Enhancing Students’ Learning Activities Using Problem-Based Learning Model on Temperature and Heat Concept

I M Astra¹, D Aminudin² and A Henukh³
¹Department of Physics Education, Faculty of Mathematics and Natural Sciences Universitas Negeri Jakarta, Jalan Rawamangun Muka, Jakarta Timur 13220, Indonesia
²Post-SM-3T Teacher Professional Education, Physics Education Department, Universitas Negeri Jakarta, Jalan Rawamangun Muka, Jakarta Timur 13220, Indonesia
³Department of Physics Education Faculty of Teacher Training and Education Musamus, Jl. Kamizaun Mopah Lama, Merauke, 99611
Email: imadeastra@unj.ac.id

Abstract. This study aimed to improve the learning activities of SMA Labschool Jakarta students in grade XI of MIPA 1 by applying the Problem-Based Learning model (PBL). The study was undertaken by employing a classroom action research method with 34 participating students on the topic of temperature and heat. The study was conducted in three cycles. The cycles are extended to; planning, action, observation, and reflection. The success indicator of the study was that students' learning activities could reach > 75%. The data collection was through the use of an observation sheet and the implementation of the learning model. Based on the data analysis, the results indicated that students' learning activities in the first cycle reached 41.7%. In cycle II, the score reached 61.76%. Finally, the score increased to 85.27% in cycle III. Therefore, it can be concluded that student learning activity increased. In other words, the results verified that Problem-Based Learning can significantly enhance students' learning activities.

1. Introduction

Act Number 33 of 2003, concerning the National Education System, requires learning that can facilitate students to take an active role in the learning process. In education, the teaching and learning process is considered the most important since it determines the success of achieving the goals of education. There are two major subjects in a learning process; students as active learners and teachers who guide the students[1].

The success of a learning process highly depends on the interaction between teachers and students. Teachers have been known to teach a lot of subjects. One of which is Physics. Physics is one of the branches of the natural science learning process. Essentially, Physics is a science that requires an understanding of concepts and scientific models that can make physics interesting. Hence, the physics learning process emphasizes providing direct experience through laboratory activities and experiences in daily life. Such learning will challenge students to develop analytical, critical and creative thinking skills in solving problems[2].

In the first observation of the class, there had been no interactive class atmosphere. Also, the researcher encountered a lack of students' direct involvement. Some students were hesitant in asking questions, and the courage of students to deliver opinions and ask questions was also lacking. Often students participated in learning by experimenting. However, the process was still a teacher-centered, so it was not optimal. In addition, students' results of daily tests were below the minimum completeness criteria.
Therefore, if the teacher explains the material without relating it to the experience of students, students will not understand the purpose of the learning and get bored. In the teaching and learning process, the lack of student activity can be seen from the attention and involvement of students during the learning process. Students are more likely to talk with friends, daydream, hold cell phones, and leave class for various reasons. When given assignments, students prefer to copy their friends’ assignments without trying to do them on their own. Then, students will not ask or answer when asked by the teacher. They prefer to be silent[3].

The importance of student activities in the teaching and learning process should be of particular concern to teachers since they, as educators, are obliged to guide students’ learning activities so that students want to play an active role in the learning process. Furthermore, students' activities are crucial to optimize the learning outcomes as activities greatly determine learning outcomes. A student with high learning activity will get satisfactory learning outcomes. In contrast, a student with low learning activity will obtain low learning outcomes[4][5].

Problem-Based Learning is a student-centered learning model that is based on problems that are often encountered by students in the surrounding environment pertinent to the learning process. Thus, there will be a two-way interaction between students and their environment. With this regard, students are involved in further analysis so that the problem can be solved properly and become a learning experience for students. In other words, when teaching in class, the teacher must optimally create a learning environment that can educate students by picturing a problem that can encourage students to learn to solve it. Besides, the teacher should allow students to play an active role in constructing the concepts of the material they are learning gradually[6][7][8].

Based on the aforementioned, it is expected that the Problem-Based Learning model can increase student activity in learning physics in class, especially in grade XI of science in the senior high school. For this reason, the author conducted a study on students’ activities through the use of Problem-Based Learning in SMA Labschool of Jakarta regarding the topic of Heat and Temperature. The study was entitled: “Enhancing Students’ Learning Activities Using Problem-Based Learning Model on Temperature and Heat Concept”.

Based on the background, the formulation of the problem is: "Has there been an increase in students’ learning activities after using the Problem-Based Learning model on Temperature and Heat Concept?". The goal of the study is to determine if Problem-Based Learning can increase students’ learning activities on temperature and heat concept.

2. Method
The study was carried out in Labschool high school in Jakarta. The subjects of the study were students of class XI MIPA 1 which consisted of 34 students, 15 male students, and 19 female students. The study employed Action Research with a qualitative approach. The type of study was Classroom Action Research (CAR). In general, CAR is open action research that is reflective and collaborative. It is carried out to improve the quality of learning practice in the classroom[8][9][10].

A classroom action research consists of 4 stages, namely (1) planning, (2) implementation, (3) observation, and (4) reflection. After conducting the reflections which include analysis, synthesis, and assessment of the process and the results of the actions taken, problems or thoughts about the need for improvement usually arise, so it is necessary to re-plan, re-act, re-observe, and re-reflect. These stages of activity continue until a problem is considered resolved.

The implementation of the learning model is considered successful if the percentage of success reaches 100%. About students' learning activities, they are analyzed descriptively based on the description that appears on the student learning activity observation sheet. Students' learning activities are said to be complete if >75% of students in the class are in the active category. Percentage analysis was employed to analyze the data of students' responses after participating in learning using the Problem-Based Learning model. As for each appearance of the descriptor using a sign (√), the appearance of 1 checkmark is proportional to the acquisition score of 1. The appearing score of each indicator is summed, and the result is called the total score. While the assessment of student learning activities is given 1 (one) if it is done and given 0 (zero) if it is not done. Regarding the aspects of Visual
activities, Oral activities, Listening Activities, and Writing activities, each of them is respectively developed into two aspects. In addition, the calculation encompasses 0.5 points for activity and 1 point for two activities of each aspect.

3. Result and discussion
Before the implementation of the PBL model, a pre-cycle was first carried out with a direct learning model. Then, it was ended with a test. During the research, each cycle used a problem-based learning model with steps extended to (1) orienting students to the problem; (2) organizing students to learn; (3) guiding investigations independently or in groups; (4) developing and presenting work results; and (5) analyzing and evaluating the results of problem-solving [11][12]. Meanwhile, according to previous research the learning activities are classified into: the visual activities (reading, viewing pictures, watching experiments, conducting demonstration, exhibiting, and watching other people work or play), oral activities (suggesting a fact or principle, connecting an event, asking questions, giving advice or opinions, interviewing, and doing discussion and interruptions), listening activities (listening to the presentation of the material, and listening to the conversation or discussion groups), writing activities (writing reports and summaries, doing tests, and completing questionnaires), drawing activities (drawing graphics and diagrams), motor activities (conducting the experiments, choosing tools and equipment, and creating models), mental activities (memorizing, troubleshooting, analyzing the factors, analyzing relationships, and making decisions), and emotional activities (having interest, differentiating, being encouraged, being calm, and feeling bored and nervous)[13][14][15].

The results of cycles I, II, and III indicated the existence of students’ learning activities. This can be seen in table 1 and table 2.

| Cycle | Activities (%) | Categories |
|-------|----------------|------------|
| I     | 41.17          | moderate   |
| II    | 61.76          | moderate   |
| III   | 85.29          | Active     |

Table 2. Students’ activities in each aspect per cycle

| No | Activity aspects | Cycle I | % Total students | Cycle II | % Total students | Cycle III | % Total students |
|----|-----------------|---------|------------------|----------|------------------|-----------|------------------|
| 1  | Visual activities | 30      | 88               | 34       | 100              | 34        | 100              |
| 2  | Oral activities  | 16.5    | 49               | 17       | 50               | 20        | 59               |
| 3  | Listening activities | 21   | 62               | 27       | 79               | 29        | 85               |
| 4  | Writing activities | 19.5    | 57               | 22.5     | 66               | 25.5      | 75               |
| 5  | Drawing activities | 15      | 44               | 20.5     | 60               | 27        | 79               |
| 6  | Motor activities  | 23      | 68               | 28       | 82               | 31        | 91               |
| 7  | Mental activities | 13      | 38               | 19       | 56               | 23        | 68               |
| 8  | Emotional activities | 25 | 74               | 29       | 85               | 34        | 100              |
Students' learning activities, for the study, were divided into 8 aspects. The aspects include Visual activities, Oral activities, Listening activities, Writing activities, Drawing activities, Motor activities, Mental activities, and Emotional activities.

Based on table 2, the encountered students' learning activities in the cycle I were as follows; Visual activities by 88%, Oral activities by 16.5%, Listening activities by 21%, Writing activities by 19.5%, Drawing activities by 15%, Motor activities by 23%, Mental activities by 13%, and Emotional activities by 25% with 41.17% completeness of active students (as seen in table 1). As the percentage of completion of active students is less than 75%, this indicates that students' learning activities in cycle I was still not complete. However, the learning process has reached 94%. When re-analyzing the results of observations, it turned out that students were active at the beginning of learning in which 30 students were involved in the visual activities aspect. At the same time, regarding 7 other aspects, 26 students were still below or more than 75% of the expected results. Furthermore, many students still rely on their friends in making a group decision during a discussion. It can be seen from the aspect of mental activities that have the lowest percentage within 38% or 13 students.

In cycle II, as seen in Table 2, the encountered students' learning activities were extended to; Visual activities by 100%, Oral activities by 50%, Listening activities by 27%, Writing activities by 22.5%, Drawing activities for 20.5%, Motor activities by 28%, Mental activities by 19%, and Emotional activities by 29%. Additionally, the percentage of completion of active students is 62.76% (seen in table 1). In cycle II, there is an increase in all aspects. However, the percentage of completion of active students is less than 75%. This means that regarding students’ learning activities, cycle II is still considered not incomplete as in the cycle I. However, the learning process has reached 100%. When re-analyzing the results of observations, it turned out that students were active at the beginning of learning in which 30 students were involved in the visual activities aspect. Altogether, regarding 7 other aspects, 26 students were still below or more than 75% of the expected results. Furthermore, many students still rely on their friends in making a group decision during a discussion. It can be seen from the aspect of mental activities that have the lowest percentage within 38% or 13 students[16][17].

Based on table 1 cycle III, it appears to have increased as in cycle II with the percentage of Visual activities by 100%, Oral activities by 59%, Listening activities by 85%, Writing activities by 75%, Drawing activities by 79%, Motor activities are 91%, Mental activities are 68%, and Emotional activities are 100%. Meanwhile, the percentage of completion of active students was 85.29% (as seen in table 1). With this regard, it can be assumed that the student's learning activities in this study have reached the success indicator, that is 75%.

The comparison of aspects of student learning activities in each cycle can be seen in Figure 1 below.

![Figure 1](image-url)

**Figure 1.** Graph of the comparison of each aspect of student learning activities in each cycle.
The data distribution of students’ learning activities for each cycle can be represented graphically, as shown in the following Figure 2.

![Figure 2. Graph of the percentage of student learning activities for each cycle](image)

**Figure 2.** Graph of the percentage of student learning activities for each cycle

It can be seen in Figure 1 the increase in every aspect of the cycle I, cycle II, and cycle III. This can be said because learning in cycle III is the result of reflection in cycle II, and cycle II is the result of reflection from cycle I. Thus, the shortcomings or weaknesses that once occurred, do not happen again. When each aspect has increased, students’ learning activities have increased on each cycle (seen in Figure 2). These findings were in accordance with previous research that there is an increase in students’ learning activities when using the problem-based learning model in classroom learning [18].

### 4. Conclusion

Based on the description of the research implementation during the three cycles of this study, it can be concluded that the application of Problem-Based Learning can increase students’ learning activities. This is proven by the increase in the percentage of achievement of students’ learning activities in each cycle. Cycle I reached 1.17%, and Cycle II increased to 70%. At last, Cycle III reached 85.27%. As previously mentioned, the success indicator of this action research is if students’ learning activities are > 75%. Regarding this indicator, cycle I and cycle II of this research were considered incomplete. However, in cycle III, the research is said to be complete as the percentage of the students’ learning activities reached 75%.

### References

[1] G. Resbiantoro and D. J. Inkuiri, vol. 4, no. I, pp. 2252–7893, 2015, [Online]. Available: http://jurnal.fkip.uns.ac.id/index.php/sains.

[2] A. Henukh, R. F. Nikat, M. Simbolon, C. Nuryadin, and Y. S. *IOP Conf. Ser. Earth Environ. Sci.*, vol. 343, no. 1, 2019, doi: 10.1088/1755-1315/343/1/012160.

[3] C. Umamah, N. Norhasan, and J. Rofi’ah, *LENSA (Lentera Sains) J. Pendidik. IPA*, vol. 8, no. 2, pp. 67–74, 2018, doi: 10.24929/lensa.v8i2.35.

[4] I. M. Astra, E. I. Rosita, and R. Raihanati, *AIP Conf. Proc.*, vol. 2169, no. November, 2019, doi: 10.1063/1.5132637.

[5] I. M. Astra, A. Henukh, and Algiranto, *J. Phys. Conf. Ser.*, vol. 1876, no. 1, p. 012064, 2021, doi: 10.1088/1742-6596/1876/1/012064.

[6] D. D. Lestari, I. Ansori, and B. Karyadi, *Diklabio J. Pendidik. dan Pembelajaran Biol.*, vol. 1, no. 1, pp. 45–53, 2017, doi: 10.33369/diklabio.1.1.45-53.

[7] F. Herlana, I. M. Astra, Y. Supriyati, H. Mazlina, and Musdar, *J. Phys. Conf. Ser.*, vol. 1460, no. 1, pp. 0–5, 2020, doi: 10.1088/1742-6596/1460/1/012125.

[8] N. W. Parwati, N. K. Suarni, I. W. Suasta, and P. B. Adnyana, *J. Phys. Conf. Ser.*, vol. 1318,
no. 1, 2019, doi: 10.1088/1742-6596/1318/1/012096.

[9] R. Pujiastuti, *Lembaran Ilmu Kependidikan*, vol. 42, no. 2, pp. 93–100, 2013.

[10] Nurul Iskandar, Mustajj, Miftakhul Jannah, and Soetam Rizky Wicaksono, *IJORER Int. J. Recent Educ. Res.*, vol. 2, no. 2, pp. 237–249, 2021, doi: 10.46245/ijorer.v2i2.93.

[11] Albert Efendi Pohan, “PROBLEM BASED LEARNING; AN EFFICIENT STRATEGY ON ENHANCING STUDENTS’ GRAMMAR ABILITY,” vol. 10, no. 1, pp. 56–66, 2019.

[12] P. Chung, R. C. Yeh, and Y. C. Chen, *Int. J. Technol. Des. Educ.*, vol. 26, no. 2, pp. 285–307, 2016, doi: 10.1007/s10798-015-9306-3.

[13] I. P. Suarbawa, *Indones. J. Educ. Res. Rev.*, vol. 2, no. 2, p. 162, 2019, doi: 10.23887/ijerr.v2i2.17624.

[14] L. Akhsani, Ahmad, and F. Eko Subekti, *J. Phys. Conf. Ser.*, vol. 1778, no. 1, 2021, doi: 10.1088/1742-6596/1778/1/012025.

[15] R. Amini, B. Setiawan, Y. Fitria, and Y. Ningsih, *J. Phys. Conf. Ser.*, vol. 1387, no. 1, 2019, doi: 10.1088/1742-6596/1387/1/012082.

[16] B. Maharani and Yohandri, *J. Phys. Conf. Ser.*, vol. 1481, no. 1, 2020, doi: 10.1088/1742-6596/1481/1/012061.

[17] A. K. A. Faozi, Hobri, M. Fatekurohman, K. Aini, and D. Yuniar, *J. Phys. Conf. Ser.*, vol. 1538, no. 1, 2020, doi: 10.1088/1742-6596/1538/1/012070.

[18] M. Widyasmah, Abdurrahman, and K. Herlina, *J. Phys. Conf. Ser.*, vol. 1467, no. 1, 2020, doi: 10.1088/1742-6596/1467/1/012072.