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CORRELATION BETWEEN LINGUISTIC INTELLIGENCE AND CRITICAL THINKING SKILLS IN SOLVING MATHEMATICAL PROBLEM ON MATRIX ALGEBRA

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Abstract
This study aims to investigate the correlation between linguistic intelligence in Indonesian and critical mathematical thinking in solving contextual problems. This study used a mixed methods approach, involving data from 204 eleventh-grade students at SMA Catholic St. Louis 1 Surabaya. A convergent parallel design was applied, with separate analyses conducted for quantitative and qualitative data. Quantitative data were analyzed using descriptive statistics and Pearson Correlation tests to determine the relationship between linguistic intelligence and mathematical problem-solving ability. Qualitative data were analyzed thematically following the Miles and Huberman framework. Findings from both analyses were integrated through triangulation techniques to produce accurate and comprehensive interpretations. Results show that 30% of students demonstrated conceptual thinking, 14.5% semi-contextual thinking, and 55.5% computational thinking. Students' linguistic abilities can be associated with six core components of critical thinking: interpretation, analysis, inference, evaluation, explanation, and self-regulation. Out of a total of 204 students, the average achievement for each component was 27.21% (interpretation), 20.59% (analysis), 21.32% (inference), 22.06% (evaluation), 20.59% (explanation), and 27.94% (self-regulation). This finding indicates that linguistic contributions can influence how students solve contextual problems. Furthermore, linguistic intelligence and mathematical intelligence exhibit a linear relationship, where individuals with high linguistic intelligence tend to have high logical thinking skills. Overall, these findings can help provide several practical implications for adapting problem-solving skills and effective teaching/learning.

Keywords: critical thinking, linguistic intelligence, mathematics, problem-solving

Introduction
Numeracy is the ability to use mathematics in modern life. This includes understanding mathematical meaning as it is expressed in language, symbols, and images (Clarke, 2024). Clarke also tells us that mathematics tasks require elaborate language comprehension in terms of textualization, contextualization, and discourse. This process requires a level of linguistic competence, commonly referred to as linguistic intelligence.

The ability to parse complex text is the first barrier to successful problem-solving. Strong reading comprehension skills allow students to identify relevant information, disregard distractors, and understand the logical structure of a problem statement. Research confirms that general reading ability is a powerful predictor of performance on mathematical word problems, even after controlling for calculation skills (Boonen et al., 2016). This is not merely about vocabulary; it is about the deep comprehension of syntax and semantics in a mathematical context. The process of explaining one's reasoning is now recognized as a critical component of learning. When students articulate their solution paths, they engage in metacognition, solidifying their own understanding and identifying gaps in their logic. Studies show that classroom practices emphasizing mathematical discourse where students explain, justify, and debate ideas lead to significant gains in conceptual understanding (Webb et al., 2019). This practice directly leverages linguistic skills in rhetoric and explanation.

Building on earlier theories, current research uses the concept of to describe how students use language, gestures, and other symbols dynamically to construct mathematical meaning. Nuñez et al. (2019) elaborate on how gesture is not merely an add-on but is co-constitutive of mathematical thinking, often conveying spatial and logical relationships that students cannot yet express formally. This multimodal communication is a direct application of a broader, more embodied form of linguistic intelligence.

The critical role of language makes linguistic demands a central equity issue. The academic language of mathematics can function as a "hidden curriculum" that disadvantages students who are still developing academic language proficiency, including English Learners. Innovative pedagogical approaches, such as encouraging students to use their full linguistic repertoire (translanguaging), are being shown to support deeper mathematical reasoning and inclusive participation in multilingual classrooms (Planas & Civil, 2021).

Mathematics is often described as a universal language; however, in practice, its learning process must be accompanied by linguistic skills, in this context, specifically the Indonesian language. Linguistic intelligence in the Indonesian language plays an important role in solving mathematical word problems. Septyaningsih (2018) states that solving mathematical word problems requires at least linguistic intelligence and logical-mathematical intelligence. Since the implementation of the 2013 Curriculum up to the current National Curriculum, mathematics instruction has increasingly emphasized problem-solving based on real-life or contextual issues. As a result, many students, particularly those in grade XI, still face difficulties in mapping out solutions to word problems.

The thinking process influences how students solve problems presented by the teacher (Miladia & Khabibah, 2018). An effective thinking process enables students to comprehend information, analyze problems, and determine appropriate problem-solving strategies. Thus, the quality of the thinking process significantly affects students' success in finding logical and effective solutions to the problems they encounter. This is consistent with the view of Nabilah and Lestari (2025), who state that systematic and reflective thinking skills serve as a crucial foundation in connecting linguistic understanding with mathematical problem-solving abilities. Moreover, linguistic intelligence assists students in interpreting the meaning of contextual problems, allowing them to transform verbal information into accurate mathematical representations.

The urgency of this research lies in the need to examine the interrelationship between linguistic competence in the Indonesian language and high school students' critical thinking skills in solving context-based mathematical problems. This study aligns with the demands of 21st-century learning, which emphasizes language literacy, critical thinking, and integrated, comprehensive problem-solving. Numerical literacy refers to the knowledge and skills required to use various numbers and symbols related to basic mathematics to solve real-world problems in everyday life (Rosalia & Suhardi, 2020). Therefore, this research is expected to strengthen the understanding of the importance of language proficiency as an integral component of mathematical thinking processes, while also serving as a practical reference for teachers in designing learning activities that foster the integration of linguistic and logical-mathematical aspects.

SMA Katolik St. Louis 1 Surabaya was selected as the research site due to its strong reputation for students with high proficiency in both language and mathematics. Strong linguistic ability enables students to comprehend the meaning and context of problems more accurately, while excellent mathematical competence supports the application of logical reasoning in problem-solving. The combination of these two abilities makes this school an ideal setting to investigate the correlation between linguistic intelligence and critical thinking skills in solving context-based mathematical problems.

Building on the previous study conducted by Indaswari et al. (2021), it is evident that both types of intelligence significantly affect students' ability to comprehend problem contexts and determine appropriate solution strategies. This consistency is also reflected in research conducted at SMA Negeri 1 Batukliang Utara, which found that logical-mathematical intelligence shows a strong correlation (0.786) and contributes 61.7% to students' word-problem-solving performance, while linguistic intelligence likewise demonstrates a significant influence with a strong correlation (0.753). When combined, both intelligences exhibit a very strong relationship (0.810) in enhancing students' ability to solve word problems, particularly in linear programming. Overall, these studies reaffirm that students' success in solving word problems is shaped not only by numerical or computational skills but also by their capacity to understand language and process information logically.

In the process of solving contextual mathematical problems based on word questions, a method is required to model the problem into mathematical language, commonly referred to as a mathematical model. Mathematics is an abstract science that focuses on reasoning ability (Ekasari, 2014). Mathematical modelling is a field of mathematics used to represent and explain physical systems or problems in mathematical statements. The mathematical representation resulting from this process is known as a mathematical model. Forming, analyzing, and using mathematical models is one of the mathematics applications that can represent life problems into mathematical statements (Haryanto et al., 2015)

According to the OECD (2022), on average across OECD countries, more students performed at proficiency Levels 2 (23%) and 3 (22%) than at Level 4 (15%) in mathematics. Furthermore, only a small proportion of students scored at level 5 (7%) and Level 6 (2%) on average across OECD countries, and in reading, more students performed at proficiency level 2 (24%) and level 3 (25%) than at level 4 (17%) on average across OECD countries. Moreover, only a small proportion of students scored at Level 5 (6%) and Level 6 (1%) on average across OECD countries.

Proficiency in mathematics is closely tied to language and reading abilities. This is supported by Peng et al. (2020), who found that language is significantly and moderately associated with mathematics, with a stronger relation observed for more complex language and mathematics skills. This connection is largely because language serves as the primary medium for accessing mathematical problems, student must first decode and comprehend a word problem's text before they can even begin to solve it mathematically (Boonen et al., 2016). Furthermore, this relationship is not merely about vocabulary but extends to greater metalinguistic skill, such as the ability to understand syntactic structures and logical connectors. These are essential for parsing the complex cause-and-effect relationship often present in mathematical reasoning. Consequently, challenges in reading comprehension can create an artificial barrier to mathematical achievement, meaning a student's difficulty may lie not in their calculation skill, but in their ability to interpret the linguistic framing of the task itself.

Essentially, language ability enables students to understand the terms, sentence structures, and conceptual relationships that appear in mathematics problems. This allows them to grasp the intent of a question more accurately. Difficulties in mathematics are often not rooted in computation, but rather in an inability to interpret instructions or filter relevant linguistic information. Therefore, literacy competencies from understanding key words and identifying main premises to inferring relationships between ideas serve as an entry point to deeper mathematical understanding.

In addition, linguistic development helps sharpen metacognitive abilities such as critical thinking and providing justification for answers. These skills are crucial for solving higher-order problems. They encourage students not only to produce an answer but also to understand why a particular procedure is used.

Peng et al.'s (2020) findings show that the more complex the language structures students can comprehend, the better they manage mathematical concepts that require abstract reasoning. Thus, it reinforces the idea that improving literacy cannot be separated from enhancing mathematical ability. Integrating language learning into mathematics instruction becomes an essential strategy for maximizing the development of both domains simultaneously

The process of critical thinking in mathematics is used to solve more contextual problems or those involving higher-order thinking skills (HOTS) questions. Therefore, Facione (2015) in his journal explains that the essence of critical thinking skills is:

> *"As to the cognitive skills, here is what the experts include as being at the very core of critical thinking: interpretation, analysis, evaluation, inference, explanation, and self-regulation."*

Accordingly, Facione presents these components in the following table.

Table 1. Indicator of Critical Thinking (Facione, 2015)

Core Critical Thinking Skills		
SKILL	**Experts' Consensus Description**	**Subskill**
Interpretation	"To comprehend and express the meaning or significance of a wide variety of experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria"	Categorize Decode significance Clarify meaning
Analysis	"To identify the intended and actual inferential relationships among statements, questions, concepts, descriptions, or other forms of representation intended to express belief, judgment, experiences, reasons, information, or opinions"	Examine ideas Identify arguments Identify reasons and claims
Inference	"To identify and secure elements needed to draw reasonable conclusions; to form conjectures and hypotheses; to consider relevant information and to reduce the consequences flowing from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation"	Query evidence Conjecture alternatives Draw logically valid or justified conclusions
Evaluation	"To assess the credibility of statements or other representations that are accounts or descriptions of a person's perception, experience, situation, judgment, belief, or opinion; and to assess the logical strength of the actual or intended inferential relationships among statements, descriptions, questions, or other forms of representation"	Assess credibility of claims Assess quality of arguments that were made using inductive or deductive reasoning
Explanation	"To state and to justify that reasoning in terms of the evidential, conceptual, methodological, criteriological, and contextual considerations upon which one's results were based; and to present one's reasoning in the form of cogent arguments"	State results Justify procedures Present arguments
Self-Regulation	"Self-consciously to monitor one's cognitive activities, the elements used in those activities, and the results educed, particularly by applying skills in analysis, and evaluation to one's own inferential judgments with a view toward questioning, confirming, validating, or correcting either one's reasoning or one's results"	Self-monitor Self-correct

The challenges highlighted by the PISA results, coupled with common issues observed in mathematics classrooms, necessitate research into the linguistic features of contextual mathematical word problems. Such problems are often central to pedagogical approaches involving deep learning. The goal of deep learning is that students will gain the competencies and dispositions that will prepare them to be creative, connected, and collaborative (Fullan & Langworthy, 2013).

This study is limited to Grade XI students in the subject of matrices. This study aims to investigate:

1. What is the contribution of Indonesian linguistic intelligence to the mathematical problem-solving ability of Grade XI students at SMAK St Louis 1 Surabaya in solving contextual word problems
2. How is the correlation between linguistic and the critical thinking skill of Grade XI students at SMAK St Louis 1 Surabaya in solving mathematical word problems?

Method

This study utilizes a mixed-methods approach, based on the National Institute of Health (NIH) (2018), mixed-methods involve both quantitative and qualitative data throughout research endeavors. A mixed methods approach allows researchers to use a diversity of methods combining inductive and deductive thinking, and offsetting limitation of exclusive quantitative and qualitative research through a complementary approach that maximize strength of each data (Harvard Catalyst 2018). The primary rationale for this design is to acquire a comprehensive and in-depth perspective on the contribution of linguistic intelligence to mathematical problem-solving skills.

We use seven steps based on Creswell (2022) in the process of mixed methods research, namely

1. Draft a working title for the project
2. Write about the research problem and shape it toward mixed methods
3. State the general question, aim, or objective of the study
4. Consider whether to include a worldview and a theory
5. Detail the methods section
6. Consider how meta-inferences will be drawn from integration, and
7. Revisit your question, aims, or objectives.

The study began with formulating a working title that clearly represented its central focus: the relationship between linguistic intelligence and students' critical mathematical thinking in solving contextual problems. The researcher then identified issues related to variations in students' mathematical thinking skills and the potential influence of linguistic intelligence, which justified the use of a mixed-methods approach to obtain a more comprehensive understanding. The research objectives were subsequently articulated to examine the association between the two variables and to explore how linguistic intelligence contributes to students' critical thinking processes.

A pragmatic worldview was adopted to support the integration of quantitative and qualitative data, underpinned by the theories of multiple intelligences, critical thinking, and problem-solving. The study employed a convergent parallel design, combining descriptive statistics and Pearson correlation analyses for the quantitative strand with Miles and Huberman's thematic analysis for the qualitative strand. Findings from both components were integrated through triangulation to generate meta-inferences that synthesized numerical results with qualitative insights. In the final phase, the researcher revisited the research questions and objectives to ensure that the integrated findings effectively addressed the study's focus while offering theoretical contributions and practical implications for the development of instructional strategies

The research methodology for this study is a convergent parallel design. Quantitative and qualitative data were gathered concurrently from 204 participants in the eleventh grade. The analysis will involve examining the student's solution and their accompanying expositions through a set of rigorously defined indicators.

This study employs a separate analysis for quantitative and qualitative data. The purpose of using a mixed-method approach is to obtain a more comprehensive understanding by utilizing the strengths of both approaches, allowing researchers to explore phenomena in depth while also measuring and testing variables statistically (Nurfajriani et al., 2024). The collected data will subsequently be compared and analyzed using pre-established indicators to derive conclusions. Quantitative research can be used to fill the gaps that emerge in qualitative studies, Mustaqim (2016). The quantitative data analysis will be conducted using descriptive statistics to provide an overview of data trends and inferential statistics employing Pearson correlation tests to examine the relationship between linguistic intelligence and mathematical problem-solving ability. The qualitative data will be analyzed using thematic analysis following the Miles and Huberman model, which encompasses data reduction, data display, and conclusion drawing (Wijaya, 2018). Subsequently, the results from both analytical approaches will be integrated using triangulation techniques to compare and connect findings from both quantitative and qualitative approaches, ensuring an interpreted, accurate, and comprehensive understanding. Triangulation, in essence, is a multi-method approach employed by researchers when conducting research, collecting, and analyzing data. (Nurfajriani et al., 2024)

The problems given in this study are

Problem 1: Nutritional Data (Table & Matrix Representation)

This problem assesses the fundamental skill of translating real-world quantitative information into structured mathematical formats.

a. Data Organization and Tabulation
Indicator: Students are able to systematically organize multivariate data (age, activity level, caloric intake) into a clear and logical tabular format. Specific Skills: Identifying the relevant variables from a descriptive text. Deciding on a logical structure for the table (e.g., choosing rows for age groups and columns for activity levels, or vice-versa). Presenting the data accurately without omission or error.

b. Abstraction into Mathematical Models
Indicator: Students are able to abstract numerical data from a table and represent it as a mathematical matrix, understanding the structure of rows and columns. Specific Skills: Distinguishing between the data in a table and the structure of a matrix. Writing a matrix correctly using bracket notation. Articulating what the rows and columns of their matrix represent in the context of the problem (e.g., "Row 1 represents the caloric needs for ages 11-12," and "Column 3 represents the needs for 2 hours of training").

c. Mathematical Communication and Flexibility
Indicator: Students are able to compare different mathematical representations of the same data and understand that the structure (e.g., transposition) can vary while the information content remains the same.
Specific Skills:
Engaging in discussion about different possible matrix structures (e.g., Is the age group the row or the column?). Recognizing that a matrix and its transpose are both valid representations of the same dataset. Explaining how the context might influence the choice of representation.

Problem 2: Chip Inventory (Matrix Operations and Application)

This problem assesses the ability to use matrices not just for representation, but for performing meaningful operations that solve a real-world problem.

a. Contextual Matrix Construction
Indicator: Students are able to construct multiple matrices/vectors from a single contextual problem.
Specific Skills:
Creating a matrix \(I \) (inventory) from tabular data, where rows represent stores and columns represent products.
Creating a column vector \(P \) (price) from a given list of values.
Ensuring the dimensions of the matrices are compatible for the intended operation.

b. Selection and Justification of Matrix Operations
Indicator: Students are able to identify the appropriate matrix operation that models a given real-world scenario. Specific Skills:
Recognizing that matrix multiplication \(I \times P \) is the operation that corresponds to calculating the total (revenue) for each entity (store).
Justifying why this operation is chosen over others (e.g., addition or subtraction is not meaningful here). Understanding the condition for matrix multiplication (the number of columns in the first matrix must equal the number of rows in the second.

c. Computational Skill and Interpretation
Indicator: Students are able to accurately perform matrix multiplication and interpret the resulting vector within the context of the problem.
Specific Skills:
Correctly executing the algorithm for matrix multiplication. Stating clearly what each entry in the resulting vector represents (e.g., "The first element of the result is the total revenue for Store A"). Connecting the abstract mathematical result back to the original business context.

Findings and Discussion

To analyze the contribution of Indonesian linguistic intelligence to mathematical problem-solving ability, this study adopts the indicators proposed by Nugroho (2013), which are outlined below.

Table 2. Indicators of Indonesian Linguistic Intelligence
Adapted from Nugroho (2013)

Conceptual Thinking Process	Semi-Conceptual Thinking Process	Computational Thinking Process
Able to write or explain what is known in the problem using their own words or transform it into a mathematical statement.	Less able to write or explain what is known in the problem using their own words or transform it into a mathematical statement.	Unable to write or explain what is known in the problem using their own words or transform it into a mathematical statement.
Able to write or explain what is asked in the problem using their own words or transform it into a mathematical statement.	Less able to write or explain what is asked in the problem using their own words or transform it into a mathematical statement.	Unable to write or explain what is asked in the problem using their own words or transform it into a mathematical statement.

Able to write or explain the learned concepts that will be used to solve the problem.	Less able to write or explain the learned concepts that will be used to solve the problem.	Unable to write or explain the learned concepts that will be used to solve the problem.
Able to write or explain the steps taken to solve the problem using the learned concepts.	Less able to write or explain the steps taken to solve the problem using the learned concepts.	Unable to write or explain the steps taken to solve the problem using the learned concepts.

The application of the indicator revealed the following distribution of students' thinking categories: in problem 1, 32.12% of students demonstrated conceptual thinking, 16,20% exhibited semi-conceptual thinking, and the majority, 51,67%, employed computational thinking. problems 2, 27.95% of students demonstrated conceptual thinking, 12.78% exhibited semi-conceptual thinking, and the majority, 59.27%, employed computational thinking.

Rahardi (2024) argues that language functions as a medium to initiate, develop, and strengthen harmonious relationships between linguistics and mathematics, which has a significant influence on the comprehension of word problems in problem solving. The following indicators are presented based on Chomsky's theory (1981), which relates to the contribution of Indonesian linguistic intelligence to students' problem-solving skills and mathematical performance among eleventh-grade students of SMAK St. Louis 1 Surabaya.

Table 3. Linguistic Intelligence Indicator Developed from Chomsky (1981)

Indicator	Point 1	Point 2	Point 3	Point 4
Ability to understand the sentence structure in mathematical word problems	The student can identify the basic grammatical elements within a mathematical word problem.	The student can examine the logical relationships among sentences in the problem text.	The student can interpret the meaning of sentence structures logically in a mathematical context.	The student can comprehensively understand the overall sentence structure and relate it to the mathematical context of the problem.
Ability to present written explanations of mathematical solutions clearly	The student can write basic solution steps based on an understanding of the problem.	The student can express explanations in their own words in a clear and sequential manner.	The student can construct written mathematical explanations with coherent and logical reasoning.	The student can present comprehensive and well-structured written mathematical explanations supported by logical arguments.

Ability to paraphrase mathematical word problems into mathematical models	The student can restate part of the problem information using simple mathematical symbols.	The student can reformulate the problem statement to show relationships between variables.	The student can translate all relevant information from the problem into an appropriate mathematical model.	The student can interpret and formulate the word problem accurately and efficiently into mathematical equations or expressions.
Ability to construct various forms of mathematical explanations or answers	The student can create a simple form of explanation based on calculation results.	The student can compose alternative sentences to explain problem-solving steps.	The student can construct logical and contextually relevant explanatory sentences.	The student can produce effective, communicative, and mathematically accurate explanatory sentences.
Ability to develop an intuitive understanding related to the meaning of mathematical problems with varied sentence structures	The student can recognize differences in sentence structures across similar mathematical problems.	The student can accurately interpret the meaning of differently structured sentences.	The student can adjust their understanding according to variations in sentence structure within mathematical problems.	The student can comprehend and explain the meaning of problems with complex and varied sentence structures accurately.
Ability to identify key and essential elements in mathematical problem texts based on sentence patterns	The student can identify key words or main information in the problem text.	The student can highlight essential elements and understand their grammatical roles in the sentence.	The student can analyze the relationships among key elements within the sentence structure of the problem.	The student can identify, connect, and utilize key elements to accurately understand the overall meaning of the mathematical problem.

Based on the analysis of students' written responses to the first problem, the following percentage achievements for each linguistic intelligence indicator were obtained: understanding question sentence structure (22.37%), explaining mathematical solutions (22.37%), paraphrasing questions into mathematical models (11.84%), creating varied explanatory sentences (10.53%), developing intuitive understanding of the problem's meaning (9.21%), and identifying key elements in the problem text (14.47%).

For the second problem, the percentage achievements were: understanding question sentence structure (19.74%), explaining mathematical solutions (22.37%), paraphrasing questions into mathematical models (11.84%), creating varied explanatory sentences (14.47%), developing intuitive understanding of the problem's meaning (18.42%), and identifying key elements in the problem text (13.16%).

Guided by a framework integrating Noam Chomsky’s theory of linguistic structure with core critical thinking components, our analysis of 204 students’ mathematical problem-solving reveals a distinct cognitive profile. The data indicate that students’ primary strengths are metacognitive and interpretative. The highest demonstrated skill was Self-regulation (27.94%), defined as the ability to identify key elements in problem text based on sentence patterns, suggesting a proficiency in monitoring one's own engagement with the linguistic structure of problems. This was closely followed by Interpretation (27.21%), reflected in the capacity to understand sentence structure within word problems. However, the application of deeper analytical processes shows a relative decline. Skills such as Inference (21.32%) able to paraphrase word problems into mathematical models, and Evaluation (22.06%), which are able to construct varied explanations or answer clusters with Analysis (20.59%) and Explanation (20.59%), which involve explaining solutions in writing and developing an intuitive understanding. This pattern suggests that while students are adept at the initial, structurally-focused stages of problem-solving (decoding and self-monitoring), they encounter a shared challenge in fluently executing the transformative and communicative acts of analysis, synthesis, and justification, pointing toward a critical area for targeted pedagogical intervention

Discussion

A significant relationship between linguistic intelligence and Critical Thinking skills indicates that an increase in one is associated with an enhancement in the other, and vice versa. This interdependence is particularly crucial in mathematics problem-solving.

Recent research substantiates this connection. Darwis et al. (2024) posit that linguistic intelligence aids students in developing mathematical communication skills, which are fundamental for articulating solution pathways. Similarly, Atmojo et al. (2024) identified a significant correlation between linguistic intelligence and computational thinking, a key component of modern problem-solving. Their study specified that among various linguistic indicators, rhetoric (structured argumentation), explanation (clarifying processes), and metalinguistics (the ability to reflect on language use) are strongly linked to computational thinking abilities. Consequently, they recommend fostering these specific skills to enhance students' computational thinking.

To fully appreciate this relationship, it is essential to understand language's multifaceted role in mathematics learning. Planas and Pimm (2023) provide a robust framework through four key concepts: instructional designing (crafting language-aware lessons), gesturing (using physical movement to embody mathematical ideas), argumenting (constructing logical cases), and languaging (the active process of using language to construct meaning). These concepts collectively outline the kind of learning environment necessary to bridge language and mathematical understanding.

However, the implementation of this ideal is challenging. The struggle to integrate everyday language with the precise language of mathematics is a global issue in education. As noted by Ingram, Abbott, and Smith et al., both teachers and students often face difficulties when appropriate analogies are missing or when the practical function of mathematics remains abstract and disconnected. This "language struggle" is a pervasive problem that can significantly hinder mathematical comprehension if not addressed.

While the findings confirming the correlation between linguistic intelligence and mathematical problem-solving are compelling, several limitations must be acknowledged. First, the sample size of this study was relatively small and restricted to eleventh-grade students, limiting its generalizability. A larger and more diverse sample would provide a more comprehensive understanding. Second, the instruments used to measure the core constructs could be refined for greater validity and reliability. Finally, the cross-sectional design of this study only captures a single moment in time. For a deeper exploration of how this relationship evolves, longitudinal studies are necessary.

In conclusion, this discussion underscores the powerful synergy between linguistic intelligence and mathematical problem-solving while opening avenues for future research. Addressing the noted limitations through larger-scale, longitudinal, and methodologically diverse studies will allow for a more complete capture of this critical dynamic in education.

Compared with earlier conceptualizations, the study conducted by Indaswari et al. (2021) demonstrated that both mathematical logical intelligence and linguistic intelligence exert strong and significant contributions to students' ability to solve word problems. Mathematical logical intelligence showed a high correlation (0.786) with an effect size of 61.7%, while linguistic intelligence also exhibited a strong correlation (0.753). Collectively, these two domains yielded a very strong correlation (0.810) with improvements in students' problem-solving performance. These findings confirm that higher levels of logical and linguistic intelligence are directly proportional to the quality of students' solutions to word problems

In contrast, the present study provides a more nuanced account of how specific components of linguistic intelligence operate within the mathematical problem-solving process. Analysis of students' written responses reveals uneven mastery across linguistic indicators. Students demonstrated the highest levels of achievement in understanding sentence structure and explaining mathematical solutions (20–22%), whereas the ability to construct varied explanatory statements was substantially lower (10–14%). When examined through the lens of a critical-thinking framework, students performed strongest in self-regulation and interpretation (approximately 27%), yet showed consistent weaknesses in inference, evaluation, analysis, and explanation, each ranging only from 20–22%. Moreover, most students continued to rely predominantly on computational thinking (51–59%) rather than conceptual thinking.

Accordingly, while the findings of Indaswari et al. (2021) underscored the positive influence of linguistic intelligence on problem solving, the present study extends this understanding by revealing that such contributions are not evenly distributed across linguistic components. Students tend to demonstrate competence in the initial stages of linguistic processing but encounter considerable difficulty in more advanced analytical processes and in transforming linguistic information into mathematical models. Thus, this study not only reinforces previous evidence but also identifies specific aspects of linguistic intelligence that remain underutilized by students in solving mathematical word problems.

Conclusion

The findings of this study indicate that the majority of students demonstrate computational thinking, with considerably smaller proportions exhibiting conceptual and semi-conceptual thinking across both problems analyzed. The mapping grounded in Chomsky's linguistic theory and Facione's critical thinking framework further reveals that students' linguistic abilities are strongly associated with the six core components of critical thinking, with the highest levels of achievement shown in interpretation and self-regulation. These results confirm that Indonesian linguistic intelligence plays a significant role in enhancing students' mathematical problem-solving abilities, particularly in comprehending the context of word problems and regulating cognitive processes more reflectively. Overall, linguistic intelligence serves as an essential factor in strengthening the reasoning, evaluation, and mathematical meaning-making of Grade XI students at SMAK St. Louis 1 Surabaya.

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