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HIGH SCHOOL STUDENTS' MATHEMATICAL REPRESENTATION ABILITY IN SOLVING COMPOSITION AND INVERSE FUNCTION PROBLEMS WITH LOCAL WISDOM NUANCES

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ABSTRACT

This study aims to analyze the mathematical representation ability of high school students in solving the problem of composition functions and inverse functions with nuances of Sumedang local wisdom. Using a descriptive qualitative approach with a case study design, involving 31 grade XII students of SMA Negeri 2 Sumedang as research subjects. Data were collected through a mathematical representation ability test with nuances of local wisdom and semi-structured interviews with 4 students. The results showed that students' overall mathematical representation ability was in the medium category (49%) with a hierarchy: symbolic (58%), visual > (50%), > verbal (40%). Verbal indicators were identified as the most challenging due to procedural learning habits, unfamiliarity with non-routine problems, and limited perception of the nature of mathematics. The context of local wisdom has been shown to provide positive motivational value and increase awareness of the relevance of mathematics, but it is not effective as a cognitive bridge when it is only integrated into test instruments. These findings imply the need to familiarize students with non-routine questions that require verbal skills, the integration of local wisdom in learning, and the development of balanced representation skills for students to face the challenges of the 21st century.

Keywords: Mathematical Representation, Composition Function, Inverse Function, Local Wisdom, Mathematics Learning.

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PRELIMINARY

Mathematics remains a subject considered difficult by many students due to their inability to achieve the expected learning objectives (Bagus, 2025). At the Senior High School (SMA) level, mathematics learning plays a strategic role in supporting student learning achievements, whether for graduation requirements, university entrance selection, or the development of 21st-century skills

The 2025 Academic Competency Test (TKA) results show West Java's average mathematics score (37.03) is far below its Indonesian Language score (58.42), and SMA

Negeri 2 Sumedang scored even lower (35.56), consistent with three years of academic data showing average pre-remedial achievement (43.8%) well under the 66-100% target (KKTP).

One prominent challenge is relatively low student participation in solving word problems. In fact, through word problems, students can connect mathematical concepts with real situations, helping them understand the meaning and application of mathematics in daily life (Hidayanto & Anggraini, 2024). The main difficulty students face in word problems is generally due to an inability to transform verbal information into mathematical modeling (Ario & Suhendra, 2025). This highlights the need to optimize mathematical representation ability, which, according to Suningsih & Istiani (2021) can help students depict, explain, and develop mathematical ideas through various forms such as symbols, equations, verbal language, pictures, tables, graphs, and even manipulative objects to transform abstract problems into more concrete ones. In fact, according to Febriyani & Setyaningsih (2024), representational ability is a crucial factor supporting students' success in understanding various mathematical concepts.

A similar point is made in the Decree of the Head of the Educational Standards, Curriculum, and Assessment Agency (BSKAP) regarding the latest Learning Outcomes, with a slight addition: mathematical representation ability includes the flexibility to choose the most appropriate representation in solving problems (BSKAP, 2025). With this ability, students can translate mathematical ideas, information, and problems from one form to another, so that it is in accordance with the opinion of Lutfi & Dasari (2023), that mathematical representation skills will trigger students to express their abstract understanding into a more concrete form.

The material of composition functions and inverse functions was chosen because it demands high-level mathematical representation skills. Composition functions involve layered transformations requiring students to switch between representations from verbal situations to symbolic notation $(f \circ g)(x)$, from symbolic to visual through graphs, and then back to verbal interpretation to give meaning to the results. Inverse functions add complexity by requiring a reversal of the process, which often challenges students' ability to represent reciprocal relationships between the domain and codomain. Observation data at SMA Negeri 2 Sumedang indicate that students often struggle to transform representations in this material, particularly in daily life word problems. Thus, composition functions and inverse functions serve as an ideal context to explore students' mathematical representation abilities.

Since the implementation of the Independent Curriculum (Kurikulum Merdeka) at SMA Negeri 2 Sumedang, mathematics learning frequently examines problems shaped as daily life stories to support the development of 21st-century skills. This is also related to educational demands regarding the mastery of 21st-century skills. Learning that utilizes the social and cultural context of the community has been shown to enhance the meaningfulness of the learning process (Republik Indonesia, 2003; Uge et al., 2019). Integrating local wisdom in mathematics serves not only as a problem context, but also as a means to bridge abstract concepts, increase learning motivation, and foster cultural pride (Ferdianto & Setiyani, 2018; Leton et al., 2025; Nisrina et al., 2021; Rusfriyanti & Rondli, 2023; Shodikin et al., 2024).

Previous research on mathematical representation ability can be mapped into three main focuses. The first focus emphasizes representation within data domains, probability, and PISA international standards across higher education as well as junior and senior high school levels (Febriyani & Setyaningsih, 2024; Nurhadida et al., 2025; Ramanisa et al., 2020; Silviani et al., 2021; Supriadi & Ningsih, 2022). The second focus examines representation aspects partially or concentrates on a single indicator, such as symbolic representation (Netti & Mastuti, 2021). The third focus explores the use of local wisdom and ethnomathematics as media or contextual learning approaches in general (Ferdianto & Setiyani, 2018; Leton et al., 2025; Nisrina et al., 2021; Rusfriyanti & Rondli, 2023; Shodikin et al., 2024).

Although these studies provide significant contributions, several gaps remain unfilled. Previous research on mathematical representation has predominantly focused on topics such as statistics, probability, and elementary algebra, whereas studies examining composite and inverse functions at the senior high school level remain scarce. These topics inherently require students to demonstrate flexibility in navigating complex transitions among verbal, symbolic, and visual representations. Furthermore, the integration of local wisdom in previous studies has largely been directed toward enhancing students' motivation or general learning outcomes at the elementary and junior secondary levels. Limited attention has been given to examining how local contexts may function as cognitive bridges in supporting the development of specific mathematical representation indicators, namely visual, symbolic, and verbal representations, among senior high school students. This research gap is further supported by findings from several systematic literature reviews (SLRs) on mathematics education incorporating local wisdom in Indonesia. These reviews indicate that, although research on mathematics learning contextualized through local wisdom has expanded across diverse educational settings, the distribution of mathematical topics and competencies investigated remains uneven. Existing studies tend to concentrate on geometry and mathematical problem-solving, whereas research linking local cultural contexts to other mathematical competencies remains limited and warrants further exploration (Riski & Fitriana, 2024; Iffah et al., 2025; Amilia et al., 2025).

Accordingly, empirical evidence regarding the mathematical representation profiles of senior high school students when solving problems involving composite and inverse functions through tasks grounded in local wisdom remains limited. This study was therefore designed to address this research gap.

The selection of Sumedang local wisdom in this study is based on the structural similarity between the processes in local wisdom and mathematical function concepts, rather than merely attaching a context. Context familiarity is expected to provide ease because students see, feel, and directly interact with it continuously, allowing abstract concepts and practical applications to be bridged engagingly, enabling students to focus more on the mathematical representation process itself (Leton et al., 2025).

Based on this description, this study aims to conduct an in-depth analysis of how students at SMA Negeri 2 Sumedang construct visual, symbolic, and verbal representations in solving composition function and inverse function problems integrated with the Sumedang local wisdom context. Three indicators of mathematical representation serve as the focus of this study: visual representation (using problem data in the form of pictures, diagrams, graphs, or tables), symbolic representation (using mathematical expressions or models to solve problems), and verbal representation (using words to write problem-solving steps). Specifically, this study formulates the research questions as follows:

1. What is the profile of students' abilities in each mathematical representation indicator (symbolic, visual, and verbal) within the context of composition functions and inverse functions with local wisdom nuances?
2. Which representation indicator is the most challenging for students, and why?
3. How does Sumedang local wisdom as a problem context facilitate or hinder students' representation abilities?

This study is expected to provide theoretical contributions in the form of an in-depth description of senior high school students' mathematical representation profiles in function material integrated with local wisdom. Practically, the research findings can serve as a foundation for senior high school mathematics teachers in designing learning that optimizes students' representation abilities through the use of meaningful local wisdom contexts, while identifying representation aspects that require special attention during the learning process. For curriculum and instructional material developers, this study offers a model for integrating local wisdom that is not artificial, but structured analogously with mathematical concepts.

METHODS

This study uses a descriptive qualitative approach with a case study design. According to Yin (Maharani et al., 2021), qualitative research using a case study approach can unearth in-depth information from cases rich in specific phenomena.

Research on mathematical representation ability was conducted at SMA Negeri 2 Sumedang in December 2025, during the odd semester of the 2025/2026 academic year. The research subjects consisted of 31 grade XII-12 students (9 male and 22 female, aged 17–18 years). All subjects were native residents of Sumedang Regency, with high familiarity with local cultural contexts, such as Cilembu sweet potato production, local merchant pricing systems, and regional landmarks like Gunung Kunci, which were subsequently incorporated into the test items to enhance the instrument's contextual and ecological validity.

The research subjects were selected using a purposive sampling technique Creswell (Sofian et al., 2023), based on two main criteria: (1) students had completed prerequisite instruction on composition functions and inverse functions, and (2) the class demonstrated high cognitive heterogeneity compared to other parallel classes, based on prior daily test scores and semester grades. Specifically, students' prior mathematical performance spanned three categories: high ability ($N = 5$, initial scores ≥ 80), medium ability ($N = 19$, initial scores $65 - 79$), and low ability ($N = 7$, initial scores < 65).

For the qualitative in-depth interviews, four students (M-1 to M-4) were selected as key informants based on distinct patterns of mathematical representation identified during preliminary observation. M-1 represents high-achieving students with strong symbolic inclination; M-2 represents medium-ability students with spatial/visual hurdles; M-3 represents medium-ability students with low verbal expression; and M-4 represents low-ability students struggling with conceptual-procedural translation. The population and sample data in this study are presented in Table 1.

Table 1. List of Research Population and Sample

Data	Class	Total
Population	XII-1 to XII-12	420
Sample	XII-12	31

The selection of research subjects utilized a purposive sampling technique, which, according to Sugiyono (Saputra, 2021) is a sampling technique based on specific considerations that can provide information aligned with the problem being studied. The consideration for selecting class XII-12, aside from having studied composition function and inverse function material at a previous level, was also the recommendation of a senior mathematics teacher, noting that students in this class possess heterogeneous variations in mathematical ability (high, medium, low).

Before the research, a preliminary study was conducted in November 2025 to validate the alignment of the Sumedang local wisdom context with the mathematical concepts of composition functions and inverse functions. Structural alignment analysis ensured that each local wisdom context had procedural stages that could be modeled as function compositions and inverse functions, with quantitatively measurable inputs and outputs.

The primary research instrument was the researcher, acting as the planner, data collector, and data analyzer. The test questions were developed based on three mathematical representation ability indicators (visual, symbolic, verbal) according to Mudzakir (Hardianti & Effendi, 2021). Question validation was carried out by three experts (two mathematics education master's lecturers and one senior mathematics teacher).

Validity was measured using the product-moment correlation, and reliability was assessed using Cronbach's Alpha ($r_{calculated} \geq 0.70$). The analysis was performed using SPSS Version 27.0. An analytic scoring rubric was developed for each indicator of mathematical representation ability, with a score range of 0–4 for each item. This rubric adapted the scoring criteria from Mudzakir's study (Hardianti & Effendi, 2021), with adjustments made to accommodate the local wisdom (*kearifan lokal*) context.

The construct validity analysis showed that items 1, 3, and 6 yielded significant correlations (r = 0,521; 0,545; 0,484, respectively; Sig. < 0,05; r_table = 0,304), while items 2, 4, and 5 did not meet the validity criterion and were subsequently dropped. The three valid items were then tested for reliability, yielding a Cronbach's Alpha coefficient of 0,886 (0,80 < r ≤ 1,00), indicating a very high level of reliability. Accordingly, items 1, 3, and 6 were confirmed as valid and reliable, and were used as the measurement instrument in this study.

Regarding the difficulty index and discrimination index, item 1 had a difficulty index of 0.51 and a discrimination index of 0.91, item 3 had a difficulty index of 0.45 and a discrimination index of 0.88; and item 6 had a difficulty index of 0.43 and a discrimination index of 0.84. This indicates that all three items fell within the moderate difficulty category (neither too easy nor too difficult), thereby meeting the proportionality requirement for use as a measurement instrument in this study. Each item was also classified as having a very good discrimination index, indicating that all three test items were effective in distinguishing between high- and low-ability student groups. Accordingly, these instrument items were deemed acceptable for use in the research data collection process.

A validated semi-structured interview guide was developed to gather information on students' thinking processes in solving questions, difficulties faced in each representation indicator, and students' perceptions regarding the role of the local wisdom context in facilitating or hindering understanding. Data collection began with the written test stage and continued with an interview. Test results were categorized based on mathematical representation ability levels, and at least three students were selected as interview subjects, considering that the errors made represented the majority of research subjects in each mathematical representation ability indicator.

Data analysis was conducted in parallel for test and interview data, then triangulated to answer the research questions. Each student's total score was converted into a percentage and categorized based on the criteria in Table 2.

Table 2. Mathematical Representation Ability Scores

Achievement Percentage	Category
81% - 100%	Very High
61% - 80%	High
41% - 60%	Medium
21% - 40%	Low
≥ 20%	Very Low

This classification refers to the guidelines of Arikunto & Jabar (Mardiani et al., 2024). Analysis per indicator was conducted by calculating the average score for each indicator to identify the most challenging ones. Qualitative analysis was performed on patterns of student answers regarding the representations used, common errors that appeared, problem-solving strategies, and the utilization of the local wisdom context in the representation process. Interview data analysis was transcribed verbatim, identifying main themes that answered research questions concerning difficulties in specific representation indicators and the role of the local wisdom context.

Data triangulation was performed on test and interview data to confirm test data findings with interview explanations, identify consistencies or inconsistencies between demonstrated abilities (test) and expressed understanding (interviews), and enrich the description of students' mathematical representation ability profiles. Data validity was maintained to ensure qualitative research credibility by utilizing data from written tests and interviews, involving two independent raters in test scoring, and confirming interview results with subjects to ensure interpretation accuracy.

RESULT AND DISCUSSION

The mathematical representation ability test administered to 31 grade XII-12 students at SMA Negeri 2 Sumedang yielded diverse scores across each indicator. Analysis was conducted on three mathematical representation indicators (symbolic, visual, and verbal) to answer the formulated research questions. The results of students' mathematical representation ability tests in solving composition function and inverse function problems with Sumedang local wisdom nuances are presented in Table 3.

Table 3. Mathematical Representation Ability Test Results Based on Indicators

Indicator	Average	Achievement	Category
Symbolic	2.32	58%	Medium
Visual	2.00	50%	Medium
Verbal	1.58	40%	Low
Average	1.97	49%	Medium

Note: Maximum score for each indicator = 4

Table 3 shows that the overall achievement of students' mathematical representation abilities falls into the medium category with a percentage of 49%. The symbolic indicator showed the highest achievement (58%, medium category), followed by the visual indicator (50%, medium category), while the verbal indicator showed the lowest achievement (40%, low category). This finding indicates a difficulty hierarchy in students' mathematical representation abilities, where the ability to communicate mathematical ideas verbally poses the greatest challenge. To obtain a more comprehensive picture of the distribution of student abilities, categorization was carried out based on the total score obtained by each student. The results are presented in Table 4.

Table 4. Mathematical Representation Ability Test Results Based on Category

Ability Category	Range	Total	Percentage
Very High	81% - 100%	2	6%
High	61% - 80%	3	10%
Medium	41% - 60%	19	61%
Low	21% - 40%	6	19%
Very Low	≥ 20%	1	3%
Total		31	100%

The data in Table 4 demonstrates a heterogeneous ability distribution dominated by the medium category (61%). Only 16% of students reached the high and very high categories, while 22% of students were in the low and very low categories. This data distribution confirms a significant competency gap among students, with individual score ranges spanning from 17% to 92%. This phenomenon aligns with the heterogeneous characteristics of grade XII-12 students, which was a consideration in selecting the research sample.

To explore information on students' thinking processes and the role of local wisdom context in facilitating or inhibiting representational abilities, interviews were conducted with three main purposively selected students, with an additional student to examine weaknesses in verbal ability further. The selection of interview subjects was based on representation across each mathematical representation indicator and answer patterns reflecting general student difficulties. The selected interview subjects are presented in Table 5.

Table 5. Selected Interview Subjects

Student Code	Indicator	Test Score on Indicator
M-1	Symbolic	2
M-2	Visual	1
M-3	Verbal	1
M-4	Verbal	0

Note: Maximum score for each indicator = 4

1. Symbolic Mathematical Representation Ability Indicator

The symbolic indicator demonstrated the highest achievement (58%) among the three examined indicators. However, qualitative analysis of student answers revealed that this achievement did not fully reflect deep conceptual mastery. Figure 1 illustrates M-1's answer, representing the general pattern of student answers for the symbolic indicator.

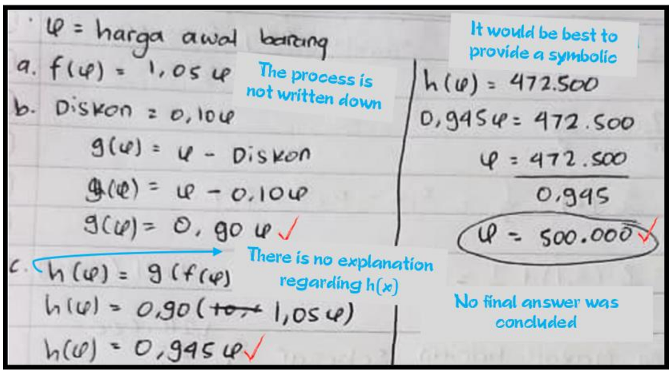

Figure 1. Test Answer of M-1 on the Symbolic Indicator

Based on Figure 1, M-1 managed to reach the final answer $x = 500.000$, but the displayed process was incomplete, earning only a score of 2 out of a maximum of 4. Several weaknesses appeared in M-1's answer, starting with the emergence of the function $h(x)$ without an explanation of the transformation process from the composition function provided in the question. Furthermore, there was no symbolic explanation bridging the transition from the composition function $(f \circ g)(x)$ to the function $h(x)$, and the final answer $x = 500.000$ was unaccompanied by a concluding statement explaining that the value signifies the total shopping cost before tax and discounts.

During the interview, M-1 said the priority was "finding the answer," reflecting a results-only orientation that disregards process completeness. M-1 also showed genuine interest in the story context (Mrs. Hera Ocim's Shop, a familiar local shop), confirming that local wisdom triggered curiosity and practical value, but did not by itself help M-1 build a complete symbolic representation.

2. Visual Mathematical Representation Ability Indicator

The visual indicator showed an achievement of 50% (medium category), slightly below the symbolic indicator. Analysis of M-2's answer revealed specific difficulties experienced by students in visually representing inverse function concepts through Cartesian coordinate graphs.

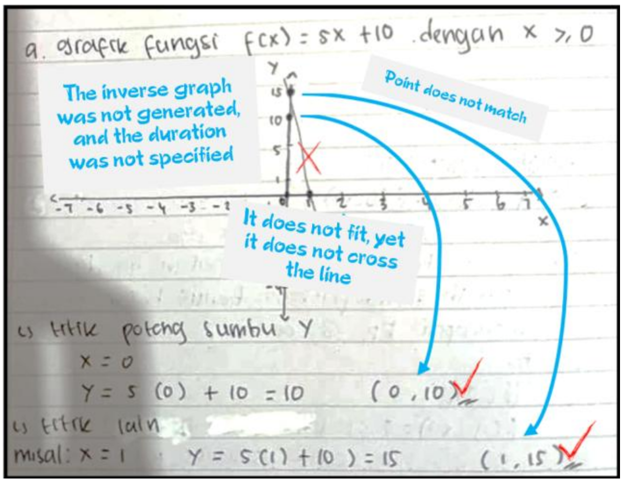

Figure 2. Test Answer of M-2 on the Visual Indicator

Based on Figure 2, M-2 received only a score of 1 out of 4. M-2 was able to determine the coordinates of points based on the given function, demonstrating conceptual understanding of ordered pairs (x, y). However, in placing these points on the Cartesian coordinate plane, systematic errors occurred, producing an inaccurate graph. This error indicates a gap between conceptual understanding and procedural skills.

M-2 described longstanding difficulty with Cartesian graphs since junior high, indicating a procedural gap rooted in earlier schooling rather than the current material. The familiar Gunung Kunci context added nostalgic, affective value ("that place is memorable to me"), but this motivation could not offset the underlying procedural weakness

3. Verbal Mathematical Representation Ability Indicator

The verbal indicator demonstrated the lowest achievement in this study, marking a crucial finding that highlights a crisis in students' ability to articulate mathematical ideas and processes logically and meaningfully through written language. Analysis of M-3's answer and interviews with M-3 and M-4 provided a comprehensive understanding of the root cause of this issue.

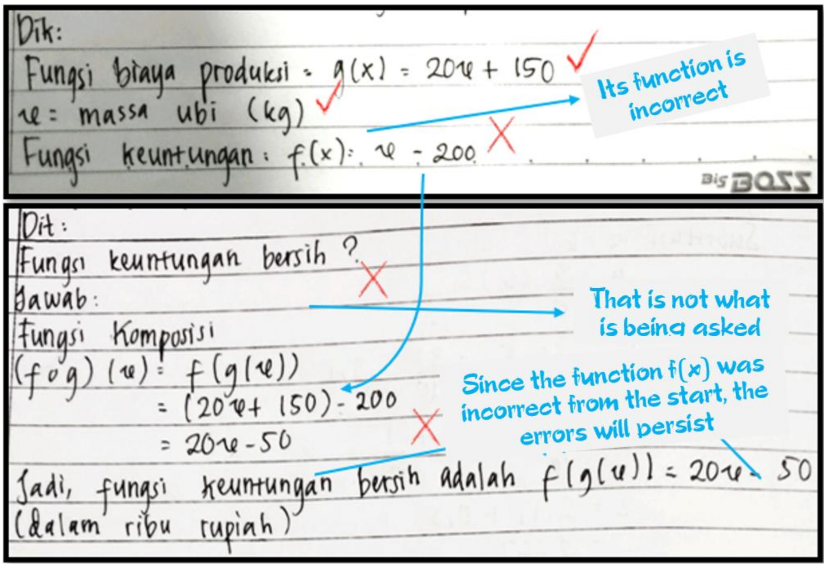

Figure 3. Test Answer of M-3 on the Verbal Indicator

Based on Figure 3, M-3 obtained a score of 1 out of a maximum of 4. There were several fundamental weaknesses in M-3's answer, starting with failing to answer question point (a), which requested an explanation of the steps to calculate net profit without numerical calculation. Furthermore, the profit function constructed in point (b) was incorrect from the beginning, indicating a conceptual error in transforming information into a mathematical model. The answer for point (b) was presented in function form, whereas the question asked for an explanation regarding profit or loss when the value is $x = 10\ kg$, along with its explanation.

This answer pattern demonstrates that M-3 barely utilized verbal representation abilities at all. The inability to answer questions explicitly requesting verbal explanations indicates that M-3 is unaccustomed to mathematics problems demanding the articulation of thought processes verbally. The interview with M-3 revealed factors contributing to low verbal representation ability.

M-3's interview revealed a view of mathematics as purely computational ("math questions tell us to calculate, not tell stories"), reflecting procedural habits rather than articulated reasoning. M-3 was also unfamiliar with non-routine, verbally explained questions; even the personally relevant Cilembu Sweet Potato context could not bridge this gap, showing that familiarity alone cannot substitute for verbal articulation skills.

M-4's statement that "what matters is memorizing the formula" reinforced this procedural orientation, and M-4's failure to recognize the Cilembu problem as a composition/inverse function confirms difficulty transforming verbal information into mathematical structure (Jupri & Drijvers, 2016).' This roughly halves the length w

The highest achievement on the symbolic indicator aligns with Silviani et al. (2021), who found that students' symbolic abilities are generally well understood. However, qualitative analysis in this study demonstrates that this achievement is more procedural than conceptual. Students can perform symbolic manipulation and find correct answers, but remain weak in process thoroughness and clarity of logical flow.

This contrasts with Netti & Mastuti, 2021), who found symbolic representation to be weak overall. Here it dominates numerically but remains procedurally shallow, consistent with Ario & Suhendra (2025) on inconsistent information transformation.

Visual indicator achievement sits in the middle of the hierarchy, aligning with Supriadi & Ningsih (2022) finding that visual representation ability is neither the highest nor the lowest. Analysis of M-2's answer revealed a gap between conceptual understanding and procedural skills. The interview with M-2 provided insight that visual representation difficulty is a hurdle originating from previous educational levels. This difficulty is systemic and cannot be overcome merely through context familiarity or high motivation.

The lowest achievement on the verbal indicator represents the most crucial finding in this study. Student difficulties lie not only in transforming problem information into mathematical models (Ario & Suhendra, 2025), but also in verbal skills—namely, the ability to articulate thought processes and mathematical logic using coherent and meaningful written language. When asked to explain problem-solving steps without numerical operations, students experienced confusion because they deemed the question unusual. The root cause lies in reducing mathematics learning to mere calculation activities. Statements by M-3 ("math questions tell us to calculate, not tell stories") and M-4 ("what matters is memorizing the formula, then using that formula to answer") reflect a deeply limited perception of the nature of mathematics.

The structural gap between the highest performance in symbolic representation (58%) and the lowest in verbal representation (40%) provides crucial theoretical insights into high school students' cognitive architectures in mathematics. The high score in symbolic representation, contrasting with the low score in verbal representation, aligns with the findings of Mataheru et al. (2021), who observed that students tend to be more comfortable solving problems involving algebraic manipulation than constructing narrative explanations. Theoretically, Rahmawati & Anwar (2020) explain this by noting that verbal representation requires a complex process of "cognitive unpacking," wherein students are required not only to understand mathematical concepts but also to articulate those ideas using appropriate linguistic structures.

Regarding symbolic proficiency, through repetitive practice with algebraic manipulations, such as applying the composition formula $(f(g(x))$ or working backward to find an inverse, students can successfully establish algorithmic pathways that minimize cognitive load during problem-solving, even if this does not necessarily entail a complete conceptual understanding. In contrast, failures in verbal proficiency stem not merely from linguistic limitations, but from the fact that verbal expression requires explicit metacognitive awareness, such as the ability to explain why a particular operational step is valid, rather than simply how to perform the calculation.

A deeper qualitative interrogation reveals that the critical weakness in verbal representation (40%) is not merely an isolated linguistic deficiency, but a systemic issue rooted in four interconnected dimensions: epistemological, pedagogical, cognitive, and metacognitive. Epistemologically, students exhibit an ingrained *arithmetical bias*, viewing mathematics exclusively as an exercise in numerical calculation rather than a language of structural communication. Interviews with M-3 ("math questions tell us to calculate, not tell stories") and M-4 explicitly reflect this epistemological obstacle; students perceive verbal explanations as extraneous to authentic mathematical activity, leading to immediate cognitive resistance when prompted to write explanatory prose.

Pedagogically, this issue stems from years of exposure to procedural mimicry and drill-oriented instruction. Mathematics teaching has traditionally prioritized algorithmic speed and final numerical accuracy over written mathematical discourse. Consequently, students are rarely afforded opportunities to construct formal mathematical arguments or verbalize problem-solving rationale in writing. Cognitively, the integration of context-rich local wisdom (e.g., Cilembu sweet potato processing) required students to perform complex semantic decoding, distinguishing the narrative context from the underlying mathematical structure. Students struggled to deconstruct the verbal story into function compositions ($f \circ g(x)$) and, conversely, failed to translate symbolic outputs back into meaningful contextual interpretations. Metacognitively, writing explanations demands reflective monitoring of one's own thought processes. Students experienced severe cognitive friction when required to articulate *why* a procedural step was taken rather than simply executing *how* to do it. The fear of imprecise mathematical phrasing coupled with low reflective habits caused students to leave verbal prompts entirely blank or resort to incomplete symbolic fragments.

This finding aligns with Ario & Suhendra (2025) research, which showed that students still experience widespread difficulties in answering word problems logically and correctly. This research strengthens Riani et al. (2022) argument that verbal ability plays a central role in mathematical representation. If students possess high verbal ability, they will better understand the meaning of problem-solving processes and can even aid symbolic ability in creating mathematical models based on problem information.

Thus, efforts to improve verbal representation ability potentially enhance symbolic representation ability indirectly. One research question sought to answer how Sumedang local wisdom as a problem context facilitates or hinders students' representation abilities. The research findings demonstrate that the role of local wisdom is complex and non-linear.

The local wisdom contexts proved to provide positive affective and motivational value. All three interview subjects exhibited positive affective responses toward familiar contexts. This finding aligns with Rusfriyanti & Rondli (2023) view that local wisdom-nuanced learning will prevent quick student boredom and make students more familiar with their region. This finding also confirms the views of Nisrina et al. (2021) and Leton et al. (2025) that integrating local wisdom can provide ease for students by bridging the gap between abstract concepts and practical applications. Students gained an understanding that mathematics learning is needed in everyday life (Ferdianto & Setiyani, 2018).

This finding differs from Leton et al. (2025) study, which successfully demonstrated the effectiveness of integrating local wisdom to improve students' mathematical abilities, because local wisdom was integrated into the learning process, so students experienced knowledge construction with the local wisdom context as a foundation. Conversely, in this study, local wisdom was only integrated into the test instrument, without prior learning processes utilizing that context.

This finding emphasizes that merely presenting local wisdom in test questions is insufficient. Sociocultural contexts must be unified within education, and local wisdom needs to be systematically integrated into the learning process, not merely serve as problem content (Republik Indonesia, 2003). Effective integration requires habituating students to interact with local wisdom contexts across various learning phases, such as concept exploration, practice, and evaluation.

To transition local wisdom from a passive assessment context into an active cognitive bridge, mathematics educators should implement a structured four-stage instructional framework. First is the experience orientation (cultural exploration), involving teacher-led activities that initiate learning by drawing upon local contexts to spark authentic problems, rather than using them merely as supplementary elements for questions. Second is structural mapping (cognitive scaffolding), involving teacher-led activities that explicitly guide students to map the flow of cultural processes onto abstract mathematical structures. The third, interactive articulation (reinforcing verbal representation) involves requiring students to write a paragraph explaining why a specific function or its inverse can model a local wisdom scenario, thereby accustoming them to articulating mathematical logic in writing. Finally, through authentic project-based assessment, which shows that evaluation does not rely only on conventional written tests. Teachers can assign group project assignments in which students explore and model other local wisdom phenomena of Sumedang, so that the flexibility of students' representations is honed in a balanced way.

Theoretically, these research findings reinforce an understanding of the mathematical representation hierarchy, where verbal ability is identified as the primary barrier for students in solving non-routine problems based on local wisdom. This study also enriches the understanding of local wisdom's role in mathematics learning. Local wisdom proved to provide affective-motivational value and increase awareness of mathematical relevance, but does not automatically function as a cognitive bridge if not systematically integrated into the learning process. Aside from difficulties in transforming verbal problem information into mathematical models (Ario & Suhendra, 2025), this research reveals that students also experience fundamental difficulties in verbal skills themselves—namely, the ability to articulate mathematical logic in writing.

The empirical findings of this study provide actionable pedagogical implications by outlining targeted instructional strategies tailored to each of the three mathematical representation indicators. The strategy for the symbolic representation indicator involves reinforcing the concepts underlying the procedures. Although students exhibited the highest proficiency in symbolic representation (58%), instruction must guard against algorithmic mimicry without deep conceptual grounding. Teachers should adopt *Reverse Engineering Tasks* and *Contrastive Example Analysis*. Next is the strategy for the visual representation indicator in bridging the concrete and the abstract. To enhance visual representation abilities (47%), educators should employ *Dual-Coding Flowcharts* and *Interactive Visual Scaffolding*. Next is the strategy for the verbal representation indicator, addressing articulation and argumentation obstacles. To address the critical deficit in verbal representation (40%), teachers must systematically incorporate *Writing-to-Learn* frameworks and *Mathematical Talk Moves* into daily instruction.

Practically, this study provides several recommendations to improve students' mathematical representation abilities, particularly at SMA Negeri 2 Sumedang:

1. Familiarization with non-routine questions demanding verbal, process-focused.
2. For the symbolic indicator, emphasis is needed on process completeness and logic.
3. For the visual indicator, improvements to prerequisite concepts.
4. The integration of local wisdom needs to be conducted systematically within the learning process, not merely in evaluation instruments.
5. Students need to be accustomed to flexibly switching between various representation forms and selecting the most appropriate representation to solve specific problems.

This study has several limitations. First, as a small-scale qualitative study, findings are specific to SMA Negeri 2 Sumedang and used three different local wisdom contexts for three indicators, which limited in-depth exploration of any single context. Second, local wisdom was integrated only into the test instrument, not into prior learning, so its role as a learning tool was not tested. Third, data analysis relied heavily on researcher interpretation, and the study did not measure long-term retention of representation ability.

Based on these limitations, several directions are recommended for future research. Future research could experimentally test local wisdom integrated throughout the learning process (not just in assessment), track representation ability longitudinally to assess retention, and study a single local wisdom context in greater depth.

CONCLUSION

This study provides an in-depth description of the mathematical representation abilities of SMA Negeri 2 Sumedang students in solving composition function and inverse function problems with Sumedang local wisdom nuances. Based on the analysis of test and interview data, several conclusions can be drawn:

First, regarding the profile of student ability in each mathematical representation indicator, it was found that students' overall mathematical representation ability falls into the medium category (49%) with a heterogeneous distribution. The symbolic indicator showed the highest achievement (58%), followed by visual (50%), and verbal was the lowest (40%), with the majority of students (61%) in the medium category.

Second, regarding the most challenging representation indicator, the verbal indicator was identified as the most challenging for students. Low achievement on this indicator was caused by several factors: (a) procedural study habits oriented toward computation without emphasizing the articulation of thinking processes, (b) unfamiliarity with non-routine questions demanding verbal explanation, (c) a limited perception of the nature of mathematics as merely a calculation activity, and (d) difficulty in transforming verbal information into mathematical representations. Although the symbolic indicator showed the highest achievement, qualitative analysis revealed that this achievement was more procedural than conceptual, with students tending to be oriented toward final answers rather than process completeness.

Third, regarding the role of Sumedang local wisdom as a problem context, it was found that the local wisdom context had a positive impact on affective-motivational dimensions and increased student awareness of the relevance of mathematics in daily life. However, the local wisdom context has not yet effectively functioned as a cognitive bridge facilitating mathematical representation ability when it is only integrated into test instruments without a systematic prior learning process.

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