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Literacy and algebra in mathematical reasoning computer-based tests: A systematic literature review

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Abstrak: This systematic literature review (SLR) aims to analyze and synthesize the role of literacy and algebraic proficiency in predicting students' mathematical reasoning abilities, specifically in the context of the Computer-Based Written Exam (UTBK). The SLR method used in this study is a review of 18 articles, consisting of 11 documents from the Scopus database and 7 from the Google Scholar database, from 2019-2025. Using bibliometric analysis with the VOSviewer application, it shows that students' difficulties often arise at the stage of understanding problem narratives (literacy) before they are able to model and generalize algebra (algebraic literacy), which then leads to their logistical reasoning. However, the existing literature data indicates a research gap because no study has explicitly used structural modeling (SEM) to quantitatively test and validate the causal relationship pathways between these three variables. Therefore, the main recommendation of this study is to develop a rigorous structural model, supported by diagnostic error analysis based on Newman's analysis (NEA), to provide a strong foundation for focused and effective pedagogical interventions.
Kata Kunci: algebra; literacy; mathematical reasoning; utbk

Literasi dan aljabar dalam penalaran matematika melalui tes berbasis komputer: Tinjauan literatur sistematis

Abstrak: Studi tinjauan literatur sistematis (SLR) ini bertujuan untuk menganalisis dan mensintesis peran literasi bahasa dan penguasaan aljabar dalam memprediksi kemampuan penalaran matematika siswa, khususnya dalam konteks ujian tertulis berbasis komputer (UTBK). Metode yang digunakan adalah SLR pada 18 artikel terdiri dari 11 dokumen dari basis data Scopus dan 7 dari basis data Google Scholar dari tahun 2019-2025 menggunakan analisis bibliometrik dengan aplikasi VOSviewer yang menunjukkan bahwa kesulitan siswa seringkali berakar pada tahap pemahaman narasi masalah (literasi bahasa) sebelum mereka mampu memodelkan dan menggeneralisasi aljabar (literasi aljabar), yang kemudian berdampak pada penalaran logis mereka. Namun, data literatur yang ada menunjukkan adanya kesenjangan penelitian karena belum ada studi yang secara eksplisit menggunakan pemodelan struktural (SEM) untuk secara kuantitatif menguji dan memvalidasi jalur hubungan kausal antara ketiga variabel tersebut. Oleh karena itu, rekomendasi utama studi ini adalah mengembangkan model struktural yang cermat, didukung oleh analisis kesalahan diagnostik berdasarkan analisis kesalahan Newman (NEA), untuk memberikan landasan yang kuat bagi intervensi pedagogis yang terfokus dan efektif.
Kata Kunci: aljabar; literasi; penalaran matematika; utbk

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INTRODUCTION

Mathematical Reasoning has been globally recognized as an essential 21st-century competency that goes beyond basic computational skills (O.e.c.d, 2024). At the national level, the shift in evaluation paradigm is reflected in the UTBK-SNBT, which specifically tests mathematical reasoning skills as part of the literacy test (Pendidikan, 2025). Success in this subtest is highly dependent on students' ability to interpret contextual problems, which requires strong literacy (Fitriani et al., 2025). In addition to linguistic aspects, mastery of algebra serves as a foundation for abstract thinking and a key prerequisite for complex problem solving (Marsaulina & Rismaria, 2024). Therefore, an in-depth study is needed to examine the simultaneous contribution of literacy and algebra to mathematical reasoning performance. The importance of this research is reinforced by the need for diagnostic tools capable of accurately identifying student difficulties. NEA is an effective framework for grouping student errors based on processing stages (from reading to transformation), making it a relevant tool for analyzing the relationship between literacy and algebraic difficulties in the numeracy domain (Smith, 2023).

Although the role of each of these variables has been extensively discussed in previous research—such as the development of local context-based instruments (Dasaprawira et al., 2019; Nusantara et al., 2021) and the exploration of psychological and pedagogical factors (Murtafiah et al., 2021; Nisa et al., 2025) there is a significant literature gap. Most studies still examine mathematical reasoning, literacy, and algebra skills separately (Chen & Huang, 2023; Sari et al., 2022), resulting in a lack of systematic observations integrating all three within the specific context of the UTBK-SNBT. Specifically, there has been no synthesis using the NEA diagnostic lens to map how failures in literacy and algebra trigger errors at specific stages of the reasoning process. The novelty of this study lies in its attempt to fill this gap by building a comprehensive predictive model through the Systematic Literature Review (SLR) method. The observation process was carried out following the PRISMA protocol, including the removal of articles from the scopus and google schoolar databases (2019-2025), filtering based on relevance variables, and qualitative synthesis to provide an overall picture of the map of students' difficulties in the numeracy domain. This literature review aims to answer the following research questions:

RQ1: What is the profile of research on literacy and algebra in relation to mathematical reasoning in the context of the Computer-Based Computer (UTBK) or similar assessments?

RQ2: How are literacy and algebra defined, measured, and analyzed in research examining numeracy-based mathematical reasoning?

RQ3: What are the main findings, limitations, and research opportunities in the literature examining the relationship between literacy, algebra, and mathematical reasoning? And what are the research recommendations for developing structural models in future research?

RQ1 aims to answer questions regarding the profile and characteristics of existing studies (such as publication year, country, methodology, and context of UTBK-like

assessments) to provide a comprehensive overview of current research on literacy and algebra in relation to mathematical reasoning in the context of UTBK or similar assessments. RQ2 aims to analyze and summarize how the concepts of literacy and algebra are operationally defined, measured, and analyzed in the literature that examines numeracy-based mathematical reasoning, so that the most valid and consistent measurement parameters can be identified. RQ3 aims to identify and synthesize the main research findings, inherent limitations of these studies, and future research opportunities.

METHOD

The method used in this research is a SLR. SLR is a research method that identifies, evaluates, and interprets relevant research findings to answer specific research questions (Kitchenham et al., 2010). There are three stages in a systematic literature review (SLR): planning, conducting, and reporting, presented in Figure 1 (Choifah et al., 2022).

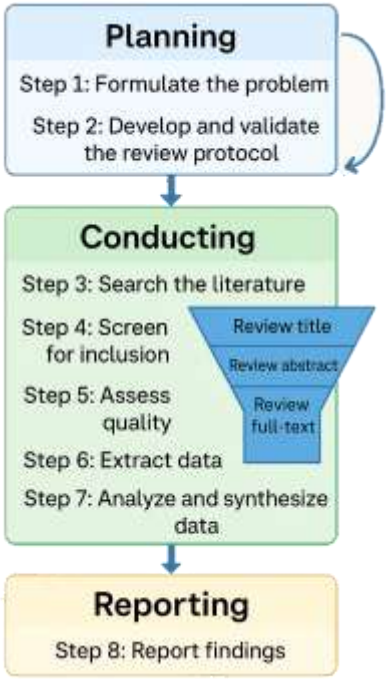

Figure 1. Steps of SLR literacy and algebra in mathematical reasoning

The planning stage is the stage where the researcher determines the research topic (Risdiyanti et al., 2024). This study will further discuss literacy and algebra in predicting mathematical reasoning in the context of the UTBK or CBT. The researcher determines the search criteria for articles to then be collected using data such as Scopus and Google Scholar from the period 2019-2025 to identify studies that meet the inclusion criteria in this review. The conducting stage is the researcher begins the search for articles that match the criteria and keywords that have been established in the previous stage. The article search was conducted through Scopus and Google Scholar. As the primary basis, Scopus is used in this study to identify related literature that will be integrated into this study. Google Scholar is used as a supplementary database to find additional articles related to this study. Finally, the

researcher must establish inclusion and exclusion criteria to ensure that the identified literature is relevant to the review (Watson & Michael, 2019). Table 1 presents the inclusion and exclusion criteria used in this study.

Table 1. Search keywords, database, exclusion and inclusion criteria

Database	Scopus (primary database) Google Schoolar (second database)
Title Words	“literacy” “algebra”
Keywords	“literacy” and “mathematical reasoning” “algebraic” and “mathematical reasoning” “ PISA” and “mathematical reasoning” “UTBK and “mathematical reasoning"
Exclusion Criteria	1. Any of the selected keywords not appearing tittle, abstract, keywords, full text 2. Not English 3. Publisher is unclear 4. Beyond the scope of mathematics design learning
Inclusion Criteria	1. Any of the selected keywords appeared in the title, abstract, keywords, full-text 2. Be published in any of the selected databases 3. Be a journal article or Thesis 4. Be in the English language

Initial screening was performed using keywords, titles, and relevant databases, resulting in the identification of 981 documents from Scopus (n = 885) and Google Scholar (n = 96), spresented in Table 2. Then, the researchers assessed the obtained articles and removed documents that met the exclusion criteria, leaving 18 documents.

Table 2. Literature search results based on database, title words, and keywords

Title Words	Keywords	Scopus	Google Schoolar
Literacy	“literacy” and “mathematical reasoning”	238	0
Algebra	“algebraic” and “mathematical reasoning”	631	0
Context	“PISA” and “mathematical reasoning”	16	0
	‘UTBK” and “mathematical reasoning”	0	96
	Total documents	885	96
	Total off all documents	981	

We identified 98 documents that met the eligibility criteria, while 883 papers did not. Of the 98 eligible documents, 18 were identified as potentially answering the research question. These 18 documents consisted of 11 documents from the Scopus database and 7 from Google Scholar. The researchers implemented a careful and rigorous selection process to thoroughly synthesize the literature. Please see Figure 2 for a visual representation of the document selection process.

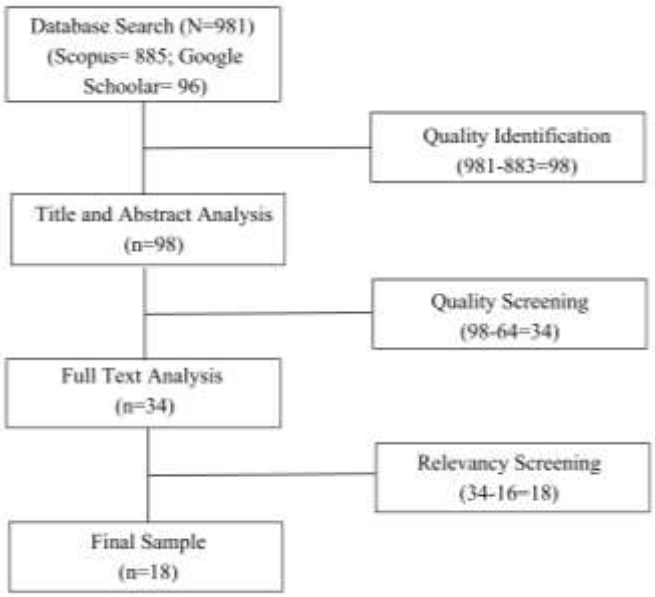

Figure 2. PRISMA selection process SLR literacy and algebra in mathematical reasoning

Literature selection was conducted systematically by screening 981 initial documents from Scopus and Google Scholar. During the quality identification stage, 883 articles were excluded due to duplication between databases and inconsistencies in the titles with the mathematics education topic. Furthermore, during the quality screening stage, 64 papers were excluded because they only discussed mathematics in general without specifically addressing literacy, reasoning, or algebra. Finally, during the full-text relevance screening stage, another 16 papers were excluded due to non-transparent methodology, insufficient data to be explained using the NEA framework, or not being peer-reviewed journal articles, resulting in a final sample of 18.

After selecting 18 relevant documents for further review and analysis, each article was coded based on several dimensions, including author name, publication year, country, content, context, and modeling tools. A custom database was developed using Mendeley for scraping. Furthermore, VOSviewer bibliometric software was used to quantitatively examine the literature and network profiles. The data was then used to analyze the context, content, and question design, identify gaps, and generate recommendations for further action based on the literature.

RESULT AND DISCUSSION

In this study, we review three analyses: research profiles and network analysis, content or qualitative analysis, research gap analysis or limitations, and suggestions for further research. This section summarizes literacy and algebra in mathematical reasoning.

Technical terminology abbreviations used throughout this section are defined upon first mention. Our literature review shows an increasing trend in scientific publications, with almost all selected studies published in the last seven years (see Figure 3). These studies primarily utilize literacy and algebra research methods from several countries.

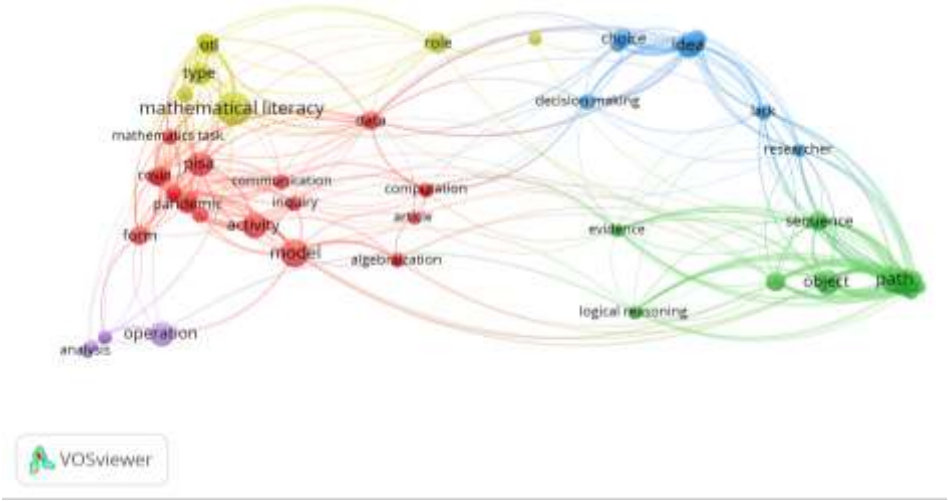

Figure 3. Annual publication of research on literacy and algebra in mathematical reasoning

The highest number of publications collected was in 2025, with 6. These studies primarily used design research methods and were mostly conducted in Indonesia. The highest number of publications collected was 14 studies from Indonesia, followed by one study from Spain, one from Korea, one from Sweden, and one from Singapore.

This study analyzed keyword relationships using the VOSviewer application. Figure 4 shows the visual keyword mapping, while Figure 5 shows the VOSViewer visualization overlay for the study "Literacy and algebra in mathematical reasoning," and Figure 6 shows the VOSViewer visualization density for the study "literacy and algebra in mathematical reasoning."

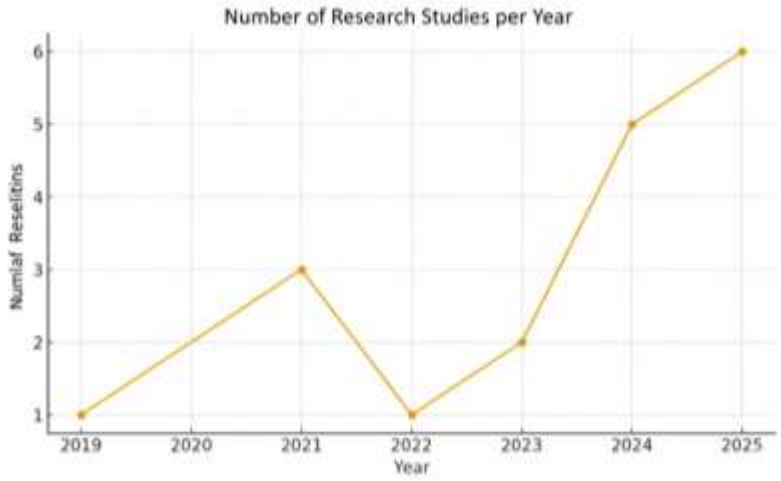

Figure 4**.** literacy and Algebra mathematical reasoning literature network keywords

Figure 5 shows that the VOSviewer keyword network visualization indicates that research is dominated by a focus on mathematical literacy, which is closely related to the modeling, data, and real-world context clusters, especially those triggered by the PISA issue and the COVID-19 pandemic. On the other hand, aspects of cognitive processes such as logical reasoning form a separate cluster centered on evidence and path, indicating that current

research is divided between context-based competency measurement and a deeper understanding of reasoning mechanisms, where explicit connections between algebraization and communication with logical reasoning still require further exploration.

Figure 5 shows that the temporal analysis of the VOSviewer map (2021-2025) shows a shift in the focus of mathematical research, which was initially (2021-2022, dark blue) dominated by issues of crisis impact assessment, namely mathematical literacy and PISA in the context of the COVID-19 pandemic. Research then shifted to a deeper investigation of cognitive processes, including logical reasoning, models, and decision-making. In the most recent period (2024-2025, yellow), the latest trend shifted to exploring computation and the role of various variables, indicating that the research community is now paying attention to computational aspects and specific functions in mathematics learning.

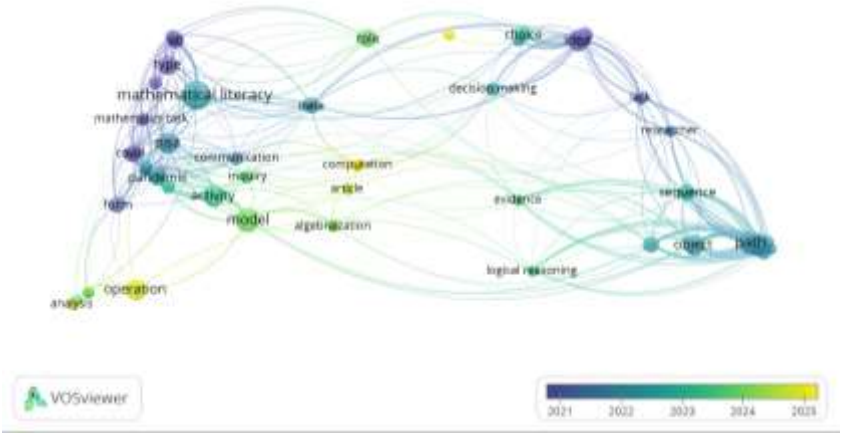

Figure 5. Overlay Visuaization VOSViewer Research Literacy and algebra in mathematical reasoning

Table 3 bibliometric cluster analysis with VOSviewer shows that the research is divided into three main focuses and shows the values of occurrence and total link strength.

Table 3. Keywords, cluster, occurrence, and link strength.

Cluster	Keywords	Occurrence	Total Link Strength
1	argument	13	0.57
	context	11	0.76
	mathematical literacy	13	0.74
	mathematical literacy skill	5	0.71
	model	9	0.65
	path	8	1.74
	pre service teacher	5	1.77
	type	8	0.71
	task	12	0.45
2	algebraic reasoning	6	0.52
	algebraic structure	4	1.79

Cluster	Keywords	Occurrence	Total Link Strength
	algebra	4	0.49
	aspect	5	0.65
	data	4	0.58
	framework	4	0.70
	group material	3	1.81
	idea	7	1.66
	object	7	1.50
	role	5	0.58
	use	4	0.58
	Unknown mathematical property	3	1.81
3	activity	7	0.84
	choice	4	0.70
	control	3	01.01
	inquiry	3	1.00
	lack	3	01.09
	mathematical literacy problem	3	1.85
	mathematics task	3	0.89
	otl	4	0.99
	pandemic	4	0.98
	pisa	7	0.71
	pisacomat	4	0.99
	religious holiday	3	01.01
	Sequence	4	1.17

Cluster 1 focuses on mathematical literacy (highest occurrence) with a central emphasis on pre-service teachers and path as the topic link; cluster 2 is dedicated to algebraic reasoning and structure, where the highest centrality belongs to abstract concepts such as unknown mathematical property and algebraic structure; while cluster 3 links problem-solving activities to external drivers such as PISA and pandemic, making mathematical literacy problem the most central term linking the cluster to the context of crisis and assessment.

In this section, we conduct a content analysis of the reviewed literature to answer our second research question. Specifically, we examine how literacy and algebra in mathematical reasoning are portrayed in the existing literature, including the content, context, modeling tools, and learning activities used. Please see Table 4 for further details.

Table 4. Content, Context, Methods, and Approach Models Used in the Article

No	Title	Author	Country	Content	Context	Modelling Tools
1	Building Mathematical Problem-Solving Skills Based on Logical Thinking Patterns to Prepare for the UTBK	Abdurahim et al. (2025)	Indonesia	Problem Solving, Logical Reasoning	UTBK	Logical Thinking Pattern
2	Improving Student Competence in Solving Mathematical Reasoning Problems in Test-Based National Selection	Apriyani et al. (2024)	Indonesia	Mathematical Reasoning	SNBT	-
3	Developing Patterns Of Students' Mathematical Literacy Processes: Insights From Cognitive Load Theory And Design-Based Research	Asmara et al. (2024)	Indonesia	Mathematical Literacy	Formulating Situations	Cognitive Load Theory, Design-Based Research, Pola Proses Literasi
4	Expanded Model For Elementary Algebraic Reasoning Levels	Burgos et al. (2024)	Spanyol	Algebraic Reasoning	Primary Education	Extended Level Algebraization Models

No	Title	Author	Country	Content	Context	Modelling Tools
5	High School Students' Proficiency in Solving Higher-Order Mathematics Problems	Ekawati et al. (2024)	Indonesia	Mathematical Problem Solving	Higher-Order Problems	-
6	Relationship between mathematical literacy and opportunity to learn with different types of mathematical tasks	Hwang & Ham (2021)	Korea/AS	Mathematical Literacy	PISA 2012 (Algebra, Procedural, Reasoning Tasks)	Opportunity to Learn (OTL), Perceived Control
7	The Role of Different Arguments: Upper Secondary School Students' Collective Mathematical Reasoning in Algebra	Johansson & Sumpter (2025)	Swedia	Algebraic Reasoning	Arithmetic Sequence	Collective Mathematical Argument
8	Exploring the Decision-Making Process of Pre-Service Teachers in Solving Mathematics Literacy Problems	Murtafiah et al. (2021)	Indonesia	Mathematical Literacy	Solution to problem	Pre-Service Teacher Decision Making Process

No	Title	Author	Country	Content	Context	Modelling Tools
9	High Ability, Hidden Gaps: Building Quantitative Reasoning amongst Singapore's Mathematically Literate	Nichols (2025)	Singapura	Quantitative Reasoning (QR)	Real World Context (University Students)	Fostering QR Education, Inquiry-based learning
10	Analysis of Students' Mathematical Critical Thinking Ability in Algebra Material Reviewed from Mathematics Anxiety	Nisa et al. (2025)	Indonesia	Mathematical Critical Thinking, Algebra	-	Mathematics Anxiety
11	Developing mathematics questions of Pisa type using Bangka context	Dasaprawira et al. (2019)	Indonesia	Mathematical Literacy	Bangka Context (Tanjung Kalian Lighthouse)	PISA Question Development, Basic Math Skills (BMS)
12	The sequence of algebraic problem-solving paths: Evidence from structure sense of Indonesian student	Junarti et al. (2022)	Indonesia	Algebraic Structure	Group Material	Problem Solving Path (Structure Sense)
13	Senior high school	Kodirun et al. (2025)	Indonesia	Logical Operations,	Mathematical Context	High School Students'

No	Title	Author	Country	Content	Context	Modelling Tools
	students' competence in logical operation and logical reasoning			Logical Reasoning	(Geometry, Algebra, Statistics, Calculus)	Competence in Logic
14	Designing pisa-like mathematics task using a COVID-19 context (Pisacomat)	Nusantara et al. (2021)	Indonesia	Mathematical Literacy (Quantity, Change and Relationship)	Konteks COVID-19	COVID-19 Context
15	Students' Mathematical Literacy in Solving PISA Problems Observed by Learning Styles	Rivai et al., (2023)	Indonesia	Mathematical Literacy	PISA Test Questions	Learning Styles (Visual, Auditory, Kinesthetic)
16	Analysis of UTBK Tryout Performance: Insights into Student Readiness Across Mathematical and Language Competencies	Sarumaha et al., (2024)	Indonesia	Mathematics and Language Competencies	Ujian Tryout (UTBK)	Student Readiness
17	Development of PISA-like Activities using the Inquiry-based Learning	Sepriliani et al., (2023)	Indonesia	Mathematical Literacy (Content Quantity)	Konteks Hari Raya Keagamaan selama Pandemi	Model Inquiry-based Learning (IBL)

No	Title	Author	Country	Content	Context	Modelling Tools
	Model and the Context of Religious Holidays during the Pandemic					
18	An Analysis of" Literasi Bahasa Inggris" Difficulties in" Seleksi Nasional Berbasis Tes"(SNBT) by Senior High School Students at SMAS Harapan 3 Deli Tua	Yunanda & Husda, (2025)	Indonesia	English Literacy	National Test-Based Selection (SNBT)	Analysis of Student Difficulties

Content

The 18 works reviewed demonstrate three main thematic focuses. The first and largest focus is on mathematical literacy within the PISA framework, where researchers are active in developing high-standard PISA instruments using specific and actual contexts, such as the bangka context (Dasaprawira et al., 2019), COVID-19 (Nusantara et al., 2021), and religious holidays (Sepriliani et al., 2023), often through design research or inquiry-based learning approaches. This study also explores influencing factors, ranging from cognitive load theory (Asmara et al., 2024), opportunity to learn (Hwang & Ham, 2021), learning styles (Rivai et al., 2023), to pre-service teacher decision-making (Murtafiah et al., 2021). The second central focus is algebraic reasoning and structure, which seeks to expand conceptual understanding, such as the development of the algebraization level model (Burgos et al., 2024), analysis of algebraic problem solving Pathways (Junarti et al., 2022), the role of collective mathematical argumentation (Johansson & Sumpter, 2025), and the impact of psychological factors such as mathematics anxiety (Nisa et al., 2025), as well as highlighting the importance of quantitative reasoning at the university level (Nichols, 2025). The final focus covers national exam readiness (UTBK/SNBT), which is practical in nature, aiming to build problem solving and logical reasoning skills (Abdurahim et al., 2025; Apriyani et al., 2024), analyze tryout performance (Sarumaha et al., 2024), and even include an analysis of difficulties in SNBT english literacy (Yunanda & Husda, 2025). Overall, these works reflect a collective effort in

improving student competencies through PISA innovations, deepening fundamental reasoning, and practical interventions for exam readiness.

Overall, these works reflect a collective effort to improve student competency through PISA innovations, deepening fundamental reasoning, and practical interventions for exam readiness. This series of studies interprets that mathematics is no longer seen as merely memorizing formulas, but has evolved into a functional thinking tool that helps students solve real-life problems (Junarti et al., 2022; Nusantara et al., 2021). Furthermore, these research findings also interpret that student learning success does not stand alone but is highly dependent on a balance between teacher teaching readiness, students' mental states such as anxiety, and how information is processed in their brains (Asmara et al., 2024; Murtafiah et al., 2021; Nisa et al., 2025).

Context

The research contexts studied are diverse, but can be summarized in three main interrelated domains. The first domain is the high-stakes standardized testing environment, primarily represented by the UTBK, where the focus is on preparation efforts (Abdurahim et al., 2025; Apriyani et al., 2024) and tryout performance analysis (Sarumaha et al., 2024) in measuring student readiness for logical and mathematical reasoning; this context even extends to the analysis of SNBT literacy difficulties (Kodirun et al., 2025; Yunanda & Husda, 2025). The second domain focuses on the application of real-world PISA-based contexts, where the development of mathematical literacy items uses local backgrounds (such as the bangka context, (Dasaprawira et al., 2019)) or actual situations (e.g., the COVID-19 pandemic, (Nusantara et al., 2021)) and (religious holidays, (Sepriliani et al., 2023)), which also serve as the basis for analyzing deeper processes such as pre-service teacher decision-making (Murtafiah et al., 2021) and the relationship with opportunity to learn (OTL) (Hwang & Ham, 2021). The third domain covers specific educational levels and subjects, ranging from a focus on algebraic reasoning in specific contexts, such as testing the structure sense of algebra in group material (Junarti et al., 2022) or collective reasoning in arithmetic sequences (Johansson & Sumpter, 2025), model development in elementary education (Burgos et al., 2024), to quantitative reasoning at the university level (Nichols, 2025); general issues such as solving higher-order problems (HOTS) (Ekawati et al., 2024) and the relationship between mathematics anxiety and algebra (Nisa et al., 2025) are also the backgrounds studied.

These findings interpret a shift in the focus of mathematics education in Indonesia, from merely mastering arithmetic procedures to developing higher-order thinking skills (HOTS) relevant to global and real-life challenges (Ekawati et al., 2024; Nusantara et al., 2021). Furthermore, the interrelationship between these domains implies that student success in high-stakes tests (UTBK) is inseparable from the strength of their conceptual reasoning foundation and psychological stability, which must be built continuously from elementary school through university (Burgos et al., 2024; Nichols, 2025; Nisa et al., 2025).

Modelling Tools

These studies utilize various modeling tools and frameworks, both theoretical and methodological, to analyze mathematical literacy and reasoning. Theoretically, Asmara et al. (2024) used CLT to develop patterns of literacy processes, while burgos, Burgos et al. (2024) applied the expanded model of levels of algebraization within the onto-semiotic approach framework to analyze algebraic structure. In terms of diagnostics, Hwang & Ham (2021) used structural equation modeling (SEM) on PISA data to examine the relationship between opportunity to learn and mathematical literacy, while Murtafiah et al. (2021) analyzed the decision-making process of pre-service teachers, and Junarti et al. (2022) mapped the sequence of algebraic problem-solving pathways to understand structure sense. Asmara et al. (2024) used design-based research (DBR) as the development framework to design learning components, and Design Research was used by (Nusantara et al., 2021; Sepriliani et al., 2023) to develop PISA-like questions (such as PISAComat), with the inquiry-based learning (IBL) model also used to improve communication skills.

Research Gaps and Recommendations for the Future

The most substantial research gap in this area lies in the limited availability of integrated predictive models capable of simultaneously measuring the strength of literacy and algebraic literacy on mathematical reasoning, particularly in the context of the computer-based written exam (UTBK/SNBT). While research acknowledges the significance of UTBK preparation (Abdurahim et al., 2025) and analyzes the difficulty of SNBT literacy (Yunanda & Husda, 2025), these studies are fragmented and fail to provide a single analytical framework that can explain variance in reasoning ability—a core competency of the UTBK scholastic potential test (TPS). This gap urgently needs to be bridged given the importance of Mathematical Reasoning to the curriculum and contemporary complex problem-solving (Stacey, 2015), where algebraic thinking is an essential basis for generalization (Jupri & Drijvers, 2016). Furthermore, the findings of Yunus et al. (2022) regarding the effectiveness of digital media (macromedia flash) in improving students' Mathematical Reasoning provides strong justification that technology-based interventions are a practical, testable solution to improve this dependent variable, which is relevant to computer-based exam formats such as the UTBK. Therefore, future recommendations are directed at: (1) conducting quantitative research with SEM Hwang & Ham (2021) to explicitly validate the combined prediction model of literacy and algebra on utbk mathematical reasoning results; and (2) Developing and testing a technology-based intervention prototype using the design-based research (DBR) framework Asmara et al. (2024) to ensure improvements in students' mathematical reasoning relevant to the demands of the (O.e.c.d, 2024) PISA 2025 mathematics framework and UTBK readiness.

CONCLUSION

This study concludes that the literature on literacy and algebraic the context of the Computer-Based Computer (CBT) is still very limited and tends to focus on single-ability

analysis. From a methodological perspective, it was found that literacy and algebra are generally measured qualitatively using contextual word problems, using the Newman Error Analysis (NEA) framework as the primary diagnostic tool. The overall synthesis of results confirmed that both types of literacy are crucial components that collectively determine students' mathematical reasoning success. The ability to help students is detected as being removed at the narrative comprehension stage (Language), which hinders the symbolic modeling process (Algebra), thus directly impacting logistical reasoning failure in numeracy assessments.

While providing new insights, this study is limited by the sample size of only 18 final documents, so the generalizability of the findings may not extend to external variables beyond the literacy context. Furthermore, the lack of studies using advanced quantitative approaches is a gap that needs further investigation. Therefore, the main recommendation of this study is the development of a structural model (SEM) validated with NEA analysis to empirically test the causal pathways between variables. This is expected to provide a strong foundation for more focused and effective pedagogical interventions to improve student readiness for higher-stakes assessments.

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