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THE EFFECT OF PROBLEM-BASED LEARNING WITH EXPERIMENT ON STUDENTS' RESPONSES AND LEARNING OUTCOME IN THE REFLECTION AND REFRACTION CONCEPT LEARNING

Ary Norsaputra*, Johansyah

[1]*Departement of Physics Education, Faculty of Education and Teacher Training Program, Mulawarman University, Samarinda, Indonesia*

*Corresponding authors' email: arynorsaputra91@gmail.com

ABSTRACT

Background: In some previous studies, an inappropriate teaching and learning was one of the factors that caused many students' misconception in the concept of reflection and refraction. Moreover, the students' response was known as a factor that lead students to have a misconception, and lead to have a low learning outcome.
Aims: This study aimed to study the effect of using of Problem-Based Learning on the students' responses and learning outcome in learning the concept of light (reflection and refraction).
Methods: The posttest only control design was applied in this study. The MCQs test and questionnaires of response were implemented to 27 students of grade 8th after the learning activity by using Problem-Based Learning with experiment. The data gained by both MCQs test and questionnaire were statistically analyzed.
Results: About 74.07 % students had passed the minimum completeness criteria (KKM). Most of the students' responses agreed that learning via Problem-Based Learning with experiment was helpful to understand the learning concept and to gain a new idea to solve the problem. In addition, the percentage of influencing of students' response to the students' learning outcome was 11 %.
Conclusion: Teaching and learning via Problem-Based Learning with experiment had helped the students to get high learning outcome and good response. The results were also revealed that the students' response was one of affecting factors on the students' learning outcome.

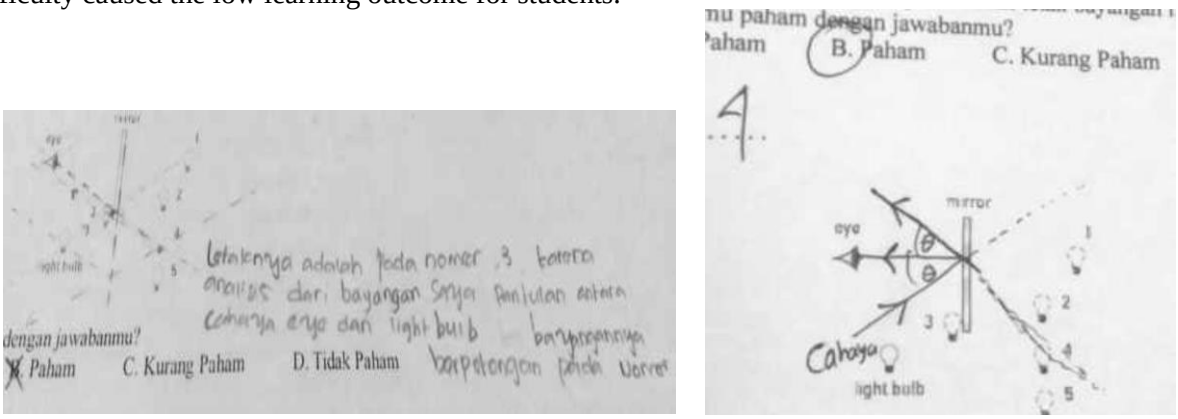
Keywords: Problem-Based Learning, Experiment, Students' responses, Students' learning outcome

INTRODUCTION

Light is one of the natural energy that is always related to daily life phenomena. Light has been continuing applied as a key component in many technologies and primary tools of science as such zoology and astronomy [1]. According to Langley, Ronen, and Eylon [2], the light is an essential key of the geometrical optics which consisted of light propagation and a visual pattern. Particularly, the geometrical optics related to the reflection, refraction, diffraction, and interference. Therefore, the light and geometrical optics had been continuously taught at the schools in several countries including in Indonesia.

However, several cases of the students' misconception and students' difficulties in learning geometrical optics had appeared because of some inappropriate ways of teaching and learning. As found by Kaewkhong, Mazzoloni, Emarat, and Arayathanitkul [3], the students had difficulty to explain; 1) 'how images are formed'; 2) how the light is propagated by a simple optical system; 3) 'how images are seen'. Those conclusions have been reported similarly for high-school students who studied optics in several countries

[4-7]. Furthermore, in Indonesia, the students' difficulty was encountered as a student could not explain the perfect reflection on the mirror and the refraction at a simple lens system [8]. Students preferred a mathematical calculation rather than a physical concept in solving a question [9]. This was confirmed by some examples of students' answer in Figure 1. In addition, the students' misconception and students' difficulty caused the low learning outcome for students.



(a) (b)

Figure.1 (a) and (b) are the example of the students' misconception on the light perfect reflection on the mirror. (source: Fauziah R, Yuliati L, Hidayat A. *Identifikasi Pemahaman Konsep Pemantulan Siswa SMK*. Pros. Semnas Pend. IPA Pascasarjana UM. 2016;(1):457-461)

On the other hand, the students' responses could be a factor of the students' misconception and students' difficulty during the learning activity. The student will misinterpret a specific learning concept if he/she does not have a good response. Therefore, in this study, we study the using of Problem-Based Learning on the students' responses and students' learning outcome in learning the concept of light (reflection and refraction) in the classroom.

What is the Problem-Based Learning?

Problem-Based Learning known as PBL was variously described by many previous studies as; 1) is an active learning based constructivist learning strategy which provides guidance, resources, and instruction for learning as they promote content knowledge and problem-solving [10]; 2) a learning strategy composes designed problems and carefully selected from the student's acquisition of critical knowledge, team participation skills, problem-solving proficiency, and self-directed learning strategies [11]; 3) is a self-directed learning, student-centered, independent style which is guided by a teacher or a facilitator [12]; and 4) an innovative learning that serve an active learning to learners [13].

Problem-Based Learning had been initially used in medical schools that had effectively enhanced retention, and many previous studies showed that Problem-Based Learning model led the student to an understanding of physics [11, 114-15]. According to Watson [16], the Problem-Based Learning in learning Physics; one must think how the previous knowledge can be applied to solve a new problem. Therefore, the high school students should be allowed to grow via their previous Physics conception in content knowledge, experience, and problem-solving skills. The Problem-Based Learning has six characteristics as follows: 1) Starting with problem, 2) Problem must be related to students' daily life, 3) Focusing the learning on the problem, not on the scientific concept, 4) Takin care the students who build and operate their learning process, directly, 5) organize a small group, and 6) Requesting the student to show what they are acquired in shape of performance or product [13].

Why Problem-Based Learning?

The Problem-Based Learning is a good approach to enhance the students' higher order thinking and to foster students' social skills [17]. This was because the Problem-Based Learning model aimed to activate the higher order thinking levels, to work correctly, to address a real problem, and to arrange their own learning process [18]. The Problem-Based Learning atmosphere requires for management skills, search an appropriate information, and verbal and nonverbal skills [19].

Another aspect, the role of students in the classroom emphasized the successful of Problem-Based Learning. In the Problem-Based learning classroom setting, the learners must be independent, inquisitive and innovative [16]. In the Problem-Based paradigm, the students must be responsible for their own learning [20]. "Students really do not understand (content) until they actually do something with it and reflect on the meaning of what they are doing [21]. The student who learn by using Problem-Based Learning should have personal understanding of the information, own academic by mixing with previous experience, and they must be in charge of their own learning and decide what to learn to foster motivation [16].

On the other hand, by combining with other techniques, the Problem-Based Learning is more effective for different level of students [22]. Some previous studies showed an integration of Problem-Based Learning with simulation [23]; computer application [24]; technology [25]; internet [26]; concept mapping [27], and even an experiment in laboratory [28].

Experiment

In science education, the experiment had a great role and distinctive aspects for promoting science process skills [28]. Several educators recommend that many benefit can be kept from emphasizing the students in doing experiment in laboratory [29]. Experiment is fit with Problem-Based Learning because the experiments is defined as "experiences in school settings in which students interact with materials to observe and understand the natural world. Laboratory classes have ranged from activities in which data are gathered to verify a stated principle or relationship to inductive activities, in which students seek to identify patterns or relationships in data which they gather" (p.249) [30].

METHODS

In this study, a quantitative approach was used to explore the use of PBL on the students' response and students' learning outcome. The posttest control design only was a research design of this study.

Participants

The participants were 27 of eighth grades students on secondary school, East Kalimantan, Indonesia. The participants were selected by Simple Random Sampling methods.

Research instruments and Data collection

There were two instruments that were incorporated in this study. The first instrument, twenty items of multiple choices questions (MCQs) of the light concept. There was four multiple choices answer provided at each question. According to (Dowing, 2002; Schuwirth & Van Der Vleuten, 2004), the MCQs could discriminate accurately the high- and low-achieving students, and evaluate the higher levels of cognitive reasoning. Second instrument, twenty items of students' response questionnaire were focused on (1) tendency to accept or reject, (2) feeling (prejudice or suspicious), (3) alternative conception, (4) ideas, (5) fear (threats), and (6) belief in a specific case that were adopted from Norsaputra and Johansyah [31]. The questionnaire item contained of 11 number of positive statements and 9 items of negative statements. The item tests were the Likert scale (1-5) with the interpretation for positive items (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree) and negative items (5 = Strongly disagree, 4 = Disagree, 3 = Neutral, 2 = Agree, 1 = Strongly agree).

Both MCQs test and questionnaire were applied after the implementation of PBL with experiment. These instruments aimed to measure the students' learning outcome and student's response.

Data analysis

The data gathered by both MCQs test and questionnaire was analyzed, quantitatively. The mean score of MCQs test is determined to compare to the minimum completeness criteria (KKM). Moreover, the correlational coefficient of both score (MCQs test and questionnaire) was measured.

RESULTS

The implementation of PBL with the experiment to learn the concept of light (reflection and refraction) showed a positive effect on the students' learning outcome. The average score of 27 students is 73.15. The results of MCQs test showed that 20 of 27 students had passed the minimum completeness criteria (KKM) (see Figure 2). This meant 74.07 % students reached their learning goals.

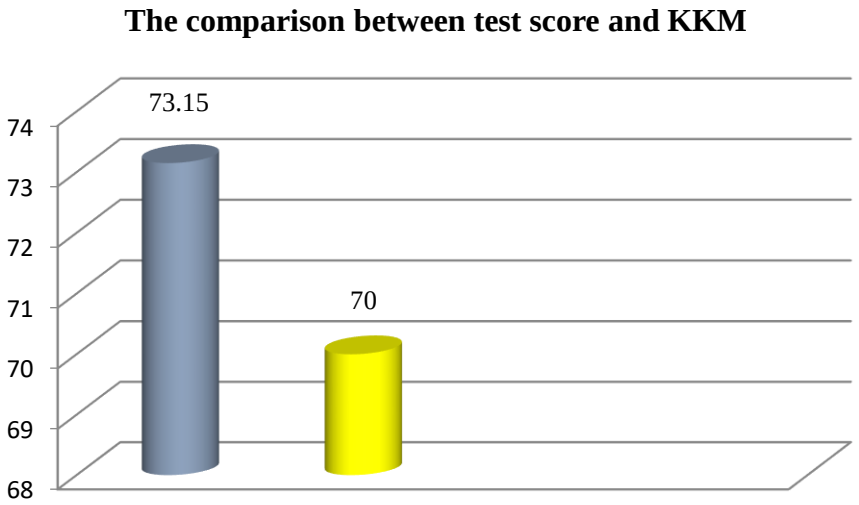


Figure 2. The comparison between the mean score of test and the minimum completeness criteria.

On the other hand, the results of the questionnaire showed that student showed a positive response on Problem-Based Learning with experiment (see Table 1). The first category, the item questionnaire on 'tendency to accept or reject' were 5th, 6th, and 7th. The score of these items indicated that most of the students accepted the Problem-Based Learning with experiment. The second category, the item questionnaire on 'feeling' were 1st, 2nd, and 4th. These items score showed that most of the students were happy to learn using Problem-Based Learning with experiment. The third category, 3rd, 8th, 11th, 12th, and 16th items were focused on 'alternative conception'. The results score of these items indicated that most of the students agreed to understand the learning concept after they learned with Problem-Based Learning with experiment. The fourth category, there is only item 13th focused on 'ideas'. This item result presented that most of the students were strongly agree that learn using Problem-Based Learning with experiment give new ideas to solve the problem in daily life. The fifth category, the item 14th concentrate on 'fear threats'. The score denoted most of the students do not agree that they do not understand the learning concept taught by Problem-Based Learning, and they are sure to solve another exercise.

Table 1. The result of questionnaires that contained 11 positive items and 9 negative items (translated from Bahasa Indonesia by author).

No	Item of questionnaire	Mean	Std . Dev
1	I am happy to learn using Problem-Based Learning	3.52	0.63
2	I feel distress in learning with the Problem-Based Learning	3.56	0.83
3	The Problem-Based Learning make me understand the learning concept of light refraction in daily life, easily.	4.07	0.77
4	I am happy to learn using Problem-Based Learning because it is motivated me.	3.96	0.58
5	The Problem-Based Learning is not relevant for me, because the most of its content is unknown.	3.15	0.80
6	I feel that the experiment applied is not suitable with the lesson and daily life.	3.37	0.86
7	The Problem-Based Learning make me lazy to solve the problem rather than the learning model that I used to know.	3.48	0.73
8	I fully understand the concept of refraction in the lens system and solve the problem given by teacher.	3.85	0.84
9	After I learned using the Problem-Based Learning, I can present the learning concept and finished my examination by myself.	3.74	0.80
10	I feel dissatisfied and do not understand with the things that I gained from learning with Problem-Based Learning and Students 'worksheet.	3.07	1.01
11	I don't understand the learning concept that I learned using Problem-Based learning with experiment and students 'worksheets.	3.26	0.80
12	I feel unsure and do not understand with the learning concept that I got learning with experiment, so I am not confident to explain before my classmate.	3.22	0.74
13	The Problem-Based Learning model with experiment is very helpful to understand the learning material, so I could have new ideas to solve the problem in daily life.	4.07	0.66
14	I do not understand to learn with Problem-Based Learning and experiment, so I feel unsure to solve the next exercise.	3.48	0.78
15	I feel match to learn the concept of refraction on the lens using the experiment to solve the problem.	3.62	0.82
16	I fully do not understand on the concept taught by the Problem-Based Learning with experiment.	3.44	0.74
17	I think that the Problem-Based Learning with experiment is understandable and easy to be followed.	3.96	0.99
18	The Problem-Based Learning is very helpful to understand this learning concept.	5	0
19	I am sure with what I learned using the Problem-Based Learning with experiment could help me to solve the problem which I do not understand yet.	3.93	0.81
20	The Problem-Based Learning with experiment can help me to solve the problem and solve the exercise in the book.	3.52	0.91

The last category, 'belief in specific case' were contained in 9th, 15th, 17th, 19th, and 20th items of the questionnaire. Most of the students believed that after they learned with Problem-Based Learning with experiment; 1) they can present the learning concept, 2) finish examination, 3) solve the problem, and 4) understand the learning concept. In addition, what we expect on the correlation of students' responses to students' learning outcome is approved. As shown in Figure 3, the correlation between students' learning outcome and students' responses are low, and it was confirmed by 'y = 0,312x + 50,37, with the value of correlation (r = 0.336). This result is supported by determination coefficient (r^2 = 0.11). It meant, the result of students' learning outcome is effected by 11 % of students' response on learning using Problem-Based Learning with experiment.

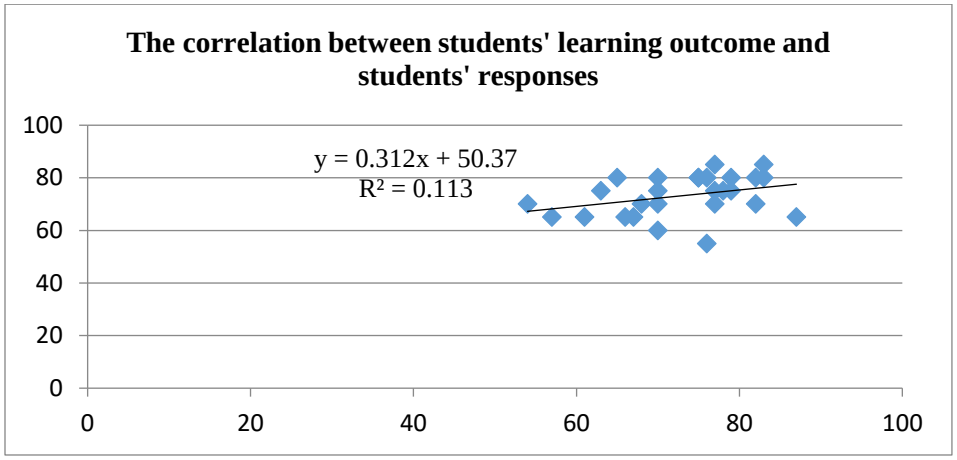


Figure 3. The correlation between students' learning outcome and students' responses

DISCUSSION

As revealed in the result, using Problem-Based Learning with experiment has a positive effect on the student's responses and students learning the outcome. Most of the students accept the Problem-Based Learning in their classroom, and it helps them to get the high learning outcome. During the learning activity, students were actively participated to solve the problem given by the teacher. This result was in accordance with Inel and Balm [22]; in the students' response, learners are actively participated in the learning process, shared their opinions with others, and discussed with each other. Furthermore, what we found in this study was better than the previous research by using Problem-Based Learning with simulation [31]. The results of six categories included as questionnaire items implied good responses.

CONCLUSION

According to our study, we conclude some keys point as follows: (1) Teaching and learning via Problem-Based Learning helped the students to get high learning outcome, and past the minimum completeness criteria (KKM), (2) The students' responses are correlated to the students' learning outcome, but the value of correlation among students' responses and learning outcome is still low, and (3) the students' responses had effected the students' learning outcome.

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