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Analysis of Biology Learning Resources and Materials in PJBL, PBL, and Deep Learning in Class X in Biology Teachers and Students of SMA Negeri 2 Lubuk Pakam

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Abstract. The success or failure of the learning process in schools is greatly influenced by teachers in their choices. Teaching materials are materials or information used by teachers for their learning. The purpose of this study was to determine the perception, analyze the availability, and analyze the difficulties of teachers and students in relation to PJBL, PBL, and learning resources and materials that support deep learning. This study is based on qualitative research methods. This method directly distributes questionnaires to 20 students of class X MIA and four biology teachers, at SMA Negeri 2 Lubuk Pakam. Data were collected using observation, interview and document techniques. The results obtained are explained by explaining the observations in the discussion. Teachers try to provide various learning resources, including textbooks, science magazines, and laboratory videos. Students believe that the three methods of learning materials are relevant to daily activities and can help them understand the material. However, there are some problems that have not been resolved. For example, it is difficult to find access to digital learning resources, and there is no variation in teaching.

Keywords: Learning resources; Learning materials; Students; Teachers

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INTRODUCTION

Education is a structured effort to create a learning environment and learning process that allows students to actively develop their potential. Therefore, students are believed to have good spiritual qualities, self-control, character, intelligence, noble character, and have the skills needed for themselves and society (Mukra *et al*., 2024). Schools are formal educational institutions that can improve the quality of human resources through a series of learning processes that occur. The success or failure of the learning process in schools is strongly influenced by teachers, including in the selection of teaching materials. Teaching materials are materials or information used by teachers to carry out learning. Teaching materials can be printed teaching materials such as books and non-printed materials such as audio, video/film, or other multimedia needed during the learning process (Hadi & Dazrullisa, 2018). Without using teaching materials, teachers and students will have difficulty in the learning process. Given the importance of teaching materials, it is expected that teachers can choose the right teaching materials in learning activities. Teachers can also develop their own teaching materials according to the needs at school (Nurfalah *et al*., 2019). The success of the learning process is also supported by the availability of relevant learning tools. Learning tools that are often used by students in biology learning activities are learning resources. Learning resources are all things that can facilitate students in obtaining information, knowledge, and skills in the teaching and learning process (Puspitasari & Salamah, 2021). Biology learning resources include all things, both objects and symptoms, which can be used to gain experience in order to solve certain biological problems. This learning resource facilitates and facilitates the learning process. Biological

learning resources in the biology learning process can be accessed at school or outside school. In general, there are two ways to utilise learning resources in school learning, namely by bringing learning resources into the classroom or bringing students to the field where the learning resources are located (Suryaningsih, 2020).

Project Based Learning (PjBL) is an educational approach that focuses on the fundamental ideas and principles (core) of a particular discipline, involves students in problem solving activities and other activities, provides opportunities for students to work independently in building their own learning, and ultimately produces realistic and well-written student work (Mukra & Nasution, 2017). *Project-based learning* uses projects or activities as its main medium. This method is intended to address complex problems that require investigation and understanding by learners. It should be noted that each learner has a unique learning style, and *project-based learning* gives them the opportunity to explore the material in an efficient and collaborative way (Simatupang *et al*., 2024). The PJBL Learning Model has a final goal in the form of a project. This learning model considers SK, KD, and curriculum carefully, and focuses on student activities that collect data that will be used to produce a project (Matondang *et al*., 2024)

PBL is a student-centred learning approach, where they are challenged to solve real problems relevant to the learning material. This model encourages students to think critically, seek information, and apply their knowledge in a meaningful context. PBL has been applied in various fields of science and shows positive results, especially in increasing student learning engagement and motivation (Satwika *et al*., 2018). *Problem-based learning* is one of the learning models that can be applied to prepare students to build important skills in the 21st century, and problem-based learning asks students to find or search for problems and solutions authentically. In addition, it is also mentioned that this problem-based learning prepares students to face authentic problem situations that can be meaningful to them as a basis for investigation (Arwita *et al*., 2017). 21st century learning has 4 main principles, including, focused on students, collaborative, connected to real life, and must have a purpose. Educational facilities in the 21st century change learning into student-oriented activities such as design investigations and collaborative project work. Student-focused learning has an impact on improving critical thinking skills and student learning motivation (Sitanggang et al., 2024).

Deep learning in education is a learning approach that focuses on deep understanding and meaning of the material, rather than rote memorisation. *Deep learning* enables learning through critical analysis, comparing new information with existing knowledge, and applying it in a real-world context. It is expected that the implementation of deep learning at primary and secondary levels will have a positive impact on student learning outcomes. *Deep Learning* enhances student understanding, knowledge integration and application in real-world scenarios, indicating that the learning process is transparent (Diputera *et al*., 2024)

Biology is often considered difficult to learn by students so that it affects the learning outcomes obtained. This is based on facts biology materials often contain abstract concepts that are difficult to understand. In addition, students' ability to learn will be affected by the lack of learning resources, such as teaching materials. Basically, teaching materials are information compiled by teachers that contain relevant information about the learning process which will later become additional information in the learning process. Teaching materials are the main action of the teacher in the learning process, and from the teaching materials prepared, it can be seen how the teacher's preparation in teaching students the preparation of teaching materials is very important before the learning and teaching process begins. Also, the teaching materials used by teachers help create an appropriate environment for students (Marlina & Lufri, 2024).

In addition, learning methods are very important in schools, especially for learning in the classroom. A learning model is a form of learning or guidance used to provide instruction to students (Trianto, 2010). The methods used by teachers in teaching are expected to be more effective in achieving learning objectives (Fathurrohman & Sutikno, 2011). Therefore, it is expected that the use of alignment between learning methods (PjBL, PBL, and *Deep Learning*) based on facts the materials or learning resources used.

Based on the explanation above, the author is interested in researching the Analysis of Biology Learning Resources and Materials in PjBL, PBL, and Deep Learning in Class X at Biology Teachers and Students of SMA Negeri 2 Lubuk Pakam. Seeing the importance of teaching materials and learning resources in learning Biology, this study aims to determine the perceptions of teachers and students of learning resources and materials used in PjBL, PBL, and *Deep Learning*, then analyse the learning resources and materials available in supporting the understanding of biological concepts in depth through PjBL, PBL, and *Deep Learning* approaches, and identify the difficulties experienced by teachers and students in accessing and utilising biological learning resources and materials in PBL, PJBL, and *Deep Learning* learning models.

MATERIALS AND METHODS

The research method used is descriptive. Descriptive is one method that explains or describes all the results of research activities obtained by researchers (Banggo, 2023). The sample population was taken by selecting 20 students in class X MIA at SMA Negeri 2 Lubuk Pakam with a total of 20 students and biology teachers in the school, while the number of teacher respondents obtained was 3 teachers.

Observation data collected in the form of questionnaire sheets distributed in one class X, when conducting research, researchers conducted documentation in the form of photos together with students in the classroom while conducting the research. Observation results were calculated using a formula that has been determined and used by many studies, such as in previous studies (Khoiriah et al., 2024).

In the research data collection techniques were carried out by utilising observation, interview, and documentation techniques. Qualitative data analysis activities are divided into three stages, namely the data reduction stage, data presentation, and conclusions or verification. This is also conveyed by previous research, that by analysing data, stages are needed, which start from (a) Data reduction by collecting questionnaire results from 30 respondents according to our research needs; (b). Presentation of data by calculating the percentage of respondents' answers with the formula (Sefti et al., 2023).

The calculation of the questionnaire data collected is done by separating (separating the teacher and student questionnaires), so that the questionnaire results between teachers and students can be analysed and describe the results obtained based on what is obtained in the field.

Table 1. Formula for Calculating Observations of Student and Teacher Activities

Formula	Description
$P = \frac{F}{N} \times 100\%$	P = Presentation to be sought F = Number of scores obtained N = Total ideal score (Student and Teacher)

RESULTS AND DISCUSSION

Teachers

The results of the analysis of research data taken from 3 teachers of SMA N 2 Lubuk Pakam can be seen in the following Table 2, Table 3 and Table 4.

Table 2. Observation of teachers of biology resources and learning materials in PjBL learning

Question	Frequency of Alternative Answers			
	TP	KD	SR	SL
The teacher includes sources and learning materials in the PjBL biology module.	0%	33.3%	33.3%	33.3%
The teacher utilizes various types of learning resources (such as textbooks, scientific journals, teaching videos, or laboratories) in PjBL.	0%	0%	66.6%	33.3%
The teacher provides tutorials to access those sources and learning materials.	33.3%	0%	33.3%	33.3%
The teacher feels that the available learning resources are diverse enough to meet students' learning needs in the PjBL project.	0%	33.3%	0%	66.6%
The effectiveness of the available learning resources in helping students achieve learning goals in the PjBL project.	0%	33.3%	33.3%	33.3%
The teacher guides students in finding and evaluating relevant learning resources for their PjBL projects.	0%	33.3%	33.3%	33.3%
The teacher updates or adjusts learning resources in the PjBL module to match the development of scientific knowledge.	0%	33.3%	33.3%	33.3%
Does the teacher experience difficulties in identifying learning resources that are suitable for the PjBL topics being taught?	33.3%	66.6%	0%	0%
Does the teacher face challenges in providing adequate learning resources and materials to implement PjBL (Project-Based Learning) in the classroom?	33.3%	66.6%	0%	0%
Does the teacher often encounter obstacles in accessing the digital learning resources needed for implementing PjBL?	33.3%	33.3%	33.3%	0%

The survey results given to teachers aim to understand how they implement resources and learning materials in PjBL, PBL, and *Deep Learning*. From the data obtained, it appears that teachers generally have made efforts to provide a variety of learning resources but still face several challenges in their implementation. In PjBL, most teachers stated that they have included resources and learning materials in their teaching modules. Additionally, the majority of teachers also utilize various types of learning resources, such as textbooks, scientific journals, instructional videos, and laboratories, to support the learning process of students. However, there are challenges in ensuring that the learning resources used are genuinely varied and relevant to the students' needs. Teachers also stated that they often provide tutorials for students to access learning resources, but some of them face difficulties in supplying sufficient resources for the projects assigned. Furthermore, some teachers feel that the available learning resources need to be updated more frequently to remain in accordance with the developments in scientific knowledge.

Table 3. Observation of source teachers and biology learning materials in PBL

Questions	Frequency of Alternative Answers			
	TP	KD	SR	SL
The teacher includes sources and learning materials in the PBL biology module	0%	33.3%	33.3%	33.3%
The teacher utilizes various types of learning resources (such as textbooks, scientific journals, teaching videos, or laboratories) in PBL.	0%	0%	66,6%	33.3%
The teacher provides tutorials to access those sources and learning materials.?	33,3%	0%	33.3%	33.3%
The teacher feels that the available learning resources are diverse enough to meet students' learning needs in the PBL project.?	0%	33.3%	0%	66.6%
The effectiveness of the available learning resources in helping students achieve learning goals in the PBL project.?	0%	33.3%	33.3%	33.3%
The teacher guides students in finding and evaluating relevant learning resources for their PBL projects.?	33.3%	0%	0%	66.6%
Does the teacher update or adjust learning resources in the PBL module to match the development of scientific knowledge?	0%	33.3%	0%	66.6%
Does the teacher experience difficulties in identifying learning resources that are suitable for the PBL topics being taught?	33.3%	66.6%	0%	0%
Does the teacher face challenges in providing adequate learning resources and materials to implement PjBL (Problem-Based Learning) in the classroom?	33.3%	66.6%	0%	0%
Does the teacher often encounter obstacles in accessing the digital learning resources needed for implementing PBL?	33.3%	33.3%	33.3%	0%

PBL, teachers tend to guide students more in searching for and evaluating relevant learning resources for their projects. However, there are still obstacles in identifying the most suitable learning resources related to the topics being taught. Some teachers also reported that they face difficulties in providing adequate teaching materials to fully support the implementation of the PBL method in the classroom. Another challenge faced in PBL is the limited access to digital learning resources. Several teachers reported that they often encounter difficulties in accessing the digital resources needed, which can affect the effectiveness of this *Problem-Based Learning* approach.

Table 4. Observation of source teachers and biology learning materials in Deep Learning-based learning.

Questions	Frequency of Alternative Answers			
	TP	KD	SR	SL
The teacher includes sources and learning materials in the Deep Learning biology module.	0%	33.3%	33.3%	33.3%
The teacher utilizes various types of learning resources (such as textbooks, scientific journals, teaching videos, or laboratories) in Deep Learning.	0%	0%	66.6%	33.3%
Does the teacher provide tutorials to access those sources and learning materials	33.3%	33.3%	0%	33.3%
The teacher feels that the available learning resources are diverse enough to meet students' learning needs in the Deep Learning project.	0%	33.3%	33.3%	33.3%

The effectiveness of the available learning resources in helping students achieve learning goals in the Deep Learning project.	0%	33.3%	33.3%	33.3%
The teacher guides students in finding and evaluating relevant learning resources for their Deep Learning projects."	0%	0%	100%	0%
Does the teacher update or adjust learning resources in the Deep Learning module to match the development of scientific knowledge?"	0%	33.3%	66.6%	0%
Does the teacher experience difficulties in identifying learning resources that are suitable for the Deep Learning topics being taught?	66.6%	0%	0%	33.3%
The teacher experiences difficulties in providing adequate learning resources and materials to implement Deep Learning in the classroom."	66.6%	33.3%	0%	0%
The teacher often encounters obstacles in accessing the digital learning resources needed for the implementation of Deep Learning."	66.6%	33.3%	0%	0%

Deep Learning, teachers stated that they strive to include learning resources in the modules they use. However, the main challenge they face is the lack of resources in providing adequate teaching materials for this method. Additionally, some teachers experience difficulties in identifying relevant learning resources related to the topics of *Deep Learning* being taught, thus requiring more references that can be effectively utilized. The majority of teachers using this method also face challenges in accessing the necessary digital learning resources. Although they are making efforts to update teaching materials in accordance with developments in scientific knowledge, the limited access to adequate resources remains a major challenge that must be addressed.

Students

The results of the data analysis from the research conducted with 20 students of class X at SMA N 2 Lubuk Pakam can be seen in the Table 5,6 and 7.

Table 5. Observation of students, source materials, and biology learning resources in PjBL

Questions	Frekuensi Alternatif Jawaban			
	TP	**KD**	**SR**	**SL**
Do you feel that the learning materials used in the implementation of PjBL are relevant to everyday life?	15%	40%	45%	0%
Does the teacher use a variety of learning resources such as books, internet videos, etc., in PjBL?	0%	35%	55%	15%
Do the learning resources used in PjBL help you understand the material more deeply?	0%	45%	30%	25%
How often do you utilize the learning resources provided by the teacher in completing PjBL projects?	5%	35%	50%	10%
Do you find it easier to understand the material if the teacher uses various types of learning resources and materials in PjBL?	0%	25%	45%	30%
Does the learning material provided include real-life examples related to PjBL?	0%	25%	55%	20%
Do you feel more confident in completing PjBL with adequate learning resources and materials?	0%	30%	45%	25%
With the implementation of PjBL, do you discuss more often with friends or groups to understand the learning resources?	0%	20%	25%	55%
Do you experience difficulties in accessing the learning resources needed during the PjBL process?	15%	5%	10%	70%
Is there an improvement in your grades when using the learning resources and materials in PjBL?	0%	65%	30%	5%

Table 6. Observation of students regarding biological learning resources and materials in PBL education

Questions	Frequency of Alternative Answers			
	TP	**KD**	**SR**	**SL**
Do you feel that the learning materials used in the implementation of PBL are relevant to everyday life?	5%	20%	70%	5%

Does the teacher use a variety of learning resources such as books, internet videos, etc., in PBL?	5%	35%	50%	10%
Do the learning resources used in PBL help you understand the material more deeply?	0%	45%	50%	5%
How often do you utilize the learning resources provided by the teacher in completing PBL projects?	10%	25%	50%	15%
Do you find it easier to understand the material if the teacher uses various types of learning resources and materials in PBL?	0%	45%	20%	35%
Does the provided learning material include real-life examples related to PBL?	0%	35%	50%	10%
Do you feel more confident in completing PBL with adequate learning resources and materials?	5%	20%	65%	10%
With the implementation of PBL, do you discuss more often with friends or groups to understand the learning resources?"	5%	20%	50%	25%
Do you experience difficulties in accessing the learning resources needed during the PBL process?	15%	80%	0%	5%
Is there an improvement in your grades when using the learning resources and materials in PBL	0%	75%	25%	5%

Table 7. Observation of students, source materials, and biology learning resources in Deep Learning-based learning.

Questions	Frequency of Alternative Answers			
	TP	KD	SR	SL
Do you feel that the teaching materials used in the implementation of Deep Learning are relevant to everyday life?	0%	40%	55%	10%
Does the teacher use a variety of learning resources such as books, internet videos, etc., in Deep Learning?	0%	35%	45%	20%
Do the learning resources used in Deep Learning help you understand the material more deeply?	0%	35%	45%	20%
How often do you utilize the learning resources provided by the teacher to complete Deep Learning projects?	0%	25%	65%	10%
Do you find it easier to understand the material if the teacher uses various types of resources and learning materials in Deep Learning?	0%	30%	35%	35%
Does the teaching material provided include real-life examples related to Deep Learning?	0%	55%	25%	20%
Do you feel more confident in completing Deep Learning tasks with the availability of adequate resources and learning materials?	5%	35%	55%	5%
Has Deep Learning made you discuss more often with friends or groups in understanding learning resources?	0%	40%	40%	20%
Have you encountered difficulties in accessing the necessary learning resources during the Deep Learning process?	15%	65%	20%	0%
Is there an improvement in your grades when using resources and learning materials in Deep Learning education?	0%	50%	45%	5%

In terms of the relevance of the teaching materials to everyday life, 70% of students feel that the materials used in PBL are often relevant to their lives, while 20% of students only sometimes feel this relevance. In addition, 5% of students always feel that the teaching materials are very suitable for their real lives, and 5% of students never feel this connection. This result shows that although the majority of students believe that PBL materials can be applied in their lives, there are still some students who do not perceive the relevance to the fullest.

Regarding the diversity of learning resources used by teachers, 50% of students state that teachers often use various learning resources such as books, videos, and the internet. Meanwhile, 30% of students feel that the variety of learning resources occurs only occasionally, and 10% of students always experience this diversity. However, another 10% of students feel that the learning resources are less varied. This indicates that although most students feel they have received a sufficient variety of learning resources, there is still a need to enhance the diversification of teaching materials to make them more engaging and effective.

In terms of utilizing learning resources to understand the material more deeply, 50% of students feel that resources often help them understand the material, while 45% of students state that they sometimes feel assisted. A total of 5% of students think that learning resources always have a positive impact on their understanding.

This data shows that most students feel supported by the learning resources in the PBL method, but there are still a small number of students who have not fully benefited from the available teaching materials.

Regarding the frequency of using learning resources, 50% of students report that they often utilize the resources provided by the teacher, while 25% of students only use them occasionally. As many as 15% of students always use these resources, whereas 10% of students never take advantage of them. This indicates that although a majority of students are active in using learning resources, there is still a portion that does not utilize them optimally, which could be due to limited access or a lack of motivation to learn independently.

In terms of ease of understanding the material with various types of learning resources, 45% of students state that they often find it easier to understand the material when teachers use a variety of sources and teaching materials. Meanwhile, 20% of students always feel this benefit, while 35% of students only sometimes experience it. This indicates that variation in the method of delivering the material plays an important role in enhancing students' understanding, and there is still a need to enrich the learning resources to better align with different learning styles.

Regarding the suitability of teaching materials with real-life examples, 50% of students report that the teaching materials often include relevant real-life examples, while 35% of students state that the materials only sometimes provide real-life examples. As many as 10% of students always feel that real-life examples are used in the lessons, indicating a need to further enhance the application of real-life examples in PBL to help students better understand the concepts being taught.

In terms of students' confidence in completing PBL-based learning, the majority, 60%, state that they often feel more confident in their studies with adequate learning resources and materials. 20% of students only sometimes feel confident, while 10% of students always feel confident in completing their assignments, and 5% of students never feel confident. From this data, it can be concluded that although most students have fairly high confidence levels in PBL, there are still a small number of students who require additional support to boost their confidence.

Although most students have a fairly high level of confidence in the PBL method, there are still a small number of students who require additional support to enhance their confidence.

In terms of the frequency of discussions with peers or groups to understand learning resources, 50% of students often discuss with their friends, while 25% of students do so only occasionally. A total of 5% of students are always active in group discussions, while 25% of students never engage in discussions. These findings indicate that although group discussions occur quite frequently in PBL learning, there are still some students who are less active in discussions, which may be due to a lack of engagement in group work or a preference for independent learning.

One of the main challenges in PBL learning is the difficulty in accessing learning resources, where 68% of students report that they often experience barriers in accessing the necessary learning resources. Meanwhile, 15% of students only occasionally face difficulties, and 5% of students always encounter obstacles in accessing learning resources. This data emphasizes that access issues regarding learning resources remain a significant challenge in implementing the PBL method, requiring further attention to ensure that all students have equitable access to the teaching materials.

Lastly, regarding the aspect of improved grades after using learning resources, 25% of students state that they often experience an increase in their grades, while 5% of students always see grade improvements. However, 5% of students report that they do not experience any increase in their grades at all. This data indicates that while most students perceive benefits from the learning resources used, the impact on academic improvement varies, likely influenced by factors such as how students utilize the learning resources, the difficulty level of the material, and individual motivation in learning independently.

Observation of learning resources and materials is a crucial step in PjBL, PBL and *Deep Learning*. This is because observation helps students to connect with the real world, develop 21st century skills, facilitate meaningful learning and enrich learning resources. In the context of PjBL and PBL, observation allows students to identify real problems that are relevant to their lives. As stated in the journals, diverse and relevant learning resources can improve the effectiveness and efficiency of learning. By observing the surrounding environment, students can find the context of authentic problems and trigger curiosity. This process exercises critical thinking, analysis and problem-solving skills, which are at the core of both learning approaches. Students learn to gather, evaluate and use information effectively and work collaboratively in teams. Meanwhile, in Deep Learning, observation plays an important role in building deep understanding. By observing various sources of information, students can broaden their horizons and build connections between concepts. Observation also helps students develop metacognitive skills, which is the ability to learn how to learn. They learn to identify effective learning resources, organise information and monitor their learning progress. Observation reports, as

found in some references, can be a valuable source of information to understand certain phenomena and enrich students' understanding.

Overall, observation of learning resources and materials is not just about gathering information, but also about building meaningful understanding and developing skills relevant to real life. Thus, observation becomes an important component in creating effective and deep learning experiences in PjBL, PBL and *Deep Learning*. PjBL is an innovative approach to teaching. In this method, the teacher acts as a facilitator who helps students understand the theory, answers questions that arise, and provides motivation so that students are more active in learning (Ibnu, 2014). According to Yahya Muhammad Mukhlis, this method allows educators to fully control the course of the learning process, by integrating project work as part of learning activities. The PjBL method is often categorised as a problem-based learning approach, which aims to help students understand and absorb material more effectively. This model emphasises contextual learning, where students are encouraged to develop critical thinking skills in solving problems. Thus, students are able to analyse various alternatives and make the best decision in solving the given problem.

PBL is a learning approach that starts with facing a problem, where learners need to gain new understanding to solve it. The application of this learning model aims to support the effectiveness of the teaching and learning process. The success of learning in the classroom can be seen from how the learning process takes place and develops. PBL is not only part of the curriculum, but also a learning method designed by presenting various problems that encourage learners to gain important knowledge, improve their problem-solving skills, develop independent learning styles, and train teamwork skills. In its implementation, this approach uses systematic methods to solve problems or face challenges that are relevant to everyday life. The problem-based learning model involves providing stimulus in the form of problems that are then solved by students, so as to improve their skills in understanding and mastering the subject matter. The *Problem-Based Learning* approach focuses more on learning based on problems in the surrounding environment, so that learners are used to analysing and finding solutions to the challenges they face (Ibnu, 2014).

Deep Learning (DL) is one of the techniques in *Machine Learning* (ML) based on artificial neural networks. In recent years, this method has been widely applied in various fields as one of the approaches in artificial intelligence-based data processing. Some studies show that DL is not only limited to one particular sector, but has developed into a learning technique that can be applied in various types of problems in various scientific fields.

CONCLUSION

Based on the results of the study analyzing resources and learning materials for Biology in *Project-Based Learning* (PjBL), *Problem-Based Learning* (PBL), and *Deep Learning* at SMA Negeri 2 Lubuk Pakam, it can be concluded that the utilization of resources and learning materials by both teachers and students has great potential in enhancing the understanding of Biology concepts, but still faces several challenges.

Based on observations of teachers, they have made efforts to provide varied learning resources, such as textbooks, scientific journals, educational videos, and laboratories, but still encounter difficulties in accessing and updating teaching materials in accordance with developments in scientific knowledge. Meanwhile, based on observations of students, they feel that the learning materials used in these three teaching methods are relevant to everyday life and help them understand the material more deeply. However, some obstacles are still found, such as difficulties in accessing digital learning resources and a lack of variation in teaching methods.

Additionally, project-based and problem-based learning has encouraged students to engage more actively in discussions and work collaboratively, although there are still some students who are less optimally involved. Therefore, it is necessary to improve the provision and accessibility of learning resources, train teachers to develop more innovative teaching materials, and enhance infrastructure support to maximally implement PjBL, PBL, and *Deep Learning* in Biology education.

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