© 2026 Sari et al. This article follows the Open Access policy of CC BY NC under CC v 4.0.

Submitted: 09/07/2026 - Accepted: 12/08/2026 - Published: 28/09/2026

Learning Contexts and Creative Attitudes in Mathematics: Evidence from Local Instruction Theory through Problem-Based Learning

Nilam Sari[1,2*], Sahat Saragih[1], E. Elvis Napitupulu[1]

[1]Universitas Negeri Medan, Medan, Indonesia
[2]Universitas Quality, Medan, Indonesia
*nilamsarie@gmail.com

DOI: 10.26417/zlprw57f

Abstract

This study examines the relationship between students' perceptions of a Local Instruction Theory (LIT) implemented through Problem-Based Learning (PBL) and their creative attitudes in junior high school mathematics. Drawing on a social-educational perspective, the study treats creative attitudes as an affective dimension of learning that can be shaped by the interaction of instructional design, peer discussion, teacher facilitation, and students' opportunities to explore and justify alternative solutions. A quantitative correlational design was used with 24 junior high school students in Medan, Indonesia, selected purposively because they participated in a five-week LIT-PBL learning program. Data were collected using a 20-item student-response questionnaire and a creative-attitude scale. The reported validity coefficients were 0.79 for the student-response instrument and 0.76 for the creative-attitude scale, while intraclass correlation coefficients were 0.783 and 0.824, respectively. Descriptive results showed a mean student-response score of 67.13 and a mean creative-attitude score of 79.88 on a 0–100 scale. Simple linear regression indicated a statistically significant positive relationship between students' responses to LIT-PBL and creative attitudes, $R = .623$, $R^2 = .388$, $F(1,22) = 13.976$, $p = .001$. Thus, students' responses to the LIT-PBL learning context accounted for 38.8% of the observed variance in creative-attitude scores in this sample. The findings are interpreted as evidence of a meaningful association rather than a causal effect because the study used a single-group correlational design and did not include a comparison group. The study contributes to educational psychology and mathematics education by showing how a context-responsive, problem-based classroom can provide social and instructional conditions that support

students' willingness to explore ideas, communicate alternative solutions, and engage with challenging mathematical problems.

Keywords: creative attitude, Local Instruction Theory, problem-based learning, educational psychology, classroom climate, student engagement, mathematics education

1. Introduction

Creativity is increasingly understood as an educational capacity with cognitive, affective, interpersonal, and contextual dimensions. Contemporary education is expected not only to transmit established knowledge but also to prepare learners to generate and evaluate ideas, adapt to unfamiliar situations, participate constructively in social settings, and contribute to innovation. From a social-science perspective, access to opportunities for creative participation is also an educational-equity issue: students who learn in classrooms where questioning, alternative strategies, and intellectual risk-taking are supported may have greater opportunities to develop and express creative dispositions than students who experience highly restrictive learning environments. The OECD's PISA 2022 creative-thinking assessment defines creative thinking as the capacity to generate diverse and original ideas and to evaluate and improve ideas, and reports associations between creative-thinking performance and students' attitudes, social-emotional characteristics, socioeconomic profile, and school environment (OECD, 2024a). In Indonesia, the broader policy discourse on education similarly places increasing emphasis on student agency, foundational competencies, formative assessment, and twenty-first-century skills (OECD, 2024b). These developments position creativity not simply as an individual talent but as an educational outcome shaped by the opportunities and conditions provided by schools and classrooms.

In mathematics education, creativity has often been examined primarily as a cognitive performance, whereas the affective and social conditions that enable students to persist, take reasonable intellectual risks, ask questions, and express unconventional ideas have received comparatively less attention. Research on mathematical creativity shows substantial variation in conceptualization and measurement, including open-ended tasks, questionnaires, and creativity tests, and emphasizes the importance of reporting clear evidence of validity and reliability for creativity-related measures (Joklitschke et al., 2022; Suherman & Vidákovich, 2022). Examining creative attitudes is therefore important because students may possess relevant mathematical knowledge but hesitate to use it flexibly when classroom norms privilege a single correct answer or treat mistakes as failure. Educational psychology provides a useful bridge to the social sciences. Social cognitive theory explains learning and behavior through reciprocal relations among personal factors, behavior, and environment (Bandura, 1986), while self-determination theory emphasizes autonomy, competence, and relatedness as conditions that support motivated

engagement (Deci & Ryan, 2000). Together, these perspectives suggest that creative attitudes should be considered not only as individual dispositions but also as dispositions that can be supported or constrained by the social organization of learning.

Problem-Based Learning (PBL) provides one such social and instructional environment. PBL places students in situations in which they identify relevant information, discuss possible approaches, construct explanations, and evaluate solutions. These activities make mathematical learning simultaneously cognitive and social because students develop, communicate, and revise ideas through interaction with peers and teacher facilitation (Hmelo-Silver, 2004; Hmelo-Silver & Barrows, 2008). In this setting, students have opportunities to experience different viewpoints, negotiate meanings, justify decisions, and learn that more than one strategy can be mathematically legitimate. Such interaction is relevant to educational equity because participatory classroom structures can widen opportunities for students to voice their reasoning rather than reserving mathematical authority primarily for the teacher or for students who are already confident. Meta-analytic and review evidence has reported positive relationships between PBL, mathematical creativity, higher-order thinking, communication, and collaborative problem solving (Yunita et al., 2020; Kurniati & Sutiarso, 2021; Fitriyah et al., 2022; Ceballos et al., 2026).

Local Instruction Theory (LIT) offers a complementary instructional-design perspective. LIT describes a hypothesized learning trajectory for a specific mathematical topic and is developed through cycles of design, experimentation, analysis, and revision (Gravemeijer, 1994; Gravemeijer & Van Eerde, 2009; Prahmana, 2017). Its relevance to the present study is not that it is 'local' only in a geographical sense, but that it is responsive to the learning context: the mathematical topic, students' prior knowledge, anticipated strategies, classroom interactions, and instructional supports. When LIT is enacted through PBL, context responsiveness can be combined with collaborative inquiry. This integration can create a learning environment in which students are expected not merely to obtain an answer but to explain, compare, revise, and communicate mathematical ideas. In social-educational terms, the learning trajectory becomes a means of structuring access to meaningful participation: instructional support can be planned around anticipated difficulties while students retain opportunities to make mathematical decisions and contribute to collective problem solving.

The social dimension is particularly important because creative attitudes are partly expressed through participation in collective learning. A student who asks a question, proposes an alternative strategy, persists after an unsuccessful attempt, or communicates an unusual idea is participating in a social process of learning and meaning making. Supportive teacher-student and peer relationships can influence students' confidence, willingness to participate, and perceptions of whether their ideas are valued. Recent research on classroom climate likewise conceptualizes open and supportive classroom environments as developmental resources because

opportunities to encounter diverse perspectives and receive teacher support are related to students' adaptive development (Rapa et al., 2026). Thus, the present study positions creative attitudes at the intersection of mathematics education, educational psychology, and the social organization of classroom learning. This framing also provides a cautious connection to educational equity: while the study does not measure inequality directly, it highlights the importance of examining whether instructional environments provide comparable opportunities for different students to participate, express ideas, and experience competence in mathematics.

The study addresses a practical, theoretical, and social-educational gap. Practically, there is a need for mathematics learning environments that combine meaningful problems with instructional trajectories responsive to students' learning needs. Theoretically, there is a need to explain how an instructional design such as LIT-PBL may relate to affective dimensions of learning through social interaction, teacher support, and classroom conditions. Socially, understanding these relationships is relevant to educational systems seeking to develop students who can participate confidently in collaborative problem solving and contribute to innovation. However, the present study does not directly measure socioeconomic inequality, cultural identity, or national policy outcomes. Its contribution is therefore framed at the classroom and educational-psychology levels, with implications for equity and educational policy presented as directions for future research rather than as direct empirical findings.

Research question

What is the relationship between students' responses to Local Instruction Theory implemented through Problem-Based Learning and their creative attitudes in junior high school mathematics?

Research objective

The study aims to determine whether students' responses to the LIT-PBL learning context significantly predict variation in creative-attitude scores, and to interpret the finding through social-educational and educational-psychological perspectives.

2. Literature Review

2.1. Creative Attitude as an Affective and Social-Educational Construct

A creative attitude can be understood as a relatively stable tendency to approach situations with curiosity, openness to alternatives, persistence, willingness to take reasonable intellectual risks, and readiness to express and develop ideas. The concept differs from a direct measure of creative performance: creative thinking describes what a learner can produce in a particular task, whereas creative attitude concerns dispositions toward engaging with possibilities and challenges. Munandar (2009) and Uno (2009) identify characteristics such as curiosity, asking questions, generating multiple ideas, expressing opinions, independence, trying new things, and

elaborating ideas. These characteristics are relevant to mathematics because problem solving frequently requires students to tolerate uncertainty, explore more than one strategy, and justify why a solution is valid. From a social-educational perspective, the opportunity to display these dispositions depends partly on whether classroom norms allow students to speak, disagree constructively, make mistakes, and revise their ideas without fear of social penalty.

The social-psychological dimension of creative attitudes is therefore central to this study. Amabile's componential perspective emphasizes the interaction of domain-relevant skills, creativity-relevant processes, and motivation, while Bandura's social cognitive theory emphasizes reciprocal interactions among person, behavior, and environment (Amabile, 1996; Bandura, 1986). Self-determination theory further suggests that motivation is strengthened when learning contexts support autonomy, competence, and relatedness (Deci & Ryan, 2000). These perspectives help explain why a student's creative attitude cannot be interpreted entirely as an internal characteristic: classroom relationships, teacher responses, peer norms, and opportunities for meaningful participation may shape whether students are willing to enact creative dispositions. The construct is consequently treated in this article as an affective disposition that is socially situated and educationally supported, rather than as a fixed personal trait.

Recent international evidence reinforces the importance of context. PISA 2022 examined creative thinking alongside students' attitudes and school environments, indicating that creativity should be understood in relation to the educational settings in which students learn (OECD, 2024a). This perspective is relevant to educational equity because the development of creativity may depend on access to classroom environments that provide opportunities for participation, feedback, and intellectually challenging tasks. A recent study of classroom climate similarly conceptualizes open classroom environments as developmental assets because students' perceptions of teacher support and opportunities for diverse perspectives are connected with adaptive development (Rapa et al., 2026). These findings provide a rationale for studying creative attitudes not as an isolated psychological characteristic but as an outcome potentially related to students' experiences of the social and instructional environment.

2.2. Problem-based Learning and the Social Organization of Mathematical Activity

PBL is a student-centered approach in which learning is organized around meaningful problems rather than around the sequential presentation of isolated procedures. Students investigate the problem, identify what they know and need to know, formulate and test strategies, and communicate and evaluate solutions (Barrows, 1996; Hmelo-Silver, 2004). In mathematics, this organization can shift classroom interaction from teacher explanation and answer checking toward student reasoning, peer discussion, and justification. Research reviews have found positive relationships between PBL and mathematical reasoning and creative thinking (Fitriyah et al., 2022;

Yunita et al., 2020; Kurniati & Sutiarso, 2021). A 2026 bibliometric review also shows continuing international interest in PBL in mathematics, particularly around conceptual understanding, problem solving, and critical thinking (Meiliati et al., 2026).

The social dimension of PBL is central to the present argument. In small-group inquiry, students encounter alternative interpretations and strategies, negotiate meaning, and make their reasoning public to peers. Collaborative problem-solving research indicates that communication quality and open-ended tasks are important design features for higher-order thinking (Ceballos et al., 2026). Thus, PBL can be conceptualized as a social learning structure rather than merely a teaching technique.

2.3. Local Instruction Theory as a Context-Responsive Design Framework

LIT is developed for a specific mathematical domain and describes a conjectured learning trajectory that connects instructional activities with anticipated student thinking. Gravemeijer (1994) and Gravemeijer and Van Eerde (2009) describe design research as a means of building a knowledge base for teaching by iteratively confronting instructional conjectures with classroom activity. Simon (1995) similarly emphasizes hypothetical learning trajectories as tools for planning and revising mathematics instruction. In the present study, LIT is therefore treated as a context-responsive design framework that organizes the sequence and support of mathematical learning activities. Its contribution is expected to arise from the fit between the learning trajectory and students' developing understanding, not from geographical locality alone.

The integration with PBL is theoretically complementary. LIT specifies a trajectory of anticipated mathematical learning, while PBL specifies a social organization in which students investigate and discuss problems. Together, they can support a classroom environment characterized by meaningful challenge, peer interaction, teacher scaffolding, reflection, and multiple solution strategies. This combination is consistent with broader research suggesting that supportive environments and instructional interventions can foster creativity and divergent thinking (Gajda et al., 2017; Ruiz-del-Pino et al., 2022).

2.4. Conceptual Framework

The conceptual framework of this study links instructional context to creative attitudes through a social-educational mechanism. LIT provides a structured but revisable learning trajectory; PBL organizes students' activity around authentic mathematical problems; and classroom interaction provides opportunities for discussion, justification, reflection, feedback, and exposure to alternative strategies. These conditions are expected to be associated with creative attitudes such as curiosity, persistence, independent judgment, willingness to express ideas, and openness to alternative solutions. From a social-science perspective, the framework assumes that students' creative dispositions are enacted within social settings and

may be supported by autonomy, competence, relatedness, teacher support, and equitable opportunities for participation. Bandura's social cognitive theory and self-determination theory are used as interpretive lenses rather than as variables directly tested in the statistical model.

3. Method

3.1. Research Design and Participants

The study used a quantitative correlational design. The original manuscript described the analysis as testing the 'effect' of LIT-PBL; however, because the study used a single group, purposive sampling, post-intervention measures, and no comparison group, causal language is not justified. The revised analysis therefore examines whether students' responses to the implemented LIT-PBL learning context statistically predict variation in creative-attitude scores. The participants were 24 junior high school students in Medan, Indonesia, selected purposively because they participated in the five-week LIT-PBL learning program. The small, non-random sample limits the generalizability of the findings beyond the participating class.

3.2. Intervention and Learning Context

The intervention consisted of five weeks of mathematics learning organized through LIT and enacted using PBL. The learning design was intended to place students in meaningful problem situations, organize collaborative inquiry, guide investigation, support the presentation of solutions, and provide opportunities to analyze and evaluate problem-solving processes. LIT informed the anticipated learning trajectory and instructional supports for the mathematical topic, whereas PBL structured the social organization of classroom activity. The available manuscript materials do not provide sufficient detail to reconstruct every lesson, problem, duration, teacher prompt, or group-composition decision; these details should be added in the final submission if they are available so that the intervention can be replicated.

3.3. Instruments and Operationalization of Creative Attitudes

Two instruments were used. First, a 20-item student-response questionnaire measured students' responses to the implementation of LIT through PBL. Items were rated on a 1–4 Likert scale, with 13 positively worded and 7 negatively worded statements. The observed scores ranged from 55 to 75, with a mean of 67.13 and a standard deviation of 5.24. Second, a creative-attitude scale contained 40 statements (22 positive and 18 negative) with a reported maximum raw score of 200. Scores were converted to a 0–100 scale for analysis; observed scores ranged from 60 to 88, with a mean of 79.88 and a standard deviation of 8.36.

The original manuscript reports validity coefficients of 0.79 for the student-response questionnaire and 0.76 for the creative-attitude scale, and intraclass correlation coefficients (ICC) of 0.783 and 0.824, respectively. These values are retained as reported evidence of instrument quality. However, the manuscript does not fully

specify the validity procedure, the number and expertise of the experts, the scoring rubric, or the exact ICC model. Because validity evidence is context dependent, the final submission should report the precise validation procedure and the construct definition used to develop the items. This information is particularly important because research on mathematical creativity assessment emphasizes the need to report validity and reliability evidence clearly (Suherman & Vidákovich, 2022).

3.4. Data Collection and Analysis

Data were collected after students completed the five-week LIT-PBL learning program. The analysis proceeded in three stages. First, descriptive statistics were used to summarize the student-response and creative-attitude scores. Second, the assumptions for linear regression were examined through residual normality and inspection of linearity. The reported Kolmogorov–Smirnov test for the regression residuals was non-significant ($p = .919$), indicating no evidence against residual normality. Third, simple linear regression was used to examine whether student responses to LIT-PBL statistically predicted creative-attitude scores. Statistical significance was evaluated at $\alpha = .05$, and R^2 was used to describe the proportion of variance accounted for by the predictor. Given the design, the regression results are interpreted as an association rather than as evidence of a causal effect.

3.5. Ethical Considerations

“Ethical approval was obtained from Khairul Imam Middle School in Medan. Participation was voluntary, and informed consent was obtained from the students prior to data collection. Students were informed that participation would not affect their academic grades, and data were reported anonymously.”

4. Results

The purpose of this study was to examine the relationship between students’ responses to Local Instruction Theory (LIT) implemented through the Problem-Based Learning (PBL) model and their creative attitudes in solving mathematical problems. To address this objective, simple linear regression was used to examine whether students’ responses to the LIT-PBL learning context statistically predicted variation in creative-attitude scores. Data on the implementation of LIT through PBL were collected using a student-response questionnaire, whereas data on creative attitudes were collected using a creative-attitude scale at the end of the learning process. The analysis involved descriptive statistics, assumption testing, simple linear regression, and interpretation of the results.

4.1 Descriptive Statistics

Student responses to the LIT-PBL learning context and creative-attitude scores were summarized using descriptive statistics rather than individual-level raw scores. Table 1 presents the sample size, mean, standard deviation, minimum, and maximum for both variables

Table 1. Descriptive Statistics for Study Variables

Variable	N	Mean	SD	Minimum	Maximum
Student response to LIT-PBL	24	67.13	5.24	55	75
Creative attitude (0–100)	24	79.88	8.36	60	88

The student-response scores averaged 67.13 (SD = 5.24; range = 55–75), while creative-attitude scores averaged 79.88 (SD = 8.36; range = 60–88) on the 0–100 scale. These summary statistics describe the distribution of the two variables used in the subsequent regression analysis

4.2 Assumption Test

To address the research question, simple linear regression was used to examine whether students' responses to LIT through PBL were statistically associated with creative-attitude scores. Before conducting the regression analysis, the assumptions required for linear regression were examined. These tests included residual normality and linearity.

Residual Normality

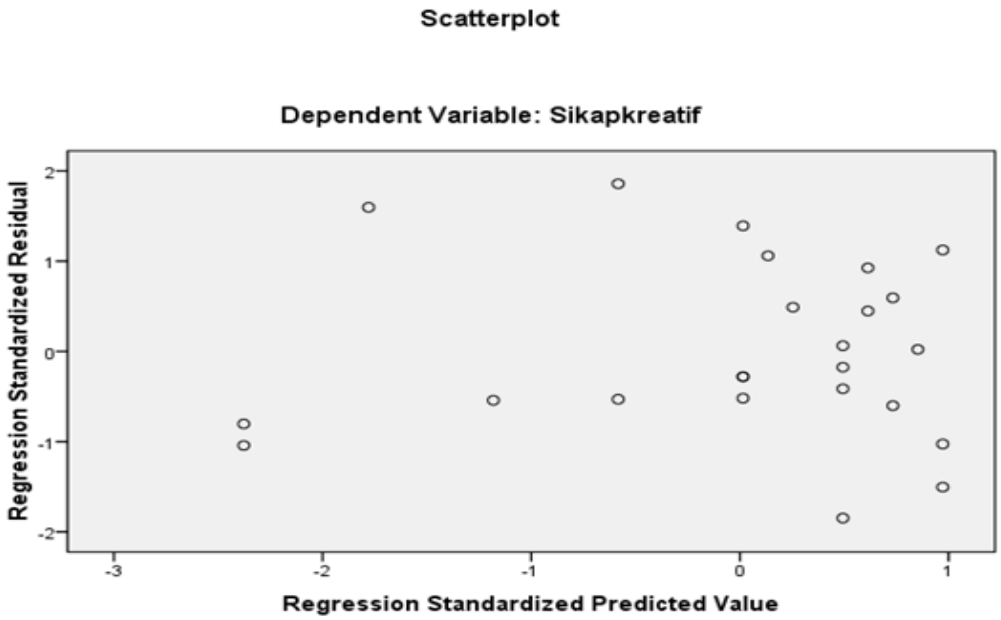
Residual normality was assessed using the Kolmogorov–Smirnov test on the regression-model residuals. The SPSS results are presented in Table 2.

Table 2. Residual Normality Test

		Unstandardized Residual
N		24
Normal Parameters[a]	Mean	.0000000
	Std. Deviation	4.09474622
Most Extreme Differences	Absolute	.113
	Positive	.113
	Negative	-.078
Kolmogorov-Smirnov Z		.553
Asymp. Sig. (2-tailed)		.919
a. Test distribution is Normal.		

Table 2 shows an Asymp. Sig. (2-tailed) value of 0.919, which is greater than 0.05. Thus, there is no evidence that the regression residuals deviate significantly from normality.

Linearity



The linearity assessment examined whether the relationship between creative-attitude scores and student responses to the LIT-PBL implementation was approximately linear. This assessment was conducted by inspecting the scatterplot generated in SPSS, as shown in Figure 1.

Dependent Variable: Creative attitude

Figure 1. Plot of linearity test results

The points in Figure 1 are distributed without a clear systematic curvature, providing visual support for the linearity assumption. Therefore, a linear regression model was considered appropriate for examining the association between student responses to LIT-PBL and creative-attitude scores.

4.3 Regression Result

After the residual-normality and linearity assumptions were considered satisfactory, a simple linear regression analysis was conducted to address the research objective. The regression results are presented in Tables 3–5.

Table 3. Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1 (Constant)	35.934	8.387		4.285	.000	18.541	53.328
student response	.390	.104	.623	3.738	.001	.174	.607

a. Dependent Variable: creative attitude

Table 4. Regression Model Significance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	244.985	1	244.985	13.976	.001[a]
	Residual	385.640	22	17.529		
	Total	630.625	23			

a. Predictors: (Constant), student response

b. Dependent Variable: creative attitude

Table 5. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.623[a]	.388	.361	4.18677

a. Predictors: (Constant), student response

b. Dependent Variable: creative attitude

Table 3 presents the estimated regression equation for the association between student responses to LIT-PBL and creative-attitude scores.

where:

Y = Creative Attitude

X = Student Response

Y = Creative attitude
X = Student response to LIT-PBL
35.934 = Intercept (the predicted creative-attitude score when the student-response score is zero)
0.390 = Regression coefficient (the predicted change in creative-attitude score associated with a one-unit increase in the student-response score). Table 6 reports $R^2 = 0.388$, indicating that 38.8% of the observed variance in creative-attitude scores is statistically accounted for by the student-response variable in this sample.

Significance Test

Table 3 shows that the regression coefficient was statistically significant, $t = 3.738$, $p = .001$ ($< .05$). This indicates a statistically significant positive association between student responses to LIT-PBL and creative-attitude scores. Table 4 also shows that the overall regression model was statistically significant, $F(1,22) = 13.976$, $p = .001$.

The simple linear regression analysis indicates that students who reported more favorable responses to the LIT-PBL learning context also tended to report higher creative-attitude scores. The positive regression coefficient (0.390) indicates a positive statistical association between the two variables. The coefficient of determination ($R^2 = 0.388$) indicates that student responses accounted for 38.8% of the observed variance in creative-attitude scores in this sample, whereas 61.2% remained unaccounted for by this single-predictor model. Because the study used a single-group correlational design without a comparison group, these findings should not be interpreted as evidence that LIT-PBL caused changes in creative attitudes.

5. Discussion

The central finding is that students' responses to the LIT-PBL learning context were positively and significantly associated with creative attitudes. The model yielded $R = .623$ and $R^2 = .388$, indicating that students who reported more favorable experiences of the LIT-PBL learning environment also tended to report higher creative-attitude scores. This finding is important for mathematics education because it shifts attention from cognitive performance alone toward the affective and social conditions under which students engage with mathematical problems. It is consistent with evidence that PBL can support mathematical creative thinking (Yunita et al., 2020; Kurniati & Sutiarso, 2021) and with broader evidence that creativity can be fostered through educational interventions and supportive learning environments (Gajda et al., 2017; Ruiz-del-Pino et al., 2022).

From a social-cognitive perspective, the association is theoretically plausible because classroom activities can influence students' beliefs, behaviors, and opportunities for

action. PBL requires students to make reasoning visible, listen to peers, compare strategies, justify decisions, and revise ideas. Such experiences can provide opportunities for modeling, social persuasion, and mastery experiences that are relevant to students' confidence in engaging with challenging and creative tasks (Bandura, 1986). Similarly, self-determination theory suggests that students may engage more deeply when they experience autonomy, competence, and relatedness (Deci & Ryan, 2000). The LIT-PBL environment potentially supports these conditions by giving students structured opportunities to explore problems while receiving guidance and working with peers. In this sense, creative attitudes are not treated as purely private psychological characteristics; they are dispositions that become visible and develop through interaction with the learning environment.

LIT contributes a different but complementary dimension. Because an LIT is designed around a hypothesized learning trajectory, teachers can anticipate common difficulties and provide scaffolding without removing students' opportunities to reason and make decisions. This may be particularly relevant to creative attitudes: students may be more willing to explore alternatives when a task is challenging but remains accessible through appropriate instructional support. The combination of a carefully designed learning trajectory and problem-centered social interaction therefore provides a plausible mechanism linking instructional context with affective engagement. Importantly, the present study does not establish which specific LIT component produced the observed association. Future research should examine individual features such as problem posing, peer discussion, teacher questioning, reflection, and opportunities to compare strategies.

The finding also has implications for the social organization of mathematics classrooms. Creative attitudes are expressed through participation: asking questions, suggesting alternatives, explaining disagreement, persisting with a difficult task, and responding constructively to peers' ideas. Creativity development can therefore be understood as partly relational. Classroom norms determine whose ideas are heard, how mistakes are treated, and whether students are given legitimate opportunities to contribute to mathematical meaning making. A classroom that treats mistakes as opportunities for inquiry and gives students space to articulate different strategies may provide broader opportunities for creative participation than a classroom organized primarily around rapid answer production. Recent research on open classroom climate and teacher support likewise emphasizes the importance of supportive relationships and diverse perspectives in students' development (Huang, 2025; Rapa et al., 2026).

The findings also have implications for educational policy and innovation, although these implications must be bounded by the study design. Contemporary education systems increasingly emphasize student agency, flexible learning, and competencies related to creativity and problem solving (OECD, 2024a, 2024b). A context-responsive PBL approach can align with these priorities because it gives teachers opportunities to adapt mathematical tasks to students' learning needs while

maintaining curricular goals. From an educational-equity perspective, however, innovation should not be evaluated only by whether it produces desirable outcomes for an average student. It should also be considered in terms of whether students with different levels of prior achievement, confidence, learning resources, and access to support can participate meaningfully. The present study did not measure socioeconomic status, differential access to resources, or equity outcomes; therefore, it cannot establish that LIT-PBL reduces educational inequality. A more defensible policy implication is that future curriculum and teacher-development initiatives should examine whether context-responsive, participatory mathematics instruction can broaden opportunities for students who are less likely to participate in conventional mathematics classrooms.

The 38.8% explained variance should also be interpreted carefully. The remaining 61.2% is not a single unexplained causal category; it may reflect measurement error, individual differences, prior achievement, motivation, teacher characteristics, peer climate, family context, socioeconomic conditions, and other factors. Because the predictor and outcome were measured after the intervention, common-method and temporal-order limitations are also possible. Accordingly, the present study should be viewed as an initial empirical indication of a relationship that warrants testing with stronger designs. The result should not be interpreted as evidence that the learning intervention alone determines students' creative attitudes.

Several limitations should be acknowledged. First, the sample consisted of only 24 students from one setting and was selected purposively, limiting external validity. Second, the design did not include a control or comparison group, so causal claims cannot be made. Third, both key variables were measured through student-reported instruments, which may introduce common-method bias. Fourth, the available manuscript does not provide sufficient detail about the development and validation procedures of the instruments or the exact structure of the five-week intervention. Finally, the analysis uses a single predictor and therefore does not disentangle the contribution of individual, social, instructional, and contextual factors. These limitations are important when considering the broader social-science implications of the findings.

Future research should address these limitations through larger and more diverse samples, comparison groups or longitudinal designs, and multimethod measurement. Researchers could combine creative-attitude scales with classroom observations, student interviews, open-ended mathematical creativity tasks, and teacher reports. Such designs would help clarify whether changes in students' creative attitudes are associated with specific social mechanisms, such as peer interaction, autonomy support, teacher questioning, perceived competence, and classroom norms. Research should also investigate whether LIT-PBL works similarly across schools with different socioeconomic and cultural contexts. Such comparative evidence would directly address questions of transferability and educational equity and would help determine whether context-responsive mathematics instruction can contribute to

broader national goals related to innovation, participation, and inclusive educational development.

6. Conclusion

This study found a statistically significant positive relationship between students' responses to a Local Instruction Theory implemented through Problem-Based Learning and their creative attitudes in junior high school mathematics. The regression model yielded $R = .623$, $R^2 = .388$, and $F(1,22) = 13.976$, $p = .001$. The result indicates that students' experiences of the LIT-PBL learning context were statistically associated with 38.8% of the observed variance in creative-attitude scores in this sample. Viewed through educational psychology and social-educational perspectives, the finding suggests that creativity-related dispositions may be connected to learning environments that combine meaningful mathematical problems, structured learning trajectories, peer interaction, teacher support, and opportunities to explain and evaluate ideas. The study therefore contributes to the discussion of creativity as an affective and socially situated dimension of mathematics learning. Nevertheless, the correlational design, small purposive sample, and absence of a comparison group mean that the result should not be interpreted as evidence of a causal effect. Implications for educational equity and policy should likewise be treated as directions for future investigation rather than as direct empirical conclusions. Further research with larger, more diverse, and longitudinal or comparative designs is needed to determine how instructional, social, and contextual factors jointly shape students' creative attitudes.

Acknowledgements

The authors thank the principal and school community of Khairul Imam Middle School in Medan for supporting the implementation of the study. The authors also acknowledge the students who participated in the learning activities and data collection.

References

[1] Aiken, L. R. (1997). Psychological Testing and Assessment (9th ed.). Allyn and Bacon.

[2] Alfani, Moch. F., Sari, P. S., & Prastowo, A. (2025). Reframing Mathematical Pedagogy: A Problem-Based Learning Approach to Cultivating Active Engagement Among Madrasah Ibtidaiyah Learners: -. Jurnal Ilmiah Mahasiswa Raushan Fikr, 14(2), 348–360. https://doi.org/10.24090/jimrf.v14i2.14810

[3] Amabile, T. M. (1996). Creativity in Context. Westview Press.

[4] Anderson, B. F. (1980). The complete thinker: A handbook of techniques for creative and critical problem solving. Prentice-Hall.

[5] Barrows, H. S. (1996). Problem-based learning in medicine and beyond: A brief overview. New Directions for Teaching and Learning, 1996(68), 3–12. https://doi.org/10.1002/tl.37219966804

[6] Beetlestone, F. (2011). Creative learning. Nusa Media.

[7] Botty, H. M. R. H., Shahrill, M., Jaidin, J. H., Li, H.-C., & Chong, M. S. F. (2016). The Implementation of Problem-Based Learning (PBL) in a Year 9 Mathematics Classroom: A Study in Brunei Darussalam. International Research in Education, 4(2), 34. https://doi.org/10.5296/ire.v4i2.9466

[8] Chhabra, M., & Gawande, A. (2025). How does project-based-learning makes difference in secondary school mathematics. Multidisciplinary Science Journal, 7(9), 2025550. https://doi.org/10.31893/multiscience.2025550

[9] Cohen, L., Manion, L., & Morrison, K. (2018). Research methods in education (8th ed.). Routledge.

[10] Csikszentmihalyi, M. (1996). Creativity: Flow and the Psychology of Discovery and Invention. Harper Collins.

[11] Dahl, B. (2018). What is the problem in problem-based learning in higher education mathematics. European Journal of Engineering Education, 43(1), 112–125. https://doi.org/10.1080/03043797.2017.1320354

[12] Fitriyan, D. 2009. Berpikir Kreatif. Jakarta: Esensi

[13] Flathers, A. M., Paternostro, L. R., Resnick, S. B., & Casa, T. M. (2024). Calling Student Referees to Promote Small-Group Discourse. Mathematics Teacher: Learning and Teaching PK-12, 117(3), 195–201. https://doi.org/10.5951/MTLT.2023.0166

[14] Gravemeijer, K. (1994). Educational Development and Developmental Research in Mathematics Education. Journal for Research in Mathematics Education, 25(5), hlm. 443-471.

[15] Gravemeijer, K and Cobb, P. (2013). Design research from the Learning Design Perspective. Dalam Jan Ven Den Akker, et. al. An Introduction to Educational Design Research. London: Routledge

[16] Gravemeijer, K. & Van Eerde, D. (2009). Design Research as a Means for Building a Knowledge Base for Teaching in Mathematics Education. The Elementary School Journal, 109 (5).

[17] Hadi, S. (2017). Pendidikan Matematika Realistik: Teori, Pengembangan, dan Implementasinya. Jakarta: Rajawali Pers.

[18] Hair, J. F., JR, Anderson, R. L. T., & Black, W. C. (1998). Multivariate Data Analysis Fifth Edition. Gramedia.

[19] Hasibuan, E. K., Armanto, D., & Amry, Z. (2024). Model pembelajaran problem based learning dalam pembelajaran matematika. Jurnal Lebesgue : Jurnal

Ilmiah Pendidikan Matematika, Matematika Dan Statistika, 5(3), 2026–2040. https://doi.org/10.46306/lb.v5i3.806

[20] Hmelo-Silver, C. E. (2004). Problem-Based Learning: What and How Do Students Learn? Educational Psychology Review, 16(3), 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

[21] Hmelo-Silver, C. E., & Barrows, H. S. (2008). Facilitating Collaborative Knowledge Building. Cognition and Instruction, 26(1), 48–94. https://doi.org/10.1080/07370000701798495

[22] Jonassen, D. H. (2000). Computers as Mindtools for Schools: Engaging Critical Thinking. Prentice Hall.

[23] Kim, H. W., & Kim, M. K. (2021). A Case Study of Children's Interaction Types and Learning Motivation in Small Group Project-Based Learning Activities in a Mathematics Classroom. Eurasia Journal of Mathematics, Science and Technology Education, 17(12), em2051. https://doi.org/10.29333/ejmste/11415

[24] Meiliati, R., Djodding, I. M., Aswin, Salido, A., Husain, D. S., Tahir, & Hidayati, U. (2026). Exploration problem-based learning in mathematics learning in higher education: A bibliometric review. Social Sciences & Humanities Open, 13, 102345. https://doi.org/10.1016/j.ssaho.2025.102345

[25] Munandar, U. (2009). Mengembangkan Bakat dan Kreativitas Anak Sekolah. PT Gramedia

[26] Mustaffa, N., Ismail, Z., Tasir, Z., & Said, M. N. H. M. (2016). The Impacts of Implementing Problem-Based Learning (PBL) in Mathematics: A Review of Literature. International Journal of Academic Research in Business and Social Sciences, 6(12), Pages 490-503. https://doi.org/10.6007/IJARBSS/v6-i12/2513

[27] Mustika, H., Ningsih, S. Y., & Wahyuni, W. (2025). The impact of project-based learning on enhancing students' mathematical communication skills. Journal of Didactic Mathematics, 6(2). https://doi.org/10.34007/jdm.v6i2.2143

[28] Pallant, J. (2020). SPSS Survival Manual: A Step by Step Guide to Data Analysis Using IBM SPSS (7th ed.). Routledge. https://doi.org/10.4324/9781003117452

[29] Prahmana, R.C.I. (2017). Design Research: Teori dan Implementasinya: Suatu Pengantar). Depok: Rajawali Pers.

[30] Rehman, N., Zhang, W., Mahmood, A., Fareed, M. Z., & Batool, S. (2023). Fostering twenty-first century skills among primary school students through math project-based learning. Humanities and Social Sciences Communications, 10(1), 424. https://doi.org/10.1057/s41599-023-01914-5

[31] Reigeluth, C. M. (1999). Instructional-Design Theories and Models: A New Paradigm of Instructional Theory (Vol. 2). Lawrence Erlbaum Associates.

[32] Sawyer, R. K. (2006). Explaining Creativity: The Science of Human Innovation. Oxford University PressNew York, NY. https://doi.org/10.1093/oso/9780195161649.001.0001

[33] Simon, M. A. (1995). Reconstructing mathematics pedagogy from a constructivist perspective. Journal for Research in Mathematics Education, 26(2), 114–145.

[34] Sternberg, R. J. (2006). The nature of creativity. Creativity Research Journal, 18(1), 87–98.

[35] Streiner, D. L., & Norman, G. R. (2000). Health Measurement Scales: A Practical Guide to Their Development and Use (2nd ed.). Oxford University Press.

[36] Sugiyono. (2019). Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Alfabeta.

[37] Suharnan. (2011). Kreativitas: Teori dan pengembangan. Laros.

[38] Torrance, E. P. (1974). Torrance Tests of Creative Thinking: Norms-Technical Manual. Personnel Press.

[39] Uno, H. B., & Masri, K. (2009). Mengelola kecerdasan dalam pembelajaran. Bumi Aksara.

[40] UNESCO. (2019). UNESCO ICT Competency Framework for Teachers. UNESCO.

[41] Vygotsky, L. S. (1978). Mind in Society: The Development of Higher Psychological Processes. Harvard University Press.

[42] Woolfolk, A. (2019). Educational Psychology (14th ed.). Pearson.