Students’ Learning Interest and Mathematical Literacy in Geometry: Evidence from Contextual Teaching and Learning at the Junior High School Level

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https://doi.org/10.17977/um065.v6.i7.2026.3

Article history
Submitted: 12 April 2026
Revised: 13 May 2026
Accepted: 14 May 2026
Published: 16 May 2026

Keywords
Contextual teaching and learning
Mathematical literacy
Students’ learning interest

Abstract
One of the problems in mathematics learning is the low level of students’ learning interest. Furthermore, the standard of education in Indonesia has not yet reached the level achieved by several other nations, as reflected in Indonesia’s scores and rankings in the PISA survey, which include mathematical literacy. The objective of this study is to assess the application of the Contextual Teaching and Learning (CTL) approach in the learning process to enhance students’ learning interest and mathematical literacy. This study employed a quasi-experimental design using a pretest–posttest control group framework. The participants comprised junior high school students from a public school in Yogyakarta, and two eight-grade groups as the sample, designated as the experimental and control groups. The instruments used were a learning interest questionnaire, a mathematical literacy test, and an observation sheet. Data were analyzed using Hotelling’s Trace and a one-sample t-test at a 5% significance threshold. The findings confirmed that CTL and expository approaches can enhance students’ learning interest and mathematical literacy. Furthermore, the comparative analysis revealed that the CTL approach demonstrated more optimal outcomes and had a significant impact compared to the expository approach in enhancing students’ learning interest and mathematical literacy.

1. Introduction

Mathematical literacy skills has become a focal point for the Ministry of Education, as it serves as a reflection of the nation's educational quality. Moreover, this competency is also assessed through the PISA (Programme for International Student Assessment) assessment organized by the Organisation for Economic Co-operation and Development (OECD) (OECD, 2023a). Based on the PISA surveys from 2003 to 2022, it is evident that Indonesian students' mathematical literacy remains a concern. According to the 2003 PISA results, the average performance of Indonesian students was 360. This increased to 391 in 2006 but dropped to 379 in 2018, and declined further to 366 in the most recent 2022 survey (OECD, 2019; OECD, 2023b) . These fluctuating results show a general downward trend in the PISA scores of Indonesian students. In terms of ranking, Indonesia remains among the lowest-performing countries, although there was a slight improvement in 2022, moving from 72nd to 66th place out of 81 participating countries. Considering the PISA scores and rankings over the years, it is essential to implement instructional strategies that can enhance students’ mathematical literacy skills. While the national curriculum does not fully align with PISA-style questions, which often focus on real-world problem-solving, adjustments in group room instruction are necessary. Observations and interviews conducted at a junior high school in Yogyakarta revealed that mathematics teaching is still largely dominated by expository methods. This method has become a learning culture in Indonesia because the majority of educational institutions use this method. This method can be good for teaching or transferring knowledge to students, but not for making students understand deeply or better known as meaningful learning. This method tends to be teacher-centered not student-centered and does not encourage students to build their ideas and knowledge independently as in constructivist learning theory. In fact, student-centered learning can improve student achievement (Salsabila, 2024). In addition, expository method is also a form of teacher response to the Indonesian education culture that is oriented towards exam results rather than how the learning process takes place. So, we cannot blame anyone because the Indonesian education system is still developing continuously and hopes that there will be a system that is most suitable for Indonesian students.

This expository method is one of the reasons why students’ learning interest is low because they are not active in learning activities according to the interview results, the teacher stated that students' interest in learning was still low. The lack of student’s interest or motivation is considered to stem from pedagogical factors (Kang et al., 2023). This was evident from their enthusiasm and motivation during mathematics lessons, as well as from their learning outcomes at the end of the instructional process. Therefore, a more varied instructional

ISSN: 2797-3174

approach is needed. Alternative teaching approaches that promote active student participation and support the development of mathematical literacy are needed. Since PISA-type problems typically involve real-life problem-solving, active engagement in learning is critical. Furthermore, interviews with mathematics teachers indicated that students' interest in learning mathematics is still low, as seen in their lack of group room engagement.

To address these issues, a mathematics teaching pedagogical approach that fosters both learning interest and mathematical literacy among students is necessary. Various instructional strategies can foster student engagement and interest, one of which is the Contextual Teaching and Learning (CTL) approach. CTL is a teaching strategy that emphasizes students' active involvement in discovering learning materials and connecting them with real-life situations (Ester et al., 2023). CTL also enables students to apply mathematics in daily life (Junianto & Wutsqa, 2019). It places students at the center of the learning activities rather than positioning the teacher as the primary source of knowledge (Sadilah & Winarto, 2021). This student-centered approach is expected to increase student engagement during group room activities. Consequently, the CTL approach may enhance students' mathematical literacy. Students tend to show greater learning interest when they are actively engaged in the learning process and facilitate their ability to solve problems. Previous research also indicates that the CTL approach positively affects students' learning interest (Sawitri et al., 2024). According to OECD (OECD, 2023a) mathematical literacy is understood as students' ability to think mathematically and to formulate, use, and interpret mathematics when addressing problems in diverse real-world contexts.

PISA assesses students' performances in mathematics through questions related to: (1) Mathematical reasoning and problem-solving processes: Includes the mathematical processes that describe what individuals do to connect the context of the problem with mathematics and thus solve the problem, (2) content dimension, four categories are identified: change and relationships, quantity, space and shape, and uncertainty and data, (3) the context dimension describes the real-world domains in which individuals encounter the problems (OECD, 2023a). Mathematical literacy also refers to the ability to understand problems, plan, analyze and use them in an individual's daily life (Isnaniah et al., 2021). There are five key components of mathematical literacy: problem solving, communication, connection, reasoning, and representation (Hasanah & Hakim, 2022). These competencies are essential for students to make use of mathematics in solving real-life problems. The consistently low PISA scores of Indonesian students over the years indicate that their abilities in these five areas require significant improvement. Enhancing students' mathematical literacy involves understanding instructional models and strategies, particularly those that connect mathematical concepts to real-world situations (Samosir, 2022). Mathematical literacy also enables students to apply the basic mathematical knowledge they have learned to solve problems in situations encountered in daily life (Junianto & Wijaya, 2019).

Mathematical literacy is crucial not only for mastering content but also for developing students' reasoning skills, conceptual understanding, factual knowledge, and problem-solving abilities in everyday contexts. In line with Niken (Sulfayanti, 2023), who said that these abilities include mathematical reasoning that entails applying mathematical concepts, procedures, facts, and tools to explain, describe, and predict various phenomena. Students who have good mathematical literacy skills are better prepared to understand the mathematical ideas they learn at school (Dhani et al., 2025). Furthermore, students are expected to communicate and describe real-life situations using mathematical concepts (Suciawati et al., 2023). Mathematical literacy assessment encompasses the ability to formulate, apply, and interpret mathematics in various contexts, use mathematical reasoning to explain and predict phenomena, and apply mathematical literacy in daily life (Hidayat et al., 2025). PISA scores also reflect the overall quality of a country's education system, suggesting a strong correlation between a nation's performance in the PISA survey and the quality of its education (Sulfayanti, 2023).

In addition to mathematical literacy, students' learning interest is also a critical factor in academic success. Interest can be defined as a sense of enjoyment and attraction toward an activity, without external pressure (Sawitri et al., 2024). Students' learning interest refers to an individual's motivation to engage in learning activities due to positive feelings or enjoyment derived from the process (Setyani et al., 2022). Another definition of students' learning interest is the desire to engage in learning because of personal enjoyment and attraction to the task itself (Siregar et al., 2022). The Contextual Teaching and Learning (CTL) approach is considered a suitable alternative to enhance students' learning interest. Research shows that CTL improves students' learning interest in mathematics by highlighting the relevance and application of mathematics to everyday life (Anggraini et al., 2024). As stated in (Muliani et al., 2022) noted that students' learning interest can be enhanced through constructivist approaches, one of which is CTL.

Contextual Teaching and Learning (CTL) is an instructional approach that helps teachers connect the subject matter with real-world situations (Artini, 2022). Contextual Teaching and Learning (CTL) is an instructional strategy that emphasizes full student involvement in discovering learning materials and relating them to real-life situations (Ester et al., 2023). CTL includes several key components: constructivism, inquiry, questioning, learning community, modelling, reflection, and authentic assessment (Sawitri et al., 2024). In constructivism theory, teachers are not tasked with transferring knowledge but as facilitators in learning who are tasked with facilitating students so that students are able to build their own initial (Anggraini et al., 2024). Students also have the opportunity to develop and apply ideas independently so that student understanding is

ISSN: 2797-3174

more meaningful. CTL can improve problem-solving skills which are an important aspect of mathematical literacy which means it is very relevant to improve mathematical literacy (Sofyan et al., 2025). In addition, CTL also emphasizes the active participation of all students and connects the material to real-world situations.

CTL has several advantages, including: (1) The learning atmosphere will be more enjoyable; (2) Students are more sensitive to their environment; (3) Students will be more confident in conveying their experiences and observations in everyday life; (4) Students will be better prepared to handle challenges that usually arise in everyday life(Ester et al., 2023). Meanwhile, according to Fitri et al. (Handayani et al., 2022) The CTL approach emphasizes that learning becomes more meaningful when students are directly involved in constructing knowledge through active engagement and real experiences, rather than passive reception of information. Previous studies have shown that CTL can effectively improve students' academic performance and mathematical problem-solving abilities (Artini, 2022; Muslihah & Suryaningrat, 2021). Some advantages of the CTL approach include: (1) creating a more enjoyable learning environment; (2) increasing students' awareness of their surroundings; (3) fostering students' confidence in sharing their experiences and observations from daily life; and (4) better preparing students to face challenges commonly encountered in real-life situations (Ester et al., 2023). Researchers are encouraged to create learning environments that help students recognize their limitations and monitor their mathematics learning within those settings (Uegatani et al., 2024). Therefore, the CTL approach is expected to yield significant improvements in students' learning interest and mathematical literacy.

Based on this background, this study seeks to evaluate the effectiveness of the Contextual Teaching and Learning (CTL) approach in enhancing students' learning interest and mathematical literacy. The findings are expected to contribute to the educational literature and provide educators with an alternative instructional approach to improve student learning outcomes. Furthermore, an increase in students' mathematical literacy is anticipated to raise Indonesia's average PISA score and global ranking in future assessments.

2. Method

The research was undertaken at the junior high school level in Yogyakarta, Indonesia following a preliminary observation and interview with one of the mathematics teachers. The method employed was a quasi-experimental design with a quantitative approach. The population consisted of all students in the selected junior high school, and the sample included two eight-grade groups. Each class consists of 33 mixed male and female students with an average age of 14 years. These two classes were selected based on observations before and recommendations from their teachers. One group was assigned as the experimental group, receiving instruction through the Contextual Teaching and Learning (CTL) approach, while the other served as the control group and received expository approach. The study identified the CTL approach as the independent variable, while the dependent variables were students' learning interest and mathematical literacy.

Quantitative data collection involved two sets of assessments: a pre-test administered before the treatment and a post-test given after the intervention. Each test included a learning interest questionnaire and an essay-based test to assess students' mathematical literacy. Figure 1 present an example of an essay question.

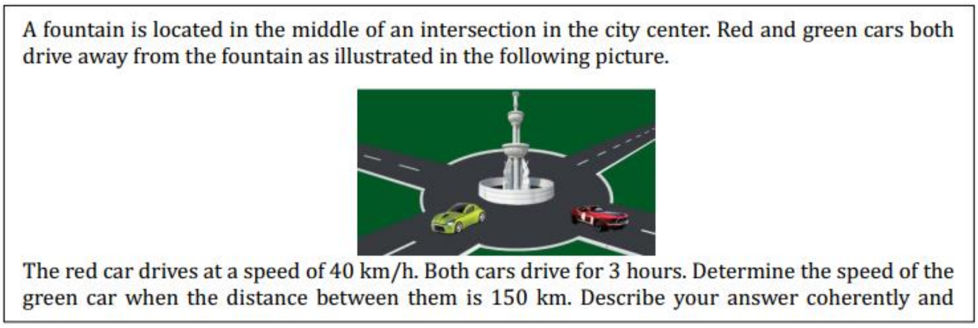

Figure 1. Example of Essay-based Test

Additionally, an observation sheet was used to evaluate the implementation of the instructional process in accordance with the lesson plan. All instruments used in this study were tested for validity and reliability using the Cronbach's alpha coefficient. The questionnaire consisted of 27 items based on indicators of students' learning interest, utilizing a five-point Likert scale with the following options: always, often, sometimes, rarely, and never. The maximum possible score for the questionnaire was 135, and the minimum score was 27. Table 1 are the results of the instrument reliability test.

Table 1. Reliability Statistic

Chronbach's Alpha	N of Items
0.861	27

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Figure 2 is the student's learning interest questionnaire that used for collecting data.

STUDENT LEARNING INTEREST QUESTIONNAIRE

Name: ....
Class: ....
Instructions for Filling Out the Questionnaire:
Please give your response by placing a check mark (√) in the column (option) that applies!
Description:
A : Always
O : Often
S : Sometimes
R : Rarely
N : Never

No	Statement	A	O	S	R	N
1	When something is unclear in math lessons, I ask the teacher.					
2	During lessons, I talk about things unrelated to the lesson.					
3	I work on math problem applications.					
4	In learning math, I don't study materials that haven't been explained yet.					
5	I learn math because I'm interested in the topic.					
6	I pay full attention during math lessons.					
7	Besides at school, I also set aside time to study math at home.					
8	After school, I review the material learned at school.					
9	I don't do the homework/tasks given by the teacher.					
10	Before attending math lessons, I review previous lessons.					
11	When I have math homework, I copy my friend's work.					
12	I don't ask the teacher or friends when I don't understand during class.					
13	I only study math when there is a test.					
14	If the homework is difficult, I don't do it even if a friend offers to help.					
15	I choose not to do assignments if they are too difficult.					
16	After lessons, I enjoy math more.					
17	I pay attention to the teacher's explanation so I don't fall behind.					
18	I don't complain when the teacher gives assignments.					
19	If I get a low score on an assignment, I don't want to redo it.					
20	I enjoy doing group assignments.					
21	I can't concentrate well during lessons.					
22	I answer the teacher's questions during lessons.					
23	I stay quiet during class discussions.					
24	I am happy when math class is canceled.					
25	Before lessons, I study the material that will be covered in school.					
26	If I have difficulty with assignments, I try to study with smarter friends.					
27	I am enthusiastic and excited during math lessons.					

Figure 2. Students' Learning Interest Questionnaire

Based on Table 1, the instrument is considered reliable as the Cronbach's alpha coefficient exceeds 0.5. To examine the effect of the CTL approach on students' learning interest. As shown in Table 1, the instrument demonstrated acceptable reliability, with a Cronbach's alpha coefficient exceeding 0.50. To investigate the effect of the CTL approach on students' learning interest and mathematical literacy, further on the sample t-test statistical analysis was conducted by assistance of SPSS software. The CTL approach is considered effective if the significance value of the t-test is less than the alpha level (0.05). The data on students' learning interest were converted into quantitative data using the criteria presented in Table 2.

Table 2. Conversion Means Score of Interest

Formula	Score Interval	Categories
$x > \bar{X}i + 1.8\ Sb_i$	$x > 113$	Very High
$\bar{X}i + 0.6\ Sb_i < x \leq \bar{X}i + 1.8 Sb_i$	$91 < x < 113$	High
$\bar{X}i - 0.6\ Sb_i < x \leq \bar{X}i + 0.6 Sb_i$	$70 < x < 91$	Medium
$\bar{X}i - 1.8\ Sb_i < x \leq \bar{X}i - 0.6 Sb_i$	$48 < x < 70$	Low
$x \leq \bar{X}i - 1.8\ Sb_i$	$x \leq 48$	Very Low

The students' learning interest scores are considered effective if the average score falls within the high category ($91 < x < 113$), while students' mathematical literacy scores are considered effective if the group average reaches at least 75, in accordance with the school's minimum mastery standards. Prior to conducting the effectiveness test, the data were first subjected to normality and homogeneity testing. The normality test used was the one-sample Kolmogorov-Smirnov test, and homogeneity was assessed using Levene's statistic. If both assumptions were met, the analysis continued with a mean difference test between the two groups. If a significant difference was found, the effectiveness of the CTL approach on students' learning interest and mathematical literacy was then further evaluated.

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3. Results and Discussion

3.1. Results

The instruments that had been tested for validity and reliability were then administered to students before and after the treatment. Table 3 and Table 4 presents the pre-test and post-test data on students' learning interest and mathematical literacy. Table 4 show that students' learning interest and mathematical literacy improved after the treatment was applied to both the experimental and control group. Subsequently, further data analysis is required to determine the effectiveness of the instruction. The first data analysis involves assumption testing, including normality and multivariate homogeneity tests. Normality testing was conducted by calculating the Mahalanobis distance and the chi-square value with the assistance of SPSS software (see Table 5).

Table 3. Student's Learning Interest Data

Description	Experimental group		Control group	
	Pre-test	Post-test	Pre-test	Post-test
Average	88.47	104.20	89.91	97.71
Minimum Score	66.00	80.00	64.00	62.00
Maximum Score	116.00	124.00	130.00	125.00

Table 4. Mathematical Literacy Data

Description	Experimental group		Control group	
	Pre-test	Post-test	Pre-test	Post-test
Average	57.17	86.21	51.53	80.20
Minimum Score	0	0	0	0
Maximum Score	100	100	100	100

Table 5. Normality Test Results

Group	Data	Pearson's Coefficient of Correlation	Sig (2-tailed)
Experimental Group	Pre-test	0.988	0.000
	Post-test	0.984	0.000
Control Group	Pre-test	0.973	0.000
	Post-test	0.980	0.000

Statistical analysis indicates a significance value of both classes less than alpha (0.05), indicating a significant correlation. This suggests that the data are derived from a sample with a normal distribution. The Table 6 summarizes the results of the homogeneity test.

Table 6. Homogeneity Result

	Pre-test	Post-test
Box's M	7.976	1.826
F	2.571	5.747
Sig.	0.052	0.061

The results demonstrated that the significance value of Box's M is greater than 0.05, indicating that the assumption of homogeneity of covariance matrices is met for both the pre-test and post-test data. After the assumption tests were satisfied, the effectiveness test of the instruction proceeded.

The effectiveness of the instruction was tested after both groups underwent a paired sample mean difference test using Hotelling's T-squared. Table 7 present the results.

Table 7. Paired Sample Average Vector Result

	Value	Exact F	Hypoth. DF	Sig. of F
Experimental group	5.54	88.71	2.00	0.000
Control group	3.61	57.83	2.00	0.000

The Hotelling's T-squared test value is less than 0.05, indicating that there is a mean difference between the pre-test and post-test for each group. Therefore, a post-hoc test is necessary to determine the effectiveness of the experimental and control groups. Table 8 and Table 9 present the results of the effectiveness test for both groups.

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Table 8. One Sample t-test Value Experimental group

Variable	T	Sig. (2-tailed)
Students' Learning Interest	5.997	0.000
Mathematical Literacy	6.219	0.000

Table 9. One Sample t-test Value Control group

Variable	t	Sig. (2-tailed)
Students' Learning Interest	2.413	0.022
Mathematical Literacy	2.211	0.034

Table 8 and Table 9 show that the significance value is less than 0.05, so H_0 is rejected. Overall, the results demonstrate that both teaching approaches are effective in improving students' learning interest and mathematical literacy. Next, it is necessary to conduct an effectiveness test between the two groups to determine which approach is more effective.

Table 10 present the results of the independent sample t-test for both groups. As shown in Table 10, the p-value is lower than the alpha level (0.05); therefore, the null hypothesis is rejected. These results indicate that the Contextual Teaching and Learning (CTL) approach is more effective than the expository approach in enhancing students' learning interest and mathematical literacy.

Table 10. Independent Sample T-test Result

Variable	t	Sig. (2-tailed)
Students' Learning Interest	2.111	0.039
Mathematical Literacy	2.021	0.047

3.2. Discussion

This study aimed to examine the effectiveness of the Contextual Teaching and Learning (CTL) approach in enhancing students' learning interest and mathematical literacy. Problems in geometry are essential for supporting effective mathematics teaching and learning (Kar et al., 2026). The research was conducted among eight-grade students at a junior high school in Yogyakarta, especially in geometry. Data obtained before and after treatment from the experimental and control groups became the primary data source to assess the effectiveness of the learning approach. The application of the CTL approach has a significant effect on students' learning interest and mathematical literacy that in line with previous relevant studies (Sawitri et al., 2024) (Aulia et al., 2024). Before the posttest data analysis was carried out, the pretest data had been tested for differences in average which showed that the two groups did not have a difference in average initial ability. This means that students in both groups have the same initial ability. Based on the posttest results, the average score of students' learning interest in the experimental group was 6.49 points higher than the control group. The average mathematical literacy score of students in the experimental group was 6.01 higher than the control group. This data was then confirmed by analysis using SPSS which showed the level of effectiveness of the CTL approach.

Based on the results of the data analysis, CTL is more effective in increasing students' interest and mathematical literacy because CTL teaches contextual problems. This is in line with the questions tested in the PISA survey. PISA-type questions are also problem-solving questions in a real-world context (OECD, 2023a). With the contextuality of real-world problems, students are also more interested in learning mathematics because they know the benefits of the knowledge they are learning. Students' interest in learning also makes them active in group discussion activities. They learn to build their knowledge through peer discussions. Learning becomes student-centered and students truly become the subject of learning (Salsabila, 2024). This is different from the control group which focuses learning on the teacher and students become the object of learning. Students tend to be passive and there is no discussion because the expository method emphasizes the process of transferring knowledge from teacher to student.

Previous research shows that CTL is able to enhance students' interest in learning (Sawitri et al., 2024). Students' interest in learning increases with the application of differentiated learning (Iim et al., 2025). Other research also shows that CTL is effective in increasing students' interest in learning and is more effective when compared to PBL (Junianto & Wutsqa, 2019). Contextual Teaching and Learning (CTL) has been proven to be effective in increasing students' numeracy literacy skills which are also indicators of students' mathematical literacy (Aulia et al., 2024). It same with other research that student's numeracy skills improved after the implementation of learning based on contextual materials dan problems related to daily life (Rosita et al., 2026). Research by Sawitri et al (2024), testing the effect of CTL on interest in learning and descriptive writing skills has slight differences in terms of the variables tested in this study. However, there are similarities in interest in learning and the test analysis carried out, namely with the t-test. However, the study showed that CTL has a

ISSN: 2797-3174

positive effect on students' interest in learning. Student interest in learning also increased in research by Iim et al. (2025) with the application of differentiated learning based on Problem Based Learning, where PBL has an intersection with CTL in terms of the contextuality of the problems given, namely in accordance with real life problems. Meanwhile, research by Junianto and Dhoriva (2019) specifically compared the effectiveness of CTL and PBL on students' learning interest, which showed that CTL was significant in increasing students' learning interest. The results of Deddy et al.'s research (Sofyan et al., 2025) also found that students' mathematical literacy skills increased in the application of the CTL model. The findings of relevant research then became one of the references that were also in line with the results of this study.

3.3. Implications

These findings reinforce the Contextual Teaching and Learning (CTL) approach and constructivist perspectives that emphasize active student engagement in learning. Practically, student-centered and contextual learning has been shown to effectively enhance students' learning interest and mathematical literacy, highlighting the teacher's role as a facilitator. From a policy perspective, the results support integrating CTL into curricula and teacher professional development. Overall, student engagement and the relevance of learning to real-life contexts are key factors in achieving successful learning outcomes.

3.4. Limitations

The study conducted has several limitations that can be addressed by future researchers who wish to investigate similar variables. Some of the limitations of this study include: 1) the mathematical literacy variable focuses only on the Pythagorean theorem material, so other researchers may apply it to different topics; 2) the learning interest questionnaire is sometimes filled out by students in a way that does not reflect their true situation, so future researchers could ask respondents to complete the questionnaire based on their actual circumstances.

4. Conclusion

The analysis revealed that both the CTL and expository approaches showed effectiveness with respect to students' learning interest and mathematical literacy. CTL approach with several advantages has been proven to be able to enhance students' learning interest and mathematical literacy. Student-centered learning and discussion play a significant role in enhancing students' learning interest and mathematical literacy. Students learn to construct their knowledge and teachers as learning facilitators rather than transferring knowledge. Students become more enthusiastic in learning and make them understand the material in depth. The evidence from this study suggests that student involvement in learning and the use of appropriate learning strategies support the achievement of learning success. The relevance of problems to students' real lives is an advantage of CTL which is confirmed to significantly increase students' learning interest and mathematical literacy when compared to the expository approach.

Author Contributions

All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

Funding

This research publication was carried out with the support of a research publication grant provided by the Ministry of Higher Education, Research, and Technology of Indonesia.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/ or publication of this article.

Data Availability

The datasets generated during and/ or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript.

ISSN: 2797-3174

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