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RESEARCH ARTICLE

Science Literacy Analysis In Students Of SMPN 40 Makassar Through The Implementation Of STEM-Based E-Modules

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Abstract:.This study aims to analyze the ability of science literacy in the knowledge aspect of junior high school students. The type of research used is survey research method. The research design used was descriptive survey. This research was conducted in January-February even semester of the 2025/2026 academic year at SMPN 40 Makassar. The population in this study were all students of class IX UPT SPF SMP Negeri 40 Makassar in the 2024/2025 school year consisting of 5 classes with a total of 190 students. Sampling was done by random sampling technique. The sample used was 1 class, namely class IX.5 with a total of 35 students. The data collection technique was carried out by giving a test on the knowledge aspect of science literacy in the form of a multiple choice test totaling 20 numbers. The results of the analysis show that the science literacy of junior high school students is still at a moderate level, with an average score of 10.11 out of a maximum total score of 20 and a standard deviation of 2.21, which reflects a moderate variation in ability. A total of 62.86% of students were in the moderate category, 22.86% in the high category, and 14.29% in the low category. The distribution of scores for each indicator showed that in the content aspect (A.01), 54% of students reached the correct answer, in the procedural aspect (A.02) only 42% of students answered correctly, while in the epistemic aspect (A.03) there were 51% of students who answered correctly.

Keywords: Science Literacy1, STEM2, E-Module3

1. Introduction

Entering the 21st century, the development of science and technology (IPTEK) is taking place very rapidly, bringing major challenges in the world of education and work (Saputra, 2024). To face this change, a generation is needed that not only masters knowledge, but also has critical, creative thinking skills, and is able to make decisions based on scientific evidence (Sanjiartha, Suwindia & Winangun, 2025; Nugroho & Hamonangan, 2024). One of the important skills that students must have is scientific literacy, which allows them to understand natural and social phenomena, and actively participate in increasingly complex community life (Pratiwi, Cari & Aminah, 2019; Redhana, 2019).

Scientific literacy is defined as the ability to use scientific knowledge, recognize relevant questions, and draw conclusions based on available evidence, with the aim of understanding

and making decisions regarding nature and changes resulting from human activities. This ability includes an understanding of scientific concepts, scientific processes, and critical and reflective scientific attitudes (Sutrisna, 2021). According to research by Redhana (2019), scientific literacy not only increases students' insight but also prepares them to be able to compete in the world of work that demands various skills.

However, various studies show that the scientific literacy skills of students in Indonesia are still relatively low. The results of the Programme for International Student Assessment (PISA) survey show that the scientific literacy scores of Indonesian students are below the average of OECD countries. The factors causing this low scientific literacy include misconceptions about science concepts, lack of mastery of scientific literacy by teachers, and limited facilities and infrastructure in schools (Yusmar & Fadilah, 2023). This shows the need for serious efforts to improve scientific literacy through more effective and contextual learning.

One approach that can be applied is scientific literacy-based learning that integrates content, procedural, and epistemic aspects. According to research by Janika, Rahayu & Nurdiansyah (2025), this approach can improve students' ability to explain phenomena scientifically, interpret data and facts, and evaluate scientific inquiries. Thus, students not only understand scientific concepts but are also able to apply them in everyday life to solve problems that arise.

Based on the results of the Program for International Student Assessment (PISA). As quoted from The Organization for Economic Co-operation and Development (OECD), the scores of Indonesian students in science literacy skills are still far below the international standard score set by the OECD, which is 500. The ranking of Indonesia's science literacy from 2000-2015 is as follows.

Table 1. Indonesian Science Literacy Ranking

Year	Indonesia Average Score	Maximum Score	Indonesia Ranking	Number of Participating Countries
2000	393	500	38	41
2003	395	500	38	40
2006	393	500	50	57
2009	383	500	60	65
2012	375	500	64	65
2015	403	500	64	72
2018	396	500	70	78

(Source: Yuliati, 2017)

Based on the results of observations and interviews conducted with science educators at UPT SPF SMPN 40 Makassar, the science literacy skills of students are still relatively low, in the learning process educators still use printed teaching materials in the form of textbooks and LKPD. Not yet using teaching materials that can facilitate students in learning. The methods often used are lecture methods, discussions, taking notes on materials presented on power points and printed books and have never taught biotechnology materials using electronic modules.

To overcome this problem, the use of interactive and independent digital teaching material e-modules is a very relevant choice in today's technological era. E-modules can be accessed via various devices such as laptops or tablets, and display multimedia content (text, images, audio, video) with easy navigation. In addition, e-modules are usually equipped with formative assessments, so they can increase student learning independence, facilitate access to materials, and provide contextual and interesting learning experiences.(Lastri, 2023). However, challenges such as limited infrastructure and teacher readiness are also obstacles in its implementation. Several studies such as by Idayanti & Suleman (2024) prove that e-modules can improve learning outcomes and understanding of science concepts, but their

effectiveness is greatly influenced by the quality of design and integration of content with learning objectives.

One very relevant approach to support the strengthening of science literacy through e-modules is the STEM (Science, Technology, Engineering, Mathematics) approach. This approach is based on an integrative philosophy that emphasizes the interconnectedness of disciplines in solving real project-based problems (Davidi, Sennen & Supardi, 2021). In the context of science education, STEM integration aims to train students to think critically, creatively, and be able to make decisions based on scientific evidence (Astuti et al., 2023). Several national curricula have even begun to adopt STEM principles into science learning, one of which is in the Merdeka Curriculum. Research by Hermansyah (2020) shows that STEM-based science learning can significantly improve science literacy and 21st-century skills. Therefore, developing STEM-based e-modules is a strategic approach to improving the quality of science learning at the junior high school level.

Several studies have linked the use of STEM-based e-modules to increased student scientific literacy. Research by Rofikoh, Supeno & Farisi (2024) showed that the application of STEM-based e-modules in ecosystem material was able to significantly improve students' scientific thinking skills compared to conventional learning. A similar study was also found in research by Mutia et al., (2025) which emphasized that interactivity and project-based problem solving in e-modules helped improve students' conceptual understanding and scientific attitudes. Based on this explanation, this study aims to analyze the scientific literacy of junior high school students through the implementation of STEM-based e-modules as an innovative solution in supporting adaptive and meaningful science education.

2. Research Methods and Materials

The type of research used is a survey research method. The research design used is a descriptive survey. Descriptive surveys attempt to reveal the current situation related to a particular study topic. This study aims to describe aspects of scientific literacy, namely the context of student knowledge. This research was conducted in the Even Semester of the 2025/2026 Academic Year at SMPN 40 Makassar. The population in this study were all class IX students of UPT SPF SMP Negeri 40 Makassar in the 2024/2025 academic year consisting of 5 classes with a total of 190 students. Sampling was carried out using the Random Sampling technique. With the consideration that all classes have the same average learning outcomes. The sample used was 1 class, namely class IX.5 with a total of 35 students.

Data collection was carried out by administering a knowledge aspect test in scientific literacy in the form of a multiple-choice test totaling 20 numbers that had been tested for validity. The research data were analyzed by calculating the ability value of the knowledge aspect in scientific literacy using the formula according to Ridho et al., (2018) below:

$$NP = \frac{R}{SM} \times 100$$

Information:

NP = Value of the knowledge aspect of scientific literacy
R = Number of scores for questions answered correctly
SM = Maximum score of the test

The interpretation of the achievement value of the knowledge aspect of students' scientific literacy is interpreted descriptively based on categories according to Ridho et al., (2018) in Table 2 below:

Table 2. Interpretation of Knowledge Aspect Values in Scientific Literacy

Value Interval	Category
81-100	Very high
61-80	Tall
41-60	Currently
21-40	Low
0-20	Very Low

3. Results and Discussion

3.1. *Results*

The results of the descriptive statistical analysis provide an overview of the scientific literacy skills of class IX.5 students of SMPN 40 Makassar. The student's score based on the results of the descriptive statistical analysis is in the form of the number of samples, the highest score, the lowest score, the average score and the standard deviation.

Table 3. Statistics of Students' Knowledge Aspect Ability in Science Literacy

Descriptive Statistics	Knowledge Aspect Ability on Science Literacy
Number of Samples	35
Highest Score	16
Lowest Score	6
Average Score	10.11
Standard Deviation	2.21

Based on Table 2, students' abilities in the knowledge aspect of scientific literacy show quite significant variations. With a sample size of 35 students, the highest score achieved was 16 out of a maximum total score of 20, while the lowest score was 6. The average score was at 10.11, indicating that most students had an understanding that was still at a moderate level. The standard deviation value of 2.21 reflects a fairly moderate distribution of scores among students, which means that there are relatively varying differences in ability in mastering the knowledge aspect of scientific literacy. This finding emphasizes the importance of developing adaptive and responsive learning strategies to students' learning needs in order to improve equity and achievement of scientific literacy more optimally.

The results of the distribution of achievement of knowledge aspects in scientific literacy based on value categorization can be seen in Table 4.

Table 4. Distribution of Achievement of Knowledge Aspects in Students' Science Literacy

Value Interval	Category	Frequency	Percentage (%)
81-100	Very high	0	0
61-80	Tall	8	22.86
41-60	Currently	22	62.86
21-40	Low	5	14.29
0-20	Very Low	0	0
Total		35	100

Based on Table 3, regarding the distribution of achievement of knowledge aspects in students' scientific literacy, it can be seen that most students are in the medium category with a frequency of 22 students or 62.86%. This shows that most students have a sufficient understanding of basic science concepts, although they have not reached a high level of mastery. As many as 8 students (22.86%) are in the high category, indicating that there is a

group of students who have mastered the material well. Meanwhile, 5 students (14.29%) are still in the low category, reflecting the need for remedial efforts or a more adaptive learning approach to improve their understanding. No students are in the very high or very low categories, indicating a relatively concentrated distribution of achievement in the middle. This finding emphasizes the importance of optimizing learning strategies based on scientific literacy to encourage an increase in student achievement as a whole.

The students' score on the science literacy ability test is then distributed to each question number for each score obtained by the students. Based on the distribution of the scores obtained for each question number, the percentage of the scores obtained for each question number based on the science literacy aspect indicators can be observed in the following diagram.
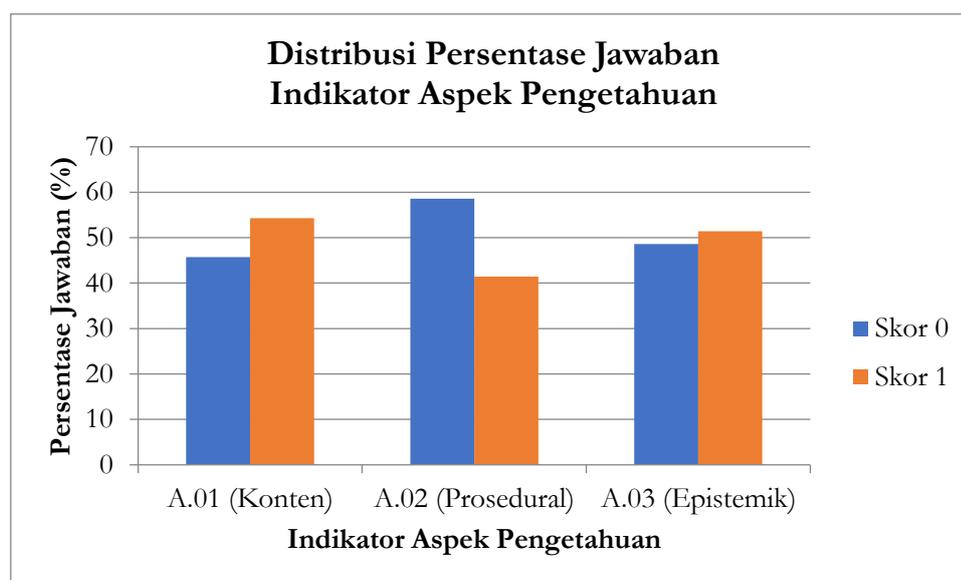

Figure 1. Percentage diagram of student answers based on knowledge aspect indicators

Information:

A.01 = Content knowledge (questions 1, 4, 7, 9, 11, 14, 17, 19)
A.02 = Procedural knowledge (questions 2, 5, 8, 10, 12, 15, 18, 20)
A.03 = Epistemic knowledge (questions 3, 6, 13, 16)
Score 0 = Wrong answer
Score 1 = Correct answer

Based on the percentage distribution diagram of answers, different patterns are seen in each aspect of knowledge. In A.01 (Content), most students, around 54%, answered correctly, while 46% answered incorrectly, indicating an uneven understanding of the content. In A.02 (Procedural), the majority of participants, 58%, answered incorrectly and only 42% answered correctly, indicating students' difficulties in applying scientific procedural steps. Meanwhile, in A.03 (Epistemic), the distribution is relatively more balanced, with 51% answering correctly and 49% answering incorrectly, indicating that almost half of the students are able to recognize and formulate scientific questions, but there is still room for improvement. This study emphasizes the need for special strengthening of the procedural aspect through directed laboratory practices and inquiry discussions, as well as content enrichment and epistemic reflection so that students' scientific literacy can improve holistically.

3.2. *Discussion*

This study involved 35 students of class IX.5 SMPN 40 Makassar who took a post-test of science literacy with 20 questions, where each answer was given a score of 0 (wrong) and a score of 1 (correct). The students' abilities in the knowledge aspect of science literacy showed quite significant variations (Table 2). This emphasizes the importance of developing adaptive and responsive learning strategies to students' learning needs in order to improve the distribution and achievement of science literacy more optimally.

Distribution of achievement of knowledge aspects in students' scientific literacy (Table 3), it can be seen that most students are in the medium category with a frequency of 22 students or 62.86%. This shows that most students have a sufficient understanding of basic science concepts, although they have not reached a high level of mastery. As many as 8 students (22.86%) are in the high category, indicating that there is a group of students who have mastered the material well. Meanwhile, 5 students (14.29%) are still in the low category, which reflects the need for remedial efforts or a more adaptive learning approach to improve their understanding. This emphasizes the importance of optimizing learning strategies based on scientific literacy to encourage an increase in student achievement as a whole. This is consistent with the results of the PISA study which shows that Indonesian students' scientific literacy tends to be concentrated at the secondary level (OECD, 2019).

The percentage distribution of students' answers (Figure 1) shows a different pattern in each aspect of knowledge. In A.01 (Content), most students, around 54%, achieved a score of 1, while 46% were still at a score of 0, indicating an uneven understanding of the content. In A.02 (Procedural), the majority of participants, 58%, were at a score of 0 and only 42% achieved a score of 1, indicating students' difficulty in applying scientific procedural steps. Meanwhile, in A.03 (Epistemic), the distribution was relatively more balanced, with 51% scoring 1 and 49% scoring 0, indicating that almost half of the students were able to recognize and formulate scientific questions, but there was still room for improvement. This emphasizes the need for special strengthening of the procedural aspect through directed laboratory practices and inquiry discussions, as well as content enrichment and epistemic reflection so that students' scientific literacy can improve holistically.

Based on direct observation in learning activities, the high achievement in aspect A.01 (Content) with 54% of students achieving a score of 1 can be explained by the dominance of lecture methods and direct delivery of materials by teachers, which makes it easier for students to understand basic concepts passively. Meanwhile, the low achievement in aspect A.02 (Procedural), where 58% of students are still at a score of 0, reflects the lack of opportunities for students to conduct experiments or laboratory practices independently, which should be the main means of practicing procedural skills. In aspect A.03 (Epistemic), the relatively balanced distribution (51% score 1 and 49% score 0) indicates that students are beginning to be exposed to scientific thinking activities such as asking questions and developing hypotheses, although these activities are still limited and not yet systematic. Therefore, this difference in achievement shows the importance of enriching learning with a hands-on approach and reflective discussion to balance mastery of all aspects of scientific literacy.

The limitations of students' scientific literacy arise because they have difficulty working on questions that require understanding and analytical skills. So far, students have rarely practiced such questions because teacher evaluations in daily tests, mid-term exams, and final exams only require them to memorize the material that has been studied. Ideally, students need to be accustomed to working on questions that emphasize analysis, in-depth understanding, and relevance to real-life contexts. In this way, they will become accustomed to developing a more comprehensive understanding of the material being studied. This is in line with the opinion of (Fakhriyah, Masfuah & Mardapi, 2019) who stated that Scientific literacy does not only include knowledge of scientific facts, but also involves the ability to

apply that knowledge in real-life situations, analyze information critically, and make responsible decisions as citizens. Therefore, a change in the approach to evaluating science learning in schools is needed, from mere memorization to strengthening higher-order thinking skills. Thus, students will be better prepared to face the challenges of the 21st century that require critical thinking, problem solving, and science-based decision making.

4. Conclusion

The results of the analysis show that the scientific literacy of junior high school students is still at a moderate level, with an average score of 10.11 out of a maximum total score of 20 and a standard deviation of 2.21, which reflects a fairly moderate variation in ability. As many as 62.86% of students are in the moderate category, 22.86% in the high category, and 14.29% in the low category. The distribution of scores for each indicator shows that in the content aspect (A.01), 54% of students achieved those who answered correctly, in the procedural aspect (A.02) only 42% of students answered correctly, while in the epistemic aspect (A.03) there were 51% of students who answered correctly. This study indicates that the implementation of STEM-based e-modules can be a solution to improve scientific literacy holistically, by providing contextual learning experiences, encouraging deeper conceptual understanding, and strengthening procedural and epistemic skills that still need to be improved.

This study can be a basis for further studies. It is recommended to conduct research with a stronger design, such as a quasi-experiment with pretest-posttest and control group, to measure the impact of increasing scientific literacy more accurately and identify the causal relationship between the use of STEM-based e-modules and scientific literacy. In addition, future studies can explore the effect of STEM-based e-modules on other variables such as students' creativity or critical thinking skills.

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