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Exploring the Implementation of Problem Based Learning for Class XI Biology in Senior High School

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ABSTRACT

This research explores the implementation of the *Problem Based Learning* (PBL) model in Biology learning for class XI students at SMAN 1 Medan. The research is motivated by the need for effective learning models that can enhance students' critical thinking and problem-solving skills in accordance with the Merdeka Belajar curriculum. The aim of this study is to investigate how well the PBL model is applied in classroom learning and identify challenges during its implementation. Using a qualitative exploratory method with a case study approach, data were collected through classroom observations and questionnaires administered to four Biology teachers and 144 students from four selected classes. The findings reveal that while the initial stages of PBL such as student orientation to problems and organizing students to learn were carried out effectively, the later stages, particularly guiding investigations, developing presentations, and evaluating problem-solving, were not optimally implemented. Teachers tended to provide less guidance during investigations and lacked structured reflection activities. Questionnaire results indicated a positive perception from both teachers and students, although observations showed inconsistency in implementation. In conclusion, the PBL model was generally well-received but still requires improvements, especially in teacher facilitation and reflective practices, to maximize its impact on student learning outcomes.

INTRODUCTION

Learning success is strongly influenced by the teacher's competence in selecting and implementing appropriate learning models, particularly in how instructional content is delivered to students. In general, learning models can be seen as an approach to completing tasks or handling work by utilizing ideas and realities systematically. A teaching model is a set of concepts used to convey lesson material to students so that the goals that have been set can be achieved. Basically, a learning model is a form of discovery that includes a picture from beginning to end, which is introduced by educators specifically (Krismawati et al., 2024). In this context, learning models function as strategies or techniques applied by teachers to facilitate learning activities so that expected learning outcomes can be achieved optimally (Prasetyo et al., 2021). One instructional model that has been widely recognized for enhancing students' critical thinking abilities is Problem Based Learning (PBL).

Biology teaching at the high school level, especially in Class XI, requires an effective approach to facilitate understanding of complex concepts and improve students' critical thinking skills. One model that has been proven effective is PBL (Halimah et al., 2023). PBL allows students to learn through solving real problems, which requires them to integrate relevant knowledge and skills to find solutions. The PBL model in Indonesia has been widely studied and shown to be effective in facilitating a more meaningful learning process for students (Halimah et al., 2023; Fauziah et al., 2024; Sandi et al; 2024). In PBL, students are given real problems related to the

subject matter, encouraging them to think critically and collaborate in finding solutions (Hidayana et al., 2022). This is relevant to the characteristics of high school students, namely analytical, critical, logical, communicative, collaborative thinking, and having a high curiosity.

The PBL model can be implemented through both individual and group learning activities. The learning process using the PBL model begins with the teacher guiding students to solve problems, then directing them to conduct research to find the right solution. The PBL learning model is an innovation in learning methods, because through structured group collaboration, students can develop their thinking skills optimally. PBL is a teaching method that encourages students to "learn" and "experience learning" while working in groups to find solutions to the problems given. The problem is used to stimulate curiosity, as well as hone students' analytical skills and initiative in the material being studied. It is hoped that the use of this model can create a more positive learning atmosphere, where students are able to respond well to the material that has been explained by the teacher (Prasetyo et al., 2021).

PBL is one of the learning models used in the Merdeka Belajar curriculum, with a learning system that focuses on students in finding solutions to problems that arise around them, so that learning is not monotonous. The application of the PBL model is very suitable to support the objectives of the Merdeka Curriculum which emphasizes the development of critical skills, collaboration, and problem solving. This curriculum gives students the freedom to engage more deeply with relevant and meaningful learning materials. PBL helps realize this goal by involving students in the process of solving real problems, which motivates them to learn and understand concepts in depth (Suryani et al., 2023).

Problem-Based Learning (PBL) is a learning approach that positions students as active participants in the process of identifying and solving real-world problems. Through activities such as small group discussions, independent exploration, and presentations of analytical results, students are trained to build deeper understanding and develop critical thinking skills. The application of PBL in biology classes has been shown to significantly improve student learning outcomes across various learning cycles (Arumsari et al., 2023). Analysis of various studies shows that the PBL model can consistently improve students' critical thinking skills in the context of biology learning. Students' active participation in identifying problems and designing solutions has become the foundation for the development of higher-level intellectual skills such as analysis and evaluation (Taufik et al., 2022).

Several studies have found that the PBL model can affect the learning process, including problem-solving skills, learning outcomes and also student learning activities. For example, Hasan et al. (2019) reported that the implementation of PBL in biology learning significantly enhanced students' problem-solving abilities and cognitive achievement compared to conventional instructional methods. In a study in South Sulawesi, the application of the PBL model in biology classes was able to significantly increase student participation and learning activities through observations and evaluations carried out in two learning cycles (Sakir & Kim, 2020). The PBL learning model has been proven to be effective in various biology materials in Class XI. Several studies have shown that biology materials in Class XI such as the immune system or body defense system, excretory system, digestive system, respiratory system, nervous system, motor system and reproductive system in humans (Utami et al., 2018; Permatasari & Anhar, 2020; Wahyuni et al., 2023; Djati et al., 2023; Qudsiya et al., 2018; Sa'diyah, 2020; Isnaeni et al., 2019). PBL has many benefits in the success of classroom learning.

Although PBL brings many benefits, the success of its implementation is highly dependent on the teacher's ability to manage discussions and provide appropriate guidance. Teachers not only act as teachers, but also as facilitators who must be able to direct students to think analytically and reflectively in solving the problems given. The implementation of PBL in the classroom is often faced with challenges, such as time constraints and lack of supporting resources (Lufri et al., 2022). Further research on the obstacles faced by teachers in implementing the PBL model is the preparation of the independent curriculum teaching module which has a contribution of 23%

regarding learning media (Ahmad, 2024). Different students' thinking abilities are also one of the obstacles in implementing the PBL model in the classroom, this is in line with research (Hasibuan et al., 2024) that students have different mindsets and abilities in the classroom, so teachers need to take an individual approach to each student to understand their conditions. This includes understanding the student's background and identifying factors that can hinder their focus on learning.

Some of the above problems were also found in SMAN 1 Medan. SMAN 1 Medan is one of the senior high schools in Medan city that implements the independent curriculum and one of the learning models used is the PBL learning model. Teachers at the school admitted that they had understood all the syntax in the PBL learning model, teachers had also prepared modules at the beginning of the semester and prepared various problems that were developing in the material to be delivered. However, in implementing the PBL model, there were difficulties experienced by teachers, namely time constraints and differences in students' thinking abilities in the class in terms of expressing opinions and working together. This can cause the implementation of PBL in the classroom to be less than optimal. Based on information obtained from biology teachers and students about the application of the PBL model to biology material for class XI at SMAN 1 Medan, it is necessary to know the suitability of the implementation of the PBL model in the classroom.

MATERIALS AND METHODS

1. Time and Place of Research

The research period was from February to May 2025. The research was conducted at SMAN 1 Medan located at Jalan Teuku Cik Ditiro No. 1, Madras Hulu, Medan Polonia District, Medan City, North Sumatra.

2. Research Method

This study uses an exploratory qualitative method. Exploratory qualitative research is a type of qualitative research used to explore or find a deep understanding of phenomena that are not widely known or studied. This study aims to identify new patterns, concepts, or theories using a flexible, open, and directed approach to exploration (Sugiyono, 2016). This study is to identify and understand how the PBL model is applied by teachers and accepted by students in the context of biology. This research uses a case study approach. A qualitative case study is an in-depth research method focused on a specific case within a real-life context, with the goal of understanding a phenomenon in detail and depth.

3. Populations and Respondents of Research

Population and respondents will be explained in the following points:

1) Populations

The population of this study was students of Classes XI-1, XI-2, XI-3, XI-4, XI-5, XI-6, XI-7, XI-8, XI-9 at SMAN 1 Medan in the 2024/2025 Academic Year, totaling 324 students divided into 9 classes and 4 class XI biology teachers.

2) Respondents

The respondents used in the study were biology teachers and students. Determination of respondents was carried out using the Purposive Sampling technique for students and the Total Sampling technique for teachers. Purposive sampling is sampling carried out in accordance with the requirements/characteristics of the sample required (Sugiyono, 2017). The characteristics used in selecting respondents in this study were learning experience with the PBL model, involvement in PBL model activities, and variations in levels of understanding and skills.

Based on the criteria above, the classes that were respondents in the research were determined to be classes XI-1, XI-3, XI-4, and XI-6 at SMAN 1 Medan, with the number of students who became respondents being 144 students. Then the teachers who were used as respondents were class XI biology teachers, totaling 4 people.

4. Research Procedure

In general, the research stages take place in three stages, namely: the preparation stage, the implementation stage and the data analysis stage.

1) Research Preparation Stage

The preparation stage was carried out with initial observations by skipping the principal and the 11th grade biology teacher to obtain an initial picture of the implementation of the Problem Based Learning (PBL) model. To support the research process, research instruments were prepared in the form of observation sheets and PBL model implementation questionnaires. Finally, the research instruments were validated by the validator to ensure accuracy and feasibility in research use.

2) Research Implementation Stage

The research implementation stage, namely the observation of the implementation of the PBL model in the classroom, was carried out to directly observe how this method is applied in the learning process, student interactions with teachers. In addition to observation, this study also involved giving questionnaires to teachers and students to collect data on their understanding, experiences, and obstacles they faced during the implementation of the PBL model.

3) Final Stage of Research

The final stage of research begins with the management of data obtained from various instruments, including observation results, and questionnaires filled out by teachers and students. The collected data is then analyzed systematically to obtain an objective picture of the effectiveness of implementing the PBL model in learning. This analysis process involves processing qualitative data to find new phenomena in the research. After the analysis is carried out, the next step is to draw conclusions based on the research findings, regarding the implementation of the PBL model.

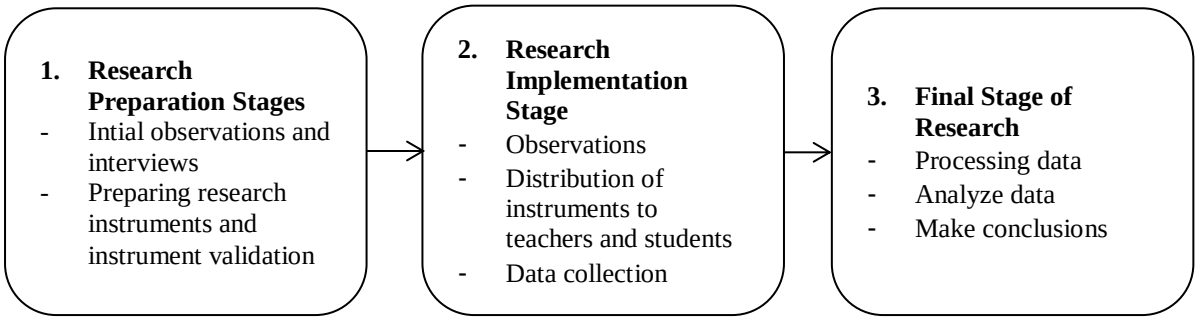

Figure 1. Stages of the research (Sugiyono, 2017).

5. Data Collection Technique

After primary and secondary data are obtained, the next step is to analyze and discuss the results of the documentation, observations, and questionnaires that have been carried out.

1) Data Collection

In this study, data collection was carried out through observation and questionnaires to determine the implementation of the PBL model in the classroom..

2) Data Reduction

Data reduction means filtering, selecting, and focusing on important information, looking for relevant themes and patterns.

3) Data Display

In qualitative research, data is presented in the form of narrative text that describes in detail the findings that have been obtained.

4) Conclusion Drawing/ verification

Conclusions in qualitative research refer to new findings that were previously unknown. These findings can be in the form of a clearer description or picture of an object that was previously not clearly revealed, so that after the research is conducted, the object becomes clearer and easier to understand.

The following table serves as a reference for categorizing observation and questionnaire results related to the implementation of the Problem-Based Learning (PBL) model in learning. These categories help interpret quantitative data in percentage form into qualitative assessments, thus facilitating analysis of the implementation level of each PBL syntax. The percentage range provides an overview of how well a syntax is implemented, ranging from "Very Not Good" to "Very Good." These categories refer to the assessment guidelines according to Arikunto (2013).

Tabel 1. Implementation Categories for Each PBL Syntax

Presentation Range	Implementation Category
81 - 100%	Very Good
61 - 80%	Good
41 - 60%	Enough
21 - 40%	Not Good
0 - 20%	Very Not Good

(Source: Arikunto, 2013)

RESULTS AND DISCUSSION

The results of this study are presented based on two aspects, namely, 1) Observation and 2) Questionnaire in seeing the implementation of the Problem Based Learning learning model on the hormone system sub-material. At the observation stage, the observer observes the teacher teaching the hormone system material. The observations made are accompanied by an observation sheet that refers to the PBL model. At this stage, the observer sees the teacher carrying out the teaching and learning process according to the PBL-based module that has been designed or not. Furthermore, at the questionnaire stage, the researcher distributes questionnaires to teachers and students, where the questionnaire is useful for emphasizing the results of the ongoing learning process related to the PBL model.

1) Observation Result Data

In an effort to explore the implementation of the Problem Based Learning (PBL) model in Biology material for class XI, observation activities have been carried out as one of the methods of collecting field data. This observation is intended to directly see the learning process in the classroom that applies the PBL model, with a focus on the activities of teachers and students in each stage of learning. Observations are carried out systematically based on indicators that reflect the steps of PBL. Observations on the implementation of learning with the PBL model were carried out on class XI Biology teachers at SMAN 1 Medan. Observations were carried out on four teachers with a focus on the implementation of the PBL model syntax. Observation data can be seen in Table 2.

Table 2. Observation Data (Implementation Of The Problem Based Learning Model)

PBL Syntax	Teacher 1			Teacher 2			Teacher 3			Teacher 4		
	Obs 1	Obs 2	Obs 3	Obs 1	Obs 2	Obs 3	Obs 1	Obs 2	Obs 3	Obs 1	Obs 2	Obs 3
Student orientation to problems	Good	Good	Good	Good	Good	Good	Not Good	Not Good	Not Good	Not Good	Not Good	Not Good
Organizing students to	Good	Not Good	Not Good	Not Good	Not Good	Not Good	Good	Good	Good	Good	Good	Not Good

PBL Syntax	Teacher 1			Teacher 2			Teacher 3			Teacher 4		
	Obs 1	Obs 2	Obs 3	Obs 1	Obs 2	Obs 3	Obs 1	Obs 2	Obs 3	Obs 1	Obs 2	Obs 3
learn												
Guiding Individual and Group Investigations	Not Good	Not Good	Not Good	Not Good	Not Good	Not Good	Good	Good	Good	Good	Good	Good
Develop and present results	Good	Not Good	Good	Good	Not Good	Not Good	Not Good	Not Good	Not Good	Not Good	Not Good	Not Good
Analyzing and Evaluating the Problem Solving Process	Not Good	Not Good	Not Good	Not Good	Not Good	Not Good	Not Good	Not Good	Not Good	Good	Good	Good

In the context of this research, the implementation of the PBL model was observed through learning activities carried out by teachers and students in the 11th grade Biology subject, with reference to the PBL syntax which includes problem orientation, student organization, investigation, presentation of results, and evaluation and reflection. The results of observations and questionnaires showed that most stages had been implemented well, although the implementation still faced several obstacles, especially in terms of teacher guidance and student reflective engagement during the learning process. This is in line with the opinion of Rohman & Fitria (2021) who stated that the implementation of PBL in high schools is still often hampered by the lack of teacher habituation in optimally facilitating student reflective and investigative activities.

The four teachers' application of student-oriented problem-solving syntax indicates that problem presentation is generally linked to students' real-life contexts, although some teachers still present them theoretically and less systematically. Stimulus delivery was largely delivered through media such as videos and images, but its effectiveness varied due to technical constraints or inadequate media support. Student responses to the problems tended to be positive, but students' ability to identify the core of the problem was uneven across the class. In the student organization stage, teachers generally conveyed the learning objectives and steps and divided tasks quite well. However, instructions and work directions were not fully implemented, resulting in some students appearing confused in carrying out group assignments. This is consistent with the findings of Suparman et al. (2022), who emphasized that the success of the initial stages of PBL is largely determined by the clarity of the problem and work instructions provided by the teacher to students.

During the guidance phase, students from all four teachers actively participated in group work, particularly in assignments and discussions. However, teacher involvement in guiding the investigation process was still suboptimal, as not all teachers provided in-depth guidance in formulating questions or assisting students when they encountered difficulties. Students tended to conduct investigations independently with minimal support from their teachers. During the development and presentation phase, students were generally able to prepare presentations using PowerPoint, but their delivery was not fully synchronized and engaging. Only a small proportion of students actively presented solutions, and teachers did not fully facilitate the development of ideas or encourage in-depth discussions of the results. These findings align with research by Hartono & Sari (2020), which states that the success of PBL is strongly influenced by the teacher's active role in facilitating investigations and guiding students' exploration of ideas.

Evaluation of the problem-solving process remains a weakness in the implementation of PBL by the four teachers. Student participation in analyzing and evaluating solutions tends to be low and is dominated by certain students. Teachers have not fully facilitated analytical discussions

that encourage all students to engage in reflecting on learning outcomes. Evaluations tend to be brief and do not provide adequate reinforcement of student understanding. Final reflections have also not been a consistent part of closing lessons. Overall, the four teachers have implemented PBL syntax, but their implementation still needs improvement, particularly in terms of guiding investigations, developing ideas, and conducting evaluation and reflection on learning. This is reinforced by the research of Prasetyo et al. (2021), which states that reflection and evaluation in PBL are often neglected, even though this stage is crucial for fostering metacognitive awareness and in-depth student understanding.

Recent studies further confirm that the effectiveness of Problem Based Learning (PBL) is highly dependent on the quality of teacher facilitation, particularly during the investigation and reflection stages. A study by Savery (2023) emphasized that although PBL is widely adopted in science education, many implementations remain procedural and fail to optimally engage students in higher-order thinking due to limited scaffolding during inquiry and reflection phases. Similarly, Hmelo-Silver and Jeong (2022) highlighted that effective PBL requires structured teacher guidance to help students formulate investigable questions, synthesize information, and reflect on problem-solving strategies, especially in complex biology topics such as human physiology.

In addition, recent research in senior high school biology learning indicates that reflective activities are a key determinant of PBL success in fostering critical thinking and conceptual understanding. Rahmawati et al. (2023) reported that students who were explicitly guided to reflect on their learning process demonstrated significantly higher analytical and problem-solving skills compared to those who only engaged in problem discussion and presentation. This finding reinforces the argument that reflection should not be treated as a supplementary activity, but as an essential component of the PBL cycle. Therefore, strengthening teacher competence in facilitating reflection and evaluation is crucial to ensuring that PBL implementation moves beyond procedural compliance toward meaningful learning outcomes.

The implementation of the PBL model in Biology learning for class XI at SMAN 1 Medan generally shows that teachers have tried to apply PBL syntax according to its stages, especially in the early stages such as student orientation to problems and organizing learning activities. Teachers are able to present learning problems using the context of students' lives and provide visual stimuli such as pictures and videos. This is in line with Arends' (2012) view which states that PBL starts from real and authentic problems, which encourage students' independent and collaborative investigation and critical thinking. This finding is also reinforced by Lintuo et al. (2022) who stated that audiovisual media in PBL improves students' critical thinking skills and understanding, which is reflected in students' activeness in responding and identifying the core of the problem.

However, the implementation of advanced stages such as investigation, solution development, and evaluation are still not optimal. Teachers have not provided comprehensive guidance in the investigation process and only guide certain groups. Guidance in compiling investigation questions has not been carried out systematically. In fact, according to Kurniasih & Sani (2020), teachers in PBL should guide students to formulate problems and provide open questions to develop high-level thinking skills. On the other hand, although students have presented their results in PowerPoint, the clarity of the presentation and equal participation are still lacking, and have not been accompanied by in-depth analysis or systematic problem solving. The learning reflection stage has also not been implemented explicitly, even though Rusman (2021) emphasizes the importance of reflection in PBL as a means of evaluating the thinking process and improving problem-solving strategies.

Student participation in the problem-solving evaluation stage was also found to be low, and teachers had not fully facilitated analytical discussions. According to Yamin (2021), the success of PBL is largely determined by the teacher's ability to encourage students to reflect on their thinking processes and draw conclusions from learning experiences, not just find the final answer. The obstacles to implementing PBL are caused by several factors such as time constraints, lack of student readiness, and challenges in classroom management by teachers. In addition, some students

are not yet accustomed to group discussions and are more comfortable working individually, which is contrary to the collaborative characteristics of PBL. Technical obstacles such as minimal supporting facilities and internet network disruptions are also challenges in optimizing the implementation of more contextual and digital problem-based learning.

2) Questionnaire Result Data

The following questionnaire data were obtained through the distribution of questionnaires to four class XI Biology teachers and students from each class representative taught by the four teachers. This questionnaire was distributed as part of an effort to collect data in a study on the implementation of the PBL model in Biology material in class XI. The questionnaires aimed to capture the perceptions, experiences, and challenges faced by both teachers and students in applying each stage of the PBL model during the learning process. The questions were structured based on the five main syntaxes of PBL to ensure comprehensive evaluation of its implementation. By analyzing student responses, researchers were able to assess the extent of student engagement, collaboration, and understanding throughout the learning activities. The results of the student questionnaire data can be seen in Table 3.

Table 3. Student Questionnaire Results Data

Syntax	Category
Student orientation to problems	Very good
Organizing students to learn	Very good
Guiding Individual and Group Investigations	Very good
Develop and present results	Very good
Analyzing and Evaluating the Problem Solving Process	Very good

Based on questionnaire data obtained from student representatives from four classes taught by four eleventh-grade Biology teachers, it was found that all aspects of the PBL syntax were implemented with a rating of "Very Good." This is evident from student perceptions, which indicate that each stage of the PBL model, from problem orientation to reflection on the learning process, has been optimally implemented by the teacher in class. In general, the application of the PBL model in Biology learning was considered very good by students, reflecting that this approach is able to create an active, meaningful learning process and support comprehensive student engagement. Furthermore, teachers were also considered capable of facilitating learning well by using contextual problems relevant to students' daily lives. This finding is in line with research conducted by Nurkhasanah and Cahyani (2023), which stated that students' positive perceptions of the PBL model indicate the teacher's success in creating a collaborative learning atmosphere and fostering students' natural curiosity. Support for problem-based learning has also been shown to improve students' conceptual understanding and emotional engagement in the learning process (Putri & Widodo, 2022), which are important indicators of the success of the PBL model implementation in the classroom.

Furthermore, regarding the results of the teacher questionnaire, the teacher questionnaire was obtained from four class XI biology teachers at SMAN 1 Medan. The teacher questionnaire data can be seen in Table 4.

Table 4. Teacher Questionnaire Results Data

Syntax	Category
Student orientation to problems	Very good
Organizing students to learn	Very good
Guiding Individual and Group Investigations	Very good
Develop and present results	Very good
Analyzing and Evaluating the Problem Solving Process	Very good

Based on questionnaire data completed by four eleventh-grade Biology teachers, it was found that all aspects of PBL syntax were in the very good category. This indicates that the teachers assessed the implementation of the PBL model in the classroom as being running optimally. However, it should be noted that teacher ratings tended to be high, which was likely influenced by a desire to evaluate themselves positively. Therefore, the results of this teacher questionnaire were also used as comparative material to determine alignment with student perceptions of the implementation of the PBL model in the classroom. This finding is in line with the results of research by Susanti and Rahmawati (2023), which stated that teachers tend to give high ratings to the implementation of PBL-based learning, although in practice, obstacles were still found that were not explicitly revealed in teacher reflections.

A questionnaire administered to four teachers and several eleventh-grade students at SMAN 1 Medan showed that the implementation of the PBL model in Biology learning received a very positive response. Both teachers and students gave a "Very Good" rating for the entire PBL syntax, from problem orientation to problem-solving evaluation. Teachers felt they had implemented all syntax systematically and were able to facilitate students in identifying problems, forming groups, and guiding the investigation and presentation process. Students also felt actively involved in group discussions, gathering information, and developing solutions to problems. This assessment is supported by findings from Siregar and Maulidina (2022), which showed that consistent PBL implementation can increase student active participation and improve critical thinking skills, especially in science learning at the high school level.

These findings indicate that in terms of perception, PBL encourages active student involvement compared to conventional methods, because students not only receive information, but also actively discuss, investigate, and express opinions. This is in line with the opinion of Kurniasih & Sani (2020) that PBL encourages students to think critically, work together, and be responsible for their learning process through exploratory and collaborative activities. Teachers also said that the implementation of PBL helps students become more independent, accustomed to working in teams, and show improvements in communication and creativity when presenting results. This supports Hosnan's view (2021) that problem-based learning provides space for students to actively seek solutions to problems that are relevant to their lives.

However, although the questionnaire results showed a high assessment, there were still obstacles, especially for some students who did not understand their role in the group, such as in formulating investigative questions or formulating logical solutions. Some students tended to follow the dominant direction of other group members without really understanding the problem. This indicates that critical thinking and reflection skills have not developed evenly. Yamin (2021) emphasized that the success of PBL depends not only on the implementation of syntax, but also on students' ability to reflect on the learning process and evaluate the strategies used. Without reflection facilitation from the teacher, the main goal of PBL to encourage high-level thinking skills has not been fully achieved. This finding reinforces the importance of teacher reflection on their learning practices, because without objective observation, the implementation of models such as PBL can be considered successful only from an administrative or personal perception perspective, not from an authentic learning outcome.

In general, the results of the questionnaire and observations mutually confirm that PBL has been implemented in Biology learning for class XI. However, the results of the observations provide a deeper picture and show that the implementation of several important stages such as investigation and reflection still need to be improved. The questionnaire data shows a positive perception, while the observations show that the implementation is still partial and not fully effective. Thus, improvements are needed in teacher facilitation practices so that the implementation of PBL truly supports the achievement of critical thinking skills and real problem solving.

Furthermore, recent empirical evidence suggests that discrepancies between observation results and questionnaire perceptions are common in PBL research. Wijnen et al. (2023) found that

students often perceive PBL positively because of increased engagement and collaboration, even when critical elements such as reflective discussion and metacognitive evaluation are not fully implemented. This aligns with the findings of the present study, where questionnaire results showed very positive perceptions, while observational data revealed weaknesses in investigation guidance and reflective evaluation. According to Dolmans et al. (2024), this perception gap indicates the importance of triangulating data sources in PBL studies to obtain a more authentic picture of learning quality and instructional effectiveness.

CONCLUSION

Based on the results of observations and questionnaires on four teachers and class XI students at SMAN 1 Medan, it can be concluded that the implementation of the Problem Based Learning (PBL) model in Biology learning has been running quite well, especially in the early stages such as student orientation to problems and organizing learning activities. Teachers have been able to convey learning problems contextually and provide supporting visual stimuli, while students show quite active involvement in responding to problems and discussing in groups. However, the implementation at advanced stages such as investigation, solution development, and evaluation and reflection are still not optimal. Teachers have not fully provided comprehensive assistance in the investigation process and have not facilitated in-depth reflection for students. In addition, students' critical and reflective thinking skills have not developed evenly, indicating that improvements are still needed in teacher assistance and management of the learning process so that problem-based learning objectives can be achieved optimally.

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