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Exploring SMPN 12 Sinjai Students' Mathematical Literacy Via Sociomathematical Contextual Problem-Solving

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ABSTRACT

Background. Mathematical literacy is a key competency in the Merdeka Curriculum, requiring students to formulate, apply, and interpret mathematics in authentic situations. However, students in rural schools often struggle because mathematics learning remains procedural and insufficiently connected to their local environment. Sociomathematical norms offer a theoretical framework for understanding how classroom interactions and mathematical argumentation contribute to students' mathematical literacy.

Purpose: This study explored Grade 9 students' mathematical literacy through sociomathematical norms in solving contextual geometry problems based on local agricultural contexts at SMPN 12 Sinjai, South Sulawesi.

Method: This descriptive qualitative case study involved 25 Grade 9 students who completed mathematical literacy tests. Four students from high- and low-achievement groups and one mathematics teacher were purposively selected for semi-structured interviews. Classroom observations across eight learning sessions examined the development of sociomathematical norms. Data from tests, interviews, and observations were analyzed through data reduction, data display, and inductive conclusion drawing, with credibility ensured through methodological and source triangulation.

Results: Students demonstrating strong sociomathematical norms achieved substantially higher mathematical literacy than those with weaker norms, particularly in problem formulation, mathematical procedures, and interpretation of solutions. Classroom interactions characterized by meaning negotiation, justification of arguments, and evaluation of peers' reasoning enabled students to connect geometry concepts with local agricultural experiences, strengthening contextual understanding and mathematical communication.

Conclusion: Sociomathematical norms function as an important mechanism for developing mathematical literacy by fostering mathematical argumentation, collaborative reasoning, and meaningful interpretation of contextual problems. Integrating local agricultural contexts with sociomathematical classroom practices can enhance students' ability to apply geometry in real-life situations and offers a promising instructional approach for rural secondary schools.

KEYWORDS

Contextual Geometry Problems, Local Agricultural Context, Mathematical Literacy, Rural Secondary Schools, Sociomathematical Norms

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INTRODUCTION

Mathematical literacy represents an essential competency for students facing

21st-century challenges. It extends beyond mere computation to encompass understanding, interpreting, and effectively applying mathematics in everyday life contexts.

Mathematical literacy represents an essential competency for students facing 21st-century challenges. It extends beyond mere computation to encompass understanding, interpreting, and effectively applying mathematics in everyday life contexts. Developing mathematical literacy is crucial for fostering critical and creative thinking in problem-solving, as evidenced by Indonesia's PISA 2018 results, where students scored 379 far below the OECD average of 489.

Research at the junior high level reveals students' low proficiency in comprehending word problems, building mathematical models, and solving contextual issues (Ekaputri & Simanjorang, 2022; Saputri et al., 2022). Teachers must prioritize literacy development across math topics, designing lessons that enhance skills and familiarize students with literacy-focused problems (Ekaputri & Simanjorang, 2022). Meanwhile, sociomathematical approaches emphasizing social interaction, meaning negotiation, and classroom mathematical norms remain underexplored, particularly in junior high schools, despite their potential to boost active engagement, argumentation, and real-world interpretation.

Studies like Salim & Ma'arif, (2021) show varied sociomathematical norms in online learning at SMKN 39 Jakarta, with high-norm students displaying greater confidence amid reduced interactions. Widodo & Purnami, (2018) highlight cooperative models like Team Accelerated Instruction for norm enhancement, though without linking to contextual learning outcomes. (Kadir, 2008 utilized local potentials for norm development via heterogeneous group negotiations, yet overlooked direct literacy contributions.

Internationally Kang & Kim, (2016) stress teachers' beliefs in shaping norms, distinguishing formal from procedural views, while (Akyüz, 2014) notes technology and inquiry fostering solution verification primarily among pre-service teachers. Pandemic-era works like (Firdaus & Maarif, 2022) identify gender differences in online norms, and (Cahayani & Maarif, 2023)correlate high literacy with strong norms, but without deep contextual interaction analysis. (Ramanda et al., 2021) found students exhibited strong mathematical communication and social skills in collaborative learning but did not address mathematical literacy. (Siregar & Khusna, 2023) demonstrated a positive correlation between mathematical reflective thinking and sociomathematical norms, yet linked only to one mathematical ability aspect (reflective), without comprehensive literacy exploration. Saskiya & Khusna, (2023) showed high-creative thinking students also possessed stronger sociomathematical norms, though limited to creativity without contextual problem connections.

At SMPN 12 Sinjai, observations indicate partial sociomathematical integration in group discussions on contextual problems, yet suboptimal due to emphasis on final answers over meaning negotiation. Teacher interviews reveal students struggle linking math to daily life, such as linear equations for canteen costs, signaling needs for better contexts, discussion norms, and argumentation facilitation.

Nationally, Indonesian junior high students, including in Sinjai, Sulawesi Selatan, face literacy gaps from conventional teaching, with only 30-40% reaching competent levels in real problems. The research gap lies in integrating sociomathematics specifically for public junior highs like SMPN 12 Sinjai, underutilizing class social norms.

This study addresses the need for exploratory research on 9th-grade mathematical literacy via sociomathematics in contextual problem-solving. Its novelty combines literacy (e.g., PISA-based) with norms, using contextual problems to reveal social processes influencing literacy quality

focusing on negotiation, representation meaning, and shared understanding in understudied junior high contexts.

RESEARCH METHODOLOGY

This study employed a descriptive qualitative approach with a case study design to explore Grade 9 students' mathematical literacy through sociomathematical norms in solving contextual geometry problems at SMPN 12 Sinjai, South Sulawesi.

The participants consisted of 25 Grade 9 students from Class IXC who completed the mathematical literacy test. To obtain in-depth qualitative data, four students were purposively selected for semi-structured interviews, representing different levels of mathematical literacy (two high-performing students and two low-performing students). In addition, one mathematics teacher who implemented contextual mathematics instruction participated in the interview to provide information regarding classroom practices and the development of sociomathematical norms.

Participants were selected using purposive sampling based on three criteria: (1) students' mathematical literacy test results representing high and low achievement levels, (2) active participation in classroom discussions involving sociomathematical interactions, and (3) willingness to participate in interviews. The teacher was selected because of direct responsibility for teaching the participating class and experience in implementing contextual mathematics learning.

Data were collected through three techniques: (1) a mathematical literacy test consisting of five contextual geometry problems adapted from local agricultural situations in Sinjai; (2) semi-structured interviews with four students and one mathematics teacher; and (3) classroom observations conducted during eight mathematics learning sessions to document the emergence of sociomathematical norms.

Data analysis followed the interactive model of Miles, Huberman, and Saldaña, comprising data condensation, data display, and conclusion drawing and verification. First, data from tests, interviews, and classroom observations were coded and condensed to identify meaningful units related to mathematical literacy and sociomathematical norms. Second, the coded data were organized into thematic displays to identify patterns of students' mathematical reasoning, argumentation, and contextual problem-solving. Finally, conclusions were drawn through continuous comparison across data sources and verified using methodological triangulation (tests, interviews, and observations) and source triangulation (students and teacher) to enhance the credibility and trustworthiness of the findings.

RESULT AND DISCUSSION

Mathematical literacy tests were administered to 25 9th-grade students in class IXC at UPTD SMPN 12 Sinjai from November 15–17, 2025. The instrument comprised 5 contextual problems adapted from local Sinjai community phenomena, particularly agriculture (rice harvest), livestock, and trading at Sentral Market. Tested mathematics content included spatial geometry concepts (e.g., estimating rice barn and livestock feed volumes). Assessment followed the PISA framework, with score proportions: 20% problem formulation, 40% mathematical procedures, and 40% result interpretation.

Distribution of Test Scores

Results from 25 students are presented in Table 1.

Table 1. Distribution of Mathematical Literacy Test Scores for Class IXC Students (N=25)

Category	Score Range	PISA Level	Number of Students	Percentage
High (H)	≥80	Level 4–5	13	52%
Medium (M)	60–79	Level 2–3	9	36%
Low (L)	<60	Level 1	3	12%
Total	—	—	25	100%

Student Response Patterns

High-scoring students demonstrate systematic steps and connect solutions to local Sinjai experiences. They effectively apply spatial geometry concepts to reasonably estimate harvest yields or feed requirements.

High-Scoring Student Pattern (H): "First, calculate the rice barn volume using the rectangular prism formula: length × width × height. Then, convert the volume to sack units. The result makes sense because my father harvests about that amount. So, the solution must align with village realities." (Student H formulates, applies procedures, and interprets results).

In contrast, low-scoring students (L) struggle with problem formulation and fail to link calculations to context.

Low-Scoring Student Pattern (L): "I'm confused about calculating volume. I only know how to subtract the discount price. Volume is hard, so I just wrote the subtraction result. Not sure if the discount calculation is correct." (Student L fails to formulate and interpret).

Average Literacy Scores per Aspect

Table 2 presents average scores per aspect based on students' sociomathematical norm strength (groups with strong vs. weak discussion norms).

Table 2. Average Literacy Scores per Aspect Based on Sociomathematical Norms

Literacy Aspect	Strong Norms (n=16)	Weak Norms (n=9)
Problem Formulation (20 pts)	17	11
Mathematical Procedures (40 pts)	37	28
Result Interpretation (40 pts)	35	22
Total Average Score (100 pts)	**89**	**61**

Interview Results

Semi-structured interviews were conducted with 4 students (2 high-ability: T-1, T-2; 2 low-ability: R-1, R-2) and 1 mathematics teacher (Teacher G) on November 20–21, 2025. Transcript analysis yielded three main themes: Meaning Negotiation, Social Reflection, and Discourse Participation.

Student Interview Quotes

These interviews provide deep insights into how students of varying abilities understand and practice sociomathematical norms.

Table 3. Student Categories and Sociomathematical Abilities

Student & Ability	Focus Theme	Specific Quote
T-1 (High)	Meaning Negotiation	"If a friend calculates barn volume differently, I challenge them to prove the formula on the board. Answers must be testable, not just teacher's word. This prevents harvest miscalculations."
T-2 (High)	Social Reflection & Context	"Livestock feed planning requires precision. Home feed is rectangular, so I used spatial geometry formula. I'm confident because it matches local farmers' practices."
R-1 (Low)	Discourse Participation	"I'm embarrassed if wrong on volume, so I stay quiet and listen. I wait for friends to confirm before writing."
R-2 (Low)	Context Connection	"I focus on numbers only. For volume, I forget the formula."

Teacher Interview Quote (Teacher G)

The interview with Teacher G focused on classroom discussion dynamics and challenges. "I always bring rice harvest and market contexts to class for relevance. But I struggle making students critique peers' arguments. Low-ability students remain passive, waiting for my final validation instead of independently assessing mathematical truth." (Teacher G)

Classroom Observation Results

Classroom observations spanned 8 sessions (November 25–30, 2025) to capture student interaction dynamics and sociomathematical norm practices in class IXC.

Table 4. Sociomathematical Norm Observation Summary

Sociomathematical Norm Indicator	Strong Norm Students (n=16)	Weak Norm Students (n=9)
Clear & Logical Communication (Argumentation)	85%	35%
Acceptance & Testing Peers' Arguments	75%	20%
Linking Math (Geometry) to Local Context	90%	45%

Observations recorded increased social interaction intensity (discussions/debates) from an average of 12 interactions/session initially to 32 by period end, indicating growing class communicativeness and collaboration. Strong-norm students consistently used mathematical evidence (geometry formulas, accurate calculations) to justify arguments.

Key Findings

Sociomathematical Norms as Literacy Predictors

Significant mean score differences in Table 2, especially Result Interpretation, show negotiation and argument evaluation as key determinants. Strong-norm students transform math from mechanical procedures to collective validation tools. They explain not just volume calculation but its logic in local rice harvest contexts (as in T-2). Sociomathematical negotiation creates extra learning via peer solution comparisons, requiring supportive class norms for diverse effective answers (Aydo, 2021; Kadir, 2008).

Role of Local Contexts and Geometry

Sinjai's agriculture, livestock, and market contexts effectively spark meaningful discussions for strong-norm students, bridging abstract volume formulas to reality. Yet, per R-2, local contexts don't automatically boost literacy strong discussion norms ensure contexts validate interpretations, not mere backdrops. This aligns with local trading contexts enhancing number systems and geometry via real exploration, boosting active discussion motivation (Siswanto & Pisriwati, 2025).

Participation Barriers and Implications

Low-ability students stay passive, avoiding social correction risks (R-1: "I'm embarrassed..."), reinforced by Teacher G's challenges in fostering independent truth assessment. This reluctance hampers norm formation without equitable participation. Math instruction must explicitly build safe norms viewing errors as learning opportunities for argument refinement (Meaning Negotiation), not personal failure. Teachers should promote independent mathematical judgment via balanced social interactions for collective understanding (Maarif, 2024; Siregar & Khusna, 2023).

CONCLUSION

This study concludes that the sociomathematical approach supports enhanced mathematical literacy among 9th-grade students at SMPN 12 Sinjai. Students with strong sociomathematical norms can accurately formulate and solve contextual problems, correctly apply mathematical concepts, and communicate results in alignment with class communication norms. Findings affirm that mathematical literacy develops through social interactions and shared mathematical thinking norms within the classroom community. Strengthening sociomathematical norms serves as a primary strategy in mathematics instruction to foster meaningful, contextual literacy skills among junior high students.

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DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work the author(s) used Grammarly in order to check grammar, spelling, and punctuation, and improve the clarity of the language. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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