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Exploration Influence Problem-Based Learning STEM-based towards Ability Literacy Mathematics Middle School Students

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Abstract

This research aims to describe the influence of mathematics learning using a STEM-based problem-based learning model on students' mathematical literacy abilities in class VII at a private junior high school in Batam City. This type of research is quasi-experimental (quasi-experimental) with a Non-Equivalent Control research design Group design. The sampling technique uses the Purposive Sampling technique. The instrument used to collect data is in the form of mathematical literacy test questions. Data analysis techniques used are Independent Sample T-test uses gain data. This gain data is required because the average of the pre-test results from second class No can be considered equivalent. The gain score is calculated using the difference between the pre-test and post-test on ability literacy mathematics. Research results at level 5% significance indicate that learning mathematics using a STEM-based problem-based learning model significantly influences literacy mathematics students' ability. Learning This has proven superior compared to the usual problem-based learning model, as seen by the average increase in ability literacy mathematics students. The research results also show that the STEM-based problem-based learning model significantly improves students' mathematical literacy skills compared to conventional problem-based learning models. In the experimental class, there was a more significant increase in average scores in the three indicators of mathematical literacy, namely identifying relevant information to solve problems and/by formulating situations mathematically using symbols, pictures or mathematical modeling (5.78 points or 17, 34%), applying concepts, facts, procedures and mathematical reasoning to solve problems (10.22 points or 30.66%), as well as interpreting solutions into the context of the problem (9.85 points or 29.56%). Meanwhile, the increase in the control class for the same indicator was lower, namely 2.91 points (8.73%) for identifying information, 1.89 points (5.67%) for applying mathematical concepts and reasoning, and 2.15 points (6.45%) for interpreting mathematical solutions into the context of the problem by providing appropriate reasons for the mathematical solutions obtained. The most significant increase occurred in the second indicator, which is applying concepts, facts, procedures, and mathematical reasoning to solve problems.

Keywords: *Problem-Based Learning; STEM-based Problem-Based Learning; Mathematical Literacy Ability*

Introduction

The challenges of the 21st century continue to develop, especially in the fields of science and technology, which emphasizes the importance of developing these two fields to maintain global competitiveness in the era of globalization. A nation's success in facing these challenges depends on innovation, creativity, and technical and cognitive skills, as stated by the National Council of Supervisors of Mathematics (NCSM) and the National Council of Teachers of Mathematics (NCTM) (2018). Technology and access to information will shape these ideas and skills, which depend on how much individuals master science, technology, engineering, and mathematics (STEM) in education from elementary to high school. Therefore, education plays a vital role in building competent and quality human resources (HR), so it is necessary to improve standards and quality, especially in the STEM field. STEM is considered a cultural achievement that reflects societal progress, drives the economy, and is a fundamental aspect of life as a citizen, worker, consumer, and parent. In addition, STEM understanding is increasingly necessary for individual and societal decision-making, from understanding medical diagnoses to evaluating environmental claims and managing daily activities with various computer-based applications National Research Council et al. (2011).

Learning STEM-based has a vital role in the current era, along with the emergence of new developments in fast technology. The need for man to understand and use mathematics daily increases. Amid a rich world of information dominated by digitalization and fast communication change, ability literacy has become vital for facing daily challenges. Literacy is related to individuals' ability to utilize various sources of Power To increase quality of life. Therefore, skills for competing globally and in a face-based society, technology, and information have become essential. One of the main things students in the 21st century need to do is to be competent in literacy and mathematics. Economic Co-operation and Development (OECD) (2019) defines *literacy mathematics* as the ability of individuals to formulate, apply, and interpret draft mathematics in various situations. Literacy in mathematics is crucial Because it gives insight and understanding of the role of mathematics in the real world. This is not inseparable from the learning process in math and is not considered a separate component in curriculum mathematics. Besides becoming objective learning, literacy math is a tool for understanding and mastering mathematics.

See the importance of literacy mathematics, which requires effective learning to increase the ability of literacy mathematics students. However, while this is still a learning process in Indonesia, many are focused on delivering material in an expository way. One cause is the burden of a lot of material, which forces teachers to finish the entire curriculum in a limited time. This matter is in line with Wang et al. (2023, p.12), that state that the main challenge in education in Indonesia is that many teachers teach without notice level of understanding of students but rather more focus on the completion demands of the curriculum. Badan Standar, Kurikulum, dan Asesmen Pendidikan (BSKAP) (2022, p. 112) also added that teachers tend to more notice preparation document administration than focus on the development ability of literacy mathematics students. As a result, the learning process is more dominated by solutions and teaching materials than efforts to practice literacy and mathematics. However, learning literacy and mathematics is essential in reaching objective education, which prepares students to face life's challenges after graduating.

One of the activities used to measure students' mathematical literacy skills is the Program for International Student Assessment (PISA). As a PISA participant, Indonesia shows that students' mathematical literacy skills still need to be higher and have reached the minimum competency in this assessment. This can be seen from the average mathematics score of Indonesian students in 2022, which will only reach 366, placing Indonesia in 70th place, far below the average for member countries of the Organization for Economic Co-operation and Development (OECD). Apart from PISA, Indonesia also has a Minimum Competency Assessment (AKM) to measure students' mathematical literacy. In July 2023, the Ministry of Education and Culture, Research and Technology released the 2023 National

Education Report Card, which evaluates the quality of education based on 2022 data. One of the competencies assessed is mathematical literacy, where only 40.63% of students managed to reach the minimum standard. Evaluation results at the school level also show a similar pattern. For example, in one private junior high school in Batam City, less than 50% of students achieved the minimum competency in numeracy, with a percentage of only 46.67%. These results are strengthened by data from each domain, which shows that student competency achievement still needs to be improved.

Education today needs to provide learning experiences that help students develop the skills to solve problems, think critically, manage projects, and use information technology. STEM is an abbreviation of Science, Technology, Engineering, and Mathematics. This approach integrates the four disciplines in one learning framework, focusing on mathematical literacy as stated by Moore et al. (Kelley & Knowles, 2016), integrated STEM education is defined as an effort to combine some or all of the disciplines of science, technology, engineering, and mathematics into one class or lesson based on the connection between these subjects and real-world problems. In the integrated STEM curriculum model, learning objectives focus on one subject, but the learning context can be drawn from other STEM subjects. Integrating STEM education into learning requires a suitable, innovative learning model. Rosana et al. (2022, p. 375) state that teachers can integrate STEM with learning models such as problem-based Learning. Dwita & Susanah (2020, p. 280) also stated that the four aspects of STEM support each other, so problem-based learning is effective in the STEM context. Apart from that, problem-based learning is suitable as the primary strategy for schools that focus on STEM because it is inquiry-based (Odell et al., 2019). Furthermore, Lou et al. (2011) state that problem-based learning in STEM education can also improve student learning outcomes and practical skills for future careers.

Problem-Based Learning, abbreviated as PBL, is a model that encourages learning and developing 21st-century skills through problem-solving and applying knowledge in real situations (Trilling & Fadel, 2009, pp. 111-112). Unlike the rote method, PBL improves students' understanding and use of information (Lee & Blanchard, 2018). The focus of PBL is to help students solve real-world problems, thereby motivating students to learn (Hung, 2016). Several research results show that the problem-based learning model effectively increases student competence. Merritt et al. (2017) found that PBL positively impacted students' academic performance, knowledge retention, conceptual understanding, and attitudes. Firdaus et al. (2017, p. 216-217) also stated that PBL effectively improves students' mathematical literacy skills. This matter aligns with Tati et al. (2017, p. 6), which states that integrating STEM into LearningLearning can increase students' science, mathematics, technology, and engineering literacy. In addition, Siswandari et al. (2021, p. 591) stated that based on several research results, information was obtained that the advantages of STEM learning had a positive effect on students' abilities, including students' mathematical literacy abilities.

Milaturrahmah et al. (2017, p. 2) also stated that STEM is very suitable for application in various mathematical materials because it encourages students to relate mathematical concepts to everyday life, use a scientific approach in solving problems, utilize technology to access information and develop engineering skills in the data processing. Analysis carried out by Ilwandri et al. (2023, p. 155)16 journals also shows that the problem-based STEM learning model positively impacts the development of 21st-century skills in Indonesia. The integration of a problem-based learning model with STEM nuances, as mentioned by LaForce et al. (2017, p. 4), allows students to be active in solving real-world problems, expands students' knowledge, and develops problem-solving and mathematical reasoning skills that are essential in mathematical literacy (Siswandari et al., 2021, p. 597).

Theoretically, applying a STEM-based problem-based learning model can improve various learning abilities in mathematics. This model encourages students to actively solve real problems to strengthen their abilities in identifying, analyzing, and solving mathematical problems effectively. Additionally, this approach develops critical thinking skills by asking students to consider various solutions and evaluate the results of different approaches. The STEM-based problem-based learning model also supports the development of mathematical literacy by linking mathematical concepts in relevant and practical contexts, enabling in-depth understanding and application of mathematical knowledge. In the learning process, the STEM-based problem-based learning model provides experience in solving challenging problems by linking mathematics learning with real-world applications so that it can increase student motivation and involvement in learning. This model also strengthens mathematical reasoning skills by asking students to use mathematical concepts in contexts that require logical and systematic reasoning. The STEM-based problem-based learning model provides a framework that allows students to connect mathematical theory with actual practice, strengthening understanding and application of mathematical knowledge.

Researchers need to apply mathematics learning using a STEM-based problem-based learning model because the learning process allows students to apply mathematical concepts in real contexts by integrating science, technology, engineering, and mathematics in one relevant framework. STEM-based PBL also encourages the development of critical thinking, problem-solving, and collaboration skills, which can ultimately strengthen students' mathematical literacy. In addition, this approach makes students actively involved in challenging and practical tasks, makes the learning process more interesting, and prepares students to face real-world challenges with more comprehensive skills and knowledge.

Based on the description above, researchers will research the effect of implementing a STEM-based problem-based learning model on mathematical literacy abilities, especially in class VII at one of the private junior high schools in Batam City. This research is essential to obtain relevant empirical data regarding whether or not the STEM-based problem-based learning model influences junior high school students' mathematical literacy abilities. As for the formulation, the problem is: (1) Does mathematics learning use a STEM-based problem-based learning model influence students′ mathematical literacy abilities? Is there an influence? (2) Is mathematics learning using a STEM-based problem-based learning model superior to learning using a problem-based learning model in terms of the average increase? Students' mathematical literacy abilities? Based on the problem formulation above, the objectives to be achieved in this research are as follows: (1) Describe the influence of mathematics learning using a STEM-based problem-based learning model on students' mathematical literacy abilities. Moreover, (2) Describe the superiority of mathematics learning using a STEM-based problem-based learning model compared to learning with a problem-based learning model in terms of the average increase in student's mathematical literacy abilities.

Method

This type of research is quasi-experimental (quasi-experimental) with a Non-Equivalent Control research design Group design. The population of this research is class VII students at a private school in Batam City, Riau Islands Province, academic year 2023/2024. The sampling technique uses the Purposive Sampling technique. The samples used were students from classes VII A and VII E. A drawing was carried out to determine which class would be the experimental class. The drawing results determined class VII A as the experimental class, which received mathematics learning using a STEM-based problem-based learning model, and class VII E as the control class, which received mathematics learning using the problem-based learning model. The instrument used to collect data is in the form of mathematical literacy test questions. The validity of the instrument content is determined by asking two experts for consideration (expert judgment) who state that the instrument used is valid after revision. The instrument reliability estimate was calculated using the alpha coefficient (Cronbach's Alpha), and the instrument was declared reliable. To determine the effect of mathematics learning using a STEM-based problem-based learning model on students' mathematical literacy abilities and whether mathematics learning using a STEM-based problem-based learning model is superior to the problem-based learning model in terms of the average increase in Students' mathematical literacy abilities used the Independent Sample T-test statistical test.

Results and Discussion

This research was conducted from April to May 2023/2024 at a private school in Batam, involving 39 class VII students. Class VII A is an experimental class with STEM-based and problem-based learning, while class VII E, as a control class, only uses the problem-based learning model. Before learning, a pretest is carried out to measure students' mathematical literacy abilities. The pretest results show that the two classes have different average scores, although the average value of the difference is sufficiently significant; Mathematical literacy comes in second class. You are welcome to enter in the low category. Based on assessment and observation during the learning process, activities learning mathematics in class experiments as well as in class control carried out by researchers walk with good and accomplished satisfactory results. A summary of teacher and student activities based on sheet observation implementation can seen in Table 1 below.

Table 1. Percentage of Learning Implementation for Control Class and Experimental Class

Activity Meeting	**Control Class**		**Experimental Class**	
	Observation of Teacher Activities (%)	**Observation of Student Activities (%)**	**Observation of Teacher Activities (%)**	**Observation of Student Activities (%)**
1	92%	81%	89%	75%
2	88%	81%	79%	71%
3	100%	100%	86%	71%
4	96%	88%	91%	91%
5	100%	92%	83%	83%
Mean	95%	88%	86%	78%

Based on the table above, the percentage of implementation of learning in the control class shows that the average percentage of implementation of mathematics learning using the problem-based learning model in the control class obtained results of 95% for teacher activities and 88% for student activities. This shows that the learning process during the five meetings went well. Likewise, in the table of the percentage of implementation of learning in the experimental class, it can be seen that the average percentage of implementation of mathematics learning using the STEM-based problem-based learning model in the experimental class obtained results of 86% for teacher activities and 78% for student activities. The results of the percentage of learning implementation above also show that the control class with a problem-based learning model has a better implementation of teacher and student activities compared to the experimental class with a STEM-based problem-based learning model. Several factors may explain this difference. One is because the density of stages in the learning process can affect the smoothness of activities. The learning process that applies the STEM-based problem-based learning model involves more stages, including applying the Engineering Design Process (EDP), an essential element in STEM learning. EDP consists of eight stages: define the problem, research, imagine, plan, create, test and evaluate, redesign, and communicate. Apart from that, integrating technology in problem-solving and the learning process also takes time to implement. This large number of stages could be why some stages still need to be fully implemented using the STEM-based problem-based learning model in teacher and student learning activities. However, the Engineering Design Process (EDP) has stages that support the mathematization process. This is because EDP involves a systematic series of steps to solve problems and create technical solutions, which often require the application of mathematical concepts.

Based on the research design, tests were done before and after treatment to measure scores at the beginning and end of the variable-ability literacy mathematics student's period. Table 2 shows the recapitulation results of the pretest and posttest for variable-ability literacy mathematics students.

Table 2. Recapitulation score *pretest-posttest* ability literacy mathematics

Group	**Variable**	***Pretest***	***Post test***
Experiment	Ability Literacy Mathematics	54.39	80.24
Control	Ability Literacy Mathematics	65,91	72,86

Table 2 above shows an increased value for each variable. Then, collected data was analyzed in statistics using the Independent Sample t-test, with the condition that assumptions statistics must be fulfilled. Results of assumption test analysis can seen in Table 3.

Table 3. Data Recapitulation of Assumption Test Results Ability Literacy Mathematical

Previous Data Treatment					
Group	**Variable**	**Shapiro-Wilk**	**Decision**	**Levene**	**Decision**
Experiment	Ability Literacy Mathematics	0.760	Normal	0.222	Homogeneous
Control	Ability Literacy Mathematics	0.336	Normal	0.170	Homogeneous

Data After Treatment					
Group	**Variable**	**Shapiro-Wilk**	**Decision**	**Levene**	**Decision**
Experiment	Ability Literacy Mathematics	0.768	Normal	0.293	Homogeneous
Control	Ability Literacy Mathematics	0.120	Normal	0.075	Homogeneous

Analysis results in assumptions made show that the data has a regular and homogeneous distribution. Therefore, this data fulfills the conditions for testing the parameters. On testing the hypothesis, data gain will implemented for ability literacy mathematics. This gain data is required because the average of the pretest results from second class No can be considered equivalent. The gain score is calculated by looking for the difference between the mark pretest and post-test ability literacy mathematics. The following are the results of the independent sample t-test calculation on the ability to gain data literacy mathematics by looking at the significance of the Equal Variance assumed.

Table 4. *Independent Sample T-Test* Results on Ability Literacy Mathematics

Variable	**Class**	***Mean***	***t***	***Sig. (2-tailed) Equal Variance Assumed***	**Decision**
Mathematical Literacy Ability	Experiment	26.00	5,912	0,000	H_0 rejected
	Control	7.06			

Based on Table 4, the calculation results show a t value 5.912, more significant than 0, and a Sig value. (*2-tailed*) of 0.000. Because $\frac{0,000}{2} < 0,05$, then H_0rejected. This matter shows that the difference in mean improvement is significant in ability literacy mathematics between groups that apply the *problem-based learning* model and groups that apply the *problem-based learning* model. This means that learning mathematics using *a problem-based learning* model significantly influences literacy mathematics students' ability and has proven superior to *problem-based learning* models, based on the average improvement ability of literacy mathematics students.

Discussion

Based on the results of the *independent sample t-test* on *Equal Variance assumed*, the t-value was 5.912. This value is greater than 0, and *the Sig value. (2-tailed)* of 0.000, because which means rejected. So, the experimental class that uses a STEM-based *problem-based learning model* is superior to the control class that uses only *the problem-based learning model*. Therefore, the STEM-based *problem-based learning model* influences the mathematical literacy abilities of class VII students at one of the private junior high schools in Batam on the material of quadrilaterals and triangles. The findings in this study are supported by research by Purnama et al. (2024), which shows that problem-based learning integrated with STEM can improve students' mathematical literacy skills. This increase occurred because the STEM-integrated PBL learning model encouraged students to learn actively through the problems presented. These problems are often found in everyday life so that students can connect mathematical literacy with the material studied. In addition, based on various studies, problem-based learning in STEM education improves student learning outcomes and helps students develop practical skills that are important for future career success (Su, 2024).

Based on descriptive statistics, it is also known that there is an increase in the average value of students' mathematical literacy skills in both classes after treatment. This can be seen from the average score of students' mathematical literacy abilities before treatment in the experimental class, which only got a score of 54.39, and the control class, 65.91. However, after the treatment, the average score of students' mathematical literacy skills in both classes increased. The experimental class achieved a score of 80.24, while the control class obtained a score of 72.86. This shows an increase in students' understanding and mastery of the material. Furthermore, data on students' mathematical literacy abilities have also been grouped according to the specified categorization criteria. Next, Table 5 presents the results as average scores on each indicator of students' mathematical literacy abilities.

Table 5. Average for Every Indicator Literacy Classroom Mathematics Experiment and Control Class

Description	**Explanation**	**Experimental Class**		**Control Class**		**Ideal Maximum Value**
		Pre-test	*Post-test*	*Pre-test*	*Post-test*	
Indicator 1	Average (%)	18.78 (56.35%)	24.56 (73.69%)	20.83 (62.50%)	23.74 (71.23%)	33.33 (100%)
Indicator 2	Average (%)	21.16 (63.49%)	31.38 (94.15%)	25.51 (76.54%)	27.40 (82.21%)	33.33 (100%)
Indicator 3	Average (%)	14.45 (43.35%)	24.30 (72.91%)	19.57 (58.72%)	21.72 (65.17%)	33.33 (100%)
Amount		54.39	80.24	65.91	72.86	100

The average score for each indicator in Table 5 is calculated by adding up the scores of all students for each indicator, converting it to a scale of 100, and then dividing it by the number of students. For the experimental class, there were 21 students, while the control class had 18 students. Meanwhile, the average value obtained for each indicator is a minimum of 0 to a maximum of 33.33. This score of 33.33 is obtained from the maximum score, namely 100, divided by the number of indicators in the mathematical literacy ability test, namely three. The percentages listed in brackets show the comparison between the average value obtained and the ideal maximum value set for each indicator, namely 33.33, representing 100%. For example, for Indicator 1, the average *pretest score* in the experimental class is 18.78, equivalent to 56.35% of the ideal maximum score. This shows that students at the *pretest stage* achieved 56.35% of the maximum expected target for this indicator. After implementing the learning model, the average *posttest score* increased to 24.56, or 73.69% of the ideal maximum score.

Based on Table 5, the average *pretest score* for mathematical literacy skills in the experimental class that uses the STEM-based problem-based learning model is relatively low. In indicator 1 (identifying relevant information to solve problems and formulating situations mathematically using symbols, pictures, or mathematical modeling), students only achieved an average score of 18.78 (56.35%). Indicator 2 (applying concepts, facts, procedures, and mathematical reasoning to solve problems) has an average of 21.16 (63.49%). Meanwhile, for indicator 3 (interpreting mathematical solutions into the context of the problem by providing appropriate reasons for the mathematical solutions obtained), the average value is only 14.45 (43.35%). The average value for each indicator in the control class, which uses the problem-based learning model, is also similar. In indicator 1, the average student score was 20.83 (62.50%), indicator 2 reached 25.51 (76.54%), and indicator 3 was 19.57 (58.72%). After *the posttest*, the experimental class showed significant improvement in all indicators. In indicator 1, the average value increased to 24.56 (73.69%), indicator 2 rose to 31.38 (94.15%), and indicator 3 became 24.30 (72.91%). This increase was more significant compared to the control class, where the average posttest score for indicator 1 was 23.74 (71.23%), indicator 2 was 27.40 (82.21%), and indicator 3 was 21.72 (65.17%). Overall, the STEM-based problem-based learning model in the experimental class is more effective in improving students' mathematical literacy skills than the PBL model in the control class. The increase in indicators 1, 2, and 3 in the experimental class was 5.78, 10.22, and 9.85 points, respectively, while in the control class, it was only 2.91, 1.89, and 2.15 points.

Furthermore, *posttest data* on mathematical literacy skills have also been grouped according to the categorization criteria established in this research. The distribution of the results of grouping data on students' mathematical literacy abilities in the experimental class with learning treatment using a STEM-based *problem-based learning model*, namely, eight students (38.10%) have very high ability, six students (28.57%) have high ability, two students (9.52%) have medium ability, and five students (23.81%) have low. Meanwhile, in the control class, the average value of students' mathematical literacy skills was in the low category, namely 72.86. The data distribution is based on categorization, namely 0 students (0%) are in the very high category, two students (11.11%) are in the high category, nine students (50%) are in the medium category, and seven students (38.89%) is in the low category.

This research uses a STEM-based *problem-based learning model focusing* on solving real problems in a STEM context using rectangular and triangular shapes. This is in line with Wahono et al. (2020, p. 1), who state that STEM education emphasizes the integration of science, technology, mathematics, and engineering to overcome challenges in the real world. In the applied learning context, students are invited to use the Engineering Design Process (EDP*)* to (Argianti & Andayani, 2021, p. 218) solve problems such as calculating the area, perimeter, or geometric properties of flat shapes. Through STEM-based learning, students are taught to learn actively by collaborating, conducting experiments, and applying mathematical concepts in practical contexts. This approach helps students deepen their understanding and develop mathematical literacy skills. This aligns with the Maryland State Department of Education's (2012) view that STEM education integrates science, technology, engineering, and mathematics to train students in cooperation, problem-solving, research, and thinking logically.

In each learning session, the teacher presents students with problems related to the STEM context. It is essential to present problems with a STEM context in mathematics learning, especially in flat figures such as quadrilaterals and triangles. These problems show how mathematics can be applied in everyday life. Additionally, by introducing these problems, students can see how mathematical concepts are used to solve practical problems such as designing buildings, calculating land area, or measuring objects in the real world. STEM-based learning improves students' understanding of mathematics and helps students develop critical thinking skills, solve problems, and apply knowledge in a broader range of situations. This also helps improve students' mathematical literacy skills. Thus, learning mathematics in a STEM context makes the material more engaging, relevant, and beneficial for students' development in facing future challenges.

Research conducted by Yıldırım & Sidekli (2018) found that the application of STEM in learning has a positive influence on improving mathematical literacy skills. This is in line with research by Kelana et al. (2020, p. 4), which reveals that mathematical literacy skills increase because, along with the implementation of STEM-based learning, students learn to use analytical skills, provide reasons, communicate ideas effectively, and interpret solutions based on calculations and data mathematically. To align STEM education with learning, an innovative model that fits the characteristics of STEM education is needed. One relevant model is problem-based learning. Su (2024) states that problem-based learning in STEM education is believed to improve student learning achievement and help students develop practical skills essential for a better career. Research by Andini and Siregar (2024, p. 118) shows that problem-based learning significantly improves students' mathematical literacy skills. This improvement is influenced by students' active involvement in solving real-world problems, collaborative learning that encourages discussion and critical thinking, and using real contexts to apply mathematical concepts.

Smith et al. (2022, p. 5) explain that using PBL in learning allows students to combine knowledge from various STEM fields, develop problem-solving skills, and think critically by working together in small groups in accurate and relevant contexts. PBL-STEM also helps students understand the connection between what students learn, how students learn, and how that knowledge can be applied in the real world. Ilwandri et al. (2023) revealed that the *Problem-Based Learning* -STEM model significantly influenced students' 21st-century skills. Other studies, such as Wijayanti and Rochmad (2023), supported this research, which found that problem-based learning with STEM modules improved students' mathematical communication skills. Hidayati et al. (2024) also show that PBL integrated with STEM improves students' problem-solving abilities. In addition, Vistara et al. (2022) found that the *problem-based learning model* integrated with STEM could develop students' creative thinking abilities. Musyafak and Agoestanto (2022) reported that PBL-based teaching materials with numeracy literacy questions with STEM elements can improve students' critical thinking abilities. Siswandari et al. (2021, p. 606) reinforce these findings by stating that problem-based learning that integrates STEM helps students face real-life problems and develop problem-solving and mathematical reasoning skills, which are the core of mathematical literacy abilities.

Conclusion

Based on the research results and discussion description, it was concluded that mathematics learning using a STEM-based *problem-based learning model* influences students' mathematical literacy abilities. This result is seen from *an independent t-sample t-test* on *the assumed equal variance,* where the t-value is 5.912. This value is greater than 0, and *the Sig value. (2-tailed)* of 0.000 because So it was rejected. It can be concluded that mathematics learning using a STEM-based *problem-based learning model* affects students' mathematical literacy abilities. This learning is superior to ordinary *problem-based learning models* in terms of the average increase in students' mathematical literacy abilities at one of the private junior high schools in Batam City on quadrilateral and triangle plane shapes.

After conducting the research, analyzing the data, and discussing the results, the researcher gave several suggestions. Based on the findings in the research, taking into account the limitations of the research, the suggestions that can be concluded are as follows: (1) It is recommended for teachers to combine learning with *problems. Based learning* or STEM-based learning with learning media that is appropriate to the learning material ; (2) It is hoped that policyholders will conduct training for teachers regarding the use of STEM-based *problem-based learning models* in mathematics learning and (3) It is recommended for researchers to study mathematics learning using STEM-based *problem-based learning models* from different aspects to enrich the study of mathematics learning further using STEM-based *problem-based learning models.*

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