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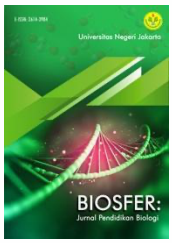

Unification of PBL with RMS: Its influence on critical and creative thinking skills in human respiratory

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ABSTRACT

Critical and creative thinking skills are two essential aspects in 21st century learning. A simultaneous development of both skills can encourage students to find a correct, varied, and adaptive solution to a problem. This study identifies the influence of the unification of the Problem Based Learning (PBL) with the Reading, Mind mapping, and Sharing (RMS) on students' critical and creative thinking. The PBL and RMS are learning models that have complementary characteristics; therefore, they can be combined in a more effective learning strategy. The research method employs quasi-experimental research with non-equivalent pretest-post-test control groups design. The research population includes students in Class XI MIPA in 2024/2025 academic year. The sampling uses a simple random sampling technique of 62 students. The research instruments consist of test and non-test instruments comprising 11 and 7 items of essay questions to measure critical thinking skills and creative thinking skills, respectively. The non-test instruments include a Student Worksheet and an observation sheet as secondary data. The pre-requisite test results in normally distributed and homogeneous data. The results of hypothesis test, MANOVA ($p<0,05$), indicate that the treatment of the unification of PBL with RMS influences student critical and creative thinking skills with a significance value of 0,001 and 0,002, respectively. The implementation of the unification of the PBL with RMS is proven to have a significant influence on student critical and creative thinking skills.

INTRODUCTION

Critical and creative thinking skills are high-level thinking skills and are often integrated in science education (Wahyudi et al., 2019). Biology learning, as part of science, requires students to think critically and find solutions to problems they face (Palennari, 2018). This aligns with research findings indicating that critical thinking is crucial for students' science learning outcomes and concept understanding (Hadi et al., 2018). However, students' critical thinking in Biology learning receives less attention, as indicated by the lack of analytical skills in answering questions during learning (Anazifa & Djukri, 2017). Previous studies found that 64% of senior high school students have low-level critical thinking skills (Susilawati et al., 2020). This is due to the learning process that focuses on the use of one method or model, thus less able to stimulate students' critical thinking skills (Diani et al., 2018).

Critical thinking is not the only skill that needs to be improved; it is also crucial to train creative thinking skills to encourage students to find ideas (Moon, 2008). Unfortunately, students' creative thinking skills are low. This is related to several factors, among others, the use of learning method that leads to a lack of confidence among students to express their creativity (Alzoubi et al., 2016), concept memorizing habits (Fatimah, 2015), and less interesting learning strategies that reduce interest in study (Hutahaean et al., 2017). Another factor is teachers who struggle to measure students' creative thinking skills since they are cautious in trying new things (Sulistiarmi et al., 2014) and less maximal in developing creative thinking skills through learning (Alghafri & Ismail, 2014). Factors causing low critical and creative thinking skills can hinder students from facing a problem; therefore, they need to be addressed. An alternative solution that can be done is by implementing an appropriate and innovative learning strategy. The Solution can induce students to not only think logically but also train them to develop critical and creative thinking skills in generating ideas (Rohmawatiningsih et al., 2018).

Problem-Based Learning (PBL) has become one of the most popular learning models in enhancing thinking skills by presenting authentic and meaningful problems (Hartini et al., 2014). The PBL presents authentic and meaningful problems that encourage students to actively engage in the problem-solving process, and theoretically, it can improve critical and creative thinking skills (Wahyu et al., 2016). Additionally, another learning model that can create an interesting learning atmosphere as well as train thinking skills is the Reading, Mind Mapping, and Sharing (RMS). Learning will be more optimal if it involves the use of cases, mind mapping, data, games, facts, or common problems (Ristanto et al., 2023a; Ristanto et al., 2023b; Muttaqin et al., 2023). The RMS not only enhances students' skills in mind mapping but also contributes to the improvement of critical thinking skills, metacognition, and concept understanding (Gumilar & Setiawan, 2016).

Based on the description, critical and creative thinking skills can be improved by implementing an integrated learning model to achieve learning objectives. Observing the synergy of excellences of the two models, PBL and RMS, they have the potential to create a more innovative learning strategy as well as be adaptive to the needs of the 21st century (Osman & Kriek, 2021; Yu & Zin, 2023a). The unification can be an alternative solution by combining two learning models or approaches that complement each other to create a more effective strategy. The term unification means the unification of parts into a whole (KBBI, 2025)

The unification of PBL with RMS has not been widely researched. Previous studies are limited to the implementation of these models individually and have not examined their effectiveness in an integrated manner, especially for human respiratory system materials. This study has a high urgency so it becomes an opportunity to conduct further research as a follow-up and a development of previous studies. This study is imperative to support the achievement of students' critical and creative thinking in Biology learning. It aims to identify the influence of the unification of PBL with RMS on students' critical and creative thinking skills in the concept of human respiratory systems.

METHODS

Research Design

The research was quasi-experimental, and the sample was divided into two groups, namely, the unification of the PBL with RMS as an experimental group and unification of the Contextual Teaching and Learning (CTL) with RMS as a control group. The research variables included the unification of the PBL learning model with RMS as an independent variable (variable X) and critical and creative thinking skills as dependent variables (variable Y). The research design is described in Table 1.

Table 1
Research Design of a Non-Equivalent Control Group Design

Group	Pre-Test	Treatment	Post-Test
Experiment	O_{1A}, O_{1B}	X_1	O_{3A}, O_{3B}
Control	O_{2A}, O_{2B}	X_2	O_{4A}, O_{4B}

Note: O_{1A} = Pre-test of the experimental class for critical thinking skills; O_{1B} = Pre-test of the experimental class for creative thinking skills; O_{2A} = Pre-test of the control class for critical thinking skills; O_{2B} = Pre-test of the control class for creative thinking skills; X_1 = Treatment of the unification of PBL with RMS in the experimental class; X_2 = Treatment of the unification of CTL with RMS in the control class; O_{3A} = Post-test of the experimental class for critical thinking skills; O_{3B} = Post-test of the experimental class for creative thinking skills; O_{4A} = Post-test of the control class for the critical thinking skills; O_{4B} = Post-test of the control class for the creative thinking skills

The research design was the non-equivalent control group design. Table 1 shows that both experimental and control groups were given a pre-test before treatment and a post-test after treatment. The research design consisted of three main stages of the unification of the PBL with RMS, namely, discussion, learning, and reporting. The treatment design can be seen in Table 2.

Table 2
Treatment Design for Implementing the Unification of the PBL with RMS

No.	Learning Phase	Syntax of Unification of the PBL with RMS
1	Discussion	1. Orients students to problems (problem identification) 2. Organize students to learn (students collaborate in a group)
		3. Guide students to read materials related to the learning topics
2	Learning	4. Perform problem analysis through group discussion
		5. Perform an independent investigation in a group (search for information from various references related to the problems)
		6. Create a mind map in a group based on the results of reading and investigation
3	Reporting	7. Develop and present the results (students present the results of the discussion and the mind map created)
		8. Analyze, evaluate the problem-solving process, and provide solutions
		9. The teacher gives feedback, assistance, and confirmation of the content or topic studied from learning sources.

Modified from Muhlisin et al. (2020)

Population and Sample

The selection of the population and sample was conducted using a multi-stage random sampling technique. The determination of the population employed a purposive sampling technique. The population consisted of 216 students in Class XI MIPA of SMA Cahaya Fadilah Jakarta in the academic year of 2024/2025. The cluster random sampling technique was used in determining two classes, namely the experimental class (XI-MIPA 1) and the control class (XI-MIPA 2). The number of students in each class was 36, thus a total of 72 students. The research sampling determination used a simple random sampling technique that resulted in a sample of 62 students. Samples were calculated using Slovin's formula to indicate that the sample was homogeneous and representative.

Instrument

The research instrument consisted of a test instrument aiming at measuring students' critical and creative thinking skills and non-test instruments in the form of a student worksheet (LKPD) and observation sheets. The instruments of critical thinking skills in this research were arranged according to the following indicators, namely, interpretation, analysis, inference, evaluation, explanation, and self-regulation (Fascione, 2015). The instruments of creative thinking skills were arranged according to indicators of fluency, flexible thinking, originality, and detail (Torrance, 2018). Both instruments would be measured using a scoring of 4-3-2-1 (excellent – good – fair – poor). The validity of the question items of critical thinking skills will be tested using the Pearson product-moment and the reliability of the instrument was calculated using the Alpha Cronbach formula.

Research Procedure

The research procedure consisted of three stages, namely preliminary, implementation, and final stages. The preliminary stage was conducted to coordinate and prepare a learning plan to be studied through an interview method. Afterwards, an instrument trial was conducted with 36 students of Class XII MIPA-1, and then the instruments were analyzed based on validity and reliability tests. The implementation stage started with determining two sample groups that will be the control and

experimental groups. Next, a pre-test was conducted for both research groups. The research assigned the unification of the CTL with RMS as the control group and the unification of the PBL with RMS as the experimental group. Post-test was then followed using the same questions as the pre-test. The final stage aimed to perform a statistical analysis and draw conclusions based on the data generated. The research procedures are illustrated in Figure 1.

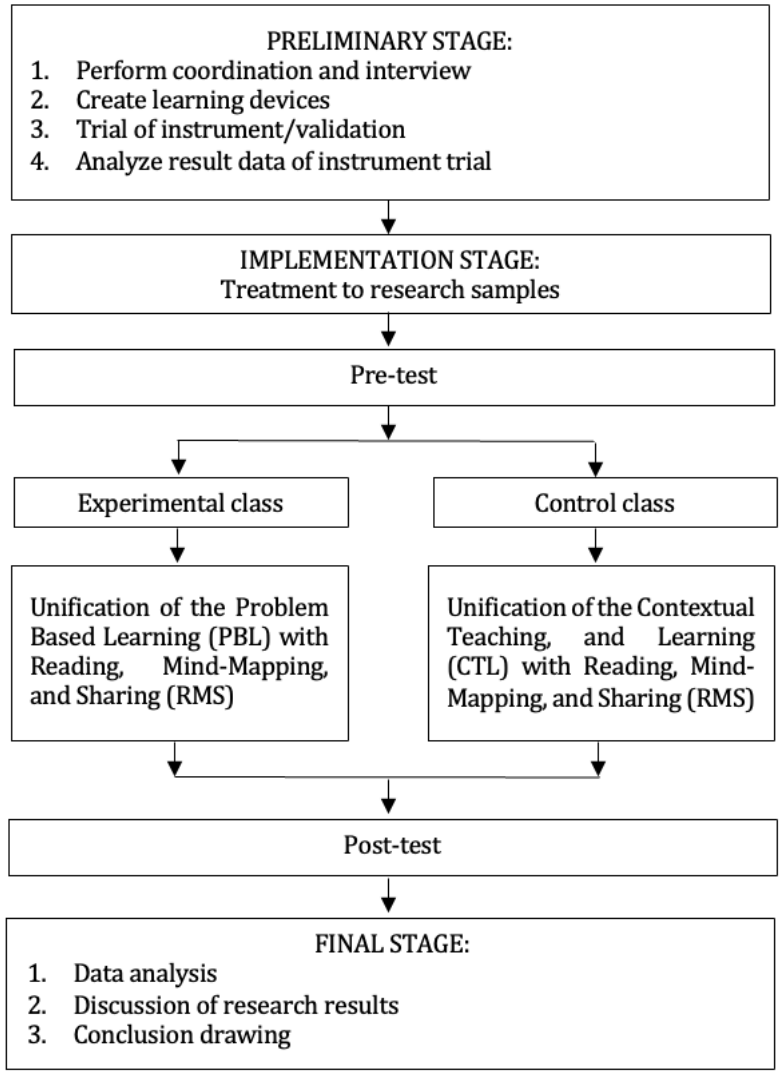

Figure 1. Research Procedures

Data Analysis Techniques

The processing and analysis of test instrument data started with the instrument feasibility test, descriptive analysis, pre-requisite tests, hypothesis test, and N-Gain test. The pre-requisite tests performed were normality test using the Kolmogorov-Smirnov test with a significance level of 5% and homogeneity test consisting of two steps, namely variance homogeneity test (Levene's Test) and covariance matrix (Box's Test). The hypothesis test was conducted using a MANOVA Test (Multivariate Analysis of Variance). The test used the SPSS 25 software. Whereas the N-Gain test aimed to identify the improvement of students' critical and creative thinking skills. The processing and analysis of the non-test instrument data were through LKPD results during the application of the treatment process, and the results of observation on learning activities by teachers and students. The processing of teacher activity observation sheets, and the implementation of learning syntax of student activities were given the following scores: 1 (very poor), 2 (poor), 3 (fair), 4 (good), 5 (excellent).

RESULTS AND DISCUSSION

The analysis results based on the generated data in both groups towards critical thinking skills are indicated in Table 3.

Table 3
Results of Critical Thinking Skills

Data	Experimental Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Sample (n)	31.00	31.00	31.00	31.00
Highest Score (Max)	63.64	95.45	61.36	90.91
Lowest Score (Min)	43.18	79.54	40.91	68.18
SD	5.18	4.59	5.78	6.18
Average	52.27	87.02	51.11	80.06
Category	Fair	Excellent	Fair	Good

The above data indicate that the pre-test results in the experimental class and control class indicate that both groups have similar initial critical thinking skills, namely in a fair category. A significant difference can be seen in the post-test results, where the experimental class was superior to the control class. Therefore, it can be concluded that both groups experienced an increase after the treatment, but the experimental group had better improvement by using the unification of the PBL and RMS. The analysis results on the creative thinking skills can be seen in Table 4.

Table 4
Results of Creative Thinking Skills

Data	Experimental Class		Control Class	
	Pretest	Post-test	Pretest	Post-test
Sample (n)	31.00	31.00	31.00	31.00
Highest Score (Max)	60.71	96.43	60.71	89.29
Lowest Score (Min)	32.14	71.43	35.71	71.43
SD	6.71	5.44	5.68	5.26
Average	47.52	87.44	49.08	80.87
Category	Poor	Excellent	Poor	Good

Based on the data in Table 4, the average score of the pre-test results in the experimental and control classes shows no significant differences. This indicates that both groups have similar initial skills. The differences were found in the post-test results in both groups, where the results of the experimental class were higher than the control class. Therefore, it can be concluded that the experimental group has better improvement using the unification of the PBL and RMS. In addition to the test analysis results, there were secondary data to measure students' critical and creative thinking skills. The assessment results on the LKPD from experimental and control classes are presented in Table 5.

Table 5
Assessment Results of LKPD from the Experimental and Control Class

Topics	Average	
	Experimental Class	Control Class
Structure and Function	58.33 (Fair)	57.14 (Fair)
Mechanism of Respiratory	83.33 (Excellent)	77.78 (Good)
Disorders or Abnormalities	89.68 (Excellent)	85.32 (Excellent)
Average	77.11 (Good)	73.33 (Good)

Table 5 indicates that the results of the LKPD assessment from the experimental class have a higher average score than the control class in every meeting. This finding confirmed that the unification of the PBL-RMS is more effective in improving students' critical and creative thinking skills. Next, the results of learning implementation by students can be seen in Table 6.

Table 6 indicates that the unification of the PBL-RMS in the experimental class has been applied effectively and in a structured. This was verified by the increase in the percentage in each meeting. Therefore, it can be inferred that the implementation of appropriate learning models can support learning implementation very well. Other supporting data, such as the results of teacher activity observation and analysis by observers, are presented in Table 7.

Table 6
Percentage of Learning Implementation by Students in the Experimental Class

Learning Activity	Topics		
	Structure and Function	Mechanism of Respiratory	Disorders or Abnormalities
Learning intro	82.61%	91.30%	100.00%
Problem identification	78.26%	86.96%	95.65%
Collaboration in group	91.30%	100.00%	100.00%
Read the materials/articles	82.61%	91.30%	100.00%
Problem analysis	82.61%	91.30%	100.00%
Investigation in a group	78.26%	86.96%	100.00%
Create a mind map	73.91%	82.61%	91.30%
Develop and present the results	82.61%	86.96%	91.30%
Analysis, evaluation, and provide solutions	82.61%	86.96%	95.65%
Provide responses and solutions	86.96%	91.30%	100.00%
Learning Closure	91.30%	91.30%	100.00%
Average	83.09%	89.64%	97.64%

Table 7
The Learning Implementation by Teachers in the Experimental Class

Learning Activity	Materials		
	Structure and Function	Mechanism of Respiratory	Disorders or Abnormalities
Learning Intro	100%	100%	100%
Problem identification	100%	100%	100%
Collaboration in group	100%	100%	100%
Read the materials/articles	100%	100%	100%
Problem analysis	100%	100%	100%
Investigation in a group	100%	100%	100%
Create a mind map	100%	100%	100%
Develop and present the results	100%	100%	100%
Analysis, evaluation, and provide solutions	100%	100%	100%
Provide responses and solutions	100%	100%	100%
Learning Closure	100%	100%	100%
Average	100%	100%	100%

The percentage of teacher activity implementation in the experimental class during the learning process in the first, second, and third meetings achieved 100% and all were in the excellent category. This suggests that all teacher activities in the learning process in the class have been implemented very well and in accordance with the pre-determined learning steps. The following data analysis was a normality test. The normality test used was the Kolmogorov-Smirnov test with a significance level of 5%. The normality test results can be seen in Table 8.

Table 8
The Normality Test Results of the Critical and Creative Thinking Skills

Variable	Group		Sample (n)	Sig_{α}	$Sig_{statistic}$
Critical Thinking Skills	Experiment	Pre-test	31	0.050	0.094
		Post-test	31	0.050	0.138
	Control	Pre-test	31	0.050	0.200
		Post-test	31	0.050	0.200
Creative Thinking Skills	Experiment	Pre-test	31	0.050	0.077
		Post-test	31	0.050	0.076
	Control	Pre-test	31	0.050	0.062
		Post-test	31	0.050	0.082

The results of the normality test indicate that both classes were normally distributed for both pre-test and post-test results. This can be seen from the significance results that are greater than the

table significance. Therefore, it can be inferred that the data distribution in both classes, either before or after treatment, has met the normality assumptions that become the prerequisite to perform the following parametric statistical test. The next test was the variance homogeneity test, and the results are presented in Table 9.

Table 9
Results of the Variance Homogeneity Test

Variable	Statistic	Sig	Results
Critical Thinking Skills	1.651	0.181	0.181 > 0.05
Creative Thinking Skills	0.492	0.689	0.689 > 0.05

Data in Table 4.9 indicate a (sig) > 0.05. Both values were greater than the significance limit of 0.05. Hence, it can be inferred that H_0 is accepted, which means that the data in both groups have the same variance or are homogeneous. The next test was the covariance matrix homogeneity test, which is presented in Table 10.

Table 10
Results of the Covariance Matrix Homogeneity Test

Box's M	F	Sig.
5.683	0.612	0.788

Based on the test results in Table 10, H_0 is accepted; therefore, it can be assumed that the variance/covariance matrix from the dependent variable is homogeneous. Thus, the MANOVA analysis can be continued to the hypothesis test. The hypothesis testing was performed using a univariate significance test of F. The univariate F-test was conducted by calculating it separately for each dependent variable. The results are presented in Table 11.

Table 11
Results of Univariate Hypothesis Test

Dependent Variable	Type III Sum of Squares	df	Average Quadrate	F	Sig.
Critical Thinking Skills	32232.780	3	10744.260	353.715	<.001
Creative Thinking Skills	13289.295	3	13289.295	392.441	<.001

Based on Table 11 in the column of the Corrected Model, the critical and creative thinking variables had a sig value < 0.050 (significant), suggesting that the unification of the PBL with RMS models affected the students' creative thinking skills on the human respiratory system material (H_0 is rejected). Next was the multivariate hypothesis test, and the results are indicated in Table 12.

Table 12
Results of Multivariate Hypothesis Test

	Effect	Value	F	Hypothesis df	Error df	Sig.
Class	Pillai's Trace	.996	15927.348	2.000	119.000	<.001
	Wilks' Lambda	.004	15927.348	2.000	119.000	<.001
	Hotelling's Trace	267.687	15927.348	2.000	119.000	<.001
	Roy's Largest Root	267.687	15927.348	2.000	119.000	<.001

Based on data in Table 12, the four procedures of the MANOVA have a significant value of 0.000<0.050 (significant). This indicates that there is a significant influence of the unification of the PBL-RMS learning model on students' critical and creative thinking skills in the human respiratory system materials. The test was continued by conducting an N-Gain test. The relevant result of the N-Gain calculation can be found in Table 13.

Table 13 indicates that the improvement of student critical and creative thinking skills in the experimental class was higher than in the control class. Therefore, the N-Gain results become an indicator that the implementation of the unification of the PBL with RMS is effective in improving

students' critical and creative thinking skills. This is supported by the results of the N-Gain test in each indicator. The results of the N-Gain test in both groups are presented in Table 14.

Table 13
Results of N-Gain Test

Variable	Group	N-Gain	Category
Critical Thinking Skills	Experiment	0.76	High
	Control	0.61	Moderate
Creative Thinking Skills	Experiment	0.72	High
	Control	0.64	Moderate

Table 14
Results of N-Gain Test for Critical and Creative Thinking Skill Indicators

Variable	Indicator	Control		Experiment	
		N-Gain	Category	N-Gain	Category
Critical Thinking Skills	Interpretation	0.54	Moderate	0.70	High
	Inference	0.54	Moderate	0.72	High
	Evaluation	0.63	Moderate	0.65	Moderate
	Analysis	0.58	Moderate	0.64	Moderate
	Self-regulation	0.63	Moderate	0.68	Moderate
	Explanation	0.54	Moderate	0.72	High
Creative Thinking Skills	Fluency	0.59	Moderate	0.80	High
	Flexible Thinking	0.64	Moderate	0.79	High
	Detail	0.61	Moderate	0.70	High
	Authenticity	0.59	Moderate	0.66	Moderate

Data in Table 14 indicates that both the experimental and control classes have the highest N-Gain score, indicating that students in both groups are superior in several indicators compared to other indicators. Therefore, learning in both classes still contributes to the strengthening of certain aspects of critical and creative thinking.

The research results suggest that there is a significant difference in the improvement of critical and creative thinking skills between the experimental and control classes, as suggested by the average pre-test and post-test scores of the students. This difference reflects the effectiveness of the implementation of the unification of the PBL-RMS learning models in improving students' critical and creative thinking skills. The PBL is designed to involve students actively in solving problems provided (Mulyati et al., 2024). Through this process, students not only comprehend the materials conceptually but also train their critical thinking skills in identifying problems, analyzing information, and formulating solutions (Ardianti et al., 2022).

The unification of the PBL with RMS can strengthen the internalization process of materials and the reflection of students' critical and creative thinking. Reading assists students to developing deep understanding of content through text and encourages interpretation and inference skills (Putri & Wicaksono, 2023). Mind Mapping serves as a visualization tool and organization of concepts that stimulates students to perform synthesis of information and develop relationships between ideas. These activities support explanation and self-regulation skills (Tambunan et al., 2023). Sharing, in the form of group discussion, provides a room for students to express ideas, evaluate arguments, and reflect on their understanding based on peer input that increases evaluation and self-regulation skills (Saputra & Sahyatini, 2022).

Both learning models encourage students to not only receive information passively but also develop the meaning actively through a deeper thinking process. Through this process, students will understand the material conceptually as well as train their critical thinking skills in identifying problems, analyzing information, and finding solutions (Muhlisin et al., 2020). This is in line with previous studies stating that problem-based learning combined with active thinking strategies, such as discussion and mind mapping, significantly enhances student achievement in critical thinking (Alwi et al., 2019).

Different learning strategies lead to different research results in both groups. The control class, which employed CTL and RMS, emphasizes real context in learning with a more structured and teacher-centric approach (Yasin et al., 2023). The CTL focuses on the relationship between learning materials

and students' real life; however, it does not involve students in solving open problems and in self-investigation as in the PBL (Mallika, 2024). Therefore, the N-Gain scores of critical thinking in the control class are lower since cognitive interaction required is not as great as in the application of the PBL-RMS model. The results are supported by previous studies stating that the PBL model is superior in developing critical thinking skills than the CTL since it encourages students to trace arguments, formulate a hypothesis, and evaluate various possible answers (Nofrizal & Suyatna, 2020).

Based on the univariate significance test or test of between-subject effect, the data have an F and significance values greater than the α value (0,050). This indicates that the application of the PBL with RMS in the learning process emphasizes problem solving and actively expressing ideas that can initiate critical thinking (Su et al., 2025). The PBL model affects the improvement of critical thinking skills since the learning is based on a problem and focuses on process, as well as creates an independent, collaborative, and group-based learning environment (Guerra & Holgaard, 2016).

The implementation of the PBL-RMS affects creative thinking skills. The research results suggest that the average score of the experimental class is higher than the control class. In the pre-test, the average scores for student creative thinking skills in the experimental class and control class are relatively equal. However, a significant improvement occurred in the post-test scores in the experimental class. The experimental class achieved a significantly higher average score than the control class, suggesting that the implementation of the unification of the PBL with RMS is more effective in improving student creative thinking skills. The PBL model can stimulate students to actively engage in solving complex and authentic problems. This directly trains students to employ divergent thinking, which is the core of creative thinking skills (Hastawan, Suryandari, & Ngatman, 2023).

The results of the N-gain analysis of creative thinking skills obtained by the experimental and control classes indicate that the improvement in the students' creative thinking skills in the experimental class was higher than in the control class. The PBL can improve student skills in generating unusual ideas, especially if it is designed with explorative and collaborative activities relevant to daily life (Zhou, 2018). The learning process in the PBL-RMS allows students to develop new knowledge by reading, connecting it through mind mapping, and deepening the knowledge in a group discussion (Yan et al., 2023).

The influence of the PBL with the RMS Model on the students' critical and creative thinking skills on the human respiratory system materials was analyzed using a Multivariate Analysis of Variance (MANOVA) to gain the MANOVA significance test results in the critical and creative thinking skills. Data of the MANOVA significance test indicate a significance value of < 0,050. The value suggests that there is a significant influence of the implementation of the PBL-RMS on students' critical and creative thinking skills in the concept of human respiratory systems. Additionally, the results also show that the experimental group has higher critical and creative thinking skills than the control group. The increase in the score in the experimental class confirms previous findings stating that problem-based learning with visual and collaborative approaches can significantly improve students' creative thinking skills (H. Pujiastuti et al., 2020).

The implementation of the PBL-RMS has advantages that can explain the high achievement of creative thinking skills in the experimental class. The PBL develops an authentic learning environment, allowing students to receive information as well as interpret, modify, and create solutions (Putra et al., 2025), thus encouraging them to think out of the box. This is consistent with the results of previous studies stating that the PBL is effective in fostering critical thinking skills since it stimulates students to think deeply and evaluate information from various perspectives (Nadeak & Naibaho, 2020). Similarly, another study indicates that the integration of PBL and discussion strategy and concept mapping can significantly improve student critical thinking (Simanjuntak et al., 2021).

The RMS strengthens creative learning through reading technique that triggers openness to new information, mind mapping that allows a non-linear connection between ideas, and sharing that stimulates improvisation of ideas generated from social interaction. According to previous studies, mind mapping has proven to be able to facilitate elaboration of creative ideas due to the resulting visualization that triggers connections between concepts (Putra et al., 2019). Other studies also support that problem-based learning combined with reading literacy and group discussion approaches can enhance student creativity in the biology learning context (Wahyuni & Corebima, 2018).

The student improvement of critical and creative thinking skills is supported by the implementation of student learning, which is shown by the results of the student worksheet (LKPD)

assessment in the experimental and control classes. The worksheet assessment results in the experimental class received higher average scores than in the control class, and they increased in each meeting. This indicates that through a worksheet based on the unification of PBL-RMS, students' critical and creative thinking can be improved. The implementation of the model allows students to express their opinions and ideas (Wulandari et al., 2022). Moreover, the implementation of mind mapping in science learning can develop critical and creative thinking skills, as indicated by creative ideas expressed by students since they were given more time to convey unlimited ideas on various problems (Kefalis et al., 2025).

The key to success in the implementation of the PBL is also in the role of teachers since their knowledge in planning and implementing innovative, effective, and fun biology learning will play a crucial role in the learning process (Ban Qingyi, 2023). However, in the implementation, teachers experienced some difficulties related to determining problems that can be used as a stimulus, longer time in learning planning and implementation, and positioning themselves as a facilitator for students (Tyas, 2017). A hurdle experienced by the teacher is time constraints, since the PBL with RMS model requires a long time in the learning process. Therefore, teachers must continue to strive to get used to the PBL and RMS implementation to improve students' critical and creative thinking (Jatmiko et al., 2018; Nasrabad, 2025; Nihlah et al., 2024; Yu & Zin, 2023).

CONCLUSION

Based on the research results and data analysis, conclusions can be drawn that the utilization of the unification of the Problem-Based Learning (PBL) with Reading, Mind Mapping, and Sharing (RMS) has a positive influence on improving students' critical and creative thinking skills on the human respiratory system materials. The implementation of the unification of the PBL with RMS has proven to be effective as an alternative learning innovation that is relevant to support the achievement of the 21st-century competencies. Therefore, the unification of both models can be applied in the learning process at school. Future studies should develop the implementation of the unification of the PBL with RMS in different materials or education levels to gain a more comprehensive depiction of the effectiveness of this learning strategy in improving students' critical and creative thinking skills.

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