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The Effect of Implementing Problem Based Learning (PBL) Learning Model Assisted by Interactive Media on Improving Problem Solving Skills and Self Efficacy of Learners

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Abstract: Their self-efficacy or self-confidence, is related to active involvement in solving problems. This belief encourages students to be actively involved in learning and overcoming academic challenges. The solution offered is the application of the Problem Based Learning (PBL) learning model assisted by interactive website-based media. This interactive model and media allow students to be actively involved in learning, to improve their problem-solving skills and strengthen their self-efficacy. The purpose of this study was to analyze the application of the Problem Based Learning (PBL) model assisted by interactive media on improving problem-solving skills and self-efficacy of students. This research method uses a quantitative R&D approach. The population in this study was 143 students, with a sample of 72 students in class XI of SMAN 4 Banda Aceh. Data collection in this study used several techniques, namely the test technique (Problem Solving Skills essay questions) and non-test techniques (Self-Efficacy questionnaire). Based on the research results, it is known that there is an influence of the application of the PBL model assisted by interactive media on improving students' problem-solving skills on the reproductive system material at SMAN 4 Banda Aceh and there is a positive relationship between self-efficacy and students' problem-solving skills through the application of the PBL model assisted by media on the reproductive system material at SMAN 4 Banda Aceh.

Keyword : Interactive media website; Problem solving skills; Self efficacy

Introduction

Biology develops along with technology towards the Industrial Revolution 4.0 Era (Haseeb et al., 2019). Education 4.0 integrates technology in learning. The purpose of learning is to improve students' skills, including critical thinking, communication, collaboration, creativity, innovation, and problem-solving skills (Bao et al., 2018). Problem-solving skills are important for students because they involve the use of knowledge, skills, and experience to solve problems (Thi Thanh Hoi et al., 2018). The Independent Curriculum in Indonesia utilizes technology in learning to meet the needs of students. One of the competencies studied in phase F in high school is the human reproductive system, covering various materials such as reproductive organs, hormones, cell formation processes, fertilization, pregnancy, childbirth, and reproductive disorders (Deng et al., 2024; Mancini & Pensabene, 2019). Teachers in Aceh face the challenge of teaching the reproductive system because students tend to be embarrassed or uncomfortable discussing it because it is considered

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taboo by society. This makes it difficult for students to understand complex biological material and terms.

The learning outcomes of students' reproductive system material at SMAN 4 Banda Aceh over the past 3 years have shown a low pass rate, only 45%. Factors such as students' lack of confidence and readiness in learning, as well as teachers' inability to choose appropriate learning models and media usage also have an impact on low learning outcomes. Educators in several regions are trying to strengthen students' competencies in facing learning challenges by focusing on problem-solving skills and self-efficacy (Mancini & Pensabene, 2019); (Chytrý et al., 2020; Hu et al., 2022). Studies show that problem-solving skills have a positive relationship with learning achievement, especially in mathematics (Beyazsacli, 2016); Yeh et al., 2019). The application of the Problem Based Learning (PBL) learning model is expected to improve students' problem-solving skills. This model allows students to be actively involved in learning and develop independent thinking skills (Saragih & Sitompul, 2021).

The suitability between the learning model and learning media is important for learning effectiveness. Interactive media, such as websites, are a relevant option because they create a dynamic learning environment by combining various elements such as text, games, animation, audio, and video (Schneider et al., 2023). Technology is used to improve students' problem-solving skills through various instructional strategies and the integration of educational tools in learning. Web-based media has the advantage of being flexibly accessible from various devices and operating systems (Kraus et al., 2021). The reproductive system material in biology is often considered challenging because it is abstract and involves processes that are not directly observed. The interaction of specific internal organs also adds to its complexity. The human body and other chemicals (hormones) are difficult to imagine without multimedia that will show how complicated the material is because we cannot see it directly with our eyes, innovative teaching approaches and methods are needed to help students understand the material (Serdyukov, 2017).

Previous studies have shown that the use of PBL methods with technology media can significantly improve students' learning achievement and problem-solving skills (Aslan, 2021). Recent research has shown that interactive media and student engagement have an effect on academic achievement. However, the relationship between student engagement and academic achievement is not directly significant, requiring further research. The integration of interactive media with creative teaching models supports innovative learning experiences (Assefa et al., 2023). Students' self-efficacy is related to their involvement in learning, with critical thinking mediating the relationship between self-efficacy and problem-solving skills (Tasgin & Dilek, 2023). Based on initial observations and case studies of several previous studies, researchers are interested in conducting further research on the effect of implementing the Problem Based Learning (PBL) model assisted by interactive media on improving problem-solving skills and self-efficacy of students in the human reproductive system material at SMAN 4 Banda Aceh. The purpose of this study is to analyze the implementation of the Problem Based Learning (PBL) model assisted by interactive media on improving problem-solving skills and self-efficacy of students.

Method

This study uses the R&D method with a quantitative approach. This type of research is an evaluation researchs. This evaluation research is focused on measuring the effect of the application of the Problem Based Learning (PBL) model assisted by interactive media on problem-solving skills and self-efficacy of students. The research was conducted at SMA Negeri 4 Banda Aceh located at Jl. Panglima Nyak Makam, Kota Baru, Kec. Kuta Alam, Banda Aceh City. This research will be conducted in April 2024 in the even semester of the 2023/2024 academic year. The selection of SMA Negeri 4 Banda Aceh as the research location is because from the survey results, SMA Negeri 4 Banda Aceh is included in the Excellent School so that the application of the PBL learning model assisted by Interactive Media is possible to be applied.

The population in this study were all students in grade XI who studied biology at SMA Negeri 4 Banda Aceh divided into 4 classes. The population in this study was 143 students. Sampling from the population above was carried out using the purposive sampling technique. Purposive sampling is sampling using certain considerations. In this study, sampling was taken by considering the abilities of students in each class which were relatively the same, the research sample to be carried out was 2 classes including students of class XI Health-Agriculture 2 totaling 36 students and XI Health-Agriculture 3 totaling 36 students. Data collection in this study used several techniques, namely test techniques (Problem Solving Skills essay questions) and non-test techniques (Self-Efficacy questionnaires).

Data analysis techniques to test students' problem-solving skills involve collecting individual scores from the initial test and final test, which are then calculated as the N-gain value to measure skill improvement. The N-gain value is then used for statistical analysis using the t-test. Normality and homogeneity tests were carried out

beforehand to ensure that the data meets statistical requirements.Data analysis to measure self-efficacy strengthening in the experimental class, a self-efficacy questionnaire was used. The answers to the questionnaire were converted into a Likert scale. Furthermore, the average score of student self-efficacy was calculated using a certain formula. The results are then interpreted using certain criteria to determine the level of self-efficacy of students. Thus, the evaluation of self-efficacy strengthening is carried out through the analysis of the average score obtained from the self-efficacy questionnaire.

Furthermore, the relationship between problem-solving skills and self-efficacy is evaluated using the product moment correlation technique. Ordinal data on the questionnaire is transformed using the MSI transformation method. The transformation steps involve calculating the proportion of answers, then converting them to an interval scale and then analyzing the relationship using the product moment correlation technique. The results are categorized based on certain criteria to determine the level of correlation between the two variables.

Result and Discussion

Problem Solving Skills

The problem solving skills instrument, namely descriptive questions on the human reproductive system material, has been tested for validity by 3 expert validators, then has been empirically validated and tested for reliability with a reliability score of 0.90 indicating a very high category reliability. The results of the study can be seen from the problem solving skills scores of students in the control and experimental classes which have been presented in Figure 1.

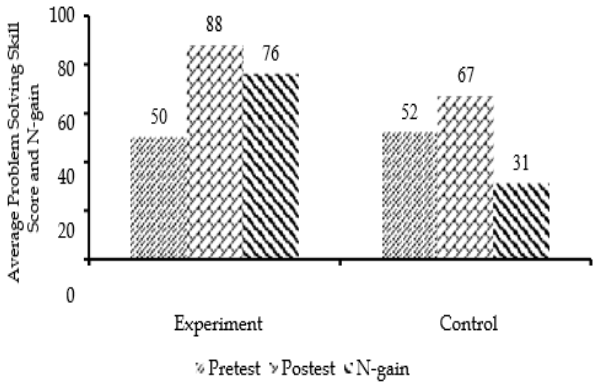

Figure 1. Average Score of Problem Solving Skills and N-gain of Students

The problem solving skills score after being given treatment with the application of the PBL learning model assisted by interactive website media in the experimental class, then a comparison of the average post-test scores of students' problem solving skills based on each indicator of problem solving skills in both the control and experimental classes can be presented in Figure 2.

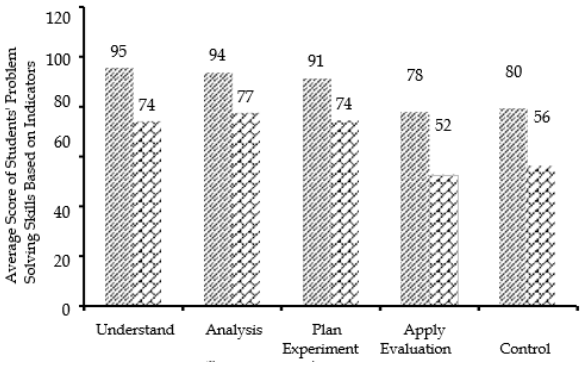

Figure 2. Average Score of Students' Problem Solving Skills for Each Indicator of the Experimental and Control Classes

Normality, homogeneity, and t-test tests were conducted to test the hypothesis of the effect of implementing the Problem Based Learning (PBL) model assisted by interactive media on improving students' problem-solving skills in the reproductive system material at SMAN 4 Banda Aceh and the data is presented in Table 1.

Table 1. Data Analysis of Problem Solving Skills

Class	N-gain score	Normality Test	Homogeneity Test	t-test
		Shapiro Wilk		Sig
Experiment	76	0.63*	0.10**	0.00***
Control	31	0.37*		

Note: Shapiro Wilk, sig > 0.05*, Levene, sig > 0.05**, Independent sample t-test, sig < 0.05***.

Self-Efficacy

The results of the study on the self-efficacy category after treatment was carried out in the experimental class showed that the average self-efficacy score of students was 87, indicating a moderate self-efficacy category. Students are divided into several self-efficacy categories based on the percentage frequency of each category. Data on the frequency of students based on the category of student self-efficacy (attachment 15) is presented in the graph in Figure 3.

Figure 3 explains that after learning was carried out by implementing the PBL model assisted by interactive media, it can be seen that 8% of students have very high self-efficacy categories, 31% of students have high self-

efficacy categories, 25% of students have moderate self-efficacy categories and 36% of students still have low self-efficacy categories. While the average self-efficacy score for each indicator is presented in Figure 4.

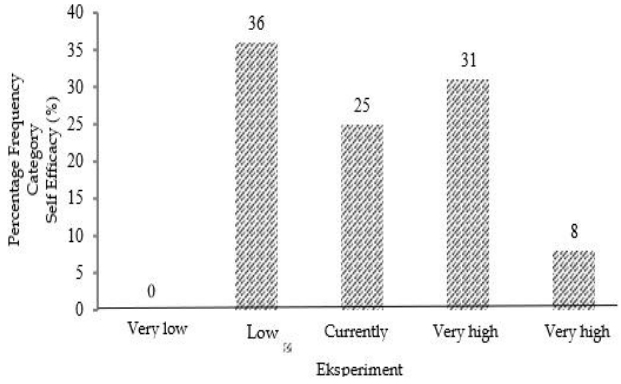

Figure 3. Percentage Frequency of Student Self-Efficacy Categories

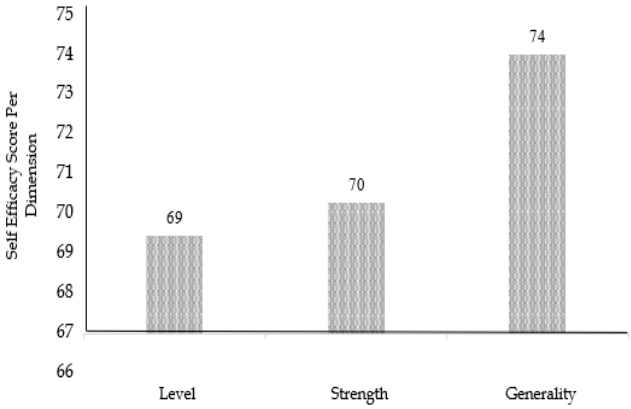

Figure 4. Average Score of Students' Self Efficacy per Dimension

Relationship Between Self Efficacy and Improvement of Problems Solving Skills

The results of statistical tests with Pearson Product Moment correlation analysis to see whether there is a relationship between students' selfs efficacy and improvement of students' problems solving skills are carried out through the SPSS program presented in Table 2.

Table 2. Statistical Test of Correlation of Self Efficacy and Improvement of KPM

Correlation Test			Regression
Pearson Correlation	Significance	R	R square
0.875	0.000	0.87	0.76

Table 2 shows the results of the statistical test of the correlation between students' self-efficacy and the improvement of problem-solving skills has a strong relationship, known from the Sig. < α (0.05) value. The Pearson correlation of 0.87 means that the correlation is at a strong correlation level with an R Square value of 0.76, meaning that self-efficacy has an effect on the problem-solving skill variable of 76.50%. The correlation and regression graphs between students' self-efficacy and the improvement of students' problem-solving skills are presented in Figure 5.

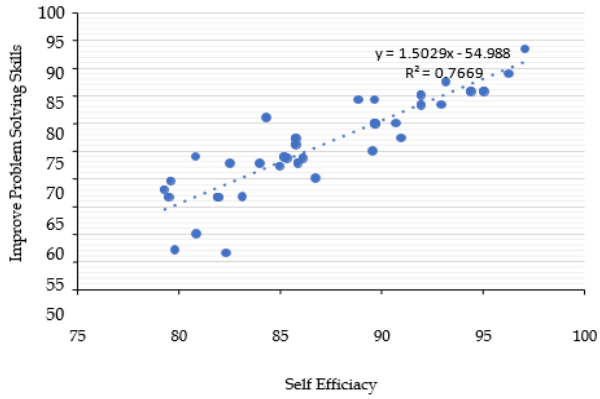

Figure 5. Correlation and Regression between Self Efficacy and Students' Problems Solving Skills

Figure 5 shows that students' selfefficacy and improvement in problem solving skills have a strong and positive linear relationship.

Discussion

Problem Solving Skills

This shows that the application of the Problem Based Learning (PBL) model assisted by interactive media has a significant effect on improving students' problem-solving skills in the reproductive system material at SMAN 4 Banda Aceh. The Problem-Based Learning (PBL) model has been proven to be effective in improving problem-solving skills. The PBL model trains students to identify and find the factors that cause problems, so that effective solutions can be found and can support students in developing critical thinking skills and problem-solving skills (Yuberti et al., 2019). Students in the experimental class have the opportunity to learn by applying the PBL learning model and assisted by interactive media in the reproductive system material. LKPD and interactive website media that have been specially designed with the aim of training problem-solving skills that are adjusted to Goldilock's help problem-solving skills.

The Goldilock's workflow and interactive website media have helped students to focus more on problems

and problem-solving steps during learning. The application of PBL trains problem-solving and problem-solving skills including planning, preparation, implementation, and evaluation (Vartiainen et al., 2019). Problem solving is often a challenge for students because of difficulties in the problem-solving and reasoning process (Supriadi et al., 2024). The interactive media about the reproductive system used in this study is one source of information that greatly helps the Goldilock's workflow. Interactive media depicts problem situations in the form of animations and real scenarios with attractive and informative visual displays. The website also provides exercises in the form of interesting games and puzzles so that it can increase students' enthusiasm and interest in solving problems.

Playing well-designed games, such as puzzles, strategies, and simulations, significantly improves problem-solving skills. This game requires players to think critically, plan, and adjust strategies according to increasingly complex and dynamic challenges. Continuous interaction between players and challenges in the game strengthen analytical skills, creativity, and mental endurance interactive media used contains information related to human reproductive material problems (Hefkaluk et al., 2024). This website is easily accessible via smartphones, both Android and iOS (iPhone Operating System) which are familiar to students, also helps them to understand more quickly how to use the website as a learning medium. The website contains various types of information at once, including animated problem videos, articles, and knowledge videos from YouTube, all of which are integrated into one website and can be easily accessed by students.

This also helps them to focus more on following the Goldilock's help flow of problem-solving skills, especially understanding, analyzing, and deconstructing knowledge as a basis for solving problems. The average posttest score on the three indicators of students' problem-solving skills learned by implementing the PBL model assisted by interactive web media, namely the indicators of understanding, analyzing, and planning in the experimental class, is included in the very good category. While the other two indicators, namely implementing and evaluating solutions, are in the sufficient category. In contrast, in the control class, three indicators, namely the indicators of understanding, analyzing, and planning, were in the sufficient category, while the other two indicators, namely implementing and evaluating, were in the insufficient category. This is in line with research conducted by Astuti et al. (2020), which stated that most students preferred science learning after using an educational website with interactive content containing games as teaching materials. PBL provides challenges that encourage students to think critically and creatively, so that all types of learners can develop their ability to solve problems effectively (Samani et al., 2019).

Three indicators of problem-solving skills in the experimental class after being given treatment have a very good category, namely indicators of understanding problems, analyzing problems, and planning solutions. In understanding problems, students are very good at defining and deconstructing various terms and principles that are relevant to the problem. They are trained to be skilled in finding information with various sources that are already available on interactive websites, making them very good at understanding problems, thereby improving problem-understanding skills. Students during learning are also trained to improve their problem-analyzing skills so that the problem-solving skill category of the indicator is classified as a very good category. Students at the problem-analyzing stage are trained to be skilled in determining what problems occur, then can determine what needs to be understood further and gather information for the problem.

Self-Efficacy

Self-Efficacy of students in the experimental class after being taught with the application of the PBL learning model assisted by interactive website media, it can be seen that the average score of the student's self-efficacy level category is included in the moderate category. Students who have had positive experiences in solving complex reproductive system problem-solving problems tend to be more persistent in trying various strategies to find solutions. This can increase their self-confidence and belief in their abilities even when facing various forms of different tasks and problems. When students succeed in solving challenging problems, their self-confidence in solving subsequent problems also increases. Thus, strengthening students' self-efficacy, especially in the Generality aspect. This is supported by the opinion of Reynolds & Yu (2021) that self-efficacy comes from four main sources, namely mastery experience, vicarious experience, social persuasion, and somatic response.

Mastery experience is the result of a person's previous experience that allows students to apply the knowledge they have learned effectively, then according to Yeh et al. (2019) mastery experience is the strongest source of self-efficacy. Other sources of self-efficacy, namely social persuasion and vicarious experience, also support strengthening self-efficacy. Students who see friends or actively discuss so that they succeed in using certain strategies will be more likely to adopt the same strategy if they feel confident they can do it (Darling-

Hammond et al., 2020). The learning experience using PBL students are accustomed to learning in groups but can access knowledge sources on the website independently while following the entire flow of problem solving in Goldilock's help available in each group's LKPD, both in the form of questions and statements. The teacher facilitates them by answering questions related to questions and statements that they do not understand and directing how to use the website when they experience certain obstacles. Most students do not hesitate to discuss with teachers or with group members so that they can answer confidently and confidently to answer the questions provided, both simple questions and difficult questions. These things lead to the formation of self-efficacy reinforcement in the Level and Strength aspects.

Other students, however, are still not good at communicating and discussing. Some of these students still feel anxious and only focus on completing the part of the answer that is given to them. These students rush to complete the LKPD and discuss very little and appear to be in a state of stress. This causes the information received by students from each other in completing the Goldilocks help stages in the group not to be conveyed and will interfere with the problem-solving process until the end. Groups with these conditions can usually still solve problems by providing solutions, but the solutions provided are less comprehensive than other groups. This also shows the source of somatic response efficacy which is basically the mood of students in carrying out and completing tasks. Students who work on assignments while experiencing stress and anxiety can result in incompetence and low performance (Di Mario et al., 2024). According to Bandura, self-efficacy beliefs broadly influence individuals in achieving their goals, the amount of effort they put into tasks, and their persistence in the face of difficulties and stress (Fortgang & Cannon, 2022). It has been observed that a person who feels doubtful is more likely to experience anxiety, confusion, negative thoughts, and negative physical tension that affect their behavior (Anderson et al., 2019).

A person who faces challenges, these negative emotions can experience disruption in cognitive function and effective decision-making (Hong et al., 2023). Students' stress and anxiety can be reduced by researchers providing support to students and helping them direct them to stay on the Goldilock's help path and use resources from the website during the learning process. During the use of the website, students are also given positive support after passing the challenges in the puzzle game session in the form of support text. After they have successfully answered all the questions, the teacher also gives a short appreciation to increase their confidence for the presentation and discussion stage. After the presentation and discussion, the teacher reinforces the information and corrects some mistakes but still provides sufficient positive feedback to them. This will also affect the students' self-confidence better. Students who receive positive feedback (such as praise or encouragement) about their performance, influence their own beliefs, so they experience lower cognitive load (Lipnevich & Panadero, 2021; Singh et al., 2022).

Verbal feedback and instructions can come from other people, texts, or self-instructions (Agricola et al., 2020). The problem-solving skills of students who are taught by implementing the PBL learning model assisted by interactive web media in the experimental class and the PBL learning model alone in the control class have relatively the same average pre-test scores, which are included in the category of moderate problem-solving skills. After being given different treatments in the experimental and control classes, students in the experimental class have an average post-test score in the very capable category, while the average in the control class who are taught by implementing the PBL model alone has a post-test score in the capable category.

Relationship of Self-Efficacy with Students' Problem-Solving Skills

Self-efficacy and problem-solving skills are closely related, and understanding this relationship can help students improve their problem-solving skills and overcome various challenges. The relationship between self-efficacy and the improvement of students' problem-solving skills who are taught using the PBL model assisted by interactive website media on the reproductive system material is analyzed using the Pearson product moment correlation test. The results of the correlation test presented in table 3 explain that self-efficacy has a strong relationship with the improvement of students' problem-solving skills. Based on the correlation and regression graphs in figure 5, it can be seen that the relationship between the two is included in the strong and linear category, namely the stronger the self-efficacy, the higher the improvement in students' problem-solving skills.

This study is supported by previous studies that found that self-efficacy is positively and significantly related to problem-solving skills. This shows that students who have higher confidence in their abilities tend to have better problem-solving skills (Hidayati et al., 2019). Self-efficacy refers to a person's belief in their ability to succeed in various tasks and situations. Students with high levels of self-efficacy show confidence that they are able to solve problems and overcome the challenges they face. Self-efficacy increases students' motivation to solve problem-solving

skills questions and try hard to find solutions. Students with high self-efficacy are more motivated to solve problems even though the questions given are difficult even when facing failure in the early stages of the experiment.

In line with previous research which states that self-efficacy has a significant correlation with various aspects of learning and motivation. Higher self-efficacy for motivational regulation is associated with higher academic grades and greater positive affect, suggesting that self-efficacy in motivational regulation is an important precursor to student effort and academic achievement (Trautner & Schwinger, 2020). Beliefs in one's abilities influence the types of problem-solving strategies used. Students with high self-efficacy use effective problem-solving strategies, such as systematic problem analysis, trying to plan with various solutions, and evaluating results. This is supported by the opinion of Hayat et al. (2020), who stated that self-efficacy influences the use of effective learning strategies. Individuals with high self-efficacy tend to be more active in self-regulation, such as setting goals and using effective learning strategies, which in turn improves their learning.

In contrast, students with low self-efficacy tend to use less effective strategies or avoid problems altogether. Self-efficacy also plays a role in how a person manages the stress associated with problem solving. In the classroom, students with high self-efficacy feel more confident in dealing with the pressure and stress that arise during the problem-solving process. They are better at managing their emotions and staying focused on solutions. Individuals with high self-efficacy are more likely to persist longer and be more persistent in the face of adversity, because they believe in their ability to overcome the challenge (Caliendo et al., 2020). Self-efficacy influences the choice of tasks that students choose. In the classroom, students with high self-efficacy are more likely to choose tasks that are challenging and require complex problem solving, because they believe in their ability to succeed. In contrast, those with low self-efficacy tend to avoid tasks that are perceived as difficult or complex. Higher self-efficacy is also associated with greater effort in the face of challenges.

Belief that one is capable of managing one's motivation helps overcome motivational challenges and increases effort (Bandhu et al., 2024). Belief in one's abilities helps overcome motivational challenges and increases effort. With high self-efficacy, individuals can overcome motivational barriers and stay focused on their goals, even when faced with difficulties (Khan et al., 2023). Self-efficacy also influences how a person responds to feedback and makes adjustments in problem-solving strategies. In the classroom, students with high self-efficacy are more open to receiving constructive feedback and making necessary adjustments to improve their effectiveness. They view feedback as an opportunity to learn and grow, rather than as an indication of failure. Positive performance feedback, such as praise for success, provides information that confirms that individuals are on the right track, which in turn increases their self-efficacy. People with high self-efficacy are more likely to accept and use feedback, both positive and negative, to improve their performance and continue to grow (Lu & Xie, 2024). Self-efficacy plays an important role in problem-solving skills because it influences how students view their abilities, manage challenges, and choose strategies to solve problems. Increasing self-efficacy can improve problem-solving skills and help students be more effective in dealing with challenges.

Conclusion

The application of the Problem Based Learning (PBL) model assisted by interactive media can improve problem-solving skills and self-efficacy of students. There is a positive relationship between self-efficacy and problem-solving skills of students in the reproductive system material at SMAN 4 Banda Aceh.

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Author Contributions
Conceptualization; T. Z.; methodology.; H. R. S. S.; validation; T. Z.; formal analysis; H. R. S. S.; investigation.; T. Z.; resources; H. R. S. S.; data curation: T. Z.; writing—original draft preparation. R. D. S.; writing—review and editing: H. R. S. S.; visualization: T. Z. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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