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Effect of the Wordwall-Assisted Problem-Based Learning Model on Motivation and Learning Outcomes Regarding Heredity and Biotechnology

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Abstract: The lack of use of interactive learning media makes students tend to be passive during learning activities. This study aims to determine the effect of the Problem-Based Learning (PBL) model, assisted by Wordwall media, on student motivation and learning outcomes in the inheritance and biotechnology material at UPT SMP Negeri 17 Medan, and to determine the relationship between learning motivation and student learning outcomes. This study used a quasi-experimental design with a pretest-posttest control group. The study population was all ninth-grade students of UPT SMP Negeri 17 Medan, which consists of 10 classes. The study sample comprised 60 students, with class IX-5 as the experimental class and IX-6 as the control class, selected through purposive sampling. Data analysis was carried out using SPSS version 26, including normality and homogeneity tests, independent-samples t-tests, and Pearson correlation tests, at a significance level of 0.05. The results of the study indicate a significant effect of the Problem-Based Learning model, assisted by Wordwall media, on students' motivation to learn, with a significance value of 0.000 < 0.05. The average post-test score for student learning motivation in the experimental class was 81.33, higher than the 72.69 in the control class. The results also indicate a significant effect on student learning outcomes, with a significance value of 0.000 < 0.05. The average post-test score for student learning outcomes in the experimental class was 81.67, while the score for the control class was 73.33. Furthermore, there was a significant positive relationship between learning motivation and student learning outcomes, with a Pearson correlation value of 0.782 and a significance value of 0.000 < 0.05. Therefore, the Problem-Based Learning model, supported by Wordwall media, can be used as an alternative learning method to improve student motivation and learning outcomes in the topics of inheritance and biotechnology.

Keywords: Inheritance and Biotechnology; Learning Motivation; Learning Outcomes; Problem-Based Learning; Wordwall.

Introduction

Education plays a crucial role in improving the quality of human resources in the 21st century. 21st-century learning emphasizes not only conceptual mastery but also requires students to develop critical, creative, communicative, and collaborative thinking skills, as well as the ability to solve problems in everyday life. Therefore, the learning process in schools needs to be innovatively designed to create active, interactive, and student-centered learning [1]. Effective learning must also enhance student motivation and learning outcomes by using learning models and media appropriate to the material's characteristics and students' needs [2].

Natural Science (IPA) is a subject that plays a crucial role in developing students' thinking skills through scientific activities and problem-solving. Science learning emphasizes not only theoretical mastery but also the process of discovering concepts through direct learning experiences. However, the reality of science learning in schools still faces various challenges, particularly low student motivation and learning outcomes. Low student learning outcomes can be influenced by a lack of student engagement during the learning process and the use of unappealing learning media [3].

Based on observations and interviews conducted at the UPT of SMP Negeri 17 Medan, students tended to be passive during the learning process. They were less engaged in discussions and still had difficulty understanding science material, particularly on inheritance and biotechnology. Furthermore, the use of conventional learning media made learning less engaging and led to low student motivation. This low motivation to learn was evident in students' lack of enthusiasm for learning and in learning outcomes that remained below the KKTP (Grade Point Average) of ≤ 75.

Learning motivation is a crucial factor influencing student success in the learning process. Learning motivation is the driving force within students that stimulates learning activities, ensures their continuity, and provides direction to achieve learning goals [4]. Similarly, [5] states that learning motivation is an internal and external drive that drives someone to engage in learning activities to achieve specific goals. Students with high learning motivation tend to be more active and diligent, and achieve better learning outcomes than those with low motivation [6].

In addition to learning motivation, the use of appropriate learning models also significantly impacts student learning outcomes. One such learning model is Problem-Based Learning (PBL). PBL is a student-centered learning model that presents contextual problems as the basis for learning. PBL encourages students to think critically, seek solutions, collaborate, and be active in the learning process [7]. This learning model can help students

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understand concepts more meaningfully by directly involving them in the problem-solving process [8].

The application of the Problem-Based Learning model has been proven to improve students' thinking skills and learning outcomes. [9] stated that the application of PBL can improve students' problem-solving abilities and cognitive learning outcomes. Furthermore, research by [10] showed that the PBL model positively influences students' problem-solving abilities in science learning. Research by [11] also found that the PBL model improves students' science learning outcomes.

To make learning more engaging and interactive, the implementation of the PBL model should be supported by digital learning media. One digital learning media option is Wordwall. Wordwall is an educational game-based learning platform that offers interactive activities such as quizzes, puzzles, word searches, and answer-matching games. This medium can be used for evaluation and as a fun learning activity, thereby increasing student participation in the learning process [12].

The use of Wordwall media in learning has been proven to improve student motivation and learning outcomes. Wordwall learning media effectively improve elementary school students' science learning outcomes [13]. The use of Wordwall media can increase students' motivation to learn through digital game-based learning activities [14]. Furthermore, the Wordwall application positively impacts student learning outcomes in science subjects [15].

Another study found that implementing a Problem-Based Learning model using Wordwall can improve junior high school students' motivation to learn [16]. Similarly, implementing a Problem-Based Learning (PBL) model using Wordwall media can increase students' motivation to learn by creating an active and enjoyable learning environment [17]. The use of a PBL model using Wordwall has a significant impact on student learning outcomes [18].

The subject of inheritance and biotechnology is considered difficult by students because it involves abstract concepts and quite complex scientific terms. Students often have difficulty understanding the concept of inheritance, genetic cross-breeding, and the application of biotechnology in everyday life. Therefore, learning innovations are needed to help students understand concepts more easily and more interestingly through interactive learning. The Problem-Based Learning (PBL) model, supported by Wordwall media, was used to assess increases in student motivation and learning outcomes in the subjects of inheritance and biotechnology. Student learning motivation was used to ensure students were actively involved in the learning process through problem-solving activities, group discussions, and interactive digital learning media. In addition, student learning outcomes were used to assess the success of applying the Problem-Based Learning model, assisted by Wordwall media, in improving students' conceptual understanding of inheritance and biotechnology. Based on the description above, this study focuses on analyzing the effect of the Problem-Based Learning model assisted by Wordwall media on student motivation and learning outcomes in the subject of inheritance and biotechnology at the UPT SMP Negeri 17 Medan.

Research Methods

This research was conducted at the Technical Implementation Unit (UPT) of SMP Negeri 17 Medan during the even semester of the 2025/2026 academic year. The study used a quasi-experimental pretest-posttest control group design. The aim of this study was to determine the effect of the Problem-Based Learning (PBL) model using Wordwall media on student motivation and learning outcomes in the topics of inheritance and biotechnology. The research design is shown in Table 1.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experimental	Y1	X1	Y2
Control	Y1	X2	Y2

The population in this study was all ninth-grade students at UPT SMP Negeri 17 Medan, which consists of 10 classes. The sampling technique used was purposive sampling. The study sample consisted of two classes: class IX-5, the experimental class, and class IX-6, the control class, totalling 60 students.

The independent variable in this study was the Problem-Based Learning model assisted by Wordwall media, while the dependent variables consisted of student learning motivation and learning outcomes. Learning motivation was measured using a learning motivation questionnaire, and learning outcomes were measured using a multiple-choice test on inheritance and biotechnology.

The research instruments consisted of a learning motivation questionnaire and a learning outcome test. The learning motivation questionnaire was structured around indicators of learning motivation, including the desire to succeed, the drive and need to learn, hopes and aspirations for the future, appreciation for learning, engagement in learning activities, and a conducive learning environment. The motivation questionnaire used a Likert scale with four response alternatives: strongly agree, agree, disagree, and strongly disagree. The outline of the learning motivation questionnaire is shown in Table 2.

Table 2. Learning Motivation Questionnaire Outline

Indicator	Positive Item	Negatif Item	Total Item
The desire and wish to succeed	1,2,3	4,5	5
The drive and need for learning	6,7,8	9,10	5
Expectations and aspirations for the future	11,12	13,14,15	5
Appreciation for learning	16,17	18,19,20	5
Engaging and interesting learning activities	21,22,23	24,25	
A conducive learning environment	26,27	28,29,30	5
Total	15	15	5

To obtain the percentage of student responses via the questionnaire, you can use the following percentage formula:

$$P = \frac{f}{N} X\ 100\%$$

The learning outcome test consists of multiple-choice questions structured based on learning indicators for the inheritance and biotechnology material in the cognitive domains C4–C6. The outline of the learning outcome test is shown in Table 3.

Table 3. Outline of the Learning Outcome Test

Indicator	C4	C5	C6	Total
Describe Gregor Mendel's experiments (design, findings, and laws of inheritance)	2,4	6		3
Predict the probability of monohybrid and dihybrid cross results, and inheritance patterns	8,9	11		3
Describe the basic concepts of biotechnology	13,15			2
Compare conventional and modern biotechnology	17,18	21	23	4
Explain the benefits of biotechnology in food, health, agriculture, and the environment	25,27,28	30	33	5
Analyze the controversies of modern biotechnology (ethics, safety, environmental impact)	35,36		39	3
Collect information on alternative food ingredients for food health	41			1
Develop simple alternative food products from local materials	42	43,44	45	4
Formulate solutions for the utilization of alternative food products	45,47	48	49,50	5
Total	17	7	6	30

Before being used in the research, the instruments were tested for validity, reliability, difficulty, and discriminatory power. The validity of the motivation questionnaire was assessed using Aiken's V, and that of the learning outcome test using the product-moment correlation. Instrument reliability was tested using Cronbach's Alpha.

The validity of the motivation questionnaire was calculated using Aiken's V formula as follows:

$$V = \frac{\Sigma s}{n(c-1)}$$

Test the validity of the learning outcome test using product-moment correlation as follows:

$$r_{xy} = \frac{N\,\Sigma XY - (\Sigma X)\,(\Sigma Y)}{\sqrt{\{N\,\Sigma X^2 - (\Sigma X)^2\}\{N\,\Sigma Y^2 - (\Sigma Y)^2\}}}$$

To test the reliability of an instrument using the Kuder & Richardson formula (K-R 20):

$$r_{11} = \left(\frac{k}{(k-1)}\right)\left(\frac{S_t^2 - \sum pq}{S_t^2}\right)$$

To determine the level of difficulty of each test item, the following formula can be used:

$$P = \frac{B}{JS}$$

The formula used for the discriminating power of questions is:

$$D = \frac{B_A}{J_A} - \frac{B_B}{J_B}$$

Data collection techniques included pretests and posttests, motivation questionnaires, learning outcome instruments, and documentation throughout the learning process. The pretest was administered before the treatment to assess students' initial abilities, while the posttest was administered after the treatment to evaluate students' motivation and learning outcomes following implementation of the learning model.

Data analysis was conducted using SPSS version 26 with a significance level of 0.05. Prerequisite analysis tests included a normality test using the Shapiro-Wilk test and a homogeneity test using the Levene test. Hypothesis testing was conducted using an Independent Samples t-test to determine the effect of the Problem-Based Learning model, delivered via the Wordwall medium, on student motivation and learning outcomes. Additionally, a Pearson correlation test was conducted to determine the relationship between learning motivation and student learning outcomes. The criteria for hypothesis testing were to reject H_0 and accept H_a if the p-value was < 0.05.

Results and Discussion

This research was conducted during the even semester of class IX at SMP Negeri 17 Medan in the academic year 2025-2026. This research involved two classes, each of which was given different treatments. Class IX-5 was the experimental class, which received treatment using the PBL learning model with Wordwall media, and Class IX-6 was the control class, which received treatment using the Problem-Based Learning learning model. Data on learning motivation and learning outcomes in this study were obtained from learning motivation questionnaires and learning outcome test questions. The learning motivation questionnaire was administered to both sample groups before and after the treatment. The pretest was administered before the learning process in both sample groups, and the posttest was administered after the learning process in both sample groups to assess motivation and learning outcomes for each sample after receiving the treatment.

Before being used in the research, the instrument was tested for validity, reliability, question difficulty, and question discriminatory power. The results of the validity test showed that the learning motivation questionnaire was declared valid by the expert lecturer. In the learning outcome test, 30 questions were valid; the remaining 20 were not used in the research. The reliability test results indicated that the instrument was highly reliable, making it suitable for use as a data collection tool. Based on the results of the difficulty level test, it was obtained that the questions were categorized as easy, medium, and difficult, with a dominance of the medium category. In addition, the results of the discriminatory power test showed that most of the questions were categorized as good and sufficient, so that the research instrument was declared suitable for use in research.

Student Learning Motivation Data Before Treatment

Data on students' learning motivation before treatment were obtained by administering learning motivation questionnaires to the experimental and control classes. The results of the student learning motivation data before treatment are shown in Table 4.

Table 4. Student Learning Motivation Data Before Treatment

Data	Pre-treatment	
	Control Group	Experimental Group
Number of Students	30	30
Minimum Score	54	54
Maximum Score	66	71
Mean	58.87	61.89
Standard Deviation	3.2939	3.8691
Variance	10.85	14.97
Percentage Increase		5.134%

Based on Table 4, the average learning motivation of students in the experimental class before treatment was higher than that in the control class. However, the difference in the average between the two classes remained relatively small, so the initial motivation for learning among students in both classes was nearly the same.

Student Learning Motivation Data After Treatment

Data on students' learning motivation after treatment were obtained by administering a learning motivation questionnaire at the end of the learning process.

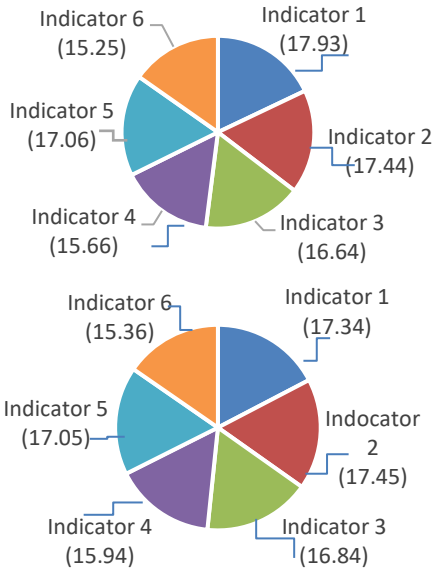
Table 5. Student Learning Motivation Scores After Treatment

Data	Pre-treatment	
	Control Group	Experimental Group
Number of Students	30	30
Minimum Score	55	68
Maximum Score	89	95
Mean	72.69	81.33
Standard Deviation	9.4292	9.7118
Variance	88.91	94.32
Percentage Increase		12.030%

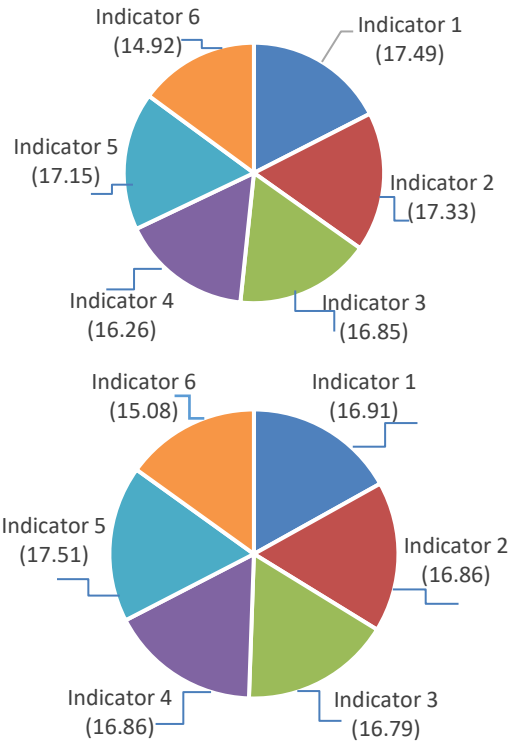
Based on Table 5, the average learning motivation of students in the experimental class was higher than that of the control class after being treated with the Problem-Based Learning model using Wordwall media.

More detailed data regarding the increase in students' learning motivation scores before treatment in the experimental and control classes can be visualized in the form of percentage values in the pie chart below.

Figures 1 and 2 Percentage of Learning Motivation Before and After Treatment Based on Indicators in the Control Class



Figures 1. Percentage of Learning Motivation Before Treatment Based on Indicators in the Experimental and Control Classes



Figures 2. Percentage of Learning Motivation After Treatment Based on Indicators in the Experimental and Control Classes

Student Learning Outcomes Data Before Treatment

Student learning outcomes data prior to treatment were obtained from a pretest administered to the experimental and control classes.

Table 6. Student Learning Outcomes Data Before Treatment

Control Group				Experimental Group			
Score Interval	f	$\bar{x}$	S	Score Interval	f	$\bar{x}$	S
≤ 19	1	36.44	12.25	≤ 19	1	45.44	11.89
20-29	8			20-29	0		
30-39	7			30-39	6		
40-49	9			40-49	8		
50-59	2			50-59	11		
60-69	3			60-69	4		

Student Learning Outcomes Data After Treatment

Student learning outcomes data after treatment were collected via posttests administered in the experimental and control classes.

Table 7. Student Learning Outcomes Data After Treatment

Control Group				Experimental Group			
Score Interval	f	$\bar{x}$	S	Score Interval	f	$\bar{x}$	S
≤ 59	3	73.33	10.36	≤ 69	3	81.67	9.58
60-69	4			70-79	6		
70-79	13			80-89	11		
80-89	8			90-99	8		
90-99	2						

Normality Test

The normality test was conducted using the Shapiro-Wilk test using SPSS version 26. The results of the normality test are shown in Table 8. Based on Table 8, the significance value is > 0.05, so the research data are considered normally distributed.

Table 8. The normality test

Variable	Sig	Distribution
Learning Motivation (Pretest)	0.934	Normal
Learning Motivation (Posttest)	0.950	Notrmal
Learning Outcomes (Posttest)	0.942	Normal
Learning Outcomes (Posttest)	0.936	Nornal

Homogeneity Test

The homogeneity test was conducted using Levene's Test. The results of the homogeneity test are shown in Table 9. Based on Table 9, the significance value is >0.05, thus indicating that the research data are homogeneous.

Table 9. Homogeneity Test Results

Data	Sig.	Description
Learning Motivation (Pretest)	0.842	Homogeneous
Learning Motivation (Posttest)	0.641	Homogeneous
Learning Outcomes (Pretest)	0.865	Homogeneous
Learning Outcomes (Posttest)	0.624	Homogeneous

Learning Motivation Hypothesis Testing

The learning motivation hypothesis was tested using an independent-samples t-test. The test results are shown in Table 10. Based on the test results, a significance value of 0.000 < 0.05 was obtained, so H0 was rejected and Ha was accepted. This indicates that the Problem-Based Learning model, assisted by Wordwall media, has a significant influence on students' motivation to learn.

Table 10. Learning Motivation Hypothesis Test Results

Class	Mean	Std. Devation	t	df	Sig (2-tailed)
Experimental Class	81.43	9.712	3.541	58	0.001
Control Class	72.70	9.389			

Learning Outcome Hypothesis Testing

The learning outcome hypothesis testing was conducted using an independent-samples t-test. The test results are shown in Table 11.

Table 11. Results of the Learning Outcome Hypothesis Test

Class	Mean	Std. Devation	t	df	Sig (2-tailed)
Experimental Class	81.50	9.619	3.224	58	0.002
Control Class	73.17	10.389			

Based on the test results, a p-value of 0.000 < 0.05 was obtained, so H0 was rejected, and Ha was accepted. This indicates that the Problem-Based Learning model, assisted by Wordwall media, has a significant influence on student learning outcomes.

Correlation Test of Learning Motivation and Learning Outcomes

A Pearson correlation test was conducted to determine the relationship between learning motivation and student learning outcomes.

Table 12. Pearson Correlation Test Results

Data	Pearson Correlation	Sig. (2-tailed)	N
Motivation and learning outcomes	0.416	0.001	60

Based on the test results, the Pearson Correlation was 0.782 ($p = 0.000 < 0.05$), indicating a significant positive relationship between learning motivation and student learning outcomes.

The research results indicate that students participating in instruction using the Problem-Based Learning (PBL) model integrated with Wordwall media exhibited higher motivation to learn than students taught using the PBL model without Wordwall media. It should be noted that both groups in this study received the PBL model intervention; therefore, the observed difference cannot be interpreted as the independent effect of the PBL model itself. Consequently, the findings are best understood as demonstrating an additional benefit of integrating Wordwall media into PBL-based instruction, rather than implementing PBL without it.

Learning motivation is a crucial factor influencing student success in achieving learning objectives. Students with high learning motivation tend to be more active during learning, exhibit heightened curiosity, and be more enthusiastic about completing learning tasks. Conversely, students with low motivation to learn tend to be less active and less enthusiastic about participating. Therefore, learning models and media that can increase student engagement are needed during the learning process.

The application of the Problem-Based Learning model in this study resulted in more active student learning because it focused on student-centered learning through problem-solving activities. Students were presented with everyday-life problems, encouraging them to think critically and seek solutions. During the learning process, students work collaboratively in groups to discuss problems, seek information, and present the results of their group discussions. These activities enable students to be more directly involved in the learning process compared to conventional teacher-centered learning.

In addition to the learning model, the use of Wordwall media also contributes to increased student motivation. Wordwall media is a digital learning tool that offers interactive activities, including quizzes, matching games, puzzles, and other educational games. The use of Wordwall media makes the learning process more engaging and less monotonous, thus increasing student enthusiasm. During the study, students appeared more active in answering questions, discussing with their group mates, and participating in learning activities due to the use of interactive, game-based media. Thus, the results of this study indicate that the Wordwall medium adds value to the implementation of the PBL model compared with implementing PBL without it.

The use of Wordwall media also helps create a fun learning environment, so students don't get bored easily during the lesson. Furthermore, Wordwall media provides direct feedback on students' answers, allowing them to quickly see their learning outcomes. This makes students more motivated to achieve better results. Thus, the combination of the Problem-Based Learning model and Wordwall media can effectively increase students' motivation to learn.

Although statistical analysis reveals a significant difference between the experimental and control classes, the importance of these findings lies not merely in statistical significance but also in educational significance, as evidenced by improved motivation and learning outcomes among students in the experimental class. The greater improvement observed in the experimental class can be attributed to the synergy between the Problem-Based Learning (PBL) model and Wordwall media, which complement each other in supporting learning. Grounded in constructivist theory, PBL enables students to construct knowledge through real-world problem-solving, group discussions, and critical thinking, thereby fostering a more meaningful understanding of concepts such as heredity and biotechnology. Meanwhile, Wordwall's interactive features-such as game-based quizzes, immediate feedback, engaging visuals, and competitive activities-enhance student attention, engagement, and enjoyment during the lesson [19]. This aligns with learning motivation theories suggesting that learning experiences offering challenges, opportunities for active participation, and recognition of success can boost students' intrinsic motivation [20]. Heightened motivation, in turn, encourages students to engage more actively in discussions, analyze heredity patterns, solve genetics problems, and grasp the applications of biotechnology in daily life. Consequently, implementing the PBL model, supported by Wordwall media, yields not only statistically significant differences but also tangible educational benefits, including enhanced student engagement, conceptual understanding, motivation to learn, and academic outcomes. Furthermore, [21] reported that using a problem-based learning model combined with digital learning media positively impacts student engagement in science learning.

In addition to influencing motivation to learn, the results indicate that the Problem-Based Learning model with Wordwall media has a significant impact on student learning outcomes. The research results showed that, after receiving the treatment, the average learning outcomes of students in the experimental class were higher than those in the control class. This indicates that implementing the Problem-Based Learning model, aided by Wordwall media, can help students better understand the material on inheritance and biotechnology. Since both groups received instruction using the PBL model, the observed difference in learning outcomes is more accurately interpreted as an additional benefit of using Wordwall media within PBL instruction, rather than as an effect of the PBL model in isolation.

The improvement in student learning outcomes in the experimental class was due to the Problem-Based Learning model, which provided students with opportunities to discover concepts independently through problem-solving activities. During the learning process, students not only received information from the teacher but also actively sought it, engaged in discussions, expressed opinions, and drew conclusions. Active student involvement during the learning process facilitated student understanding of the concepts being studied, resulting in improved learning outcomes.

The subject of inheritance and biotechnology involves abstract concepts and complex scientific terms, which are often considered difficult by students. In inheritance, students are required to understand the concepts of genes, chromosomes, and monohybrid and dihybrid crosses, which demand strong analytical skills and conceptual understanding. Meanwhile, in biotechnology, students need to understand the various applications of biotechnology in everyday life and their impacts. Therefore,

learning models and media are needed to help students grasp concepts more concretely and engagingly.

The use of Wordwall media in this study helped students understand the material through interactive, game-based learning activities. Through quizzes and educational games on the Wordwall, students can learn while playing, making the learning process more enjoyable. Furthermore, the engaging media display also helps increase students' attention to the material. Students become more focused during the lesson, thus enhancing their conceptual understanding of inheritance and biotechnology.

The results of this study align with those [22], which found that the use of Wordwall media can improve student learning outcomes by making learning more engaging and interactive. [23] also showed that implementing the Problem-Based Learning model, supported by Wordwall media, had a positive impact on students' science learning outcomes. Furthermore, [24] stated that the use of digital-based learning media can help students better understand learning concepts because they are directly involved in learning activities.

The correlation test results revealed a significant positive relationship between learning motivation and student learning outcomes. This indicates that students with high learning motivation tend to achieve better learning outcomes than those with low learning motivation [25]. High learning motivation makes students more active in learning, more enthusiastic about completing assignments, and more focused on understanding the learning material [26].

Although the Pearson correlation test results indicate a significant positive relationship between learning motivation and student learning outcomes, these findings merely demonstrate an association; they do not establish that learning motivation is a predictor or cause of improvements in learning outcomes. This relationship may also be influenced by the implementation of the Problem-Based Learning model supported by Wordwall media, or by other factors not analyzed in this study. Therefore, the results should be interpreted with caution, and future research should employ regression or mediation analyses to examine the contribution of learning motivation to learning outcomes while accounting for the influence of the instructional intervention.

A consistent relationship between learning motivation and learning outcomes was observed throughout the research process. Students demonstrating high learning motivation tended to participate more actively in discussions, answer questions, and engage optimally in learning activities supported by Wordwall. This active engagement contributed to a better understanding of concepts, thereby leading to improved learning outcomes. Conversely, students with lower levels of learning motivation tended to be less active during the learning process and achieved relatively lower learning outcomes. These findings indicate that learning motivation is a crucial factor influencing student engagement in the learning process and contributing to optimal learning outcomes [27].

Thus, the results of this study indicate that integrating Wordwall media into Problem-Based Learning (PBL) provides additional benefits in enhancing student motivation and learning outcomes compared to implementing PBL without Wordwall. Consequently, these findings reflect the contribution of using Wordwall within a PBL learning environment more than the effectiveness of the PBL model in isolation.

This study has limitations in isolating the specific contributions of each treatment component. Both groups utilized the Problem-Based Learning (PBL) model, with the only difference in treatment being the use of Wordwall media in the experimental class. Consequently, the study's findings cannot independently determine the magnitude of the effects attributable to the PBL model versus the Wordwall media. Thus, the observed differences primarily reflect the added benefits of incorporating Wordwall media into PBL instruction. Future research is advised to employ comparison groups involving conventional instruction, PBL without Wordwall, and PBL with Wordwall support to enable a more comprehensive analysis of each treatment's contribution.

Conclusion

Based on the research results, it can be concluded that the Problem-Based Learning model, assisted by Wordwall media, has a significant effect on student motivation and learning outcomes for the inheritance and biotechnology material at UPT SMP Negeri 17 Medan. The average learning motivation and learning outcomes of students in the experimental class were higher than those in the control class. In addition, there is a significant positive relationship between learning motivation and student learning outcomes. Therefore, the Problem-Based Learning model, supported by Wordwall media, can serve as an alternative innovation in science learning to improve student motivation and learning outcomes. However, since both groups utilized the PBL model, the results of this study cannot be used to independently isolate the effects of the PBL model and the Wordwall media.

Author's Contribution

F.A. Kembaren: Conceptualization, Methodology, Data Curation, Formal Analysis, Writing-Original Draft. E. Prasetya: Validation, Resources, Writing-Review & Editing, Supervision, Funding Acquisition.

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