styasih et al., 2021; Faoziyah, 2021; Widana & Septiari, 2021; Vikrayati, 2022), and many other studies. PBL research involves STEM in the field of science (Mayasari & Adawiyah, 2015; Cahyaningsih & Roektingroem, 2018; Rivai et al., 2018), sedangkan di bidang matematika (Amelia, 2019; Faoziyah, 2021; Styasih et al., 2021; Vikrayati, 2022; Widana & Septiari, 2021). From research in the field of mathematics, each researcher focuses on problem solving abilities (Amelia, 2019; Faoziyah, 2021), mathematical connection ability (Styasih



et al., 2021), mathematical ability (Vikrayati, 2022), creative thinking (Widana & Septiari, 2021). From research in the field of mathematics there is a gap regarding the application of STEM-based PBL associated with higher order thinking skills (HOTS).

This gap is interesting for researchers because HOTS is a 21<sup>st</sup> century skill that must be possessed by students. For this reason, this research is important because it aims to determine the significance of the application of STEM-based PBL on HOTS abilities in Hang Tuah 4 High School students Surabaya. This study focuses on the material of linear inequalities of two variables that are taught to students at the high school level. The results of this study can be used as a source of information to conduct further studies on students' mastery of the concept of linear inequalities in two variables.

## METHOD

This research design is a pre-experiment type one group pretest-posttest design (Arikunto, 2010). The design used in this study is as follows.

$$O_1 \quad X \quad O_2$$

Information:

O<sub>1</sub> pretest

O<sub>2</sub> posttest

X STEM-based PBL implementation

The population of this research is the students of 10<sup>th</sup> grade, SMA Hang Tuah 4 Surabaya, while the sample is 17 students of 10<sup>th</sup> grade Science 2, SMA Hang Tuah 4 Surabaya. The independent variable in this study is the application of STEM-based PBL on the material of linear inequalities of two variables, while the dependent variable is the HOTS ability of students on the material of linear inequalities of two variables.

Data were collected through tests, pretest and posttest in the form of 4 questions. While the documentation was carried out by researchers by noting



interesting things during the implementation of STEM-based PBL. The pair of hypotheses carried out in this study are

Ho : There is a significant effect between the application of STEM-based PBL on the HOTS ability on the linear inequalities of two variables of students at Hang Tuah 4 High School Surabaya.

H1: There is no significant effect between the application of STEM-based PBL on the ability of HOTS on the linear inequalities of two variables of students at Hang Tuah 4 High School Surabaya.

The results were analyzed using independent sample t-test using SPSS 25.0 for windows software. When drawing a conclusion when the probability value is greater than 5% then Ho is accepted, and instead of.

## RESULT AND DISCUSSION

### HOTS ability of students

This research was carried out in the even semester of the 2021-2022 academic year which was held at Hang Tuah 4 High School Surabaya by applying STEM-based PBL to the linear inequalities of two variables. Data on students' HOTS abilities were obtained from the results of the pretest and posttest after being analyzed. The descriptive analysis of the HOTS ability from the pretest results is presented in Figure 1 below:.

		Statistic	Std. Error
PRETEST	Mean	47.35	3.513
	95% Confidence Interval for Mean		
	Lower Bound	39.91	
	Upper Bound	54.80	
	5% Trimmed Mean	47.34	
	Median	50.00	
	Variance	209.743	
	Std. Deviation	14.482	
	Minimum	25	
	Maximum	70	
	Range	45	
	Interquartile Range	25	
	Skewness	.113	.550
	Kurtosis	-1.150	1.063

Figure 1 Results of descriptive analysis of HOTS ability (pretest)

From Figure 1 above, it shows that the lowest value of the HOTS ability of students on the material of a linear inequality system of two variables is 25, while the highest



value is 70. While the descriptive analysis of the HOTS ability of the posttest results is presented in Figure 2 below.

POSTTEST	Mean		91.18	1.634
	95% Confidence Interval for Mean	Lower Bound	87.71	
		Upper Bound	94.64	
	5% Trimmed Mean		91.31	
	Median		90.00	
	Variance		45.404	
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	Std. Deviation		6.738	
	Minimum		80	
	Maximum		100	
	Range		20	
	Interquartile Range		13	
	Skewness		-.137	.550
	Kurtosis		-.986	1.063

**Figure 2 Results of descriptive analysis of HOTS ability (posttest)**

From Figure 2 above, it shows the lowest posttest score of students' HOTS abilities on the material of a linear inequality system of two variables is 80, while the highest value is 100. Based on the information in Figures 1 and 2 above, there is an increase in the value of HOTS abilities. Furthermore, the researchers tested normality and tested the effect of the data obtained above.

After analyzing descriptively the HOTS ability from the pretest and posttest results, the researcher tested the normality of the data using Saphiro-Wilk based on SPSS 25 software for windows. The results of the normality test output using SPSS 25 are presented in Figure 3 below.

	Tests of Normality					
	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
PRETEST	.165	17	.200*	.938	17	.290
POSTTEST	.158	17	.200*	.910	17	.101

\*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

**Figure 3 Normality test results using SPSS 25. software**



From the calculation of Figure 3 above, the pretest and posttest significance values are greater than the 5% significance value. So it can be concluded that the data used is normally distributed.

### Hypothesis testing

Hypothesis testing using independent sample t-test technique with the help of SPSS 25 for windows. The output results of the independent simple t-test using SPSS 25 software are presented in Figure 4 below:

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
HASIL	Equal variances assumed	11.883	.002	-11.312	32	.000	-43.824	3.874	-51.715	-35.932
	Equal variances not assumed			-11.312	22.617	.000	-43.824	3.874	-51.845	-35.802

**Figure 4. Results of t-test using SPSS 25 . software**

From Figure 4 above, it is known that  $\text{sign} = 0.002 < 5\%$ , it can be said that  $H_0$  is rejected and  $H_1$  is accepted. It can be concluded that the application of STEM-based PBL has an effect on the HOTS ability of students at Hang Tuah 4 High School Surabaya.

The results of this study are in line with several previous studies that STEM-based PBL has an influence on HOTS not only in learning mathematics but other learning. PBL that is integrated with other approaches has a positive interaction with the HOTS of students (Mayasari & Adawiyah, 2015; Widiawati et al., 2018; Iolanessa et al., 2020; Simanungkalit et al., 2019; Andini & Retno, 2022; Vikrayati, 2022).

From the results of observations, students are more motivated to follow the learning process of linear inequalities of two variables carried out by the teacher.



This is in line with the opinion Carlisle & Weaver (2018) that the STEM approach has the advantage of motivating students to be active during the learning process. This can be seen in the enthusiasm of students participating in learning with pleasure, taking the initiative to carry out discussions on the problems presented. This is because students are invited to connect the concepts learned with the real world (Widana & Septiari, 2021)

The other side of STEM is that the existence of technology is an attraction for students to arouse their motivation in learning. The use of STEM becomes a tool to motivate students' learning so that they can find out HOTS abilities through their learning outcomes (Laboy-Rush, 2010; Saeed & Zyngier, 2012; Suratno et al., 2020). The results of this study indicate an increase in the results of the pretest and posttest after being given treatment through the application of STEM-based PBL.

In terms of students' HOTS abilities, habituation of students to think at higher levels has a good impact on themselves (Rusyna, 2014; Suratno et al., 2020). This can be seen from the HOTS ability of students who experienced an increase in posttest scores after following the application of STEM-based PBL for several meetings.

## CONCLUSION

From the results of the data analysis above, it is concluded that the application of STEM-based PBL has an effect on the HOTS ability of students at Hang Tuah 4 High School Surabaya. This can be seen at the sign =  $0.002 < 5\%$  which indicates a significant influence from the application of STEM-based PBL. Thus, mathematics teachers are recommended to implement STEM-based PBL to equip students with HOTS abilities.

In future research, it is necessary to study further about the appropriate assessment model for the application of STEM-based PBL. It is hoped that the learning carried out is in line with the assessment used in accordance with the contextual conditions in the field.



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