Mathematics Education Journals
Vol. 8 No. 1 February 2024

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
http://ejournal.umm.ac.id/index.php/MEJ

Implementation of Problem Based Learning (PBL) Model Using Maple Software in Solving a Trigonometry Material Problem

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Keywords:
Problem Based Learning Model; Maple Software; Ability Based Problem Solving.

Abstract

This study aims to investigate the implementation and effectiveness of the PBL learning model with Maple Software in solving Trigonometry problems during mathematics lessons. It is descriptive research with a quantitative approach. The participants were 20 tenth-grade students from an vocational school in the second semester of the 2022/2023 academic year. Data were collected through student questionnaires and written tests. The questionnaires assessed student understanding in solving Trigonometry problems with Maple Software, while the tests included 5 questions to evaluate problem-solving skills using the software. The findings indicate that: (1) The PBL model with Maple Software enhances student engagement and effectively solves Trigonometry problems. (2) The PBL model using Maple Software is effective in improving students' problem-solving abilities in Trigonometry.

Ni'mah, Dewi Nailin, Inganah, Siti & Putri, Octvaina R. U. P.. (2024). Implementation of Problem Based Learning (PBL) Model Using Maple Software in Solving a Trigonometry Material Problem. *Mathematics Education Journal*, 7(2), 81-89. DOI : 10.22219/mej.v8i1.28344

INTRODUCTION

Mathematics is a basic science of knowledge that studies theories, definitions, theorems, numbers, models, correlations, facts, and structures in space and form (Nur'aini et al, 2017). Not only that, mathematics also learns about simple concepts to complex concepts that are arranged in stages, structured and systematic (Hasratuddin, 2013). Thus, learning about mathematics needs to be given from elementary to high school/vocational school, so that students can think critically, analytically, professionally, creatively, and be involved in their learning (Sholihah & Mahmudi, 2015). According to ((Algado et al., 2014)) problem-based learning is a learning strategy that aims to integrate the curriculum, motivate students, and make it easier for them to identify a problem. Learning mathematics that uses problem solving, expects students to be able to apply it in real life (Haryani, 2011).

One learning model that can help complete learning that uses problem solving is PBL (Problem Based Learning). According to ((Algado et al, 2014)) PBL has the goal of improving the quality of independent learning, teamwork, developing reflective attitudes, critical evaluation, assessment, and improving learning and cognitive integration in education. The learning model is a learning that describes an overview from the beginning of the learning activity to the end with the presentation of the teacher for implementing an approach, strategy, method, and learning technique (Helmiati, 2017). PBL (Problem Based Learning) is a learning process based on everyday life problems, so students can

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
http://ejournal.umm.ac.id/index.php/MEJ

solve problems by compiling their own knowledge and trying to find solutions so students can think creatively (Purnamaningrum et al., 2012). In PBL students can play an active role in solving problems that occur based on the scientific field that is their expertise (Fajrin, 2006). There are three important principles in PBL, namely: learning is a constructive process, learning is a self-influenced process, and learning is a process that is given contextually (Fitri, 2016). Therefore, researchers want to use the PBL model because it utilizes the student learning process and determines student progress in problem solving (Marlina et al, 2018).

Given the importance of students in identifying a problem in learning mathematics, this shows that using the PBL model using Maple Software, students are able to improve their ability to understand and answer questions in their own way, as well as express concepts related to solving problems (Mulyani, 2017). Maple software is a software that is used to solve mathematical problems in the form of numeric or symbolic (Parma & Saparwadi, 2015; Stepanus & Astuti, 2014). According to Retno Marsitin (2018) Maple Software also has several functions in the field of mathematics including trigonometry functions, so the use of Maple Software is suitable to be used to make it easier for students to solve problems related to this material. Maple was discovered in 1988 in Canada by Wateloo Maple Software (WMS), which are several researchers from the University of Wateloo, in which there are symbols, syntax, and semantics that are the same as computer languages or programming languages (Parma & Saparwadi, 2015; Saifudin, 2017). Maple software can be used to solve mathematical computing problems easily and quickly without the requirement to master a particular computer programming language, so that everyone can use this application even if that person does not master a computer programming language (Junaidi et al, 2016).

The application of the PBL learning model using Maple Software has a good effect. This can be seen from the development of problem solving skills, motivation and initiatives related to problem solving, so that after succeeding through the PBL learning model using Maple Software, students can solve problems even better (Andy Purnomo & Rohman, 2015a). The problem-solving abilities of each student are different, this is because students can solve problems that require their special skills and abilities (Oktaviani & Tari, 2018). Therefore, the application of problem-based skills in classroom learning can encourage students to be creative and enable students to solve problems in learning (Suardani et al., 2014). The purpose of this research is to investigate the implementation and effectiveness of utilizing the PBL learning model with Maple Software to solve a Trigonometry problem in mathematics education.

RESEARCH METHOD

This type of research is descriptive research using a quantitative approach which aims to describe the application of the PBL learning model using Maple Software in solving a problem in Trigonometry material.

The research was conducted at SMK Hayam Wuruk, Mojokerto. The subjects of this study were class X students of SMK Hayam Wuruk Mojokerto for the 2022/2023 academic year with a total of 20 students. There are three stages of the research procedure carried out in this study, namely (1) research preparation, (2) research implementation, (3) final / post-research stage. The initial stage (preparatory) of the research was carried out to determine the time and place of research, the object of research, the material to be

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
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taught and determine the KKM for mathematics at the school, as well as develop learning tools such as lesson plans, worksheets, written test sheets, and questionnaire sheets. The research implementation was carried out in accordance with the RPP that had been designed, namely 3 meetings and observing student activities in the ongoing learning process using the LKPD instrument to collect data through the application of PBL using Maple. The first and second meetings were used for face-to-face learning about trigonometry material by giving students problems to solve using maple software, and the third meeting was held for a written test regarding the material taught at meetings one and two. In the final stage / after the research, data research is carried out, analyzing data, making research decisions and compiling research data.

Data collection techniques were carried out by giving student response questionnaires and written tests. The instruments used in the study were student response questionnaires and written test sheets. Data analysis techniques are carried out after all activities in learning take place. There are 2 data analysis techniques, namely (1) analysis of student response questionnaires which have the aim of knowing student answers and the basis for understanding the effectiveness of the PBL learning model. (2) written test analysis which aims to determine student understanding by analyzing the scores obtained from the results of written tests carried out by students according to the KKM.

$$\%\text{NRS} = \frac{\sum_1^n \text{NRS}}{\text{NRS Maksimum}} \times 100\%$$

Keterangan :
%NRS= Persentase nilai respon siswa
$\sum_1^n$ NRS= Total nilai respon siswa pada setiap item pertanyaan
NRS maksimum = n x skor pilihan terbaik, n x 4, dengan n adalah banyaknya seluruh responden

Mengubah nilai rata-rata instrument menjadi nilai kualitatifberdasarkan dengan kriteria penilaian sebagai berikut :

$$\text{p} = \frac{\text{L}}{\text{n}} \times 100\%$$

Keterangan:
p = persentase ketuntasan klasikal
L = banyaknya kelompok yang lulus KKM
n = banyaknya kelompok.

Table 2. kriteria presentase respon siswa

%NRS	Kategori
0,22 ≤ %NRS < 43	Sangat kurang baik
0,44 ≤ %NRS< 0,62	Cukup
0,63 ≤ %NRS < 0,81	Baik
0,82 ≤ %NRS≤ 1	Sangat baik

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ISSN : 2579-5260 (Online)
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RESULTS AND DISCUSSION

This chapter presents research data and discusses the application of the PBL model using Maple Software in solving a problem in trigonometry. Data collection was carried out by giving student response questionnaires and written tests. A total of 20 students filled out a student response questionnaire so that the following results were obtained:

Table 1. Research Results of Student Response Questionnaire Sheets

Pernyataan	Nama siswa																			
	KAS	MSP	ERFS	UKK	NED	SN	MH	AVDV	VFA	ANF	SA	NNM	DAF	MDA	MK	NHW	APS	MA	NR	FA
1	3	3	3	4	3	3	3	3	4	3	3	3	3	3	4	3	3	4	3	3
2	4	3	3	4	3	3	3	3	4	3	3	3	3	3	4	3	3	4	3	3
3	3	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
4	3	4	3	3	3	4	3	3	4	3	3	3	3	3	3	3	3	3	3	3
5	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
6	4	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
7	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
8	4	4	3	4	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
9	4	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	4	3	2
10	3	3	3	4	3	3	3	3	3	4	3	3	3	3	4	4	3	3	4	3
11	3	4	3	3	3	3	4	3	3	4	3	3	3	3	3	4	4	3	4	3
12	4	3	3	3	3	4	3	3	4	3	3	2	2	3	3	3	4	3	3	2
13	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
14	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
15	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3
17	4	3	3	3	4	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3
18	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
20	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	2	3	3
21	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
22	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
23	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
24	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
25	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
26	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
27	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
28	4	4	3	3	3	3	3	4	4	4	3	4	4	4	3	3	3	3	3	3
29	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3
30	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3
31	3	4	3	4	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3
32	3	4	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3
33	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
34	3	4	3	4	3	3	3	3	4	3	3	3	3	2	2	3	3	3	3	3
35	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
36	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
37	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
38	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
39	4	4	3	3	4	3	3	4	4	4	3	3	3	3	3	3	3	3	3	3
40	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	3	3
Total	134	130	121	127	122	124	121	125	127	124	119	120	121	120	122	124	122	122	122	118
%NRS	0.84	0.81	0.76	0.79	0.76	0.78	0.76	0.78	0.79	0.78	0.74	0.75	0.76	0.75	0.76	0.78	0.76	0.76	0.76	0.74

Following are the results of the analysis of student response questionnaire sheets, namely:

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
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Table 2. Distribution of Student Categories in Material Mastery Based on Student Response Questionnaires

%NRS	The number of students	Percentage	Category
$0{,}22 \leq \%NRS < 0{,}43$	-		Very Less Good
$0{,}44 \leq \%NRS < 0{,}62$	-		Enough
$0{,}63 \leq \%NRS < 0{,}81$	2	0,74	Good
	2	0,75	
	8	0,76	
	4	0,78	
	2	0,79	
	1	0,81	
$0{,}82 \leq \%NRS \leq 1$	1	0,84	Very Good

According to table 2, it can be concluded that there are 19 students belonging to the good category. Those who obtained 0.74% were 2 students, 0.75% were 2 students, 0.76% were 8 students, 0.78% were 4 students, 0.79% were 2 students, 0.81 were 1 student. And those belonging to the very good category are as much as 1 student with a percentage of 0.84%

The results of the student's written test will be presented as follows :

Table 3. Student Ability Percentage Results

Question	Group 1	Group 2	Group 3
1	20	20	20
2	15	20	20
3	20	20	20
4	20	20	10
5	20	20	20
value amount	95	100	90
pass percentage		100	

Following are the results of the analysis of students' written tests in each group.

According to table 4, it is known that all groups that fall into the very effective category have 3 groups out of 3 groups, in other words 100% have a completeness score with very effective criteria. Based on the results of the analysis of the percentage of student response questionnaires in PBL learning using maple software with a good distribution. Meanwhile, based on the results of the analysis of the percentage of problem-based student ability writing tests using maple software, the distribution is very effective. So it can be concluded that the learning process using the PBL model on maple software in

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
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solving a problem is better than the direct learning model. So that the PBL model using maple software in learning mathematics affects students' ability to solve a problem.

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
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Table 4. Distribution of Student Categories in Material Mastery Based on Student Writing Test Results

Completeness Value	Number of Groups	Percentage	Criteria
$22 \leq p < 43$	-		Very Less Effective
$44 \leq p < 62$	-		Effective enough
$63 \leq p < 81$	-		Effective
$82 \leq p \leq 100$	3	100%	Very Effective

The implementation of the PBL model at Hayam Wuruk Vocational School was successful, with students showing great enthusiasm. The application of the PBL model increased student engagement and made the learning process more enjoyable compared to traditional methods.

In this study, PBL was utilized to encourage active student participation in problem-solving. Research by Hotimah (2020) supports the use of PBL in small groups, where students present their findings related to the case and engage in group discussions. The integration of Maple software with the PBL model was found to enhance problem-solving skills effectively, consistent with Marlina et al. (2018) findings on improved problem-solving abilities through PBL.

Analysis of student response questionnaires indicated positive outcomes for PBL learning with Maple software. Additionally, assessments of problem-solving skills through written tests using Maple software were highly effective. Therefore, it can be concluded that the PBL model with Maple software is more beneficial for problem-solving compared to direct learning, particularly in mathematics education.

This study highlights the use of the PBL learning model with Maple software to enhance problem-solving abilities and improve learning effectiveness. Findings align with Andy Purnomo & Rohman (2015) research, showing that well-mastered materials and active participation lead to improved learning outcomes. Similarly, research by Prayoga & Setyaningtyas (2021) supports the superiority of the PBL learning model in problem-solving over traditional methods.

CONCLUSION

Based on the results of the research that has been presented in the results and discussion regarding the application of the PBL model using Maple Software in solving a problem in trigonometry material, the following conclusions can be drawn: (1) the implementation of the learning process with the PBL model using Maple Software in solving a problem in SMK Hayam Wuruk can run well, the students are very enthusiastic and full of enthusiasm and the application of the PBL model makes students more active and the learning process becomes more enjoyable. (2) The results of the effectiveness of the PBL learning model using Maple Software in solving a problem at Hayam Wuruk Vocational School are well

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
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distributed. This can be seen based on the results of the analysis of the percentage of student response questionnaires where a total of 19 students belonged to the good category, and as many as 1 student belonged to the very good category. Meanwhile, based on the results of the analysis of the percentage of students' written tests, it is known that all groups are included in the very effective category, where there are 3 groups out of 3 groups as a whole, in other words 100% have a completeness score with very effective criteria.

The researcher's suggestion for further research is to expand the scope of the study. Apart from trigonometry, the PBL learning model can also be applied to other mathematics material, the subject used should be larger so that it can provide effectiveness in applying the PBL learning model to trigonometry material at the SMK level. As well as the use of the PBL learning model using Maple Software requires more time in research, therefore, it will be more effective in its use.

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