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High School Students Perceptions of Problem-Based Learning (PBL) Integrated with Anthropogenic Phenomena: An Analysis of Engagement and Motivation

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Abstract: The importance of student engagement and motivation in the physics learning process at the high school level, which has often been perceived as a difficult subject and less relevant to real life. Through the integration of anthropogenic phenomena, learning is expected to become more contextual and foster awareness of environmental issues. This study aims to determine students' perceptions of physics learning activities using the Problem-Based Learning (PBL) model integrated with anthropogenic phenomena. The research was conducted at the high school level using a quantitative descriptive approach. The respondents consisted of 108 tenth-grade students who had participated in physics learning using this model. The research instrument was a validated questionnaire. Data were analyzed using a Likert scale and presented in percentage form. The results of the study indicate that students' perceptions of physics learning using the integrated anthropogenic PBL model are in the good and very positive categories. This is demonstrated by the percentage of engagement aspects exceeding 80% and the motivation aspects reaching 86%. Overall, both aspects scored 61% or higher, indicating that the application of this model is effective in enhancing student engagement and motivation in learning. These findings are expected to serve as a reference for teachers in developing contextual physics learning and contribute as supporting literature for future research.

Keywords: Anthropogenic Phenomena; Engagement Analysis; Motivation; Problem-Based Learning.

Introduction

Education is a basic human need for advancing the quality of human resources, which will ultimately drive progress and prosperity in life [1]. According to the National Education System Law No. 20 of 2003, education aims to develop the potential of students to become people who are faithful, have noble character, are healthy, knowledgeable, creative, and become democratic citizens. An effective educational process requires synergy between three main components: (1) competent educators, (2) a relevant curriculum, and (3) innovative teaching methods. The role of educators in education today has undergone a significant transformation. Educators are no longer merely conveyors of information; they must now function as facilitators who guide students in constructing knowledge independently. Education has a purpose that makes it a very important factor, namely, as a direction to be achieved or pursued. A successful educational process requires the important role of an educator, as the outcomes of education are influenced by the quality of the educator in the learning process [2].

The learning process certainly has a goal, and if that goal is achieved, the educator can be said to have been successful [3]. The learning process requires preparation so that activities can take place effectively and the desired goals can be achieved. One of the initial preparations that educators can undertake in the learning process is selecting an appropriate learning model [4]. Varied learning models aim to enhance learning activities, resulting in increased active engagement of students and improved learning outcomes throughout the learning process [5].

One of the global issues that is becoming increasingly urgent to address is the anthropogenic phenomenon, namely, changes to natural systems caused by human activity. Problem-based learning can encourage students to integrate scientific concepts with environmental phenomena, raise awareness about reducing human impact, and emphasise the importance of environmental management [6]. Through problem-based learning, students will gain an understanding of how science serves as a medium for understanding and addressing environmental problems caused by human actions.

Human-induced changes have a broad impact on environmental phenomena. The burning of fossil fuels from the use of motor vehicles, livestock farming, and modern factories, among other sources, if done continuously, will also increase the Earth's temperature and harm humans [7]. Environmental problems caused by human actions can be integrated into the context of physics. Physics is one of the branches of science that plays an important role in understanding various natural phenomena, including environmental changes caused by human activities (anthropogenic). One application of the connection between matter and real life is the integration of anthropogenic phenomena. Anthropogenic phenomena refer to human actions or processes that impact the environment. These phenomena affect the frequency and intensity of natural hazards [8].

Human activities can influence the emergence of greenhouse gases, which can ultimately lead to a warmer Earth, resulting in significant changes in the Earth's temperature, commonly referred to as climate change.

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Knowledge and skills are essential for the public to support efforts in preventing and preserving the environment when addressing environmental issues such as climate change [9]. Addressing such issues requires the ability to enhance students' potential.

Field evidence shows that physics education at the high school level still faces several major challenges, namely: (1) a tendency toward theoretical and abstract learning, (2) low levels of student engagement in the learning process, and (3) a lack of connection between the material and real-life contexts. These findings are supported by observations and interviews conducted at one public high school in Surabaya. According to students' perceptions, physics is perceived as a difficult and monotonous subject because there is a scarcity of practical examples or phenomena related to daily life. On the other hand, students reported finding it easier to understand and more engaging when learning is connected to the surrounding environment, nature, or astronomical phenomena [10].

Based on the results of the needs survey, students admitted to experiencing difficulties in learning physics. These obstacles arise due to the abstract nature of physics concepts, which require in-depth understanding, as well as teaching methods that rely solely on theoretical explanations without being balanced by practical activities. Based on several previous related studies, it is interesting to conduct research on students' responses to learning. Therefore, based on the background description above, an analysis of engagement and motivation is necessary to determine the results of implementing physics learning in integrated high schools on anthropogenic phenomena.

Research Methods

This study is classified as a quantitative descriptive research study. Quantitative research uses scientific methods to record observations as numerical data [11]. The research procedure is presented in Figure 1.

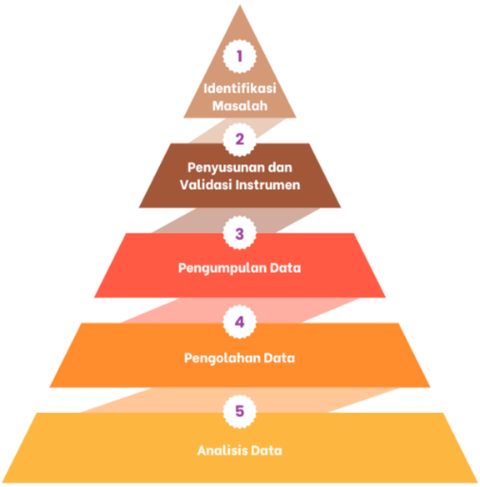

Figure 1. Research Procedures

Based on Figure 1, it is evident that the research procedure consists of five stages. In the first stage, which involves problem identification, the researcher conducts preliminary observations. The respondents in this study were 108 tenth-grade students who had received treatment in the form of integrated anthropogenic PBL physics learning. Additionally, the researcher conducted a literature review relevant to the research topic and aligned with the issues being studied. This stage is important to note because it allows researchers to obtain information that supports their research [12].

In the second stage, the researcher developed the instruments. The instrument used was a questionnaire containing 20 statements grouped based on the aspects of the PBL model phase and motivation. The instrument that had been created was validated by three expert validators. The input provided by validators serves as a basis for refining learning instruments [1]. In the third stage, data collection was conducted by distributing the validated instrument via Google Forms. Data collection from participants depended on the availability of respondents and was anonymous; confidentiality was maintained [13].

Data processing in the fourth stage was conducted using Microsoft Excel. The data results were obtained from the respondents' answers based on the Likert scale criteria. The Likert scale scores used are presented in Table 1 below.

Table 1. Skor Skala Likert

Positive Category	Skor	Negative Category
Strongly Agree	4	Strongly Disagree
Agree	3	Disagree
Disagree	2	Agree
Strongly Disagree	1	Strongly Agree

After obtaining the results, calculate the total score (total for each category) and the maximum score. The maximum score is obtained by multiplying the number of respondents by 4 (total Likert scale score) [14]. Then determine the percentage using the following equation (1).

$$P = \frac{\sum R}{\sum N} \times 100\% \quad (1)$$

Information:
P = response percentage (%)
$\sum K$ = number of scores obtained
$\sum N$ = maximum number of scores

The scores, expressed as percentages, are adjusted according to the category descriptions outlined in Table 2 below.

Table 2. Percentage of Questionnaire Responses

Percentage Range (%)	Categori
0 - 20	Very Negative
21 - 40	Negative
41 - 60	Fair
61 – 80	Positive
81 - 100	Very Positive

The data results were then analyzed to determine the students' perceptions of the learning activities that had been carried out.

Results and Discussion

The data collection process involved 108 tenth-grade students who had undergone treatment in the form of integrated PBL physics learning applying anthropogenic phenomena. The statements covering the PBL model aspects are divided into 5 phases [15]. Based on the data results, the involvement aspect in accordance with the PBL model aspects is presented in Table 2 below.

Table 3. PBL Phase 1 Data Results

No.	Statement	Average Score (%)
Phase 1. Orientation to the Problem		
1	The problems given at the beginning of the lesson are interesting and relevant to everyday life	86.57
2	I understand the learning objectives after the teacher explains the problems	87.96
	Average	87.27

Based on the results in Table 3, the average total score in phase 1 was 87.27% and was categorised as very positive. This section explains that students participated in contextual problem-solving activities related to real-life phenomena, guided by their teachers. The PBL model bases the learning process on contextual problems [16].

Table 4. PBL Phase 2 Data Results

No.	Statement	Average Score (%)
Phase 2. Organizing Students		
3	I don't know the steps to take to solve the problem	84.49
4	The teacher guides each group in planning a problem-solving strategy	87.50
	Average	86.00

Based on the results in Table 4, the average total score in phase 2 was 86.00% and was categorized as very positive. This section contains the stages of problem-solving and collaborative problem-solving strategy planning in groups with teacher assistance. Using the PBL model will help students learn in a more contextual and relevant way, thereby increasing their motivation and involvement in the learning process [17].

Table 5. PBL Phase 3 Data Results

No.	Statement	Average Score (%)
Phase 3. Guiding Problem Solving		
5	I actively sought information from various sources (books, the internet, and experiments) to solve the problem	86.57
6	The time allotted for the investigation was too short	81.02
	Average	83.80

Based on the results of Table 5, the average total in phase 3 is 83.80% and is categorized as very positive. This section covers the active involvement of students in seeking information to solve problems and time management during the investigation process. PBL-based learning encourages students to be more participatory in learning activities, although it still requires teacher guidance in understanding relevant concepts [17].

Table 6. PBL Phase 4 Data Results

No.	Statement	Average Score (%)
Phase 4. Developing and Presenting Problem-Solving Results		
7	Presenting the results of the discussion helped me understand the material better	88.65
8	The teacher provided constructive feedback after the presentation	87.96
	Average	88.31

Based on the results in Table 6, the average total in phase 4 is 88.31% and is categorized as very positive. This section presents the results of discussions and feedback from teachers. The presentation of students' work, which demonstrates their understanding and application of learning concepts, receives feedback from teachers and serves as material for reflection on the learning process and outcomes. This activity can develop students' self-confidence and cooperation skills [18].

Based on the results of Table 7, the average total in phase 5 is 85.65% and is categorized as very positive. This section covers teacher assessments and the duration of reflection activities conducted during the learning process. The PBL model is designed to enable students to reflect on, evaluate, and understand the concepts reinforced by teachers in the classroom [19]. The percentage of all phases of the PBL model is presented in Figure 2 below.

Table 7. PBL Phase 5 Data Results

No.	Statement	Average Score (%)
Phase 5. Evaluation and Reflection on the Results of Problem Solving		
9	The teacher's evaluation helped me correct my mistakes	87.27
10	The reflection activities in class felt rushed	84.03
	Average	85.65

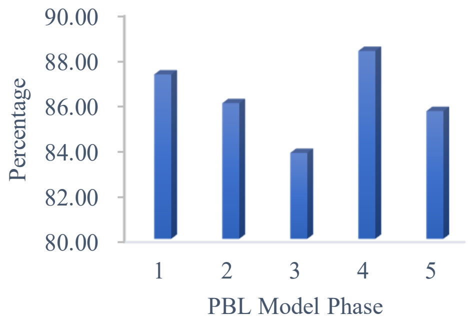

Figure 1. Percentage of All Phases of the PBL Model

Based on Figure 2, the results of the percentage of all phases of the PBL model show a very positive category. These results indicate that the learning method employed was effective in increasing student engagement. The data on responses to the motivation aspect are presented in Table 8 below.

Table 8. Motivation Aspect Data Results

No.	Statement	Average Score (%)
1	I enjoy learning physics in class	88.42
2	I like it when physics lessons use problem-based learning models because they help me understand the material better	85.42
3	I don't really enjoy group discussions during physics lessons in class	82.18
4	I like it when physics lessons involve simple experiments/practical work because they help me understand the material better	85.65
5	Learning about climate change in physics lessons makes me more interested in participating in classroom activities	88.19
6	I feel less enthusiastic when physics lessons raise issues related to climate in everyday life	81.94
7	Physics lessons related to anthropogenic phenomena (human activities) make me less interested in participating in classroom activities	82.87
8	I feel I understand physics concepts better when they are related to anthropogenic phenomena (human activities)	88.89
9	I am interested in whether physics lessons include science literacy-based exercises	87.96
10	Science literacy-based physics lessons help me understand physics concepts	91.44
	Average	86.30

Based on the results of Table 8, the average total score for the motivation aspect was 86.30% and was categorized as very positive. Student responses can be considered good if they show a percentage of ≥ 61% and are categorized as minimally positive. In line with these findings, the interest levels of 10th-grade science students at public high schools are generally high, with 57% of the total sample falling into the “good” category. However, the role of teachers is still very much needed, utilising teaching methods that support and motivate students' interest in physics learning to further improve [20-22].

The high positive response from students indicates the effectiveness of implementing the PBL model in climate change material integrated with anthropogenic phenomena. The success of this learning implementation not only encourages active student participation in learning activities but also makes learning more contextual and relevant to real life [23-24]. Therefore, based on the average total results, the students' responses can be considered good, indicating that the implemented learning approach is effective in enhancing students' interest.

Conclusion

Based on the research results obtained, it can be concluded that, in general, students' perceptions of physics learning using the PBL model integrated with anthropogenic phenomena received positive responses. The average score percentage in the five phases in terms of engagement was more than 80%. In terms of motivation, the average percentage score was 86%. The high average percentage scores of student responses in the aspects of engagement and motivation indicate that the implementation of the learning process has been carried out effectively. The implementation of the learning process has successfully increased student engagement and interest, as evidenced by the results of the response questionnaire.

Author’s Contribution

Evie Sylviana Dewi contributed by actively participating as the principal investigator responsible for all stages of the research, including the development of research instruments, data collection, data processing, and analysis. Nurita Apridiana Lestari contributed to the research by providing guidance, reviewing and providing feedback, and assisting in the interpretation of research data.

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