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Literature Review: The Use of Justified Multiple-Choice Tests in Scientific Literacy at Elementary School Level

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ABSTRACT

Evaluation plays a vital role in the learning process, especially in measuring students' science literacy. Among various assessment methods, reasoned multiple-choice tests stand out as a valuable tool. They don't just determine correct or incorrect answers; they also reveal the reasoning behind students' choices. This allows educators to gain a clearer and deeper understanding of students' abilities to comprehend and critically think about science concepts, particularly at the elementary school level. This research aims to investigate and summarize current research trends in applying reasoned multiple-choice tests to assess elementary students' science literacy. By using a Systematic Literature Review (SLR) approach guided by the PRISMA framework, this study ensures transparent and rigorous article selection. Data collection involved gathering various studies focusing on science literacy and test instruments, which were then synthesized to produce meaningful conclusions. The data analysis process included identifying, selecting, and extracting articles that met the inclusion criteria, followed by thematic analysis to uncover patterns and key findings. The results of this review indicate that this test instrument is widely considered an appropriate and practical method for comprehensively assessing science literacy in elementary education, providing valuable insights into students' knowledge and reasoning abilities.

Keywords: *Learning evaluation; scientific literacy; multiple-choice reasoning test; elementary school; systematic literature review*

ABSTRAK

Evaluasi berperan krusial dalam pembelajaran, khususnya dalam mengukur literasi sains siswa. Tes pilihan ganda beralasan menonjol sebagai alat efektif karena tak hanya menentukan kebenaran jawaban, tapi juga mengungkap penalaran siswa. Ini memberi pendidik pemahaman lebih jelas tentang pemahaman dan pemikiran kritis siswa terkait konsep sains, terutama di tingkat SD. Studi ini bertujuan meninjau literatur tentang penerapan tes pilihan ganda beralasan dalam mengukur literasi sains siswa SD. Dengan pendekatan Systematic Literature Review (SLR) berpandu kerangka PRISMA, studi ini menjamin seleksi artikel yang transparan dan ketat. Pengumpulan data melibatkan studi berfokus literasi sains dan tes pilihan ganda beralasan, yang lalu disintesis untuk kesimpulan bermakna. Analisis data meliputi identifikasi, seleksi, ekstraksi, dan analisis tematik artikel. Hasil tinjauan menunjukkan bahwa tes ini dianggap metode yang tepat dan efektif untuk menilai literasi sains secara komprehensif di pendidikan SD, serta memberi wawasan berharga tentang pengetahuan dan penalaran siswa.

Kata Kunci: Evaluasi pembelajaran; literasi sains; tes pilihan ganda beralasan; sekolah dasar; systematic literature review

INTRODUCTION

Science literacy in elementary schools serves as an essential foundation for developing students' critical thinking skills and scientific understanding from an early age, supporting the development of the national curriculum and preparing them to face future scientific challenges (Wahyudi & Purwanto, 2024). In facing the challenges of the modern era, which is filled with complex information, scientific literacy becomes one of the key competencies students must possess. According to the 2022 Programme for International Student Assessment (PISA) report, the average science literacy score of Indonesian students was 485, far below the OECD average of 485 (OECD, 2023). This data indicates that many Indonesian students still have limitations in understanding scientific concepts and applying them in real-life contexts.

Scientific literacy in elementary schools is essential in forming students' foundational knowledge and skills in understanding the scientific world (Atta et al., 2020). Science literacy, which is students' ability to understand, interpret, and apply scientific concepts in everyday contexts, becomes a fundamental goal of science education. It's crucial for them to be able to analyze scientific information relevant to real life, such as environmental issues (Rusmansyah et al., 2023). In this context, measuring scientific literacy becomes crucial to determine the extent to which students can master scientific knowledge and think critically. One effective instrument for measuring scientific literacy is the *reasoned multiple-choice test*, which not only assesses students' knowledge but also their ability to provide reasoning or explanations for the answers they choose.

Improving science literacy is often hindered by the lack of assessment instruments that can effectively connect scientific knowledge with students' everyday realities, a gap that can be addressed with a more comprehensive assessment approach (Setiawani et al., 2021). Commonly used instruments often only assess students' superficial understanding without exploring their critical thinking abilities and the reasoning behind their answers. Multiple-choice tests can be an effective alternative because they can reveal both students' answers and the logical justification underlying them (Khalilullah et al., 2023). However, the use of this type of test in Indonesia, especially at the elementary school level, is still very limited (Kurino, 2017).

Multiple-choice tests allow teachers to evaluate and gain deeper insights into student understanding (Julaeha et al., 2020). By requiring students to provide reasons for the answers they choose, these tests can measure students' ability to think critically and connect scientific concepts (Mulyana & Desnita, 2023). The use of this type of test can help detect higher levels of understanding, where students not only recall facts but are also able to explain their thought processes in solving scientific problems (Rusilowati et al., 2018). Therefore, reasoned multiple-choice tests can be a very useful tool for assessing scientific literacy at the elementary school level.

METHODS

Type and Design

Using a Systematic Literature Review methodology through the PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), this article discusses an instrument based on reasoned multiple-choice tests in the context of scientific literacy in elementary schools. The review was conducted using the online database Google Scholar,

applying keywords related to "reasoned multiple-choice test" and "scientific literacy." Articles were collected within a time range from 2014 to 2024, or a maximum of the past 10 years. The researcher used 27 articles for analysis in this study.

Data and Data Sources

To support the analysis, the following table presents a summary of selected studies related to the development and use of reasoned multiple-choice tests in assessing scientific literacy. Each study is categorized based on the author, publication year, journal, and the main findings relevant to this research.

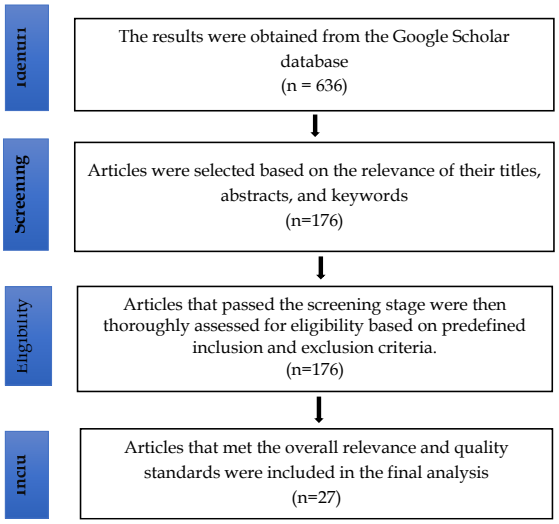

Figure 1. Flow Diagram of Article Selection

Figure 1 explains that the article selection process was carried out in several structured phases to ensure the inclusion of the most relevant and high-quality studies, consisting of the following steps:

Identification Phase

Initial searches through the Google Scholar database using the combination of keywords mentioned yielded a total of 636 records.

Screening Phase

From the 636 identified records, an initial screening was conducted based on title and abstract relevance. The purpose of this screening was to identify articles that explicitly discussed the use of multiple-choice tests in evaluating or gaining information related to student understanding. After this initial screening stage, 178 records were considered relevant and passed for full-text review.

Eligibility Phase

Full-text articles from the 178 records that passed the screening stage were then thoroughly assessed for eligibility based on predefined inclusion and exclusion criteria. Our main inclusion criteria covered studies focusing on the use of multiple-choice tests as an evaluation tool, research discussing how multiple-choice tests can uncover student understanding more deeply, and publications available in Indonesian or English.

Included Phase

After going through all stages of screening and eligibility assessment, a total of 27 studies met all inclusion criteria and were finally included in the qualitative synthesis of this

literature review. These studies form the basis of the analysis to explore how multiple-choice tests can provide more in-depth information related to student understanding.

This transparent and systematic selection process ensures that the articles analyzed are relevant and of high quality to answer the established research questions.

Data Collection Technique

The data collection process in this study was conducted using the Google Scholar and Scopus databases as primary sources of scientific literature. The researchers used specific keywords, such as "reasoned multiple-choice test" and "scientific literacy," to find relevant articles. The literature search was limited to publications from 2014 to 2024 to ensure the relevance and recency of the sources. A total of 636 articles were initially retrieved from the databases during the identification phase. The bibliographic details and abstracts of these articles were compiled in a reference manager using the Mendeley application for further screening.

Data Analysis

The data analysis in this study was carried out by carefully reading and understanding the content of each selected article. The articles were grouped based on their topics, objectives, research methods, and findings. Subsequently, a thematic analysis was conducted to identify patterns, similarities, and differences among the studies. The results of this analysis were used to draw conclusions about the use of justified multiple-choice tests in assessing scientific literacy at the elementary school level. The themes analyzed in this article are as follows:

Theme 1: Publications from 2014-2024
Theme 2: Scientific Literacy
Theme 3: Reasoned Multiple-Choice Test Instruments
Theme 4: Elementary School

This four-step selection process ensures that the literature review is built upon credible, high-quality sources that directly contribute to the understanding of the research problem. The use of a structured selection procedure also enhances the transparency and replicability of the study. After filtering the relevant articles, the researchers developed the results into a comprehensive discussion based on the selected studies, which were then formulated into the main conclusions of this research. Once the sources were structurally compiled, the next step was to synthesize the content across various issues and perspectives

RESULTS AND DISCUSSION

Reasoned multiple-choice tests are a type of assessment instrument designed to measure not only students' cognitive abilities in selecting the correct answer, but also their ability to provide logical explanations for their (Andriyani, 2022). In the context of scientific literacy, this type of test is highly relevant because scientific literacy does not merely focus on factual scientific knowledge, but also on critical thinking, analytical skills, and the ability to connect scientific concepts with real-life situations. Therefore, reasoned multiple-choice tests offer students the opportunity to demonstrate the depth of their understanding of scientific concepts and how well they can explain their reasoning rationally.

In assessing scientific literacy, reasoned multiple-choice items have several advantages over regular multiple-choice questions (Saputri et al., 2022). Scientific literacy instruments can evaluate students' conceptual understanding, higher-order thinking skills, and their ability to relate science to everyday life phenomena. For example, if a test item is related to the topic of artificial sweeteners, students are not only asked whether artificial sweeteners are harmful but also to provide a scientific reason for their answer. This is supported by previous research showing that students with a sufficient understanding of concepts don't just select an answer

option, but also have a reason for the answer they choose (Samaduri, 2022). Thus, this type of test provides a clearer picture of students' ability to understand and apply science in real-world contexts.

On the other hand, a major challenge in developing reasoned multiple-choice tests lies in ensuring that students' explanations can be assessed objectively. The test development process requires rigorous stages, from identifying the scientific literacy indicators to be measured, constructing appropriate test items, to conducting validation and trials to ensure the validity and reliability of the questions (Haryati & Azrina Purba, 2023). The reasoning options provided must reflect various levels of student understanding, from simple responses to those demonstrating higher-order thinking. Therefore, educators and researchers need to ensure that the developed items comprehensively reflect the goals of scientific literacy.

In the development of reasoned multiple-choice tests, item validity and reliability are crucial. Studies implement questionnaire validation strategies such as logical validation, content validity, construct validity, and empirical validity (Anshari et al., 2024). Item analysis is essential for refinement, while test-retest and internal consistency (e.g., Cronbach's Alpha) are used to determine if the analyzed questions are reliable (Utami, 2023). This combination of approaches increases confidence in the test's quality for measuring students' reasoning.

The use of reasoned multiple-choice tests in scientific literacy is not only beneficial for measuring students' abilities but also for identifying areas in science learning that need improvement. Analysis of test results can offer teachers better insight into which concepts students struggle to understand or the types of thinking processes that require further development (Setiawani et al., 2021). Consequently, the implementation of this test is expected to help improve the quality of science education, support the development of students' scientific literacy, and better prepare them to face real-life challenges that require science-based reasoning.

Table 1. Findings from Research on the Development and Validation of Science Literacy Assessment Instruments

Author & Year	Journal	Research Result
(Zulfiana et al., 2023)	Pendasi: Jurnal Pendidikan Dasar Indonesia	The results of research using the 4D R&D model indicated that the science literacy assessment tool was found to be less effective based on the effectiveness test results of the items.
(Akbarudin & Kurniawati, 2023)	Jurnal Edukasi Biologi	Research findings using the 4D R&D model showed that the instrument to measure scientific literacy was considered appropriate based on expert judgment and empirical investigation results from 44 items.
(Haryati & Azrina Purba, 2023)	Bionatural	A study using the ADDIE R&D model revealed that the assessment tool was

		categorized as effective and highly suitable. Therefore, it can be concluded that the digital-based scientific literacy test is both good and feasible for use in the learning process.
(Chasanah et al., 2022)	PENDIPA : Journal of Science Education	Research using the 4D R&D model demonstrated that the developed science literacy evaluation tool was appropriate for use, as indicated by the correlation coefficient (r) obtained through the product moment formula.
(Rasyidin et al., 2023)	Eduproxima : Jurnal Ilmiah Pendidikan IPA	The findings from a 4D R&D-based study showed that, with an average percentage score of 87.58%, the formative assessment using Wizer Me to evaluate ninth-grade students' understanding of the food revolution theme was highly valid.
(Herianingtyas, 2022)	Elementar (Elementary of Tarbiyah): Jurnal Pendidikan Dasar	Another study using the 4D R&D model indicated that the development of a module transformed the scope of scientific literacy, particularly in the context of scientific literacy assessment.
(Sinyanyuri et al., 2022)	Jurnal Basicedu	Research using a qualitative approach found that teachers had a good understanding of scientific literacy and recognized various challenges faced by students in relation to language use in science education. Specifically, the study identified that the influence of local languages, the use of scientific vocabulary, and scientific writing were among the most significant issues.
(Agustin & Sartika, 2022)	Jurnal PAJAR (Pendidikan dan Pengajaran)	Qualitative research showed that activities focused on AKM (Minimum Competency Assessment) scientific literacy tasks in the classroom improved students' scientific literacy skills.
(Helendra & Sari, 2021)	Jurnal Ilmiah Pendidikan Profesi Guru	A study using the Plomp R&D model showed that the science literacy-based assessment instrument for excretory and respiratory systems was highly valid, practical, and had excellent reliability.

(Santy Dinar Permata & Tri Wardati Khusniyah, 2022)	Jurnal Pendidikan Modern	Descriptive qualitative research indicated that the method of direct practice in introducing scientific literacy can be used to enhance science literacy in elementary school GLS (School Literacy Movement) activities.
(Nurhanifah & Diah Utami, 2023)	Jurnal Elementaria Edukasia	Qualitative research found that the teacher's role is crucial in instilling scientific literacy among fourth-grade students.
(Yohamintin & Huliatunisa, 2023)	Indonesian Journal of Elementary Education	Quantitative research showed a positive relationship between scientific literacy and science problem-solving skills; with a regression equation of 18.65 plus 1.09X and a determination coefficient of 0.97, scientific literacy contributed 94.04% to science problem-solving ability.

Test Instruments

Based on the table above, it can be concluded that according to Zulfiana et al. (Zulfiana et al., 2023), scientific literacy is directly related to students' thinking abilities, which can be identified through test instruments. Furthermore, according to Akbarudin & Kurniawati (Akbarudin & Kurniawati, 2023), the development of test instruments related to scientific literacy can refer to HOTS (Higher Order Thinking Skills) questions developed by the PISA Framework. The need for scientific literacy test instruments is crucial so that students become accustomed to dealing with issues in the field of literacy (Haryati & Azrina Purba, 2023). However, sometimes scientific literacy test questions still fail to distinguish students' capabilities (Chasanah et al., 2022). In the construction of scientific literacy tests, digital platforms can be used to assist in creating more interactive questions (Rasyidin et al., 2023).

Higher Order Thinking Skills (HOTS) Based Tests

Based on the table above, it can be concluded that according scientific literacy test instruments are highly relevant if they are based on HOTS, as they require students to engage in higher-order thinking (Herianingtyas, 2022). In the preparation of scientific literacy assessments, language aspects can be integrated into science education, as this proves that language can enhance students' literacy skills (Sinyanyuri et al., 2022). The ability to solve AKM scientific literacy questions can also be viewed from a gender perspective, although it cannot be denied that literacy ability is built through individual cognitive processes (Agustin & Sartika, 2022). In its development process, scientific literacy assessments can be constructed using various themes and topics related to science in daily life (Helendra & Sari, 2021).

Scientific Literacy

Based on the table above, it can be concluded that according through the school literacy movement, students' scientific literacy skills can be improved by providing adequate learning resources (Santy Dinar Permata & Tri Wardati Khusniyah, 2022). Teachers play a crucial role in advancing and reducing obstacles in the implementation of scientific literacy improvement processes in schools (Nurhanifah & Diah Utami, 2023). Moreover, scientific literacy is closely

related to science problem-solving skills because students must be able to think critically about problems they face in their environments (Yohamintin & Huliatunisa, 2023).

From the explanations above, it can be understood that the entire process of constructing scientific literacy test instruments serves as a cornerstone in the availability of effective evaluation tools.

Table 2. Research Result on the Use of Tests for Leraning Evaluation

Author & Year	Journal	Research Result
(Samaduri, 2022)	Jurnal Pendidikan Glasser	Using a qualitative descriptive approach, this study found that students can be assessed and their level of conceptual understanding determined through multiple-choice tests with reasoning.
(Hasan et al., 2021)	Jambura Jounal of Educational Chemistry	Using a qualitative descriptive approach, this study found that the highest percentage of misconceptions occurred in the indicator of explaining the reasoning ability for electrolyte solutions.
(Widiastuti et al., 2023)	Jurnal Pembelajaran Bahasa dan Sastra	The results of a quasi-experimental study showed a significant difference between students' ability to read explanatory texts in the pre-test and post-test.
(Sa'adah, 2023)	Jurnal Pembelajaran Bahasa dan Sastra	An action research study (PTK) found that the core activities of the intervention helped students individually understand and complete key answer responses.
(Pramanda & Aisiah, 2023)	Jurnal Family Education	An evaluation study showed that the material elements focused on in the test, the construction of the questions, and the language used in the questions were all included in the qualitative review of the exam items.
(Mansyur et al., 2023)	Pembahas : Jurnal Pembelajaran Bahasa dan Sastra	Using action research (PTK), results showed that multiple-choice tests as a teaching technique were collected through documentation techniques (LKPP), provided to each training participant in the form of 1–3 paragraphs consisting of five multiple-choice questions.
(Sabariah & Norisah, 2023)	Jurnal Pembelajaran Bahasa dan Sastra	An action research study showed that the specific type of multiple-choice test technique discussed in this article was part of the student worksheet (LKPD) described

		above, which contained 24 exposition-based questions.
(Andriyani, 2022)	Jurnal Pembelajaran Bahasa dan Sastra	According to a study conducted through a workshop method, this was due to the fact that the exposition text indicators were developed very carefully, resulting in 24 indicators. This is one of many advantages of this multiple-choice test specification.
(Tamba et al., 2022)	Jurnal Kata (bahasa, sastra, dan pembelajarannya)	An R&D study showed that the development of the test focused on higher-order thinking skills in procedural text learning using five stages as outlined by Borg & Gall: information gathering, product design, product development, product testing, and product revision.
(Kurnia, 2021)	Indonesian Journal of Educational Science (IJES)	A quantitative descriptive study concluded that multiple-choice tests can assess students' creative abilities in science subjects.
(Purwati et al., 2021)	Jurnal pendidikan universitas garut	A survey study showed that after using the Anates Windows application, the research found that the difficulty level of the most common questions was easy, the discrimination index of the questions was generally effective, the distractors were highly effective, and a total of 16 items were valid and reliable. These results were then compiled in an item analysis recap.
(Syahlani & Setyorini, 2021)	Jurnal Akrab Pekanbaru	Using an R&D method, research showed that students could use valid and credible multiple-choice tests to evaluate their mathematics learning outcomes.
(Sakahuni & Ramadhanti, 2021)	Integrated Science Education Journal	A quantitative descriptive study found that multiple-reasoning choice test formats can improve the physics learning outcomes of students with high critical thinking skills.
(Ariyanti & Bhakti, 2020)	Titian Ilmu: Jurnal Ilmiah Multi Sciences	An experimental study found that using multi-option multiple-choice tests with a scoring method can improve the accuracy and reliability of results. Finally, it supports the development of better evaluation systems for both formative and summative assessments.

(Yani, 2019)	Al Khawarizmi: Jurnal Pendidikan dan Pembelajaran Matematika	A qualitative descriptive study found that distractors can help identify students' errors when solving mathematics problems.

The findings presented in Table 2 strongly support the relevance of tests in the learning evaluation process, including in the context of scientific literacy. Factors such as the use of distractors, difficulty level, and the choice of language significantly influence the effectiveness of the evaluation being conducted. Specifically, reasoned multiple-choice tests prove to be an effective option for constructing scientific literacy evaluation questions. This is because by requiring reasoning in student answers, students will not answer carelessly, and their thinking abilities will be more clearly evident. Findings from various studies strengthen the claim regarding the effectiveness of reasoning-based multiple-choice tests for elementary level scientific literacy through several aspects, such as the assessment of conceptual understanding, the ability to detect misconceptions, and the measurement of creative thinking skills. Although some studies cover other subject domains or higher educational levels, the basic principle of reasoned multiple-choice tests namely, revealing the reasoning behind answers remains applicable and essential for measuring in-depth understanding in elementary scientific literacy, especially those focusing on Higher Order Thinking Skills (HOTS) as scientific literacy requires more than just factual recall.

Nevertheless, there are some gaps or inconsistencies observed across the studies. Some research focuses on the general validity of instruments, but less specifically explains how reasoned multiple-choice tests uniquely address the challenges in assessing scientific literacy at the elementary school level compared to other domains. Furthermore, not all studies explicitly discuss how this test format can be adapted to accommodate the cognitive and developmental characteristics of elementary school-aged children. Therefore, the development of reasoned multiple-choice tests remains a strong option for scientific literacy instruments in elementary schools, but with careful consideration of specifications tailored to the context and needs of students at this level.

CONCLUSION

Reasoned multiple-choice tests are highly appropriate and effective instruments for evaluating students' scientific literacy skills, particularly at the elementary school level, as they not only assess correct answers but also reveal the reasoning behind students' choices, indicating their depth of understanding and higher-order critical thinking abilities. This systematic review highlights that the development of such test instruments requires rigorous validation and reliability, including various types of validity and careful item analysis, although their implementation in Indonesia, especially at the elementary school level, remains limited, with the primary challenge being the design of reasoning options that can be objectively assessed and reflect diverse levels of understanding. Therefore, we recommend the integration of reasoned multiple-choice tests as a comprehensive evaluation tool to identify areas in science learning that need improvement and to tailor teaching strategies accordingly , and suggest future research to develop instruments that incorporate real-life issues and problems relevant to students' daily experiences to enhance the relevance and effectiveness of scientific literacy assessment, while acknowledging potential limitations of this review such as reliance on local studies or a narrow search scope.

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