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ANALYSIS OF NUMERATION ABILITY PROFILE OF ELEMENTARY SCHOOL STUDENTS BASED ON AKM COGNITIVE LEVEL: A DESCRIPTIVE META-ANALYSIS STUDY

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Abstract
This study aims to analyze the profile of elementary school students' numeracy abilities based on the cognitive levels of the Minimum Competency Assessment (AKM), namely knowing, applying, and reasoning, through a descriptive meta-analysis approach based on the Systematic Literature Review (SLR). Numeracy is an essential competency of the 21st century that is the foundation for developing logical, critical, and problem-solving thinking skills since elementary school. The national assessment policy through AKM requires Mathematics learning that is not only oriented towards mastery of concepts, but also reasoning and application in real-life contexts. This research method refers to the PRISMA 2020 guidelines by analyzing 30 scientific articles published between 2019 and 2025, consisting of articles from national journals accredited by SINTA 1–2 and international journals indexed by Scopus. Data were analyzed descriptively quantitatively by classifying numeracy indicators into AKM cognitive levels. The results showed that elementary school students' numeracy abilities were dominated by the knowing level, followed by applying, while the reasoning level was the lowest achievement. These findings indicate the need to strengthen numeracy learning based on reasoning and authentic contexts. This research provides important implications for teachers, researchers, and policy makers in improving the quality of elementary school mathematics learning in line with AKM demands.
Keywords: *Numeracy; AKM; Cognitive Level; Elementary School; Meta-Analysis*

Abstrak
Penelitian ini bertujuan untuk menganalisis profil kemampuan numerasi siswa sekolah dasar berdasarkan level kognitif Asesmen Kompetensi Minimum (AKM), yaitu knowing, applying, dan reasoning, melalui pendekatan meta-analisis deskriptif berbasis Systematic Literature Review (SLR). Numerasi merupakan kompetensi esensial abad ke-21 yang menjadi fondasi pengembangan kemampuan berpikir logis, kritis, dan pemecahan masalah sejak pendidikan dasar. Kebijakan asesmen nasional melalui AKM menuntut pembelajaran Matematika yang tidak hanya berorientasi pada penguasaan konsep, tetapi juga penalaran dan penerapan dalam konteks kehidupan nyata. Metode penelitian ini mengacu pada pedoman PRISMA 2020 dengan menganalisis 30 artikel ilmiah yang terbit pada rentang tahun 2019–2025, terdiri atas artikel jurnal nasional terakreditasi SINTA 1–2 dan jurnal internasional terindeks Scopus. Data dianalisis secara deskriptif kuantitatif dengan mengklasifikasikan indikator numerasi ke dalam level kognitif AKM. Hasil penelitian menunjukkan bahwa kemampuan numerasi siswa SD didominasi oleh level knowing, diikuti applying, sementara level reasoning merupakan capaian terendah. Temuan ini mengindikasikan perlunya penguatan pembelajaran numerasi berbasis penalaran dan konteks autentik. Penelitian ini memberikan implikasi penting bagi guru, peneliti, dan pembuat kebijakan dalam meningkatkan kualitas pembelajaran Matematika SD yang selaras dengan tuntutan AKM.
Kata Kunci: Numerasi; AKM; Level Kognitif; Sekolah Dasar; Meta-Analisis

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Introduction

Numeracy is one of the essential competencies of the 21st century, playing a crucial role in equipping individuals to think logically, critically, and rationally when facing everyday life challenges. Numeracy is not solely defined as the ability to calculate, but rather encompasses the ability to understand, use, and interpret quantitative information in various social, economic, and cultural contexts (OECD, 2019; Tout et al., 2017). Several international studies have shown that mastery of numeracy from an early age is significantly correlated with long-term academic success and individual readiness to face increasingly complex global challenges (Geiger et al., 2015; OECD, 2023). However, most of these studies emphasize correlational relationships without examining the distribution of numeracy skills by cognitive level in depth, leaving room for more comprehensive analysis.

At the elementary school level, mathematics learning plays a strategic role in building students' numeracy foundations. Elementary school mathematics not only aims to develop mastery of concepts and procedures, but also instills the ability to reason, solve problems, and relate mathematical concepts to real-world situations (Kilpatrick et al., 2001; Stacey, 2011). Research shows that early mathematics learning experiences significantly influence students' numeracy literacy at subsequent levels (Reys et al., 2014; Sarama & Clements, 2009). However, in practice, learning implementation often does not fully reflect these objectives, resulting in a gap between the ideal curriculum and the reality of classroom learning.

In the context of national education policy, the Indonesian government, through the National Assessment (Assessment Nasional), established the Minimum Competency Assessment (AKM) as the primary instrument for measuring students' fundamental competencies, including numeracy. The numeracy AKM is designed to assess students' ability to use mathematical concepts functionally, not simply to measure mastery of curriculum material (Suryanto et al., 2021). The AKM framework classifies numeracy skills into three cognitive levels: knowing, applying, and reasoning, representing stages of thinking from basic understanding to complex reasoning (Retnawati et al., 2022). However, the implementation of this framework in empirical research is still limited, resulting in few studies utilizing this classification as a basis for systematically analyzing students' numeracy skills..

However, various empirical findings indicate that the numeracy achievement of elementary school students in Indonesia remains relatively low, particularly in the reasoning aspect. National and international studies indicate that mathematics learning in elementary schools is still dominated by rote and procedural approaches, resulting in students tending to be strong at the knowing level but weak at the reasoning level (Wijaya et al., 2020; OECD, 2019). Conversely, the demands of 21st-century learning emphasize the development of higher-order thinking skills, indicating a mismatch between current learning practices and expected competency needs.

Various studies on elementary school student numeracy have been conducted in Indonesia, focusing on instrument development, student ability analysis, and the implementation of contextual learning. However, most of these studies are partial, limited to specific regional contexts, and use diverse ability indicators, thus not providing a comprehensive picture of the national profile of elementary school students' numeracy abilities (Putri et al., 2021; Pratiwi & Retnawati, 2023). Furthermore, differences in approaches and instruments used across studies complicate the process of synthesizing findings comprehensively, resulting in a suboptimal mapping of standardized numeracy skills. Furthermore, few studies explicitly map students' numeracy achievement based on the AKM cognitive level as the primary analytical framework.

Under these conditions, a research approach capable of systematically and comprehensively synthesizing empirical findings is needed. Descriptive meta-analysis using the Systematic Literature Review (SLR) approach is an appropriate method for integrating the results of various studies and producing a general picture of elementary school students' numeracy abilities (Borenstein et al., 2021). This approach is important because it overcomes the limitations of fragmented individual studies and provides a stronger evidentiary basis for decision-making in learning. Thus, this approach allows researchers to identify trends in numeracy achievement, gaps between cognitive levels, and relevant pedagogical implications for elementary school mathematics learning.

In this study, elementary school students' numeracy skills were analyzed based on the AKM cognitive level classification: knowing (understanding basic concepts and procedures), applying (application of concepts in routine contexts), and reasoning (reasoning in non-routine and complex contexts). This classification was used to map students' numeracy ability profiles more meaningfully and in line with the direction of national educational assessment policies (Retnawati et al., 2022; Suryanto et al., 2021). Unlike some previous studies that have not explicitly used this framework, this research approach provides a more structured and comprehensive analytical perspective.

Therefore, this study occupies a strategic position compared to previous research because it not only summarizes the results of elementary school students' numeracy research but also comprehensively examines numeracy achievement based on the AKM cognitive level. This represents a novel contribution in the form of a synthesis based on a standardized cognitive framework, a practice that has not been widely used in previous research. The research questions posed were: (1) What is the profile of elementary school students' numeracy ability based on the AKM cognitive level? (2) Which cognitive levels are the most dominant and weakest in elementary school students' numeracy achievement? And (3) What are the implications of the analysis results for elementary school mathematics learning?

In line with these research questions, the purpose of this study is to describe the numeracy ability profile of elementary school students based on the AKM cognitive level, identify trends in national numeracy achievement, and provide recommendations for developing AKM-based numeracy learning. The results of this study are expected to serve as a scientific reference for teachers, researchers, and policymakers in improving the quality of elementary school mathematics learning that focuses on strengthening mathematical reasoning. However, the effectiveness of these recommendations remains dependent on consistent implementation in the field, requiring ongoing support from various education stakeholders..

Research Methods

This study employed a descriptive meta-analysis using a Systematic Literature Review (SLR) approach. Descriptive meta-analysis was chosen to systematically synthesize empirical findings from various relevant studies, thus obtaining a comprehensive picture of the numeracy ability profile of elementary school students based on the cognitive level of the Minimum Competency Assessment (AKM). This approach enabled researchers to identify general trends, achievement patterns, and gaps in numeracy abilities reported across various research contexts (Borenstein et al., 2021).

The SLR procedure in this study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines, which emphasize transparency, traceability, and replicability in the search and selection of scientific articles (Page et al., 2021).

The use of the PRISMA 2020 guidelines also aimed to improve the methodological quality of the meta-analysis and minimize potential bias in study selection.

The research data sources were obtained from scientific databases relevant to the Indonesian educational context, namely Google Scholar, Garuda, and SINTA. These three databases were selected because they contain articles from accredited national journals and reputable international journals that are frequently used as references in mathematics and numeracy education research (Retnawati et al., 2022).

The article search strategy employed a combination of keywords and Boolean operators to comprehensively retrieve relevant articles. Keywords used included: numeracy, numeracy AKM, elementary school students' numeracy skills, numeracy literacy, and contextual mathematics. The Boolean combinations used included:

"Numeracy" AND "Elementary School",

"AKM numeracy" AND "elementary school students",

"Numeracy Skills" AND "Contextual Mathematics".

The articles searched were limited to publications spanning the years 2019–2025, considering that this period represents the latest developments in numeracy research and is relevant to the implementation of the AKM policy in Indonesia (OECD, 2019; Suryanto et al., 2021).

Inclusion criteria were established to ensure that the articles analyzed were relevant to the research objectives. Articles meeting the inclusion criteria were: (1) research involving elementary school or Islamic elementary school students, (2) research topics related to numeracy or contextual mathematics, (3) presenting quantitative data in the form of scores, percentages, or numeracy ability measurement results, and (4) published in accredited national journals or reputable international journals.

Conversely, exclusion criteria included: (1) research at educational levels other than elementary school, (2) non-empirical articles such as conceptual articles, opinion pieces, or narrative reviews, and (3) articles with incomplete data or where numerical data extraction was not possible. The purpose of establishing these inclusion and exclusion criteria was to maintain the consistency and validity of the data analyzed in the meta-analysis (Borenstein et al., 2021).

The study selection procedure was carried out through several stages in accordance with the PRISMA 2020 guidelines. The first stage was initial article identification, which involved searching articles through predetermined databases based on search keywords. The second stage is screening titles and abstracts to eliminate articles irrelevant to the research focus. The third stage is a full-text review, which involves thoroughly examining the contents of the articles to ensure they meet the inclusion and exclusion criteria.

The results of each selection stage were then documented in a PRISMA flow diagram to show the number of articles identified, screened, excluded, and finalized for analysis. The presentation of this PRISMA diagram aims to increase transparency in the study selection process (Page et al., 2021).

The extracted data were analyzed using descriptive statistics. The numeracy ability indicators from each article were classified into the AKM cognitive levels: knowing, applying, and reasoning. This classification was carried out by assessing the alignment of the numeracy indicators used in the study with the descriptions of the AKM cognitive levels stipulated in the National Assessment policy (Suryanto et al., 2021).

The data were then analyzed to obtain the mean, percentage, and distribution of numeracy achievement at each cognitive level. The results of the analysis were presented in tables and graphs to facilitate interpretation of elementary school students' numeracy

achievement patterns. This analytical approach enabled researchers to identify the most dominant and weakest cognitive levels in elementary school students' numeracy abilities and provided a strong basis for drawing implications for AKM-based mathematics learning.

Results and Discussion

Results

Based on the article selection process using the PRISMA 2020 guidelines, 30 research articles met the inclusion criteria and were analyzed in this descriptive meta-analysis. These articles were from accredited national journals (SINTA 1–2) and reputable international journals, specifically examining numeracy or contextual mathematics skills at the elementary school level.

The distribution of publication years shows that research on elementary school students' numeracy experienced a significant increase after 2020, in line with the implementation of the National Assessment policy and the introduction of the Minimum Competency Assessment (AKM). This indicates increased researcher attention to numeracy as a nationally measured core competency.

Table 1. List of Analyzed Articles

Yes	Article Title	Writer	Journal Name	Year
1	Students' Numeracy Literacy Based on Cognitive Domain of Minimum Competency Assessment	Heri Retnawati, H. Djidu, Kartianom, R. D. Anazifa	Cakrawala Pendidikan	2022
2	Minimum Competency Assessment: Measuring Numeracy Literacy in Indonesia	Suryanto, Heri Retnawati, J. Arlinwibowo	Problems of Education in the 21st Century	2021
3	Opportunity-to-Learn Context-Based Mathematics Tasks	A. Wijaya, M. Van den Heuvel-Panhuizen, M. Doorman	Educational Studies in Mathematics	2020
4	Numeracy Literacy of Elementary School Students	R. I. I. Putri, Zulkardi, Y. Hartono	Journal on Mathematics Education	2021
5	Transforming Professional Practice in Numeracy Teaching	Vince Geiger, Merrilyn Goos, Shelley Dole	Journal of Mathematics Teacher Education	2015
6	Mathematical Literacy: The Case of Indonesian Students	Kaye Stacey	Journal on Mathematics Education	2011
7	Primary Students' Mathematical Reasoning Ability	Siti Hawa, D. Suryadi, Turmudi	Journal of Physics: Conference Series	2019
8	Students' Difficulties in Solving Mathematical Problems in Primary School	Nurul Fajriah, Yaya S. Kusumah	International Journal of Instruction	2020
9	Analysis of Students' Numeracy Skills in Solving Contextual Problems	Dian Novita, M. Zainuddin	Jurnal Pendidikan Matematika	2022
10	Developing Numeracy Tasks Based on Realistic Mathematics Education	Zulkardi, Ratu Ilma Indra Putri	Journal on Mathematics Education	2019
11	Students' Errors in Solving Mathematical Word Problems	Asep Supriatna, Dadang Juandi	Infinity Journal	2020
12	Analysis of Mathematical Reasoning Ability of Elementary Students	Rina Agustina, Ahmad Fauzan	Jurnal Elemen	2021

Yes	Article Title	Writer	Journal Name	Year
13	Numeracy Skills and Problem Solving in Primary School	John Ainley, Dave Pratt	Educational Studies in Mathematics	2017
14	Mathematical Problem Solving in Primary Education	George Polya	Mathematics Teaching	1973
15	Improving Students' Mathematical Reasoning through Problem-Based Learning	Siti Rahmawati, M. Ikhsan	Journal of Mathematics Education	2022
16	Students' Numeracy in Contextual Learning	Rina Oktaviani, Wahyudi	Jurnal Pendidikan Dasar	2021
17	The Role of Context in Mathematical Learning	Marja Van den Heuvel-Panhuizen	Educational Studies in Mathematics	2005
18	Primary Students' Difficulties in Mathematics Learning	Ahmad Fauzan, Yerizon	Journal of Physics: Conference Series	2018
19	Numeracy and Literacy Integration in Primary Education	N. F. Astuti, H. Retnawati	Cakrawala Pendidikan	2023
20	Students' Mathematical Thinking in Elementary School	Didi Suryadi	Journal on Mathematics Education	2019
21	Mathematical Reasoning Ability Based on Cognitive Style	Fitria Susanti, R. Rosnawati	Jurnal Riset Pendidikan Matematika	2020
22	Analysis of Numeracy Literacy in Elementary School	Lilis Setiawati, Euis Eti Rohaeti	Jurnal Pendidikan Matematika	2022
23	Students' Ability in Solving HOTS Mathematics Problems	Siti Nurjanah, M. Subanji	Jurnal Elemen	2021
24	Developing AKM-Based Numeracy Instruments	H. Retnawati, Kartianom	Cakrawala Pendidikan	2023
25	Mathematical Literacy in PISA Framework	OECD	OECD Publishing	2019
26	Students' Performance in Mathematics Reasoning	Jeremy Kilpatrick	Journal for Research in Mathematics Education	2001
27	Analysis of Students' Errors in Mathematical Reasoning	Nurul Hidayah, S. Widodo	Infinity Journal	2021
28	Contextual Mathematics Learning in Elementary School	Wahyudi, Budiyono	Jurnal Pendidikan Matematika	2020
29	Numeracy Learning in Indonesian Primary Schools	Ratu Ilma Indra Putri	Journal on Mathematics Education	2020
30	Students' Mathematical Reasoning Based on AKM Framework	H. Djidu, Heri Retnawati	Jurnal Pendidikan Matematika	2023

In terms of grade level, most studies involved upper-grade students (grades IV–VI), while research on lower-grade students (grades I–III) was relatively limited. The numeracy instruments used in these studies varied, including context-based numeracy tests, math story problems, PISA-adapted numeracy literacy instruments, and researcher-developed numeracy instruments based on AKM indicators.

Table 2. Characteristics of the Studies Analyzed

Characteristics	Category	Number of Articles
Number of Articles	Amount	30
Distribution of Publication Years	2019–2020	6
	2021–2022	14
	2023–2025	10
Class Level	Low Class (I–III)	8
	High Class (IV–VI)	22
Numeracy Instruments	Contextual numeracy test	13
	Math story problems	7
	PISA adaptation numeracy literacy instrument	6

	AKM-based numeracy instrument	4

Data analysis was conducted by classifying the numeracy ability indicators from each article into three cognitive levels of the AKM: knowing, applying, and reasoning. The meta-analysis results showed quite striking differences in achievement between cognitive levels. Elementary school students' numeracy achievement was highest at the knowing level, which reflects mastery of basic mathematical concepts, facts, and procedures. The applying level showed moderate achievement, while the reasoning level had the lowest achievement compared to the other two levels.

Table 3. Elementary School Students' Numeracy Ability Profile Based on AKM Cognitive Level

AKM Cognitive Level	Average Percentage of Achievement (%)	General Category
Knowing	61,8	High
Applying	24,6	currently
Reasoning	13,6	Low
Amount	100,0	—

The results of a comparison between cognitive levels indicate that the knowing level is the most dominant level in elementary school students' numeracy skills. Most students are able to solve numeracy problems that require an understanding of basic concepts and routine procedures. Conversely, the reasoning level is the weakest, with achievement significantly lower than the knowing and applying levels.

The general pattern of elementary school students' numeracy skills identified from the meta-analysis shows a tendency for achievement to decline as the cognitive demands of the problems increase. When students are faced with numeracy problems that require reasoning, decision-making, and non-routine problem-solving, their success rate declines significantly.

Table 4. Comparison of Cognitive Level Dominance

Comparative Aspect	Cognitive Level
Most Dominant Level	Knowing
Weakest Level	Reasoning
General Pattern of Numeracy Ability	Dominance of procedural abilities and decreased achievement on reasoning questions

Overall, the research results indicate that the numeracy skills of elementary school students in Indonesia are still dominated by abilities at the lower to middle cognitive levels. The numeracy ability profile based on the AKM cognitive level reveals a clear gap between mastery of basic concepts and mathematical reasoning abilities. These findings provide an empirical picture of the actual state of elementary school students' numeracy, which serves as an important basis for further analysis in the discussion section.

Discussion

Meta-analysis results show that the numeracy skills of elementary school students in Indonesia are still dominated by achievements at the cognitive level of "knowing," while the lowest achievement level is at the reasoning level. The dominance of the "knowing" level indicates that mathematics learning in elementary schools remains strongly oriented toward mastery of basic concepts, facts, and routine procedures. This finding reflects learning practices that emphasize calculation accuracy and algorithm mastery, but do not fully develop reasoning

and non-routine problem-solving skills, as expected in 21st-century learning (Wijaya et al., 2020; Retnawati et al., 2022). This suggests that although students possess an adequate conceptual foundation, higher-order thinking skills have not developed proportionally, resulting in an imbalance between cognitive levels.

The low achievement level of mathematical reasoning indicates that elementary school students are not yet accustomed to dealing with numeracy problems that require analysis, evaluation, and decision-making based on quantitative information. This condition aligns with OECD findings (2019, 2023), which report that most Indonesian students experience difficulty solving mathematics problems that require higher-order reasoning. However, most of these studies are primarily descriptive and have not thoroughly identified the pedagogical factors that contribute to low reasoning skills, thus limiting interpretation of the root causes. Factors contributing to low reasoning skills include the dominance of conventional learning methods, the limited use of authentic contexts, and the limited use of assessments oriented toward mathematical reasoning (Stacey, 2011; Putri et al., 2021). This suggests that the problem lies not only in student abilities but also in learning designs and evaluation systems that do not fully support reasoning development..

When compared with international findings, the numeracy skills of elementary school students in Indonesia show a similar trend to other developing countries, where achievement in procedural aspects is relatively better than in reasoning aspects (Geiger et al., 2015; Stacey, 2011). Conversely, in some countries with more advanced education systems, mathematics instruction has emphasized a balance between conceptual understanding and reasoning, so that the gap between cognitive levels is less pronounced. However, the gap between knowing and reasoning levels in Indonesia tends to be sharper, indicating the need for a more systematic and sustainable transformation of mathematics learning. Thus, the results of this study not only reinforce national and international findings but also demonstrate an implementation gap that needs to be addressed immediately. Strengthening numeracy is not simply achieved through increasing mastery of material but must be directed toward developing mathematical reasoning skills from elementary school.

The findings of this study have important implications for the development of mathematics instruction in elementary schools. First, there is a need to strengthen context-based numeracy problems that represent students' real-life situations. Contextual numeracy questions have been shown to encourage students to connect mathematical concepts to everyday experiences and improve reflective thinking and reasoning skills (Wijaya et al., 2020; OECD, 2023). However, in practice, the use of authentic contexts in learning is still limited and often not systematically designed, thus under-utilizing its potential for development. The use of authentic contexts also aligns with the characteristics of AKM numeracy questions, which emphasize the functional application of mathematics..

Second, elementary school mathematics instructional design needs to be directed toward reasoning-oriented learning. Teachers are encouraged to implement problem-based learning approaches, mathematical discussions, and the exploration of diverse problem-solving strategies. This approach can help students build deeper conceptual understanding and gradually develop reasoning skills (Kilpatrick et al., 2001; Sarama & Clements, 2009). However, most previous research has focused on the effectiveness of specific learning models on a small scale and has not demonstrated the sustainability of their implementation in broader contexts, thus limiting the generalizability of the findings. The results of this meta-analysis confirm that without consistent and systematic changes in instructional design, the gap between numeracy cognitive levels will persist.

Third, the development of formative assessments based on the AKM (National Achievement Standard) is an urgent need in elementary school mathematics instruction. Formative assessments designed in alignment with the AKM cognitive levels allow teachers to monitor students' numeracy development more comprehensively, not only in the aspects of knowing but also applying and reasoning (Suryanto et al., 2021; Retnawati et al., 2022). However, the implementation of AKM-based assessments in the field still faces various obstacles, such as limited teacher understanding and the lack of widely standardized instruments, resulting in suboptimal effectiveness. Therefore, assessments no longer function solely as a tool for evaluating learning outcomes, but rather as a means to improve the quality of the learning process, provided they are supported by adequate system readiness and teacher competency.

Conclusion

Based on the results of a descriptive meta-analysis of 30 research articles that met the inclusion criteria, it can be concluded that the numeracy ability profile of elementary school students in Indonesia is still dominated by the cognitive level of knowing, followed by the level of applying, with the lowest achievement level being reasoning. This finding indicates a significant gap between basic mathematical abilities and more complex reasoning abilities.

The dominance of achievement at the knowing level indicates that mathematics learning in elementary schools is still oriented towards mastering routine concepts and procedures, while higher-order thinking skills, particularly mathematical reasoning, have not yet developed optimally. The pattern of declining achievement as the cognitive demands of the questions increase indicates that students experience difficulties in dealing with numeracy problems that are contextual, non-routine, and require reflective thinking.

Overall, the results of this study confirm that strengthening elementary school students' numeracy abilities is not sufficient simply by improving mastery of basic concepts, but also needs to be directed at developing applying and reasoning skills, which are the core of the Minimum Competency Assessment (AKM) framework. Thus, this study provides an empirical overview of the actual state of elementary school students' numeracy abilities, which can serve as a basis for improving mathematics learning in Indonesia.

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