



The relationship of learning motivation and higher-order thinking skills with students scientific literacy ability

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Article Information	Abstract
Keyword: Learning motivation; Higher-order thinking skills; Scientific literacy; Senior high school; Ex post facto Kata Kunci: Motivasi belajar; Keterampilan berpikir tingkat tinggi; Literasi sains; Sekolah menengah atas; Ex post facto History: Received : 14/05/2025 Revised : 16/06/2025 Accepted : 26/06/2025 Published : 29/06/2025	Scientific literacy is a key 21st-century competency that students must possess. However, assessment results show Indonesian students' science literacy remains low. This study aims to determine the relationship between learning motivation and higher-order thinking skills (HOTS) toward students' scientific literacy. A quantitative approach with an ex post facto design was used. The sample consisted of 350 twelfth-grade science students selected through cluster random sampling from four public high schools in Maros Regency. Instruments included a learning motivation questionnaire, a HOTS test, and a scientific literacy test. Results showed average scores for learning motivation (67.41), HOTS (64.29), and scientific literacy (66.70), all in the moderate category. Correlation analysis revealed significant relationships between learning motivation ($r = 0.626$) and HOTS ($r = 0.430$) with scientific literacy. Simultaneously, both variables contributed 22.6% to science literacy ($R^2 = 0.226$; sig. = 0.00). These findings emphasize the importance of integrating affective and cognitive aspects to improve students' scientific literacy in science education. It is recommended that efforts to improve science literacy focus on strengthening students' affective and cognitive aspects through contextual, project-based, and inquiry-based learning approaches that are relevant to real life. Abstrak. Literasi sains merupakan kompetensi penting abad ke-21 yang harus dimiliki peserta didik. Namun, hasil asesmen menunjukkan tingkat literasi sains siswa Indonesia masih rendah. Tujuan studi ini adalah untuk mengetahui hubungan antara motivasi belajar dan keterampilan berpikir tingkat tinggi terhadap literasi sains peserta didik SMA. Penelitian menggunakan pendekatan kuantitatif dengan desain ex post facto. Sampel terdiri dari 350 siswa kelas XII IPA yang dipilih secara cluster random sampling dari empat SMA di Kabupaten Maros. Instrumen berupa angket motivasi belajar, tes HOTS, dan tes literasi sains. Hasil menunjukkan nilai rata-rata motivasi belajar sebesar 67,41, HOTS sebesar 64,29, dan literasi sains sebesar 66,70 (kategori sedang). Uji korelasi menunjukkan motivasi belajar berhubungan signifikan dengan literasi sains ($r = 0,626$), demikian pula HOTS ($r = 0,430$). Secara simultan, kontribusi kedua variabel terhadap literasi sains sebesar 22,6% ($R^2 = 0,226$; sig. = 0,00). Temuan menekankan pentingnya penguatan aspek afektif dan kognitif dalam pembelajaran untuk meningkatkan literasi sains. Direkomendasikan upaya peningkatan literasi sains difokuskan pada penguatan aspek afektif dan kognitif siswa melalui pendekatan pembelajaran kontekstual, berbasis proyek, dan inkuiri yang relevan dengan kehidupan nyata.

A. Introduction

The 21st century, science and technology are evolving rapidly and the main focus of global development, so education is required to adapt to these changes. According to Yusuf et al. (2022) and Oktaviana et al. (2023), one of the 21st century skills that needs to be provided to students to answer these challenges is scientific literacy. Scientific literacy is an essential skill that plays a key role in facing global challenges (Fadlika et al., 2020). The OECD (2019) defines scientific literacy as the ability of individuals to identify statements, acquire knowledge, explain phenomena that occur scientifically, and make decisions based on facts, scientific understanding, and scientific issues. By mastering scientific literacy, students can apply scientific knowledge to solve problems in daily life (Mukti et al., 2019). In line with the previous opinion, Maryani and Rupilu (2025) emphasized that scientific literacy is a basic ability that students must have. Thus, strengthening scientific literacy needs to be done from an early age so that students are able to adapt and actively contribute to the development of the times (Adawiyah & Chastanti, 2023).

Regarding scientific literacy skills, Indonesia has participated in international assessments, namely TIMSS (Trends International Mathematics and Science Study) and PISA (Programme for International Student Assessment). The results of the TIMSS and PISA assessments show that the achievements of Indonesian students are still below those of other participating countries. Referring to the results of the 2015 TIMSS assessment, Indonesia is ranked 44th out of 49 countries with an higher-order thinking skills results, Indonesia is in the 67th position out of 81 participating countries in the science aspect. The PISA 2022 score has even decreased compared to 2006, which was 393 to 383 (OECD, 2023). These findings indicate that the scientific literacy skills of students in Indonesia tend to be stagnant and still low.

The low achievement of students' scientific literacy needs to be a serious concern. Efforts to improve scientific literacy skills are inseparable from various factors. According to Hidayah et al. (2019), learning motivation is one of the factors that affect students' scientific literacy skills. This opinion is strengthened by the results of research conducted by Syah et al. (2020) which show that learning motivation has a positive and significant effect on students' scientific literacy, meaning that the higher the students' motivation to learn, the higher the scientific literacy ability. Nuryasana and Desiningrum (2020) stated that students who have the motivation to learn will learn well. Therefore, efforts to improve scientific literacy skills also require learning motivation that can encourage students to be active in the learning process (Maryani & Rupilu, 2025).

In addition to learning motivation, another factor that subsequently affects students' scientific

literacy skills is higher-order thinking skills (Yuriza et al., 2018). High-level thinking skills are described as the ability to Analyzing (C4), Evaluating (C5), and Creating (C6), according to Bloom's revised taxonomy (Apino & Retnawati, 2017). With higher-order thinking skills, learners can develop the ability to investigate problems, connect, and obtain new solutions or ideas (Saraswati & Agustika, 2020). Higher-order thinking skills represent cognitive activities required to understand and apply science concepts in depth.

Theoretically, there is a relationship between high-level thinking skills and scientific literacy. Judging from the indicators of higher-order thinking skills and scientific literacy, in the Programme for International Assessment (PISA), there are indicators of students' scientific literacy skills, including the ability to identify and evaluate problems, analyze information, and infer based on scientific data (OECD, 2019). Which is also part of the indicator of higher-order thinking skills (Ulfa & Kuswanti, 2021). In other words, to achieve literacy skills, ability must have high-level thinking skills. This is in line with research conducted by Thahir et al. (2021) which shows that there is a relationship between higher-order thinking skills and scientific literacy, where students' low-level thinking skills have an impact on the ability to solve science problems. These findings confirm that improving higher-order thinking skills can be one of the important factors in efforts to improve students' scientific literacy skills.

Various studies that have been conducted in the past show that learning motivation and higher-order thinking skills are important variables in improving students' scientific literacy skills. However, these studies still focus on the analysis of each variable separately. Research that examines the combined relationship between motivational learning and higher-order thinking skills with scientific literacy abilities simultaneously is still limited, especially in the context of biology learning at the state senior high school level in Maros district.

Therefore, it is important to conduct research that examines not only the relationship between learning motivation and higher-order thinking skills separately, but also analyzes the relationship between the two simultaneously with students' scientific literacy skills. Moreover, the limitations of research that raises this topic in the context of learning biology at the public senior high school level in Maros district further strengthens the urgency of this research. This research aims to determine the extent of the relationship between learning motivation and high-level thinking skills with scientific literacy skills together. The results of this research are expected to contribute to the development of more effective biological learning strategies, as well as support the improvement of the quality of scientific literacy of

educators as a provision to face the challenges of the 21st century.

B. Material and method

The approach used in the research is quantitative with an ex post facto design. The ex post facto design was chosen because the independent variables in the research, namely learning motivation and higher-order thinking skills, are internal aspects of students that have been formed naturally and cannot be manipulated directly. Meanwhile, the ability of scientific literacy as a dependent variable is measured to find out the extent to which the two independent variables contribute to it. The population consists of all students in class XIIIPA with a total of 2,822 students, based on data from the Ministry of Education and Culture in 2024. To determine the number of representative samples, a slovin formula is used with a margin of error of 5% or 0.05. The formula used is as Formula 1. With such sum Sample research 350 students were determined.

$$n = \frac{N}{1 + Ne^2} \dots\dots\dots \text{Formula 1}$$

Description :

n = Number of samples

N = Number of population

e = Error rate

The sampling technique used was cluster random sampling, from all SMA Negeri in Maros district, four schools were selected as samples, namely SMA N 1 Maros, SMA N 3 Maros, SMA N 4 Maros, and SMA N 13 Maros based on feasibility considerations as the main cluster. The selection criteria include: (1) the school has a minimum of two study groups in class XII of science; (2) have adequate science learning facilities and infrastructure; (3) implementing the Merdeka curriculum which encourages the development of scientific literacy and higher-order thinking skills. After the four schools are designated as clusters, the sampling of students is carried out proportionally based on the number of students in class XII of science in each school, so that the distribution of samples accurately represents the population conditions fairly and accurately.

The variables studied include learning motivation (X1), higher-order thinking skills (X2), and scientific literacy ability (Y), learning motivation is an internal drive that affects the intensity, direction, and perseverance of students in learning science, measured through a Likert-scale questionnaire with a total of 40 questions, based on the four main components of the ARCS model developed by (Keller, 1987). Including: Attention, Relevance, Confidence, and Satisfaction.

Higher-order thinking skills (HOTS) is the ability of individuals to think more complexly, such as analyzing, evaluating, and creating based on information or scientific phenomena faced. The measurement of higher-order thinking skills using biology HOTS questions in the form of multiple-choice questions with a total of 20 questions, which are arranged based on the HOTS question indicators according to the cognitive level in the revised bloom's taxonomy (C4) analyze, (C5) evaluate, and (C6) create (Apino & Retnawati, 2017).

Scientific literacy is defined as the capacity of educational students to use their knowledge in identifying questions and being able to draw conclusions based on facts or data to understand various natural phenomena and make decisions. Scientific literacy was measured using a multiple-choice test instrument with a total of 20 questions. Scientific literacy questions were developed based on scientific literacy knowledge competencies within the framework of the Programme for International Student Assessment (PISA) including interpreting data and evidence scientifically, explaining phenomena in a scientific manner, and evaluating and designing scientific investigations (OECD, 2019).

Validity and reliability tests were conducted to ensure the accuracy and consistency of the data, the instrument validity test using Pearson product-moment correlation. The basis for decision-making:

- 1) Comparing the value of r calculated and r of the table. If $r_{\text{count}} > r_{\text{table}}$ then the item is said to be valid. On the other hand, if $r_{\text{calculates}} < r_{\text{Table}}$ then the item is said to be invalid.
- 2) Compare the value of Sig. with alpha (0.05) if the value of Sig. < 0.05 then the item of the instrument is valid. On the other hand, if Sig. > 0.05 , then the instrument item is invalid.

Meanwhile, the reliability test is carried out by comparing the Cronbach's alpha coefficient value with the Cronbach's alpha coefficient value of at least 0.6. If the Cronbach's alpha coefficient value obtained from the calculation SPSS > 0.6 , then it can be concluded that the instrument is reliable. Conversely, if Cronbach's alpha coefficient value is below 0.6 then the instrument is declared unreliable.

The data analysis techniques used are descriptive statistics and inferential statistics, descriptive statistics are used to describe data from three variables, namely learning motivation, higher-order thinking skills, and scientific literacy ability. Descriptive analysis was carried out by calculating the minimum, maximum, mean, and standard deviation values for each variable.

Furthermore, based on the average value and standard deviation obtained, categorization was carried out for each variable, referring to the categorization according to Azwar 2017, which can be seen in Table 1.

Table 1 Five-level categorization

Interval	Category
$X > M + 1.5 \text{ SD}$	Very high
$M + 0.5 \text{ SD} < X \leq M + 1.5 \text{ SD}$	High
$M - 0.5 \text{ SD} < X \leq M + 0.5 \text{ SD}$	Moderate
$M - 1.5 \text{ SD} < X \leq M - 0.5 \text{ SD}$	Low
$X \leq M - 1.5 \text{ SD}$	Very low

Description: X = Score, M = Average, and SD = Standard deviation

Table 2 Degree of closeness of relationship

Interval correlation	Relationship level
0.00 – 0.199	Very weak
0.20 – 0.399	Weak
0.40 – 0.599	Moderate
0.60 – 0.799	Strong
0.80 – 1.000	Very powerful

(Source: Zuhri et al., 2023)

Inferential test is intended to test the research hypothesis, the hypothesis test is carried out with simple and multiple tests using the spss version 25.0 software. Before the hypothesis test is carried out, it is necessary to perform the prerequisite test first, that is, the normality test and the homogeneity test, the normality test functions to find out whether the data are distributed normally or not, the normality test is carried out with Kolmogorov-Smirnov. The basis of decision-making, the data are considered distributed normally if the value of Asymp.Sig. (2-tailed) greater than 0.05, otherwise if the value of Asymp.sig. (2-tailed) smaller than 0.05 data is said to be abnormal. Furthermore, the homogeneity test aims to find out whether the variance distribution is equal or not, the homogeneity test was conducted using Bartlett's test on the basis of decision-making. If the value of Sig. (P-Value) > 0.05 then the data variant is said to be homogeneous, on the other hand, if the Sig. (P-Value) is < 0.05, then the data variant is not homogeneous.

After the prerequisite test, it is followed by a hypothesis test with simple and multiple regression analysis. Simple correlation analysis is used to see the relationship between the independent variable and the bound variable, the basis for decision-making based on the significance value, if the value of Sig. (2-tailed) < 0.05 then there is a correlation or relationship between variables (H0 rejected, H1 accepted), while if the value of Sig. (2-tailed) > 0.05 then there is no significant relationship (H0 is accepted, H1 is rejected). The hypothesis for simple correlation analysis can be formulated as follows :

- H0: There is no significant relationship between the independent variable and the bound variable.
- H1: There is a significant relationship between free and bound variables.

Meanwhile, multiple regression analysis was performed to see the simultaneous relationship between the independent variables X1 and X2 and the bound variable Y. if the value of Sig. F Change < 0.05 is said to be a significant simultaneous relationship

between variables (H0 is rejected, H1 is accepted), and if the Sig. FChange value is > 0.05 then there is no simultaneous significant relationship (H0 is accepted, H1 is rejected). The hypothesis for the analysis of multiple correlations is formulated as follows :

- H0: there is no significant relationship simultaneously between variables X1 and X2 and variable Y.
- H1: there is a significant relationship simultaneously between variables X1 and X2 and variable Y.

From the correlation test, the strength or tightness of the relationship between variables is determined by looking at the value of the correlation coefficient, while the guidelines for degree relationships are explained in Table 2.

C. Results and discussion

Descriptive statistical analysis of learning motivation, higher-order thinking skills, and scientific literacy skills, descriptive statistics data of learning motivation can be seen in Table 3. The data on the frequency and percentage of learning motivation can be seen in Figure 1.

Based on Table 3. An overview of the condition of learning motivation was obtained, as seen in table 3, the average score of tudents was 70.11, with the students was 70.11, with the lowest score of 50 and the highest score of 95. Furthermore, table 3 presents the average achievement in each learning motivation indicator, the statisfaction indicator shows the highest score of 74.90, followed by confidence with an average score of 71.05, attention 68.47, and relevance 68.32. These results show that some of the students are not able to maintain focus, are not active in learning, have limited curiosity, and students do not feel a strong connection between the material learned and personal and academic needs. Meanwhile, based on figure 1, most students are in the medium category 44.6%, followed by the low category 24.3% and high

19.7%. A small portion of students' learning motivation is in the very high category 5.1%. and very low 6.3%. Referring to figure 1, it is known that the learning motivation in 350 samples of grade XII students of State Senior high school in Maros district is mostly in the medium category, the learning motivation that is in the medium category reflects that students have sufficient learning encouragement, but are not consistent or strong internally. Instability of internal motivation can have an influence on the learning process and students' learning outcomes,

learning motivation is one of the factors that affect learning outcomes (Suciani et al., 2022). Students with strong motivation Students with high motivation show good learning outcomes (Sihombing et al., 2021). Therefore, learning motivation needs to be improved, increasing students' learning motivation can be done by encouraging students to be more enthusiastic about learning, using interesting learning models and media and giving rewards to students when students have achieved good achievements (Suciani et al., 2022).

Table 3 Descriptive statistics of learning motivation

Descriptive	Learning motivation
Number of samples	350
Mean	70.11
Standard deviation	7.72
Minimum	50
Maximum	95
Mean score for each indicator	
Indicator	Mean
Attention	68.47
Relevance	68.32
Confidence	71.05
Satisfaction	74.90

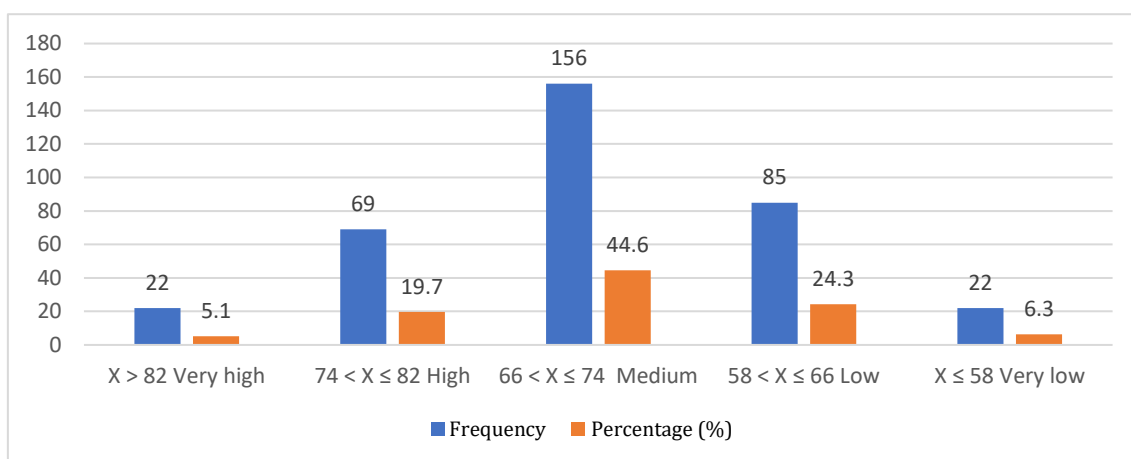


Figure 1 Distribution of learning motivation categories

Table 4 Descriptive statistics higher-order thinking skills

Descriptive	Higher-order thinking skills
Number of samples	350
Mean	24.51
Standard deviation	7.40
Minimum	10
Maximum	45
Mean score for each indicator	
Indicator	Mean
Analyze	22.46
Evaluate	26.10
Creating	21.69

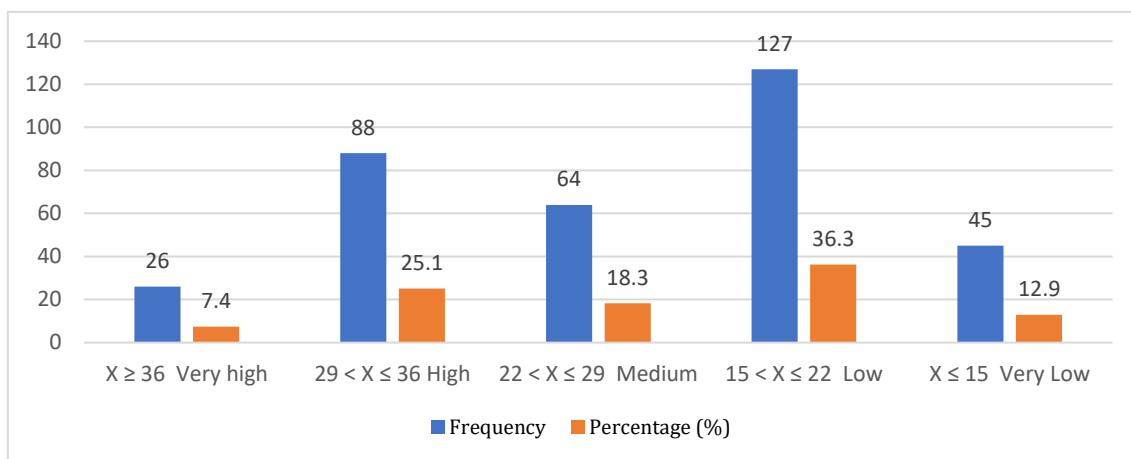


Figure 2 Distribution of higher-order thinking skills categories

Table 5 Descriptive statistics of scientific literacy ability

Descriptive	Scientific literacy ability
Number of samples	350
Mean	33.07
Standard deviation	10.86
Minimum	10
Maximum	65
Mean score for each indicator	
Indicator	Mean
Interpreting data and evidence scientifically	32.25
Explaining phenomena in a scientific manner	33.83
Evaluating and designing scientific investigations	31.23

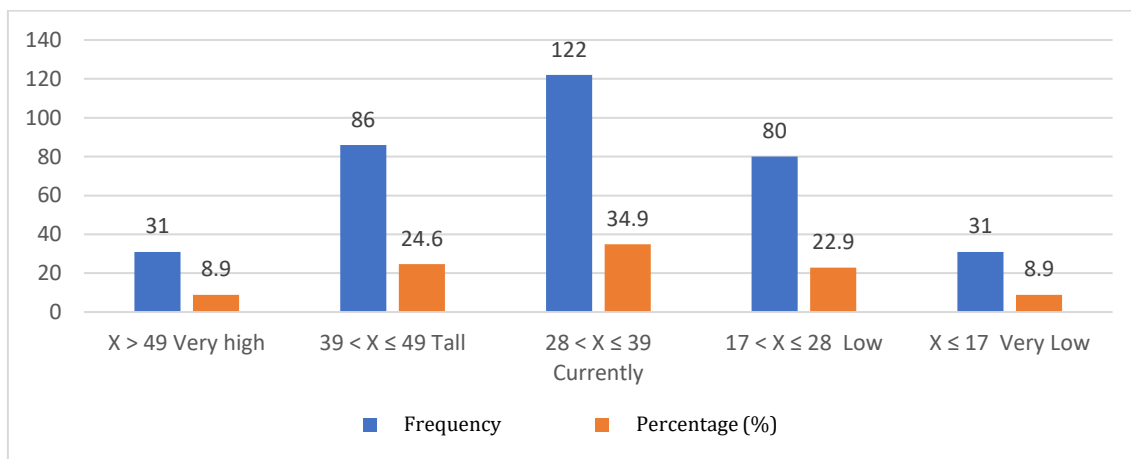


Figure 3 Distribution of scientific literacy skills

Descriptive statistical analysis of higher-order thinking skills can be seen in Table 4. Based on Table 4, an average score of 24.51 was obtained, with the lowest score of 10 and the highest 45. Based on the results of the analysis mean score for each indicator in table 4, it can be seen that the higher-order thinking skills in the evaluating indicator have the highest average score of 26.10, followed by analyzing with a score of 22.46 and creating with a score of 21.69. that students are more skilled in assessing or evaluating information than the ability to analyze and create. Furthermore, the score of higher-order thinking skills

were categorized based on the set value interval, the distribution of the frequency of higher-order thinking skills of learners can be seen in Figure 2.

Based on Figure 2, the results of the categorization of high-level thinking skills in 350 samples of grade XII students of public senior high schools in Maros district, most of them were in the low category, which was 36.3%, followed by the high category of 25.1%, and medium category 18.3%. Meanwhile, the proportion of students who are classified as very high only reaches 7.4%, and very low at 12.9%. The findings indicate that the majority

of students have not reached the optimal level of higher-order thinking skills. The same results were shown in previous research conducted by Putri et al. (2020) revealed that the average score of higher-order thinking skills of students was in the low category. The low achievement of students in higher-order thinking skills can be caused by various factors. One of them is that students are not used to working on HOTS type questions (Thahir et al., 2021). In addition, the findings of research conducted by Sari and Yulianti (2024), that students can memorize concepts in learning so that their understanding is limited, students who only memorize concepts will have difficulty using their knowledge when faced with problems that require higher-order thinking skills. Another factor that contributes to the low level of thinking skills of students, as presented by Syam et al. (2024), namely the use of learning models that are not optimal and appropriate, this is in line with Sidabutar and Mercuriani (2024) which states that if the learning model is applied correctly, it can help improve students' higher-order thinking skills.

Statistical analysis of scientific literacy ability based on Table 5. obtained the average score obtained was 33.07, with a low score of 10 and highest 65. In addition, the achievement of students in each of the indicators of scientific literacy ability in more detail is presented in Table 5, based on the results shown in Table 5, it is known that the Indicator related to explaining the phenomenon of scientific practice has the highest average score of 33.83, followed by the indicator of interpreting data and evidence in a scientific manner with an average value of 32.25, as well as evaluating and designing scientific investigations with an average score of 31.23. These findings show that students tend to better master conceptual explanations of scientific phenomena more than the ability to interpret data and evidence in a scientific way, as well as the ability to evaluate and design scientific investigations.

Furthermore, the scientific literacy score is categorized based on the set value interval, the distribution of the frequency of higher-order thinking skills of students can be seen in Figure 3. The distribution of scientific literacy skills is known in 350 samples of class XII students of public Students who have strong learning motivation tend to show better learning outcomes in Maros district. The results of the categorization showed that most of the students were in the medium category at 34.9%, followed by the high category at 24.6%, and the low category at 22.9%. Meanwhile, the proportion of students were in the each 8.9% fall into the very high and very low

categories This distribution pattern shows that students' higher-order thinking skills are in the medium category. These are in line with the results of research conducted by Solheri et al. (2022) and Zuhri et al. (2023) where the results of the analysis showed that students' scientific literacy skills were in the medium category. However, the results of research conducted by Nefianthi and Wahab (2024) show different results, namely the scientific literacy ability of students is in the low category. The representation of scientific literacy abilities from various study results shows the same tendency, namely the need to improve students' scientific literacy skills. According to Adnan et al. (2021), in an effort to improve students' scientific literacy skills, teachers have an important role in facilitating students in developing scientific literacy skills. Teachers are emphasized in providing effective learning situations for students, so that they can develop knowledge and an attitude of inquiry into science.

Inferential statistics

Prerequisite test

Normality test results account using Kolmogorov-Sminov normality test uses spssversion 25.0. For a more detailed explanation of the normality of each variable, see Table 6. The significance values in the variables of learning motivation, higher-order thinking skills, and scientific literacy ability were $0.200 > 0.05$, so it can be concluded that the variables of learning motivation, higher-order thinking skills, and scientific literacy abilities were distributed normally.

Calculation results with Barlett's Test homogeneity test using SPSS version 25.0. For a more detailed explanation of the normality of each variable can be seen in Table 7. The significance value of the learning motivation variable is $0.540 > 0.05$; high-level thinking skills are $0.07 > 0.05$, and scientific literacy skills are $0.200 > 0.05$, so it can be concluded that the data on the learning motivation variables, high-level thinking skills, and scientific literacy skills are homogeneous.

Hypothesis test

After a prerequisite test was carried out that showed normal distributed data and homogeneous data variants, followed by a parametric hypothesis test. to test the relationship between learning motivation, higher-order thinking skills, and scientific literacy skills of students. The results of the correlation test of learning motivation with scientific literacy ability are presented in Table 8.

Table 6 Variable normality test

Variable	Sig.	Description
Learning motivation	0.200	Normal
Higher-order thinking skills	0.200	Normal
Scientific literacy ability	0.200	Normal

Table 7 Variable homogeneity test

Variable	Sig.	Description
Higher-order thinking skills	0.540	Homogen
Higher-order thinking skills	0.07	Homogen
Scientific literacy ability	0.118	Homogen

Table 8 The relationship between learning motivation and scientific literacy ability of students

Variable	R square	Sig,
Learning motivation	0.623	0.00

Table 9 The relationship between higher-order thinking skills and students' scientific literacy abilities

Variable	R square	Sig,
Higher-order thinking skills	0.430	0.00

Table 10 The relationship between learning motivation and higher-order thinking skills together to literacy ability science

Model	R square	Sig, F change
1	0.226	0.00

Based on Table 8, it can be explained that the learning motivation variable shows a significance value of $0.00 > 0.05$. This shows that there is a significant relationship between learning motivation and students' scientific literacy ability, in addition, the determinant coefficient value of 0.62 indicates that 62% of the variation in scientific literacy ability can be explained by learning motivation. Thus, the relationship between the two variables is included in the strong category, which indicates that learning motivation makes a great contribution to students' scientific literacy skills.

However, different results were found by Yanti et al. (2020) who stated that learning motivation is not yet able to exert an influence on scientific literacy ability. These differences can be caused by a number of factors, such as sample characteristics, learning approaches, or measurement instruments used.

Therefore, although the relationship between learning motivation and scientific literacy in a strong category, it is important to note that the contribution of learning motivation is highly dependent on how the learning environment, models, and learning strategies can accommodate the needs and potential of students (Artika et al., 2025). With high learning motivation, it will encourage students to continue learning, as well as be active in the learning process to gain deeper knowledge. Motivated students will certainly feel enthusiastic and can focus their attention on learning (Taufiq et al., 2021).

Based on Table 9, showed that the variable of high-level thinking skills obtained a significance value of 0.00, this value was below 0.05. This value shows that there is a significant relationship between higher-order thinking skills and students' scientific literacy skills. In addition, the correlation coefficient value of 0.430 shows a positive relationship with the degree of

relationship severity in the medium category, which indicates that the higher the students' level thinking skills, the higher their scientific literacy skills. These findings show similar results to the research conducted by Susiati et al. (2018) which concluded that there is a significant relationship between higher-order thinking skills and students' scientific literacy skills. Thahir et al. (2021) expressed a similar opinion, namely that there is a positive relationship between the two variables, but the level of correlation is different (in the weak category).

The strong or weak relationship between higher-order thinking skills and scientific literacy skills can occur due to the relationship between indicators of each variable. This opinion is supported by a statement from Arifiyyati et al. (2022) who states that higher-order thinking skills such as analyzing, evaluating, and creating. It is an important foundation in the development of scientific understanding. Based on these indicators, there are direct implications for scientific literacy, such as the ability to identify and evaluate problems, analyze data or information, and solve problems in a systematic manner. It can be concluded that there is a close relationship between higher-order thinking skills and scientific literacy skills, considering that these two variables require complex cognitive processes and deep conceptual understanding.

Based on Table 10, a significance value of 0.00 indicates that the value is below the significance threshold of 0.05. This indicates that learning motivation and higher-order thinking skills simultaneously have a significant effect on students' scientific literacy skills. Based on the determinant coefficient value of 0.226, it can be explained that 22.6% of the variation in students' scientific literacy skills is simultaneously influenced by motivation and

higher-order thinking skills. This figure shows that the two independent variables make a significant contribution to the scientific literacy ability of students.

Linkages between motivation learn and Skills think high level towards Scientific literacy ability can be understood as theoretical. Learning motivation acts as an internal motivation that directs students to be directly involved in the learning process, pay more attention to learning, and listen to and analyze the material or concepts provided by the teacher (Adnan et al., 2023). This leads students to a deeper understanding of the basic concepts of learning. On the other hand, higher-order thinking skills, which include the ability to analyze, evaluate, and create, enable learners to develop a reflective way of thinking about scientific information they obtain, this process supports the achievement of scientific literacy because it requires an understanding that is not only memorized but also analytical and applicative in solving problems.

These findings are reinforced by previous research, as stated by Susiati et al. (2018), that there is a significant relationship between higher-order thinking skills and scientific literacy skills. In line with that, Adnan et al. (2021), also emphasizes the importance of motivation in the learning process, which is able to encourage students to be more involved in learning activities and be able to comprehensively understand concepts. Thus, it is important to pay attention to the affective aspects of the learning process. The significant relationship between learning motivation and higher-order thinking skills and scientific literacy skills indicates that these two aspects play a major role in shaping students' scientific understanding. High learning motivation encourages active involvement in the learning process, while Higher-order thinking skills strengthen students' ability to be educated in analyze, evaluate, and formulate solutions to various contextual problems.

The large coefficient of 22.6% reflects the significant contribution of motivation and Higher-order thinking skills to scientific literacy ability. This requires the active role of teachers in developing learning strategies that are not only content-oriented, but also foster curiosity and critical thinking skills, for example through inquiry approaches, project-based learning, and contextual activities. Support from schools and curriculum policies is also needed to create a learning environment that supports the development of scientific literacy in a sustainable manner. These findings can be used as a basis for developing further studies related to other factors that affect scientific literacy, such as the role of digital literacy, self-efficacy, and family involvement in the educational process.

D. Conclusion

The scientific literacy ability of senior high school students in Maros Regency is generally in the category medium with an average score of 66.70. The highest achievement is found in the content aspect, while the context and scientific process aspect shows the lowest achievement. This condition shows that students still experience difficulties in understanding and applying science concepts as a whole, especially in interpreting data, drawing conclusions, and critically evaluating information. This is strengthened by the average result of higher-order thinking skills of 64.29 and learning motivation of 67.41 which is also in the medium category. Both variables significantly contribute significantly to scientific literacy, as shown by correlation and regression analysis, with a simultaneous contribution of 22.6%. Thus, efforts to improve scientific literacy need to be focused on strengthening the affective and cognitive aspects of students through contextual, project-based, and inquiry approaches that are relevant to real life.

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