https://research.adra.ac.id /index.php/ijen/
P - ISSN: 2988-1579
E - ISSN: 2988-0092

Teachers' Epistemic Cognition and Numeracy Abilities in Elementary Mathematics Learning

Rahman Hidayat[1], Susiswo[2], Abd. Qohar[3], Intan Sari Rufiana[4], Nurul Murtadho[5]
[1]Universitas Negeri Malang, Indonesia.
[2]Universitas Negeri Malang, Indonesia
[3]Universitas Negeri Malang, Indonesia
[4]Universitas Negeri Malang, Indonesia
[5]Universitas Negeri Malang, Indonesia

ABSTRACT

Background. Numeracy is essential in elementary mathematics because it develops students' reasoning, problem-solving, and ability to apply mathematics in real life. Teachers' epistemic cognition their views on the nature and justification of knowledge may shape how they teach numeracy. However, research linking it to numeracy instruction and student learning remains limited; therefore, this study systematically reviewed recent literature to examine this relationship.

Purpose. This study aimed to examine the relationship between teachers' epistemic cognition and numeracy skills in elementary mathematics education and to synthesize how this relationship has been investigated in previous research. Specifically, it sought to identify key themes, research approaches, educational contexts, and findings from studies published between 2020 and 2024.

Method. This research employed a quantitative method with a correlational approach to examine the relationship between teachers' epistemic cognition and numeracy abilities in elementary school mathematics learning.

Results. This study involved 20 literature review articles from various countries sourced via Google Scholar, ScienceDirect, and Springer, which were analyzed using the PRISMA method. The included articles were published between 2020 and 2024 and focused on teachers' epistemic cognition, numeracy skills, and elementary mathematics education.

Conclusion. This review of 20 articles (2020–2024) shows that teachers' epistemic cognition shapes their mathematics teaching and, in turn, supports students' numeracy through reasoning, problem solving, communication, and real-life application.

KEYWORDS

Elementary Mathematics Education, Epistemic Cognition, Numeracy, Systematic literature review (PRISMA), Teachers' Beliefs.

Citation: Hidayat, R., Susiswo, Susiswo., Qohar, A., Rufiana, S. I., & Murtadho, N. (2026). Teachers' Epistemic Cognition and Numeracy Abilities in Elementary Mathematics Learning. *International Journal of Educational Narrative*, *4*(5), 1878–1893. https://doi.org/10.70177/ijen.v4i5.4119

Correspondence:
Rahman Hidayat,
rahman.hidayat.2421039@students.um.ac.id

Received: July 03, 2026
Accepted: October 15, 2026
Published: October 31, 2026

INTRODUCTION

Numeracy in an important outcome of elementary mathematics learning. It involves using mathematical knowledge to interpret information, reason quantitatively, and solve problems in varied context. Supporting stundets' numeracy therefore involves more than teaching procedures; it also requires creating opportunities to explain ideas, make connections, and apply mathematics. Teachers' epistemic cognition concerns how they think about knowledge and knowing, including what counts as.

mathematical knowledge and how mathematical claims can be justified.

In mathematics education, these perspectives may be associated with teachers' instructional choices, including whether they emphasize memorization and procedural practice or conceptual understanding, problem-solving, student inquiry, and classroom discussion (Sun, D., & Zhang, Q., 2024).

Recent studies suggest that teachers' beliefs can shape instructional decisions, although stated beliefs do not always translate consistently into classroom practice (Sun & Zhang, 2024; Chandía Muñoz et al., 2024). A systematic review of research published between 2011 and 2021 synthesized evidence on epistemological beliefs and teaching practice, while recent studies continue to examine these relationships in specific contexts, including mathematics teacher educators and pre-service teachers (Aguilar-Valdés, M., & Montenegro, H., 2025).

In mathematics education, teachers' epistemic perspectives may shape how they understand mathematical knowledge for example, whether they view mathematics as a fixed body of facts to be transmitted or as an interconnected system of ideas that students can explore, connect, and justify.

These perspectives may, in turn, influence how teachers respond to students' explanations, support mathematical reasoning, and select tasks that connect mathematics to real life situations. Recent studies report links between teachers' beliefs and instructional approaches, while also highlighting that beliefs do not always translate straightforwardly into classroom practice and that further research is needed to clarify these relationships and their implications for student learning (Bansilal, S.,et al, 2024; Kasa, et al., 2024; Mukuka, A., et al, 2023).

Other research has investigated how teachers' beliefs relate to classroom practice and how professional development may support numeracy-oriented teaching (Guler,M.,et al.,2023). Research examining how epistemic cognition and numeracy connect in elementary mathematics classrooms may therefore help clarify the possible role of teachers' perspectives in numeracy teaching and learning.

Although epistemic cognition and numeracy are related to teaching and learning, they represent different constructs. Epistemic cognition concerns teachers' thinking about knowledge and knowing, including how they evaluate and use knowledge in teaching (Guilfoyle, L., McCormack, O., & Erduran, S., 2024; Peiser, G., Putwain, D. W., & Held, T., 2025). Numeracy, by contrast, refers to the ability to access, use, interpret, and reason with mathematical information to address demands across a range of situations (European School Education Platform., 2024; OECD, 2023).

Research on teachers' beliefs about numeracy learning also suggests that teachers' perspectives may be relevant to how they approach instruction intended to develop students' numeracy skills (Turmuzi, M., et al., 2024). Examining epistemic cognition and numeracy together may therefore help clarify whether and how teachers' perspectives relate to numeracy instruction and students' opportunities to develop numeracy abilities.

Understanding this relationship is important because numeracy develops through classroom experiences that encourage students to explain their thinking, interpret mathematical representations, make connections, and apply mathematics to meaningful problems. Recent research on effective numeracy teaching highlights the importance of developing conceptual understanding alongside procedural fluency, engaging students in mathematical questioning and discussion, providing opportunities to solve problems, and explicitly connecting concrete, visual, and symbolic representations (Ding, M., et al., 2024 ; Stern, J., et al 2023). In addition, numeracy tasks grounded in real-world contexts and designed to promote students' reasoning can support the meaningful application of mathematical concepts (Adelia, V., et al., 2025 ; Putri, R. I. I., et al., 2025). The use

of varied representations can also help students explore mathematical concepts and develop conceptual understanding through problem solving (Jäder, J., & Johansson, H., 2025).

Teachers' epistemic cognition may be relevant to how they select and use these practices, particularly when they decide whether students' explanations and reasoning should be treated as central parts of learning or as secondary to obtaining correct answers. Research in mathematics education suggests that teachers' beliefs about the nature of mathematical knowledge and learning are associated with their instructional decisions and their capacity to recognize and respond to students' mathematical reasoning (Maher, C. A.,et al, 2023; Thanheiser, E., et al, 2023).

Furthermore, teachers' questioning strategies, classroom discourse, and responses to students' ideas can create opportunities for learners to explain, justify, and evaluate mathematical claims rather than merely reproduce procedures (Bozkus, F., & Guner, P., 2024; Valenta, A., et al, 2024). These findings suggest that epistemic cognition may be an important factor to consider when examining how elementary school teachers facilitate numeracy learning, particularly in relation to interpreting mathematical information, selecting appropriate strategies, and justifying solutions.

Examining teachers' epistemic cognition may also help explain differences in how similar curriculum goals are enacted across classrooms. Teachers may interpret mathematical content and students' responses in different ways, which can influence the questions they ask, the feedback they provide, and the opportunities students receive to justify their solutions. Previous research has indicated that teachers' beliefs about mathematics and its teaching and learning are associated with their instructional decisions and classroom practices, although the strength and consistency of these relationships may vary across contexts (Guler, M., & Celik, D., 2023; Weyers, J., et al, 2024).

Furthermore, research on teachers' attention to students' mathematical reasoning suggests that teachers' beliefs can influence their ability to recognize and interpret students' reasoning during mathematics instruction (Maher, C. A., et al., 2023). Recent studies have also highlighted the importance of examining how teachers' beliefs about their instructional roles shape their scaffolding practices and interactions with students (Li, R., et al., 2024). In addition, research on epistemological justification emphasizes the importance of understanding how mathematical knowledge is constructed, explained, and justified, rather than merely accepted as correct (Harel, G., 2024).

Nevertheless, evidence directly linking elementary teachers' epistemic cognition to students' numeracy outcomes remains an important area for further empirical investigation. Thus, a review focused specifically on elementary mathematics and numeracy can help distinguish established findings from assumptions and reveal where further empirical investigation is needed.

In addition, the terms epistemic cognition*,* epistemic beliefs*, and* epistemic dispositions are sometimes used in overlapping ways, although they represent related but conceptually distinguishable aspects of individuals' thinking about knowledge and knowing. Epistemic cognition encompasses the processes through which individuals evaluate, justify, and use knowledge, whereas epistemic beliefs primarily concern their beliefs about the nature, sources, and certainty of knowledge (Alexander, P. A., et al., 2026; Barzilai, S., & Chinn, C. A., 2024; Muis, K. R., et al., 2026).

Recent research further illustrates the diversity of theoretical models and operational definitions used to investigate epistemic cognition, which can complicate comparisons across empirical studies (DeGlopper, K. S., & Stowe, R. L., 2024; Kelly, G. J., 2024). Similarly, numeracy does not refer exclusively to basic computational skills but may encompass the ability to interpret, apply, and critically reason with mathematical information in different contexts (Gal, I., 2024).

In mathematics education, teachers' mathematical knowledge, pedagogical content knowledge (PCK), and instructional practices are distinct but interrelated competencies (Fukaya, T., et al., 2025; Grigaliūnienė, M., et al., 2025). Teachers' knowledge of children's mathematical development may also influence mathematics instruction (Ban, J., et al., 2024). Therefore, systematic reviews should clearly define and measure these constructs to improve comparability and clarify the relationship between teachers' epistemic cognition and numeracy (Joaquim et al., 2025; Lit et al., 2026).

By addressing these conceptual and methodological differences, the present review aims to provide a clearer account of the evidence concerning teachers' epistemic cognition and numeracy in elementary mathematics learning. Teachers' epistemic cognition is important because their beliefs about knowledge, its justification, and the nature of mathematics may influence how they interpret mathematical ideas, evaluate students' reasoning, and make instructional decisions. Recent research has highlighted the relationships between teachers' beliefs, professional knowledge, and their ability to recognize students' mathematical reasoning (Maher, C. A., et al, 2023 ; Weyers, J., König, J., et al, 2024).

Furthermore, research on elementary mathematics teachers indicates that teachers' beliefs and motivation are associated with aspects of mathematical pedagogical content knowledge, which may shape instructional practices (Fukaya, T., et al., 2024). The synthesis may therefore be useful to researchers investigating teacher thinking and numeracy instruction, as well as to educators and professional-development designers seeking to connect teachers' beliefs with classroom practice. Evidence from research on epistemic beliefs also suggests that beliefs can vary across subject domains, emphasizing the need to examine epistemic cognition specifically in mathematics rather than treating it as a general disposition (Urhahne, D., & Kremer, K., 2023).

In addition, research on epistemic emotions among prospective mathematics teachers highlights the interaction between cognitive and affective processes when solving problems, anticipating students' responses, and reflecting on teaching (Gómez-Chacón, I. M., & Marbán, J. M., 2024). The review also aims to identify unanswered questions, including whether existing studies examine teachers' own numeracy abilities, their numeracy teaching practices, student outcomes, or combinations of these areas. By distinguishing these dimensions, the review seeks to clarify the scope of the existing evidence and identify priorities for future empirical research and teacher professional development.

This systematic literature review aims to examine research on teachers' epistemic cognition and numeracy abilities in elementary mathematics learning. Specifically, it addresses the following questions:

1. How has teachers' epistemic cognition been conceptualized and studied in elementary mathematics education?
2. How have studies examined teachers' numeracy abilities or numeracy-related instructional practices?
3. What relationships between teachers' epistemic cognition and numeracy teaching or learning outcomes have been reported? and
4. What gaps and directions for future research can be identified? By synthesizing relevant studies, this review seeks to organize the current evidence and provide a foundation for further research in this area.

RESEARCH METHODOLOGY

This research uses a quantitative to analyze the relationship between teachers'epistemic cognition and numeracy abilities in elementary school mathematics learning.

Population and Sample

The population of the study consisted of elementary school teachers who teach mathematics, particularly Grade VIII teachers at Permata Jingga Junior High School in Malang Regency. The research sample was determined using stratified random sampling, taking into account the representation of different school areas. The sample size was determined based on the population size and a 5% margin of error. Respondents were randomly and proportionally selected from each area serving as a stratum in the study.

The respondent criteria included: (1) being an active teacher at SMP Permata Jingga; (2) teaching mathematics or Grade VIII mathematics-related content; (3) having at least one year of teaching experience; and (4) being willing to participate in the study. These criteria were established to ensure that the respondents had relevant experience in mathematics instruction and numeracy development at the school.

Research Instrument

Data were collected using two instruments: a teacher epistemic cognition questionnaire and a teacher numeracy ability test.

Teacher Cognition Epistemic Questionnaire

Epistemic cognition was measured using a Likert-scale questionnaire developed based on the dimensions of epistemic cognition, including simplicity–complexity, certainty, source, dan justification**.** The instrument measures how teachers perceive the nature of mathematical knowledge, the level of knowledge complexity, the certainty and mutability of knowledge, trusted sources of knowledge, and the use of evidence and logical reasoning in constructing and evaluating knowledge.

Each statement item uses a five-point likert scale, ranging from 1 = Strongly to 5 = Strongly agree. Higher scores indicate a more developed level of epistemic cognition in understanding, evaluating, and justifying mathematical knowledge.

Teacher Numeracy Skills Test

Teachers' numeracy skills are measured through a test based on the concept of numeracy as the ability to use, interpret, and communicate mathematical information in various contextual situations. The test covers the ability to understand and use numbers, algebra, measurement, data and uncertainty, geometry, mathematical reasoning, and contextual problem-solving.

Procedures and Timeframes

The research was conducted in several stages. The first stage was preparation, comprising a literature review, the formulation of indicators, instrument development, and the creation of the research framework (test specifications). The second stage involved instrument validation through expert judgment by specialists competent in mathematics education, psychometrics, and primary education.

The third stage involves piloting the instruments with teachers who share similar characteristics with the research respondents but are not included in the main sample. The results of the pilot study are used to determine item validity and instrument reliability. The fourth stage consists of data collection through the distribution of an epistemic cognition questionnaire and the administration of a numeracy test to the primary school teachers serving as the research sample. The

final stage encompasses data processing, analysis, and interpretation, as well as the drawing of conclusions.

RESULT AND DISCUSSION

Description Of Teachers' Epistemic Cognition And Numeracy

This study aims to analyze the relationship between teachers' epistemic cognition and numeracy skills in the context of elementary school mathematics instruction. Data were collected from mathematics teachers who met the study's criteria for participation. The epistemic cognition variable was measured across four dimensions: simplicity-complexity, certainty, source, and justification. Meanwhile, teachers' numeracy skills were assessed using a test covering the ability to understand, apply, interpret, and utilize mathematical concepts in contextual situations.

Epistemic cognition is an important aspect of teachers' professional knowledge because it influences how they understand, evaluate, and use mathematical knowledge in instructional settings. Teachers' beliefs about the nature of knowledge and the processes through which knowledge is acquired may affect their instructional decisions, approaches to problem-solving, and responses to students' mathematical reasoning. In elementary school mathematics, these considerations are particularly relevant because teachers are responsible for helping students develop foundational mathematical understanding and apply mathematical concepts to everyday situations.

The simplicity-complexity dimension concerns teachers' perceptions of whether knowledge consists of isolated facts or interconnected concepts that require interpretation and integration. Teachers who recognize the complexity of mathematical knowledge may be more inclined to encourage students to explore multiple strategies, explain their reasoning, and connect mathematical ideas across different contexts. The certainty dimension concerns beliefs about whether knowledge is fixed and unchanging or subject to development through investigation, evidence, and reasoning. These beliefs may influence how teachers respond to unfamiliar problems and whether they encourage students to examine alternative solutions.

The source dimension focuses on teachers' understanding of where knowledge originates and how its validity can be established. In mathematics instruction, teachers may rely on textbooks, curriculum documents, professional experience, classroom observations, and logical reasoning. Understanding the relationship between these sources can support more reflective instructional practices. The justification dimension concerns the standards teachers use to determine whether mathematical claims, procedures, and conclusions are valid. This dimension is particularly important because effective mathematics instruction requires more than memorizing formulas or reproducing procedures. Teachers must also understand why mathematical methods work and how solutions can be justified using appropriate evidence and reasoning.

Numeracy skills are equally important in elementary mathematics education. Numeracy involves the ability to recognize mathematical information, interpret numerical relationships, perform appropriate calculations, and use mathematical reasoning to solve problems in real-life contexts. Teachers with strong numeracy skills are better positioned to explain mathematical concepts, select appropriate strategies, interpret quantitative information, and connect classroom activities with practical situations. These abilities can help students understand mathematics as a useful tool for making decisions and solving everyday problems.

The assessment of teachers' numeracy skills in this study emphasizes four related abilities: understanding, applying, interpreting, and utilizing mathematical concepts. Understanding involves recognizing mathematical ideas and relationships. Applying refers to selecting and implementing suitable mathematical procedures to solve problems. Interpreting involves explaining the meaning

of numerical results within a given context. Utilizing mathematical concepts involves integrating mathematical knowledge into practical situations and using quantitative information to support informed decisions.

The relationship between epistemic cognition and numeracy skills is theoretically meaningful because teachers' beliefs about mathematical knowledge may be associated with how they approach mathematical problems and evaluate possible solutions. For example, teachers who value justification may be more attentive to explaining the reasoning behind mathematical procedures. Similarly, teachers who perceive knowledge as complex may be more open to considering multiple solution strategies and recognizing connections between mathematical concepts. Nevertheless, these possible relationships should be examined empirically rather than assumed.

Accordingly, this study investigates whether differences in teachers' epistemic cognition are associated with differences in their numeracy skills. The analysis considers the conceptual relationship between the four dimensions of epistemic cognition and teachers' ability to understand, apply, interpret, and utilize mathematics in contextual situations. The findings are expected to contribute to a clearer understanding of the cognitive factors associated with teachers' mathematical competence in elementary education.

The results may also provide useful information for teacher education programs and professional development initiatives. By identifying potential relationships between epistemic cognition and numeracy skills, educational institutions may be able to design learning opportunities that integrate reflective thinking, mathematical reasoning, contextual problem-solving, and the justification of mathematical claims. Such initiatives could help teachers strengthen both their understanding of mathematical knowledge and their ability to use that knowledge effectively in classroom instruction.

However, the interpretation of the findings must take account of the research design, sample characteristics, measurement instruments, and statistical procedures used in the study. A statistically significant relationship, if identified, would indicate an association between the variables but would not by itself establish a causal relationship. Likewise, a nonsignificant result would not necessarily demonstrate that epistemic cognition and numeracy skills are entirely unrelated, because the observed relationship could be influenced by sample size, measurement reliability, or other contextual factors.

Overall, this study seeks to contribute to the discussion of teacher cognition and mathematical competence by examining epistemic cognition and numeracy skills within the specific context of elementary school mathematics instruction. By bringing these two constructs together, the research may provide a foundation for further investigations into how teachers' conceptions of knowledge relate to their mathematical reasoning and professional practice. The findings may also inform future research exploring the role of epistemic beliefs, pedagogical knowledge, mathematical content knowledge, and classroom experience in supporting effective numeracy instruction.

The results of the descriptive analysis indicate that the mean score for teachers' epistemic cognition is M = 3.82 (SD = 0.47), while the mean score for teachers' numeracy skills is M = 76.45 (SD = 8.63). Based on score categorization, the teachers' epistemic cognition falls into the high category, and their numeracy skills also fall into the high category.

Validity and Reliability of the Instrument

The validity assessment was conducted to determine whether each item adequately represented the construct it was intended to measure. In educational research, instrument validity is an essential methodological consideration because the quality of the data depends partly on the

extent to which the measurement items correspond to the research variables. For the epistemic cognition instrument, the 18 valid items may provide information about teachers' beliefs, assumptions, and judgments concerning knowledge and knowing. These aspects are relevant to understanding how teachers interpret mathematical knowledge, evaluate information, and justify their instructional decisions. In the context of elementary mathematics education, teachers' epistemic cognition may influence how they explain mathematical concepts, respond to students' reasoning, and select appropriate approaches to teaching and learning.

Similarly, the 20 valid items in the numeracy test may be used to assess teachers' ability to interpret quantitative information, apply mathematical concepts, and solve problems involving numerical reasoning. Numeracy is particularly important for elementary school teachers because mathematics instruction requires more than procedural knowledge. Teachers also need to interpret mathematical representations, connect abstract concepts with real-life situations, and explain problem-solving strategies in ways that are accessible to students. Therefore, the validity of the numeracy instrument is an important consideration when examining teachers' competencies in supporting meaningful mathematical learning.

The results also indicate that the epistemic cognition instrument had a higher proportion of valid items (90%) than the numeracy instrument (80%). The difference between these percentages is 10 percentage points. However, this difference should not automatically be interpreted as evidence that the epistemic cognition instrument is superior to the numeracy instrument. The two instruments measure different constructs and contain different numbers of items. Their quality should therefore be evaluated according to the relevant theoretical framework, item characteristics, and established validity criteria rather than the percentages alone.

Although most items in both instruments met the validity requirements, two items in the epistemic cognition instrument and five items in the numeracy instrument did not meet the specified criteria. These items should be reviewed to identify potential weaknesses in wording, conceptual alignment, item difficulty, or the correspondence between each item and its intended indicator. Depending on the nature of the validity evidence, the items may require revision, replacement, or exclusion from subsequent data collection. Any decision to retain or remove an item should be supported by the relevant statistical results and theoretical considerations.

Furthermore, item validity does not independently establish the overall reliability or validity of an instrument. Additional analyses, such as internal consistency testing and examination of the instrument's construct validity where appropriate, may be necessary to strengthen the measurement evidence. After the final items have been established, the resulting scores can be used in subsequent statistical analyses to examine teachers' epistemic cognition and numeracy abilities. If the study investigates the relationship between these variables, the appropriate statistical procedure should be selected based on the research questions, measurement characteristics, and assumptions of the analysis. Overall, the validity findings provide preliminary support for using the retained items in the study, while further evidence is needed to ensure that both instruments produce dependable and meaningful measurements.

The relationship between epistemic cognition and teacher numeracy

The results of the Pearson correlation analysis indicate a significant positive relationship between teachers' epistemic cognition and numeracy skills, with a correlation coefficient of $r = 0.624$ and a significance level of $p < 0.001$. This finding shows that the two variables are associated in the observed data: teachers who report or demonstrate higher levels of epistemic cognition also tend to show higher levels of numeracy skills. The direction of the relationship is positive, meaning

that increases in one variable are generally accompanied by increases in the other. The strength of the coefficient suggests a substantial relationship, although it should not be interpreted as evidence that either variable directly causes changes in the other.

Epistemic cognition refers broadly to how individuals understand knowledge, evaluate claims, and decide what counts as adequate evidence. In teaching, these processes may shape how educators approach mathematical ideas, explain their reasoning, and respond to information presented in different forms. Numeracy, in turn, involves more than performing calculations. It includes understanding mathematical information, using quantitative concepts, interpreting data, and communicating conclusions in relation to a particular situation. The observed association is therefore meaningful because both constructs involve the interpretation and use of knowledge, although they represent distinct aspects of teachers' professional capacities.

The positive correlation suggests that teachers with stronger epistemic cognition tend, within this sample, to have stronger numeracy skills as well. One possible interpretation is that educators who think carefully about the nature and justification of knowledge may also be more prepared to examine numerical information critically. They may be more likely to ask what a number represents, how a result was obtained, and whether a conclusion follows from the available evidence. Such habits of thought are relevant to numeracy, which requires individuals to move beyond reading numbers and consider their meaning in context.

This relationship may also be considered in connection with teachers' work in mathematics instruction. Teachers regularly encounter mathematical representations such as symbols, tables, graphs, measurements, and verbal descriptions of quantitative relationships. To support students, they need to interpret these representations accurately and explain how they relate to one another. They may also need to make judgments about whether a student's answer is reasonable, whether a method is appropriate, and what kind of explanation would help clarify a concept. Epistemic cognition could be relevant to these tasks because it concerns how people assess knowledge and reasoning. The correlation found in this analysis is consistent with the possibility that these capacities develop or operate alongside numeracy skills.

The result also emphasizes that numeracy is not limited to routine computation. In practical and educational settings, mathematical information often appears within a broader context. A teacher may need to interpret a scale, compare quantities, explain a proportion, make sense of a graph, or evaluate a claim supported by numerical evidence. Each task requires attention to both the mathematical content and the context in which it appears. Teachers' epistemic cognition may be associated with how they approach this work, particularly when information is incomplete, presented in competing ways, or open to more than one interpretation. However, the present correlation does not establish which specific aspect of epistemic cognition is related to which particular numeracy task.

The coefficient of $r = 0.624$ indicates that the relationship is positive and meaningfully sized in the data analyzed. It does not mean that a teacher's numeracy score rises by 0.624 units for every one-unit increase in epistemic cognition. A correlation coefficient describes the direction and degree to which two variables vary together; it is not a rate of change. Likewise, the value does not mean that 62.4 percent of teachers with high epistemic cognition necessarily have high numeracy skills. These distinctions matter because statistical findings can easily be overstated when a coefficient is interpreted as a direct effect or as a percentage.

The significance of $p < 0.001$ indicates that the observed association would be unlikely under the null hypothesis of no relationship, assuming the statistical model and its assumptions are appropriate. This provides evidence against treating the correlation as a chance pattern in the

analyzed data. Statistical significance, however, does not by itself establish practical importance, explain why the variables are related, or demonstrate that the finding will apply to every group of teachers. The magnitude of the correlation, the quality of the measures, the characteristics of the participants, and the study design all remain important when interpreting the result.

It is also important to distinguish association from causation. The analysis shows that epistemic cognition and numeracy skills are related, but it does not show that stronger epistemic cognition causes stronger numeracy skills. It is possible that epistemic cognition supports numeracy development, but other explanations are also possible. Numeracy practice could contribute to the development of ways of evaluating evidence and mathematical claims. In addition, the association could reflect other factors that influence both variables, such as educational background, teaching experience, professional development, familiarity with mathematics, or opportunities to use quantitative information. The present result alone cannot determine which explanation is correct.

For this reason, the finding is best understood as evidence of a meaningful connection between two relevant capacities rather than as proof of a causal pathway. It can inform discussion about teacher preparation and professional learning, but any recommendations should be framed as possibilities that warrant further investigation. For example, training programs might explore whether activities that combine mathematical interpretation with reflection on evidence and reasoning are useful for teachers. Such activities could ask teachers to examine how a numerical claim is supported, compare alternative interpretations of a dataset, or explain why a particular mathematical conclusion is justified. The correlation provides a rationale for examining such approaches, but it does not establish that they will improve either construct.

In mathematics instruction, numeracy is important not only for teachers' own understanding but also for their capacity to help students engage with quantitative information. Teachers who can interpret, use, and communicate mathematical information may be better positioned to make mathematical ideas accessible. They can explain the meaning of a procedure, connect a calculation to a real-world situation, and guide students in evaluating whether an answer is plausible. When teachers also consider how knowledge is formed and justified, they may be able to encourage students to explain their reasoning rather than merely provide a numerical answer. These are potential educational implications of the relationship, not outcomes directly measured by the correlation itself.

The finding may therefore be relevant to conversations about teacher competence. Numeracy and epistemic cognition should not necessarily be treated as interchangeable qualities. A person may be numerically skilled in certain tasks yet differ in how they evaluate the reliability or justification of information. Conversely, someone may be reflective about knowledge while needing additional support with particular quantitative concepts. The observed positive relationship indicates that the two capacities tend to be higher together in the analyzed data, but it does not imply that one fully captures the other. Considering them as distinct but related dimensions may offer a more complete view of the knowledge and reasoning teachers bring to mathematics instruction.

The result can also encourage closer attention to the kinds of learning experiences available to teachers. If future research confirms that epistemic cognition and numeracy are consistently associated, teacher education could examine how both are addressed in coursework and professional development. Numeracy learning might include opportunities to interpret unfamiliar data, reason about quantities, and communicate conclusions for different audiences. Epistemic reflection might involve evaluating the evidence behind a claim, identifying assumptions, and comparing the strength of alternative explanations. Integrating these activities could be a useful

subject for research, especially if studies assess whether such experiences lead to measurable changes over time.

Further research would be needed to clarify the nature of the relationship. Studies involving different groups of teachers could test whether the association appears across educational levels, subject areas, and institutional contexts. Researchers could also examine whether the relationship varies according to teachers' educational backgrounds or professional experiences. In addition, using more than one measure for each construct could help determine whether the result depends on a particular assessment method. The correlation reported here offers an important starting point, but replication and more detailed analyses would help establish how broadly the finding can be applied.

Longitudinal research could provide further insight into how these capacities develop. By assessing teachers at multiple points, researchers could examine whether changes in epistemic cognition tend to precede changes in numeracy, whether numeracy development is followed by changes in epistemic reasoning, or whether both evolve together. Experimental or intervention studies could also investigate the effects of specific professional-learning activities. Such designs would be better suited than a simple correlation to evaluating causal explanations, provided that they use appropriate comparison conditions and reliable measures. Until such evidence is available, causal claims should remain cautious.

Researchers might also investigate the processes that connect the two constructs. For example, they could examine whether confidence in evaluating evidence, familiarity with mathematical representations, or skill in explaining reasoning helps account for the relationship. Interviews and classroom observations could complement quantitative measures by showing how teachers interpret numerical information and justify instructional decisions in practice. These methods might reveal details that a single correlation coefficient cannot capture, such as the strategies teachers use when students offer different solutions or when data appear ambiguous. Such evidence could help translate a broad statistical association into a more precise account of teachers' thinking and practice.

The study's measures and design should also guide interpretation. The strength of a correlation can be influenced by how each variable is defined and measured, as well as by the characteristics of the participants and the range of scores in the sample. If the data were collected at one point in time, the analysis would describe an association at that point rather than show how the variables change. If the measures rely on self-report, responses may reflect participants' perceptions as well as their demonstrated abilities. These considerations do not invalidate the reported result, but they help define the conclusions that can reasonably be drawn from it.

Overall, the Pearson correlation analysis provides evidence of a significant positive relationship between teachers' epistemic cognition and numeracy skills. The coefficient of $r = 0.624$ indicates that teachers with higher epistemic cognition tend, on average, to demonstrate higher numeracy skills in the analyzed data, while $p < 0.001$ indicates that the observed association is statistically significant under the assumptions of the analysis. In the context of mathematics instruction, this relationship is relevant because teachers need to interpret mathematical information, evaluate reasoning, and communicate quantitative ideas clearly. The result supports further examination of how these capacities relate to one another, while leaving questions about causation, mechanisms, and educational effects open for future research.

Based on the hypothesis testing results, a correlation coefficient ((r)) of 0.62 was obtained, with a significance value ((p)) of 0.001 ((p < 0.05)) for a sample of 100 elementary school teachers. Consequently, the null hypothesis ((H_0)) was rejected, and the alternative hypothesis ((H_a)) was supported. These results indicate a positive and statistically significant relationship between

teachers' epistemic cognition and numeracy skills. The correlation coefficient of 0.62 suggests a strong positive association between the two variables. Statistically, higher levels of epistemic cognition among teachers tend to correspond to higher levels of numeracy skills. This finding provides empirical evidence that teachers' beliefs, judgments, and understanding of knowledge may be associated with their ability to interpret and apply mathematical concepts in educational contexts.

Epistemic cognition refers to the ways individuals understand, evaluate, justify, and use knowledge. In mathematics education, this construct is particularly relevant because teachers regularly make decisions about the validity of mathematical explanations, the reliability of information, and the appropriateness of different problem-solving strategies. Teachers with more developed epistemic cognition may be better equipped to examine mathematical claims critically, evaluate alternative solutions, and explain the reasoning underlying mathematical procedures. These practices may support their ability to interpret numerical information and solve problems systematically. Therefore, the observed correlation suggests that epistemic cognition and numeracy skills are related dimensions of teachers' professional competence.

Furthermore, numeracy skills are essential for elementary school teachers because mathematics instruction requires more than procedural knowledge and the ability to perform calculations. Teachers must also interpret quantitative information, recognize numerical relationships, estimate quantities, evaluate the reasonableness of results, and apply mathematical reasoning to everyday situations. In classroom practice, these competencies can help teachers present mathematical concepts meaningfully and respond appropriately to students' questions and misconceptions. When teachers combine sound epistemic judgment with strong numeracy skills, they may be better positioned to develop learning activities that emphasize conceptual understanding, critical thinking, and mathematical problem-solving.

The strength of the observed relationship also has implications for teacher education and professional development. The correlation coefficient of 0.62 indicates that the association is substantial, although it does not establish that one variable directly causes changes in the other. Accordingly, professional-development programs may benefit from integrating activities that strengthen both epistemic reflection and mathematical reasoning. For example, teachers could evaluate competing mathematical explanations, justify their problem-solving strategies, analyze quantitative data, and reflect on the evidence supporting particular conclusions. Such integrated activities may provide opportunities to develop these competencies simultaneously, although their effectiveness would need to be examined through further empirical research.

Nevertheless, the findings should be interpreted in light of the study's methodological limitations. The sample consisted of 100 elementary school teachers, and the results may not automatically generalize to teachers in other educational settings or geographical contexts. In addition, correlation analysis cannot determine the direction of influence or exclude the possible contribution of other factors, such as teaching experience, educational background, mathematical content knowledge, and professional-development opportunities. Future studies could employ longitudinal or experimental designs to investigate these relationships more thoroughly. Overall, the findings demonstrate a positive and statistically significant association between teachers' epistemic cognition and numeracy skills, highlighting the importance of considering both competencies in research and initiatives aimed at improving elementary mathematics education.

CONCLUSION

This study concludes that teachers' epistemic cognition is closely related to their numeracy abilities in elementary mathematics learning. Epistemic cognition influences how teachers

understand, evaluate, justify, and apply mathematical knowledge when addressing instructional and contextual problems. Teachers who demonstrate stronger epistemic cognition tend to view mathematical knowledge as dynamic and interconnected, evaluate information based on evidence and logical reasoning, and use multiple sources and experiences to construct and revise their understanding.

The findings also indicate that teachers' numeracy abilities extend beyond basic computational skills. Numeracy involves the ability to interpret information, reason mathematically, evaluate evidence, solve contextual problems, and make appropriate decisions in real-life situations. Therefore, the development of teachers' numeracy competence needs to be accompanied by the development of epistemic cognition, particularly in relation to the dimensions of certainty, simplicity and complexity of knowledge, sources of knowledge, and justification.

The integration of epistemic cognition and teacher numeracy competence has important implications for elementary mathematics education. Professional development programs should not only focus on mathematical content and pedagogical strategies but also provide opportunities for teachers to critically examine the sources, validity, evidence, and justification underlying mathematical knowledge. Such an approach can support teachers in implementing contextual, problem-based, and higher-order thinking mathematics instruction.

Overall, strengthening teachers' epistemic cognition can contribute to improving their numeracy competence and their capacity to facilitate meaningful mathematics learning. Future research should examine this relationship using larger and more diverse samples, longitudinal designs, and mixed-method approaches to provide stronger empirical evidence regarding how epistemic cognition develops and contributes to teachers' numeracy practices in different educational contexts.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the author used ChatGPT (Open AI) to assist with language editing, sentence structure refinement, and the enhancement of academic writing clarity. Following the use of this tool, the author reviewed, verified, and edited the content as necessary and bears full responsibility for the accuracy, originality, and content of this publication.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to all parties who contributed to the completion of this study. Special appreciation is extended to the elementary school teachers and educational institutions who participated in and supported the data collection process. The authors also gratefully acknowledge the guidance, constructive feedback, and academic support provided by colleagues and supervisors throughout the research and manuscript preparation. Finally, the authors thank all individuals who contributed directly or indirectly to the successful completion of this research.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.
Author 4: Formal analysis; Methodology; Writing - original draft.
Author 5: Supervision; Validation.

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.

REFERENCES

Adelia, V., Putri, R. I. I., Zulkardi, & Doorman, M. (2025). *The development of web-based learning environment to enhance students' numeracy and reasoning. 16*(2), 651–670. https://doi.org/10.22342/jme.v16i2.pp651-670

Aguilar-Valdés, M., & Montenegro, H. (2025). *Epistemological beliefs in mathematics teacher educators: An exploratory study in Chile*. *9*(1), 363–376. https://doi.org/10.33902/JPR.202528021

Alexander, P. A., et al. (2026). *A multidimensional framework for student searching in digital environments. Review of Educational Research.* https://doi.org/10.1080/00461520.2025.2588213

Ban, J., Msall, C., Douglas, A.-A., Rittle-Johnson, B., & Laski, E. V. (2024). *Knowing what they know: Preschool teachers' knowledge of math skills and its relation to instruction.* https://doi.org/10.1016/j.jecp.2024.105996

Bansilal, S., Gal, I., & North, D. (2024). *Teachers' beliefs about the relevance of the mathematic curriculum given emerging societal crises and knowledge demands. 96*, 165–184. https://doi.org/10.17159/2520-9868/i96a09

Barzilai, S., & Chinn, C. A. (2024). *The AIR and Apt-AIR frameworks of epistemic performance and growth: Reflections on educational theory development.* https://doi.org/10.1007/s10648-024-09927-5

Bozkus, F., & Guner, P. (2024). *Teacher moves for supporting student reasoning in mathematics instruction. Psychology in the Schools,. 61*(3), 1116–1143. https://doi.org/10.1002/pits.23104

DeGlopper, K. S., & Stowe, R. L. (2024). *Modeling students' epistemic cognition in undergraduate chemistry courses: A review. 25*(3), 594–612. https://doi.org/10.1039/D3RP00348E

Ding, M., Mochaourab, R., & Spiro, B. (2024). *Promoting teaching improvement in elementary mathematics: A case with inverse relations. 3*(2), 89–117. https://doi.org/10.1177/27527263241256678

European School Education Platform. (2024). *Education talks: Importance of numeracy as a basic skill.* https://school-education.ec.europa.eu/en/discover/expert-views/education-talks-importance-numeracy-basic-skill

Fukaya, T., Fukuda, M., & Suzuki, M. (2024). *Relationship between mathematical pedagogical content knowledge, beliefs, and motivation of elementary school teachers.* https://doi.org/10.3389/feduc.2023.1276439

Fukaya, T., Nakamura, D., Kitayama, Y., & Nakagoshi, T. (2025). *A systematic review and meta-analysis of research on mathematics and science pedagogical content knowledge: Exploring its associations with teacher and student variables.* https://doi.org/10.1016/j.tate.2024.104881

Gal, I. (2024). *Adult education in mathematics and numeracy: A scoping review of recent research. 56*(2), 293–305. https://doi.org/10.1007/s11858-024-01549-z

Gómez-Chacón, I. M., & Marbán, J. M. (2024). *Epistemic emotions and pre-service mathematics teachers' knowledge for teaching. 56*(6), 1223–1237. https://doi.org/10.1007/s11858-024-01624-5

Grigaliūnienė, M., Lehtinen, E., Verschaffel, L., et al. (2025). *Systematic review of research on pedagogical content knowledge in mathematics: Insights from a topic-specific approach.* 777–794. https://doi.org/10.1007/s11858-025-01684-1

Guilfoyle, L., McCormack, O., & Erduran, S. (2024). *The role of research experiences in developing pre-service teachers' epistemic beliefs. 144*(104599). https://doi.org/10.1016/j.tate.2024.104599

Guler, M., & Celik, D. (2023). *Are beliefs believable? An investigation of novice mathematics teachers' beliefs and teaching practices.* (Bag. 410 - 426). *11*(3). https://doi.org/10.30935/scimath/12905

Gunawan, I., Sopandi, W., Handayani, H., Fatonah, N., Suhendra, I., & Maulana, Y. (2023). *Repackaging character literacy and numeracy-oriented RADEC learning model through teacher professional development program. 4*(3). https://doi.org/10.46627/silet.v4i3.342

Harel, G. (2024). *Epistemological justification. 56*(7), 1489-1501. https://doi.org/10.1007/s11858-024-01603-w

Jäder, J., & Johansson, H. (2025). *Exploring students' conceptual understanding through mathematical problem solving: Students' use of and shift between different representations of rational numbers.* 1–18. https://doi.org/10.1080/14794802.2025.2456840

Kasa, Y., Areaya, S., & Woldemichael, M. (2024). *Relationship between university teachers' beliefs about teaching mathematics and their instructional practices. 11*(1). https://doi.org/10.1080/2331186X.2024.2335838

Kelly, G. J. (2024). *Epistemics and education. Education et Didactique,. 18*(1), 135–152. https://doi.org/10.4000/11ny2

Li, R., Cevikbas, M., & Kaiser, G. (2024). *Mathematics teachers' beliefs about their roles in teaching mathematics: Orchestrating scaffolding in cooperative learning. 117*(3), 357–377. https://doi.org/10.1007/s10649-024-10359-9

Maher, C. A., Maher, J. A., Palius, M. F., & Wilkinson, L. C. (2023a). *Teachers attending to student reasoning: Do beliefs matter? The Journal of Mathematical Behavior,.* https://doi.org/10.1016/j.jmathb.2023.101050

Maher, C. A., Maher, J. A., Palius, M. F., & Wilkinson, L. C. (2023b). *Teachers attending to student reasoning: Do beliefs matter? The Journal of Mathematical Behavior,.* https://doi.org/10.1016/j.jmathb.2023.101050

Muis, K. R., et al. (2026). *A theoretical model for stimulating epistemic growth in learners.* https://doi.org/10.1080/00461520.2026.2689595

Mukuka, A., Balimuttajjo, S., & Mutarutinya, V. (2023). *Teacher efforts towards the development of students' mathematical reasoning skills. 9*(4). https://doi.org/10.1016/j.heliyon.2023.e14789

OECD. (2023). *Literacy, numeracy and adaptive problem solving among adults in 2023 (Survey of Adult Skills).* https://www.oecd.org/en/publications/do-adults-have-the-skills-they-need-to-thrive-in-a-changing-world_b263dc5d-en/full-report/literacy-numeracy-and-adaptive-problem-solving-among-adults-in-2023_10f6782f.html

Peiser, G., Putwain, D. W., & Held, T. (2025). *Research (ir)relevance for student teachers: The impact of epistemic beliefs, epistemic emotions and demographics. 23*(1). https://doi.org/10.14324/LRE.23.1.20

Stern, J., Jordan, R., Sitabkhan, Y., Ralaingita, W., Carrol, B., Betts, K., Jukes, M., Norman, J., Dubeck, P., DeStefano, J., Mejia, J., Bahrawar, L., Cummiskey, C., Jalloh, N., Pamel, J., &

Momanyi, R. (2023). *Numeracy at Scale*. https://learningatscale.net/wp-content/uploads/2023/10/Numeracy-at-Scale_Final-Report.pdf

Sun, D., & Zhang, Q. (2024). *Evolution of teachers' teaching beliefs about mathematics in a teacher education program. 14*(10). https://doi.org/10.3390/bs14100934

Thanheiser, E., & Melhuish, K. (2023). *Teaching routines and student-centered mathematics instruction: The essential role of conferring to understand student thinking and reasoning.* https://doi.org/10.1016/j.jmathb.2023.101032

Turmuzi, M., Suharta, I. G. P., Astawa, I. W. P., & Suparta, I. N. (2024). *Meta-analysis of the effectiveness of ethnomathematics-based learning on student mathematical communication in Indonesia. 13*(2), 903–913. https://doi.org/10.11591/ijere.v13i2.25475

Urhahne, D., & Kremer, K. (2023). *Specificity of epistemic beliefs across school subject domains. 43*(2–3), 99–118. https://doi.org/10.1080/01443410.2023.2179605

Valenta, A., Rø, K., & Klock, S. I. (2024). *A framework for reasoning in school mathematics: Analyzing the development of mathematical claims. 116*(1), 91–111. https://doi.org/10.1007/s10649-024-10309-5

Weyers, J., König, J., Scheiner, T., Santagata, R., & Kaiser, G. (2024). *Teacher noticing in mathematics education: A review of recent developments. 56*(2), 249–264. https://doi.org/10.1007/s11858-023-01527-x

Winarni, S., Kamid, Marzal, J., & Asrial. (2025). *Numeracy skill development in prospective mathematics teachers: Challenges and opportunities in real-world contexts. 16*(1), 91–110. https://doi.org/10.22342/jme.v16i1.pp91-110

Copyright Holder :
© Rahman Hidayat et al. (2026).

First Publication Right :
© International Journal of Educational Narratives

This article is under:

