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Systematic Literature Review: Mapping Mathematical Literacy to Academic Ability Test (TKA) Readiness

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Abstract

Mathematical literacy is an essential skill for high school students as they prepare for academic assessments that demand more than just computational accuracy. This study aims to map research trends on mathematical literacy and identify components relevant to Academic Ability Test (TKA) readiness. Employing a Systematic Literature Review (SLR) approach, this study analyzed 215 articles sourced from seven databases, including Google Scholar, Scopus, DOAJ, Garuda, SINTA, ERIC, and ScienceDirect. Following a rigorous PRISMA-based filtering process, 25 high quality studies were included for thematic synthesis. The findings indicate that TKA readiness is fundamentally rooted in contextual reasoning, mathematical modeling, and non-routine problem-solving. Furthermore, the synthesis reveals that instructional strategies such as Problem-Based Learning, Realistic Mathematics Education, and STEM/STEAM are effective in fostering these cognitive capacities. These findings carry significant practical implications: educators should shift instruction from procedural drills to contextual-based reasoning tasks, specifically by integrating narrative decoding and mathematical modeling into the high school curriculum to better prepare students for high-stakes academic assessments.

Keywords: mathematical literacy, TKA, high school students, mathematical reasoning, systematic literature review

1. Introduction

Mathematical literacy has evolved from a basic computational skill into a critical intellectual capacity for analyzing real-world problems. The PISA framework defines it as the ability to formulate, use, and interpret mathematics in various contexts (2024-2025). At the high school level, students are expected to move beyond rote memorization toward interpreting graphs, recognizing patterns, and establishing relationships between variables. Despite this, classroom instruction remains heavily procedural, often prioritizing formula substitution over contextual understanding.

Recent studies emphasize that traditional pedagogical approaches are no longer sufficient to navigate the complexities of modern academic assessments, which increasingly demand non-routine and high-order thinking skills. A significant research gap exists because, while mathematical literacy is widely studied, there is a lack of targeted literature specifically connecting these literacy components to the cognitive demands of high-stakes Academic Ability Tests (TKA). Existing research often treats TKA as an isolated testing event rather than a measurable outcome of cumulative mathematical literacy development. Furthermore, current frameworks fail to adequately bridge the gap between abstract theoretical literacy and the practical application required in TKA.

Focusing on TKA readiness is justified by the shifting landscape of secondary education, where assessments have become the primary gatekeepers for higher education entry. Without a pedagogical shift toward contextual reasoning— specifically addressing the intersection of modeling and argument justification—students remain disadvantaged in competitive academic environments. This study addresses these gaps by proposing a conceptual synthesis model that explicitly links literacy components to TKA demands. By grounding this synthesis in recent findings (2024–2025), this article provides a structured framework that educators can utilize to design TKA-oriented instruction, ensuring that mathematics education aligns with both current academic standards and future student success.

2. Methods

This study employed a Systematic Literature Review (SLR) approach based on PRISMA guidelines to identify, evaluate, and synthesize research trends over the past five years. The review protocol was not formally registered in a public database. The systematic search was conducted between January 2026 and February 2026 to ensure the inclusion of the most recent literature.

The literature search was conducted via Google Scholar, Scopus, DOAJ, Garuda, SINTA, ERIC, and ScienceDirect using keywords such as "mathematical literacy," "high school," and "academic assessment." The search yielded 215 articles; a number subsequently reduced to 25 through a rigorous filtering process. For efficient management of the literature, Mendeley was utilized as the reference management software to organize, store, and remove duplicate entries. The screening process was conducted using Microsoft Excel to track inclusion and exclusion criteria at each phase. No specific specialized SLR automation software was employed; instead, a manual, consensus-based approach was implemented by the research team to ensure data accuracy and reliability. All inclusion and exclusion decisions were audited by co-authors to maintain consistency throughout the screening process

2.1. Development of Research Questions

RQ1. What are the trends in research on high school students' mathematical literacy over the past five years?

RQ2. Which components of mathematical literacy are most relevant to students' readiness for the TKA?

RQ3. What learning strategies, media, or approaches have the greatest potential to improve TKA-oriented mathematical literacy?

2.2. Inclusion and Exclusion Criteria

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
The article discusses mathematical literacy, mathematical reasoning, problem-solving, modeling, or the interpretation of mathematics.	The article does not address mathematical literacy or relevant mathematical thinking skills.
The article focuses on high school students or secondary education.	The article focuses only on other educational levels with no connection to secondary education.
The article was published between 2020 and 2025.	The article was published outside the 2020–2025 timeframe.
The article is a scientific journal article, a paper in a reputable conference proceeding, an academic report, or an indexed article.	Articles include opinion pieces, blog posts, educational materials, or non-academic documents.
Articles are available in Indonesian or English.	The article is not available in Indonesian or English.
The article includes the full text or sufficient methodological information and findings.	The article is not adequately accessible or does not contain findings that can be synthesized.
The article is relevant to academic assessment, PISA, AKM, HOTS, TKA, or reasoning-based evaluation.	The article is not relevant to student academic assessment or readiness.

2.3. Literature Search Strategy

The literature search was conducted via Google Scholar, Scopus, DOAJ, Garuda, SINTA, ERIC, and ScienceDirect. Keywords were formulated in both Indonesian and English to broaden the scope of the articles. The Boolean operators AND and OR were used to combine the main terms.

Table 2. Search strings used

Language	Search String
English	"Mathematical literacy" AND "senior high school"
English	"Mathematical literacy" AND "reasoning" AND "problem solving"
English	"Mathematical literacy" AND "academic assessment"
English	"Mathematical literacy" AND "mathematical modeling" AND "secondary education"
English	"Contextual problem solving" AND "mathematics education" AND "high school"
Indonesian	"Mathematical literacy" AND "high school students"
Indonesian	"Mathematical literacy" AND "mathematical reasoning" AND "assessment"
Indonesia	"Mathematical literacy" AND "problem-solving" AND "high school"
Indonesia	"TKA" AND "mathematics" AND "high school"
Indonesia	"Academic assessment" AND "mathematics" AND "mathematical literacy"

2.4. Article Selection

Article selection was conducted in four stages. First, articles were identified based on the search string. Second, articles were screened based on their titles and abstracts. Third, articles that passed the initial stage were reviewed for full-text availability and compliance with the inclusion criteria. Fourth, articles that met the criteria were analyzed using a quality assessment.

Figure 1. Stages of article search and document selection using the PRISMA method
PRISMA Literature Review Flowchart

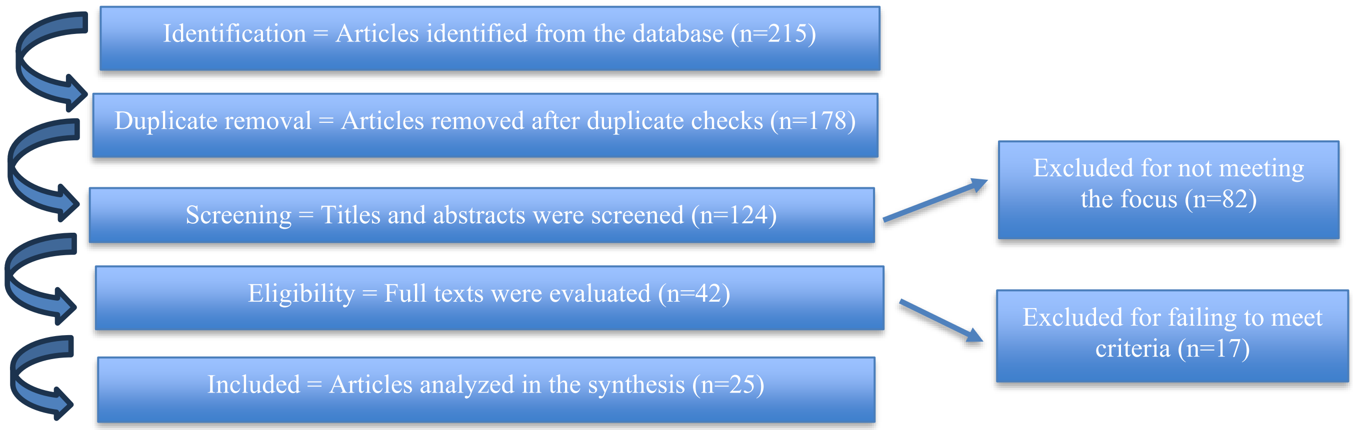

Table 3. Article selection flowchart

Selection Stage	Number of Articles
Articles identified from the database	215
Articles after duplicate removal	178
Articles filtered by title and abstract	124
Articles excluded after screening	82
Full-text articles assessed for eligibility	42
Articles excluded after eligibility screening	17
Final articles analyzed	25

2.5. Quality Assessment

Quality assessment was conducted to ensure the articles aligned with the research focus. Articles were assigned a score of “Y” if they met the criteria and “N” if they did not. Articles that received three “Y” scores were included in the synthesis stage.

QA1. Does the article discuss the mathematical literacy of high school students or secondary education?
QA2. Does the article include aspects of mathematical reasoning, problem-solving, modeling, or interpretation?
QA3. Is the article relevant to academic assessment readiness, such as TKA, PISA, AKM, HOTS, or reasoning-based assessments?

2. 6. Data Synthesis

Articles that passed the quality assessment were extracted based on author, year, title, research focus, subject, components of mathematical literacy, relevance to TKA readiness, and key findings. The synthesis was conducted thematically, rather than as a statistical meta-analysis, because the reviewed articles varied in research design, instruments, subjects, and learning contexts.

3. Result and Discussion

Instead of listing individual studies, the extracted data from the 25 included articles were categorized into three overarching themes. The table below summarizes the thematic synthesis, highlighting the core components of mathematical literacy required for Academic Ability Test (TKA) readiness

Theme 1: Contextual Reasoning as a Cognitive Foundation

Ten studies identified contextual reasoning as the core component of TKA readiness. These studies consistently found that students who struggle with academic assessments often fail at the initial stage of translating non-routine, context-heavy problems into mathematical language. While findings across these studies are common, they differ in their proposed interventions; some emphasize individual problem-solving practice, while others suggest collaborative discourse. The implication is that TKA readiness instruction must explicitly teach students how to decode narrative information before performing calculations.

Theme 2: Mathematical Modeling and Representation

Eight studies focused on modeling. Common findings suggest that modeling serves as a bridge between abstract concepts and real-world application. Differences arise in the complexity of tasks, with some focusing on simple linear models while others explore complex functions. This implies that TKA readiness requires progressive modeling exposure.

Discussion: Theoretical Underpinnings

The effectiveness of identified strategies such as Problem-Based Learning (PBL), STEM, and digital tools like GeoGebra can be grounded in specific educational theories. The success of PBL in fostering literacy is explained by Constructivism and Situated Learning theory; by embedding mathematical problems in real-world situations, students build knowledge through active exploration rather than rote reception. Furthermore, the effectiveness of interactive digital media, such as the Desmos application, can be analyzed through Cognitive Load Theory. These tools minimize extraneous cognitive load by visualizing abstract relationships, allowing students to focus their mental resources on high-level reasoning and modeling tasks. Additionally, the impact of STEM approaches aligns with Social Constructivism, where the multidisciplinary nature of tasks encourages peer argumentation and social negotiation of mathematical meanings. These findings suggest that the efficacy of any instructional intervention depends on its ability to support these underlying cognitive and social processes, rather than just the implementation of the media itself

3.1. Article Extraction Results

Table 4. Results of the Literature Review

Author & Year	**Article Title**	**Focus of Study**	**Subject**	**Components of Mathematical Literacy**	**Relevance to TKA**	**Key Findings**
OECD (2023)	PISA 2022 Results	Mathematical Literacy Framework	15-year-old students	Formulating, using, interpreting	High	Mathematical literacy requires the use of mathematics in real-world contexts, including reasoning and evaluating solutions.
Bolstad (2020)	Secondary Teachers' Operationalization of Mathematical Literacy	Teachers' Understanding of Mathematical Literacy	Secondary school teachers	Contextual reasoning	Moderate	Teachers interpret mathematical literacy as the ability to apply mathematics to meaningful situations.
Bolstad (2023)	Lower Secondary Students' Encounters with Mathematical Literacy	Students' Experiences with Mathematical Literacy	Middle school students	Interpretation and Reasoning	Intermediate	Students need exploratory experiences to be able to understand mathematical contexts more deeply.
Kolar & Hodnik (2021)	Mathematical Literacy from the Perspective of Solving Contextual Problems	Contextual Problem Solving	Students	Problem-solving, contextualization	High	Mathematical literacy is directly related to the ability to solve contextual problems.
Ekawati et al. (2020)	Primary Students' Mathematical Literacy: A Case Study	Mathematical literacy profile	Students	Modeling and interpretation	Moderate	Students face many difficulties when selecting relevant information and translating context into mathematical form.

Harisman et al. (2023)	Analysis of Students' Ability to Solve Mathematical Literacy Problems	Mathematical literacy problems	Middle school students	Reasoning, representation	Moderate	Students' main difficulties occur on problems that require interpretation and reasoning.
Novita & Herman (2021)	Digital Technology in Learning Mathematical Literacy: Can It Be Helpful?	Digital Technology and Mathematical Literacy	Students	Modeling, Representation	High	Digital technology can help students understand mathematical representations and contexts.
Supianti et al. (2022)	Development of Teaching Materials for E-Learning-Based Statistics	E-learning and Mathematical Literacy	Vocational High School Students	Statistical literacy, reasoning	High	E-learning-based teaching materials effectively improve mathematical literacy in statistics.
Nuri et al. (2023)	Effectiveness of the Desmos Application Integrated with PjBL	Desmos and Project-Based Learning	High School Students	Modeling, visualization	High	The integration of Desmos and PjBL supports conceptual understanding through visualization and problem-solving.
Komarudin et al. (2024)	The RMS Teaching Model with Brainstorming Technique and Student Digital Literacy	Learning model and digital literacy	Students	Reasoning, digital literacy	High	The learning model and digital literacy contribute to mathematical literacy.
Muhaimin et al. (2024)	Unlocking the Secrets of Students' Mathematical Literacy	SLR in mathematical literacy	Students	Problem-solving, reasoning	High	Mathematical literacy is influenced by context, learning strategies, and thinking skills.
Wijaya et al. (2024)	Exploring Contributing Factors to PISA 2022 Mathematics Achievement	Perspectives of Indonesian Teachers	Indonesian Teachers	Assessment readiness	High	Mathematics achievement is influenced by the curriculum, resources, student characteristics, and environmental support.

Hidayat et al. (2024)	Online Game-Based Learning in Mathematics Education for Generation Z	Game-Based Learning	Students	Motivation, problem-solving	Moderate	Game-based learning has the potential to increase student engagement in mathematics.
Hussein et al. (2022)	Digital Game-Based Learning in K-12 Mathematics Education	Digital Math Game SLR	K-12 Students	Concepts, motivation	Moderate	Digital games are effective when learning objectives are clear and challenges are designed in stages.
Yimer (2020)	Stimulating Content Knowledge Learning through Active Technology-Based Learning	Technology-Based Active Learning	Students	Conceptual understanding	Moderate	Technology-based active strategies help strengthen mathematical understanding.
Pratiwi et al. (2024)	The Potential of Interactive Multimedia with Contextual Teaching and Learning	Interactive multimedia and CTL	Students	Contextualization	High	Interactive multimedia is effective when combined with a contextual approach.
Purnama et al. (2024)	A Systematic Review: Interactive Media in Mathematics Learning	Interactive Mathematics Media	Students	Representation, motivation	Moderate	Interactive media supports mathematics learning, but its effectiveness depends on pedagogical design.
Cahyono et al. (2025)	STEM Education through Math Trails with Digital Technology	Math trails and STEM	Middle school students	Contextual reasoning	High	Technology-based math trails activities enhance mathematical literacy through the exploration of real-world contexts.
Nurmala et al. (2025)	The Effectiveness of PBL Assisted by H5P Interactive Video	PBL and interactive videos	Middle School Students	Problem-solving, interpretation	High	PBL supported by interactive videos is effective in improving mathematical literacy.

Putri et al. (2025)	Developing STEAM-Based Interactive E-Modules	STEAM E-Modules	High School Students	Modeling, reasoning	High	STEAM e-modules promote mathematical literacy through the integration of context and meaningful activities.
Yanuarto & Hanum (2025)	Game-Based Learning Using the Kahoot! App	Game-based learning	Elementary school students	Motivation, literacy	Moderate	Quiz-based games can increase students' motivation and readiness to tackle literacy problems.
Supianti et al. (2022)	Development of Teaching Materials for E-Learning-Based Statistics Materials Oriented Towards the Mathematical Literacy Ability of Vocational High School Students	Game-based learning	Vocational High School	Motivation, literacy	Moderate	The results show that this media is highly valid and effective in significantly improving students' mathematical literacy, with an N-Gain score of 0.6 (moderate category).
Chen (2022)	Measurement, Evaluation, and Model Construction of Mathematical Literacy Based on IoT and PISA	Interactive Mathematics Media	High School	Representation, motivation	High	This IoT-based measurement model has been proven to have high output quality and minimal error in quantitatively evaluating mathematical literacy, as well as ensuring the security of assessment data
Akbar et al. (2023)	The Development of Animation-Based Learning Media on Students' Mathematical Literacy Ability	Interactive Mathematics Media	Senior High School	Motivation, literacy	Moderate	This animation-based media proved to be highly valid, practical, and

Nuri, Zikriana, & Iqbal (2023)	Effectiveness of Desmos Application Integrated with PjBL in Multimedia Mathematics Learning in Terms of Mathematical Literacy Skills	PjBL and interactive videos	Senior High School	Conceptual understanding	Moderate	effective, marked by positive responses and a mathematics literacy test completion rate of 66.67%. The results confirm the effectiveness of this model with a classical completeness of 93% and a significant difference in average mathematical literacy compared to the control class (Sig. 0.002).

Table 5. Thematic Synthesis of Mathematical Literacy Components for TKA Readiness

Thematic Category	Number of Studies	Key Findings & Consensus
Contextual Reasoning	10	The ability to decode narrative contexts is identified as the primary hurdle in TKA. Instruction must explicitly teach students how to translate real-world situations into mathematical language
Mathematical Modeling	8	Modeling serves as the critical bridge between abstract concepts and practical application. TKA readiness requires progressive exposure to modeling.
Non-Routine Problem Solving	7	Success in high-stakes assessments demands moving beyond algorithmic drills. Approaches like PBL and STEAM effectively foster this skill by encouraging argumentation

While the reviewed articles predominantly examine mathematical literacy through the lenses of PISA, AKM, and HOTS frameworks, this study posits that these domains are not mutually exclusive from TKA readiness. It is important to acknowledge that the current literature base offers limited direct empirical evidence explicitly linking mathematical literacy interventions to specific TKA performance outcomes. Consequently, the conclusion that mathematical literacy enhances TKA readiness is currently grounded in theoretical synthesis rather than a direct longitudinal causal analysis

3.2. Quality Assessment

Table 6. Quality assessment results

Article Title	Year	QA1	QA2	QA3	Results
PISA 2022 Results	2023	Y	Y	Y	√
Secondary Teachers' Implementation of Mathematical Literacy	2020	Y	Y	Y	√
Mathematical Literacy from the Perspective of Solving Contextual Problems	2021	Y	Y	Y	√
Digital Technology in Learning Mathematical Literacy: Can It Be Helpful?	2021	Y	Y	Y	√
Development of Teaching Materials for E-Learning-Based Statistics	2022	Y	Y	Y	√
Effectiveness of the Desmos Application Integrated with PjBL	2023	Y	Y	Y	√
Unlocking the Secrets of Students' Mathematical Literacy	2024	Y	Y	Y	√
Exploring Factors Contributing to PISA 2022 Mathematics Achievement	2024	Y	Y	Y	√
The RMS Teaching Model with Brainstorming Technique and Student Digital Literacy	2024	Y	Y	Y	√
Online Game-Based Learning in Mathematics Education for Generation Z	2024	Y	Y	Y	√
STEM Education through Math Trails with Digital Technology	2025	Y	Y	Y	√
The Effectiveness of PBL Assisted by H5P Interactive Video	2025	Y	Y	Y	√
Developing STEAM-Based Interactive E-Modules	2025	Y	Y	Y	√
A Systematic Review: Interactive Media in Mathematics Learning	2024	Y	Y	Y	√
Digital Game-Based Learning in K-12 Mathematics Education	2022	Y	Y	Y	√

3.3. Discussion

RQ1. Trends in Research on High School Students' Mathematical Literacy

The findings of this study show that research on mathematical literacy over the past five years has shifted from merely measuring procedural skills to analyzing more complex thinking skills. The term "mathematical literacy" is no longer used solely to refer to the ability to solve word problems. In many articles, mathematical literacy is understood as a set of skills involving reading context, selecting information, constructing models, solving problems, and reinterpreting solutions.

In secondary education, this trend is evident in the growing emphasis on reasoning, representation, visualization, analytical thinking, and non-routine problem-solving. High school students are expected not only to solve problems similar to those demonstrated by teachers but also to tackle new problems that require strategic adaptation. This trend aligns with the need for academic assessments that increasingly emphasize conceptual understanding and reasoning.

Another prominent trend is the use of active learning approaches. Problem-Based Learning, Project-Based Learning, Realistic Mathematics Education, STEM/STEAM, and technology-based learning are frequently chosen because they provide students with opportunities to engage with problems that are closer to real life. These approaches help students view mathematics as a tool for understanding situations, rather than merely a set of procedures to be memorized.

Research also indicates a growing focus on digital media. Desmos, GeoGebra, interactive videos, e-learning, and digital simulations are seen as helping students visualize abstract concepts and identify relationships between different representations. However, digital media do not automatically improve mathematical literacy. Their impact depends on how the media are designed, the types of questions posed, and the quality of discussions facilitated by teachers.

In general, research trends indicate that mathematical literacy is increasingly being positioned as a key competency for tackling assessments that require contextual thinking. However, the explicit relationship between mathematical literacy and readiness for the TKA has not yet been extensively studied. It is this gap that makes the topic of TKA-oriented mathematical literacy worthy of development as a focus of mathematics education research.

RQ2. Components of mathematical literacy relevant to TKA readiness

The first and most relevant component is contextual reasoning. Mathematics problems in academic assessments do not always appear in a direct form. Information may be presented through narratives, tables, graphs, images, or everyday situations. Students with contextual reasoning skills can determine what is known, what is being asked, which information is important, and what strategies might be used.

The second component is mathematical modeling. Many literacy problems require students to transform verbal situations into mathematical models—such as equations, functions, graphs, tables, diagrams, or relationships between variables. At the high school level, modeling is crucial because topics like functions, statistics, probability, sequences, and trigonometry are frequently used to explain real-world situations. Without modeling skills, students tend to rely on ready-made formulas.

The third component is non-routine problem-solving. Problem-solving does not stop at finding the final answer but also involves understanding the problem, planning a strategy, carrying out the solution, and checking the plausibility of the result. Readiness for the TKA requires this kind of flexibility because academic assessment questions may be presented in formats that do not always match classroom exercises.

The fourth component is the interpretation of representations. Students' errors often arise not because they are unable to perform calculations, but because they misread graphs, misinterpret tables, or fail to understand the relationship between symbols and context. Therefore, students need to be trained to transition from one representation to another—for example, from a narrative to a table, from a table to a graph, or from a graph to an equation.

The fifth component is mathematical argumentation and justification. Students who are prepared for academic assessments are not only able to select an answer but also understand the reasons why that answer makes sense. Justification makes students' thinking processes more focused and reduces reliance on memorizing patterns. In the long term, this ability helps students view mathematics as a rational activity.

RQ3. Learning Strategies for TKA-Oriented Mathematical Literacy

Problem-Based Learning is one of the most frequently recommended strategies for improving mathematical literacy. This model places problems at the starting point of learning. Students are encouraged to understand the situation, formulate hypotheses, gather information, choose strategies, and evaluate solutions. This approach aligns with the needs of TKA because students are trained to tackle problems that do not always have a single solution path.

Realistic Mathematics Education is also relevant because it uses real-world contexts as a bridge to formal concepts. Through contexts that are close to students' lives, mathematics does not appear as symbols that must suddenly be memorized, but rather as the result of the process of understanding a situation. This approach provides a strong foundation for contextual reasoning and mathematical modeling.

STEM/STEAM can strengthen mathematical literacy by placing mathematics within multidisciplinary contexts. Students use mathematics to measure, estimate, compare, design, and make decisions. Activities like these provide the experience that mathematics

does not stand alone but is connected to science, technology, engineering, the arts, and social life.
Interactive digital media can be used to help students understand abstract concepts. Desmos and GeoGebra, for example, allow students to explore graphs, functions, changes in parameters, and patterns of relationships between variables. Interactive videos and e-modules can also help students learn step by step. However, these media must be accompanied by tasks that require students to explain, interpret, and evaluate—not just view visual displays.

Context-based assessments should be a regular part of learning. Teachers can design questions that include data, graphs, tables, short articles, or real-life situations. Such questions train students to read information before performing calculations. To avoid overwhelming students, the difficulty level should be structured progressively, starting with understanding simple contexts and progressing to solving problems that require several steps of reasoning.

Mathematical discussion and argumentation also need to be strengthened. When students are asked to explain their reasoning, compare strategies, or respond to their peers' answers, they learn to view mathematics as a thinking process. This practice is essential for transforming the classroom from a place for copying procedures into a space for building understanding. Through a combination of contextual problems, appropriate media, and meaningful discussions, readiness for the TKA can be built more solidly.

4. Conclusion

This study has synthesized existing research on mathematical literacy, mapping its potential alignment with the cognitive demands of the Academic Ability Test (TKA). It is important to emphasize that this review serves as a conceptual synthesis rather than an empirical validation of TKA performance. While the findings suggest that components such as contextual reasoning, mathematical modeling, and non-routine problem solving are theoretically essential for TKA readiness, these relationships remain speculative without direct empirical testing. Consequently, the conclusions drawn herein should be interpreted as a foundational framework for future curriculum design rather than a proven causal link

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