Problem based learning instruction assisted by e-book to improve mathematical representation ability and curiosity attitudes on optical devices

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Abstract. This study aims to determine the increase in mathematical representation abilities and curiosity attitudes of students of SMA Negeri 1 Banguntapan through learning Problem Based Learning assisted with e-books. The research subject is MIPA 2 class XI with 30 samples. Questionnaire is given at the beginning and end of learning to measure students' curiosity attitudes. The pretest and posttest questions are in the form of descriptions to measure the ability of mathematical representation. There are two indicators of mathematical representation, namely (1) determining the exact equation in accordance with the problem, and (2) carrying out mathematical operations into the equation. Indicator (1) increase is 61,90% and 66,67% for indicator (2). Overall mathematical representation improvement is 55,83%. The percentage of curiosity attitudes of most students are in the good category that is equal to 57%. There is an increase of 27% when compared to the attitude of curiosity before learning PBL assisted by e-book that is equal to 30%. It can be concluded that problem based learning instruction assited by e-book can improve mathematical representation and curiosity attitudes of students on optical devices.

Keywords: *problem based learning, e-book, mathematical representasion, curiosity attitude*

1. Introduction

Education in Indonesia applies the Kurikulum 2013. The learning process in the Kurikulum 2013 is carried out using a scientific approach, which is a student-centered learning approach [1]. One of the criteria in a scientific approach is fact-based learning material or phenomena that can be explained with a certain logic or reasoning.

One of model that fits the Kurikulum 2013 and scientific approach is problem based learning (PBL). PBL is intruction that is centered on students through research activities to complete a particular learning project [2]. PBL uses problems as a stimulus or scenario where students can determine their own learning goals [3] – [4]. In PBL, the problem used is a contextual problem found in the surrounding environment. This is intended to stimulate students' learning activeness [5]. The main characteristics of PBL include; (1) problem-focused, (2) student-centered, (3) self-directed, (4) self-reflective, and (5) facilitative [6]. The main process of PBL lies with students, the teacher is only a facilitator who directs students to find and find solutions and at the same time determine the criteria for achieving the learning process [7]. PBL was developed to help students develop the ability to think, train using various concepts, principles, and skills that have been learned to solve problems independently [8] – [9].

Learning media play an important role in instruction [10]. Learning media has two main roles namely, the media as a teaching aid (effectiveness) and the media as a learning resource that is used independently by students or is called independent media. The Kurikulum 2013 in Indonesia emphasizes technology utilization information and communication to improve efficiency and effectiveness learning (Minister of Education and Culture Regulation No. 22 of 2016 concerning Basic and Secondary Education Process Standards). Interactive e-book can be used as a source of learning in the classroom or independently by students [11]. The advantages of the e-book according to Fojtik [12] are (1) easier distribution and purchase; (2) simple backup and storage; (3) the ability to adjust font size; (4) add text to multimedia; (5) read on different devices; and (6) the ability to have a large number of devices in electronic books. E-books can be used online or offline [13].

Optics is one of the most challenging topics in physics because there is no concrete frame of reference [14-15]. To help students understand the concept of optics it is necessary to design multi-representation integration in learning. Then do the assessment in using light diagrams and other representations [13].

Multi representation is a way of expressing or conveying a concept in different ways or methods such as verbally, pictures, graphics, symbols, simulations, and mathematical equations [16] – [17]. The more proficient the students present a concept with various representations, it can be concluded that the student masters the concept. Mathematical representations are often used in physics [18]. Mathematical representation is the ability of students to express mathematical ideas in the form of mathematical symbols that are used to solve problems in physics [19]. Mathematical representation is one of the problem solving strategies and helps students understand concepts in physics [20] – [22].

Learning outcomes in the affective domain are attitudes or characters. One of the characters developed in Indonesia based on the Ministry of Education and Culture is curiosity or attitude of curiosity. Curiosity is an aspect of intrinsic motivation that has the potential to improve student learning [23]. Student negative assumptions about physics can reduce curiosity and enthusiasm in the learning process [24]. If students have a curiosity attitude towards something, students generally also want to know that deeper. Curiosity attitude makes students more attentive to do everything, students will be more concentrated and not easily bored and more eager to learn and understand something.

This research focuses on increasing the ability of mathematical representation and the attitude of curiosity. The reasons for using e-book is that can be used to study independently or in class. The e-book can contain videos, animations, text, and image. Additionally, e-book can be used on android media. Increasing the ability of mathematical representation and attitude of curiosity is done by applying a problem-based learning model assisted by e-book.

2. Research method

This research uses a quantitative approach. This type of pre-experimental research with the aim to determine the effect of problem based learning assited by e-book on improving mathematical representation and curiosity attitudes of students of optical devices. The subject of this research was the XI MIPA class of SMA N 1 Banguntapan 2018/2019. The research subjects were determined by purposive sampling technique. The subjects consisted of 30 students of Class XI MIPA 2. The form of this study was pre-experimental design with one group pretest – posttest design as shown in table 1.

Table 1. One group pretest – posttest design.

Prestest	Treatment	Posttest
T_1	X	T_2

Information: T_1 = Pretest of mathematical representation and students' curiosity attitude, X = Problem-based learning Instruction assisted by e-book and T_2 = Posttest of mathematical representation and students' curiosity attitude

The instrument used was a questionnaire attitude curiosity and a matter of description. Problem description is used to assess the increase in mathematical representation after the application of e-book-

based problem-based learning. The indicators for evaluating mathematical representations are listed in table 2

Table 2. Guidelines for evaluating mathematical representation.

Indicator Mathematical Representation	Problem Number					Total
	1	2	3	4	5	
Determine the exact problem in accordance with the problem	4	4	5	3	5	21
Conduct mathematical operations into equation	2	5	5	2	5	19
The maximum Score						40

Student's curiosity attitude is measured by a questionnaire given before and after learning PBL assisted by e-book. The attitude of curiosity of students measured is positive and negative. Questionnaire filled out by students without coercion from other parties.

Table 3. Indicator of curiosity attitude.

Aspect	Indicators	Question	
		Positive	Negative
Desire to learn objects	a. Desiring to study physics	2, 18	16, 21
	b. Trying to understand the concepts of physics	1, 10, 6, 22	17
Enthusiastic in participating in learning	a. Trying to find solutions to difficulties in understanding physics by asking friends or people who know more	11, 19	13, 25
	b. Trying to find solutions to difficulties in understanding physics by reading / studying physics books	4, 8, 9 ,30	20, 26, 28, 29
	c. Happy and studious, full of enthusiasm, not easily bored with varied tasks	12, 23	5, 3, 24
Coordinate existing cognitive structures (known) with existing reality	a. Using theories / concepts that have been studied previously in understanding new concepts and considering them.	15, 27	7, 14
	Total	16	14

The questionnaire sheet used consisted of several positive and negative statements with the answer choices Always (SL), Often (SR), Sometimes (KK), Rarely (JR), and Never (TP). The criteria for scoring questionnaire sheets for each positive and negative questions are listed in Table 4.

Table 4. The criteria for scoring curiosity attitude questionnaire.

Statement Characteristics	Scoring Criteria				
	Always (SL)	Frequently (SR)	Sometimes (KK)	Rarely (JR)	No Ever (TP)
Positive	5	4	3	2	1
Negative	1	2	3	4	5

Table 5. The curiosity attitude category of students.

Formulas	Empirical score (X)	Classification
$X > \overline{X}_i + 1.8 \times sb_i$	$X > 126$	Very good
$\overline{X}_i + 0{,}6 \times sb_i < X \leq \overline{X}_i + 1.8 \times sb_i$	$102 < X \leq 126$	Good
$\overline{X}_i - 0{,}6 \times sb_i < X \leq \overline{X}_i + 0.6 \times sb_i$	$78 < X \leq 102$	Sufficient
$\overline{X}_i - 1{,}8 \times sb_i < X \leq \overline{X}_i - 0.6 \times sb_i$	$54 < X \leq 78$	Less
$X \leq \overline{X}_i - 1.8 \times sb_i$	$X \leq 54$	Very less

To determine the measurement results criteria used to clarify based on:

$\overline{X}_i$ (mean ideal) $= \frac{1}{2}$ (Ideal maximum score – Ideal minimum score)

$\overline{X}_i$ (mean ideal) $= \frac{(150+30)}{2} = 90$

sb_i (ideal standart deviation) $= \frac{1}{6}$ (Ideal maximum score – Ideal minimum score)

sb_i (ideal standart deviation) $= \frac{(150-30)}{6} = 20$

Ideal maximum score = theoretical highest score

Ideal minimum score = theoretical lowest score

2.1. The Preparation Phase

The research began with (1) observation of learning in the classroom; (2) formulating research problems; (3) making learning tools in the form of lesson plans (RPP), student worksheets (LKPD), and media e-books of optical eye material; (4) making research instruments; (5) validating learning tools and research instruments; and (6) revising learning tools and research instruments. Learning tools are made based on the syntax of problem based learning, namely (1) Meeting the problem, (2) Problem analysis and generation of learning issues, (3) Discovery and reporting, (4) Solution presentation and reflection, (5) Overview, integration, and evaluation, with self-directed learning bridging one stage and the next [25].

2.2. The Implementation Phase

The implementation phase begins with (1) giving pre-test questions and angles for curiosity attitude in MIPA 2 class XI of SMA Negeri 1 Banguntapan; (2) providing e-book-assisted problem based learning treatment; and (3) provide a post-test about mathematical representation and curiosity attitude questionnaire.

2.3. The Final Phase

The final phase of this study is (1) analyzing the results of the pre-test and post-test using descriptive analysis and the Sign Test using a significance level of 0.05. Sign Test is used because it compares data that are interconnected, (2) Describe the results of data analysis and draw conclusions based on data analysis.

3. Results and Discussion

This research is focused on problem based learning instruction assisted by e-books towards increasing mathematical representation and students' curiosity attitudes. Learning is given to the optical eye material. E-books and Student Worksheets (LKPD) are integrated in Android. Learning activities carried out in groups. Researchers provide learning in accordance with the steps of the model of problem based learning, in the core activities through the phase of organizing students to learn and guide group investigations, students discuss and conduct library studies using e-books that have been distributed to complete LKPD. In the phase of developing and presenting the results, students conduct an analysis of the phenomena presented at the LKPD then present the results of the discussion in front of the class.

Before and after the learning activity, the researcher distributes the questionnaire to the attitude of curiosity to students. Researchers also distributed pre-test and post-test questions that were used to

determine students' initial and final abilities in mathematical representation. Comparison of pre-test and post-test values is shown in figure 1 and figure 2. The results of the pre-test and post-test were analysed using SPSS. Descriptive statistical results are shown in table 6 and table 7 while the Normality Test in table 8. Tabel 6 shows the pre-test value of 49.00 and post-test 87.77. Mathematical representation improvement is 55.83%. Comparison of students' curiosity attitudes after and before PBL instruction assisted by e-book is shown in figure 3.

Table 6. Paired samples statistics.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	49.00	30	5.540	1.011
	Postets	87.77	30	5.507	1.005

Tabel 7. Paired samples test.

	Paired Differences					t	df	Sig. (2-tailed)
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1 Pretest-Posttest	-38.767	5.981	1.092	-41.000	-36.533	-35.502	29	.000

Tabel 8. Tests of normality.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.128	30	.200*	.974	30	.663
Posttest	.150	30	.082	.965	30	.414

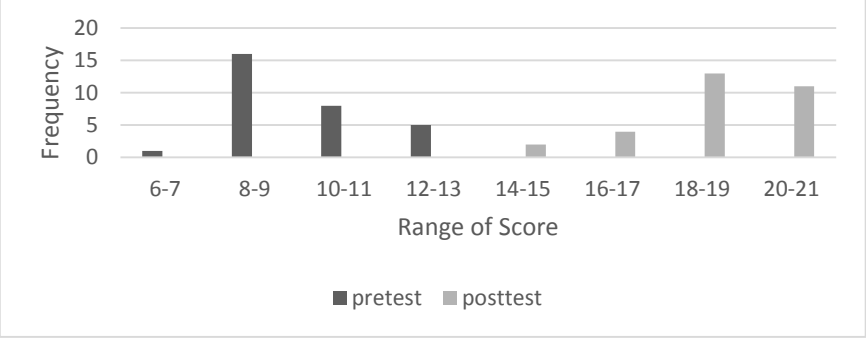

Figure 1. Graphic comparison of pre-test and post-test mathematical representation of indicators determining the exact equation in accordance with the problem.

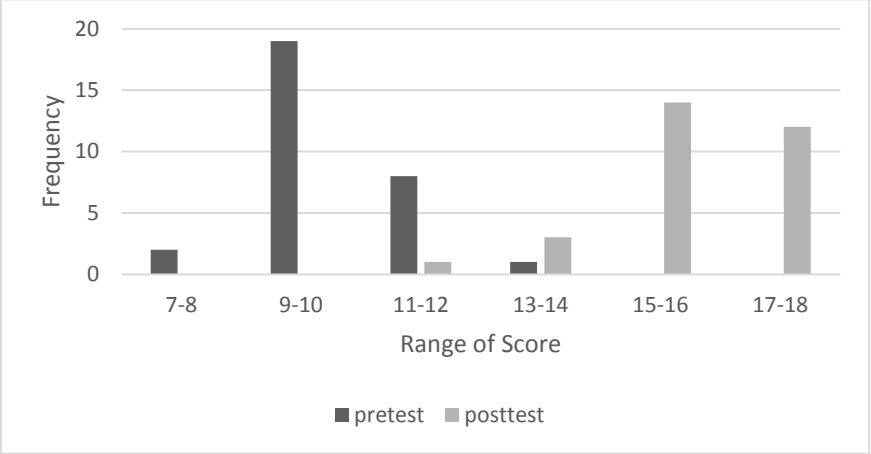

Figure 2. Graphic comparison of pre-test and post-test mathematical representation of indicators of carrying out mathematical operations into equation.

Figure 3. Graphic comparison of students' curiosity attitudes before and after using problem based learning assisted e-books.

Seseorang yang memiliki *punctum proximum* 50 cm dan *punctum remotum* tak terhingga. Agar dapat membaca pada jarak normal, orang tersebut haruslah memakai kacamata yang berlensa....

a. Positif dengan jarak fokus 0,5 m
b. Positif dengan jarak fokus 0,25 m
c. Negatif dengan jarak fokus 0,5 m
d. Negatif dengan jarak fokus 0,25 m
e. Positif dengan jarak fokus 0,2 m

Penyelesaian:

Dik = punctum proximum = 50cm, punctum remotum = tak terhingga } membaca pada jarak baca normal
Dit = Jenis dan fokus lensa?
Jwb =

$$P = \frac{100}{s} - \frac{100}{PP} =$$

$$\frac{1}{f} = \frac{1}{s} + \frac{1}{s'} =$$

Figure 4. Examples of answers to prestest questions.

Titik dekat mata seseorang terletak pada jarak 120 cm di depan mata. Untuk melihat benda dengan jelas suatu benda yang terletak 30 cm di depan mata, kekuatan lensa kacamata yang harus dipakai adalah ....

a. -5,0 dioptri
b. -4,16 dioptri
c. -2,5 dioptri
d. 2,5 dioptri
e. 4,16 dioptri

$P = \frac{100}{Sn} - \frac{100}{PP} = \frac{100}{30} - \frac{100}{120}$

$= \frac{400 - 100}{120}$

$= \frac{300}{120} = 2{,}5$

Penyelesaian:

Diket : Sn = 30 cm
PP = 120 cm
Ditanya : kekuatan lensa ? P ?
Jadi kekuatan lensa kacamata yg harus dipakai adalah 2,5 dioptri

Figure 5. Examples of answers to posttest questions.

ANGKET SIKAP *CURIOSITY*

Nama : RESTU CANDRA MARLINA
Kelas : XI MIPA 1
Nomor Absen: 23

A. Petunjuk pengisian:
1. Tunjukkan apakah Anda selalu, sering, kadang-kadang, jarang dan tidak pernah tentang masing-masing pernyataan di bawah ini.
2. Beberapa pernyataan ada yang positif dan ada yang negatif.
3. Tidak ada jawaban benar atau salah dan tidak berpengaruh terhadap nilai Anda. Jadi silahkan menjawab jujur didasarkan pada bagaimana perasaan Anda.
4. Berilah tanda *checklist* (√) pada kolom yang merupakan pilihan dari sikap kalian yang sebenarnya.

B. Ada 5 (lima) alternatif jawaban, yaitu:
1. Selalu (SL)
2. Sering (SR)
3. Kadang-kadang (KD)
4. Jarang (JR)
5. Tidak Pernah (TP)

No	Pernyataan	Jawaban				
		SL	SR	KD	JR	TP
1	Saya berusaha memahami materi fisika secara mandiri		✓			
2	Saya akan mengulang pelajaran fisika yang telah dipelajari ketika pulang sekolah				✓	
3	Saya mengerjakan soal fisika yang mudah-mudah saja		✓			
4	Saya berusaha mengatasi kesulitan belajar (ngerjain soal) fisika dengan membaca/mempelajari materi fisika dari beberapa buku.		✓			
5	Saya mudah menyerah jika menghadapi soal fisika yang menantang		✓			
6	Saya akan mencatat materi yang penting dalam pelajaran fisika	✓				
7	Saya senang kalau guru langsung memberikan rumus tanpa harus menemukan rumus terlebih dahulu		✓			
8	Saya membaca buku fisika untuk mendapat cara yang mudah dalam memahami dan menyelesaikan soal fisika		✓			
9	Saya berusaha memahami sendiri pelajaran fisika tanpa dijelaskan guru			✓		
10	Saya mendiskusikan materi fisika yang saya pelajari dengan teman			✓		
11	Saya akan bertanya kepada teman atau guru jika mengalami kesulitan belajar		✓			
12	Saya berusaha menyelesaikan soal latihan fisika disekolah			✓		

No	Pertanyaan	Jawaban				
		SL	SR	KD	JR	TP
13	Jika saya ragu dengan jawaban saya sendiri ketika menyelesaikan soal fisika, maka saya melihat pekerjaan teman		✓			
14	Saya belajar fisika cukup dengan menghafal rumus saja			✓		
15	Saya menggunakan konsep yang sudah saya miliki untuk belajar materi baru				✓	
16	Saya malas belajar fisika di luar jam sekolah		✓			
17	Saya malas mencoba menyelesaikan latihan soal tanpa disuruh oleh guru		✓			
18	Saya mengerjakan soal latihan di buku paket walaupun tidak diperintahkan guru			✓		
19	Saya bertanya kalau tidak mengerti mengenai materi fisika yang baru dipelajari			✓		
20	Saya malas mempelajari kembali materi fisika yang belum saya pahami			✓		
21	Saya tidak mempelajari materi yang telah dipelajari walaupun mengerti			✓		
22	Saya mengerjakan soal-soal sebagi latihan agar terampil		ı	✓		
23	Saya bersemangat saat jam pelajaran fisika				✓	
24	Saya mengantuk saat belajar fisika		✓			
25	Saya hanya mencatat jawaban pekerjaan teman saat mengerjakansoal fisika					✓
26	Saya diam saja ketika mengalami kesulitan saat mengerjakan soal				✓	
27	Saya menggunakan berbagai cara dalam menyelesaikan soal yang diberikan				✓	
28	Saya melihat pekerjaan teman saat ujian fisika				✓	
29	Saya cepat menyerah dalam memahami pelajaran fisika		✓			
30	Saya mempelajari contoh soal yang serupa sebagai acuan dalam mengerjakan soal				✓	

Figure 6. Curiosity attitude questionnaire.

Table 1 shows the average pretest score of 49.00 and posstest 87.77. Table 2 shows the difference between the mean pretest and posttest of -38.767. Significance is smaller than α (0.000 <0.05) so it can be concluded that there are differences before and after learning a problem based learning assisted by e-book. The normality test in table 3 shows that sig> α, then the data is normally distributed. The reading of normality test based on Shapiro-Wilk is because the number of samples is 30.

Comparison of pretest and posttest values per indicator of mathematical representation can be seen in figures 1 and 2. The pretest value for the indicator determines the exact problem in accordance with the problem obtained by the lowest 8 and the highest 13 from the maximum score 21. Whereas the lowest posttest value is 15 and the highest 21. This indicator increase is 61.90%. The indicator performs mathematical operations into the equation of the lowest pretest value 8 and the highest 12 of the maximum score 19. The lowest posttest value is 14 and the highest 18. This indicator increase is 66.67%. Figures 4 and 5 show an example of students answering questions about the pretest and posttest. Figure 4 learners do not make mathematical calculations. This is because students have not been able to link problems with concepts. Figure 5 students have been able to carry out mathematical calculation operations into equations and get results correctly. Lower pretest value is because students do not write

the equation that corresponds to the question statement. Learners only write the equation without explaining the connection with the situation in question [13].

Figures 1 and 2 show the increased ability of mathematical representation. PBL provides problems related to daily life. Students are more challenged in finding solutions to solve the problems displayed in LKPD. Problem based learning can improve students' mathematical representation ability [26] – [28]. In addition, learning to use technology has a positive effect [29]. The use of e-books as learning resources also contributes to the increase in student learning outcomes. In the e-book there are learning materials, LKPD, and video animation of optical eye material. The e-book format used is EPUB and can be used on smartphones. Students are more interested in mobile applications and e-books [12]. The EPUB e-book is a new opportunity for learning [30]. The use of multimedia modules in learning can be said to be successful in improving students' mathematical representation abilities even though it is not perfect [24]. E-books can support and enhance help the learning process better [31] – [32]

Figure 3 shows the percentage of curiosity attitudes. As many as 57% of students are in the good category after PBL instruction assisted by e-books. There is an increase of 27% when compared to the attitude of curiosity before learning PBL assisted by e-book that is equal to 30%. This could be due to the influence of the learning media used. E-books that contain material, animated videos arouse the curiosity of students.

4. Conclusion

Based on the results of research that has been done, through PBL instruction assisted by e-books, the ability of mathematical representation in students has increased. This is evidenced by the increase in the posttest value when compared with the pretest value on the two indicators. PBL instruction assisted by e-books can improve students' curiosity.

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