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Determinant Factors of Scientific Literacy in Elementary School Science Learning

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Abstract

Science literacy is becoming an essential skill for students in the modern era to understand and participate in scientific and technological developments. This study explores the factors determining students' science literacy in learning Science in Elementary School. The research method used a quantitative method with an ex post facto approach. The population of this study was elementary school students in Jakarta, Indonesia, with a cluster random sampling technique helpful in determining a sample of 513 students. Data collection used a questionnaire instrument to obtain data related to the variables in this study. Data analysis used a structural equation model (SEM) with the help of the SMART-PLS 3.0 application program. The results explained that the significance value obtained was 0.000 (<0.05), indicating that students' science literacy skills have been positively and significantly influenced by various factors, both internal factors, including motivation, interest, and self-efficacy, as well as external factors including classroom climate, learning quality, and parental support. Likewise, understanding the factors that positively influence scientific literacy can equip teachers to approach science instruction more comprehensively and effectively, helping students enhance their conceptual understanding. By paying attention to these factors, teachers can also design learning models that are more conducive and supportive towards students' needs, thus providing the solution to improve science literacy at the elementary school level.

Keywords:

Internal Factors, External Factors, Science Learning, Science Literacy

Introduction

Scientific literacy, which is a vital skill for people in this era (Koyuncu et al., 2021), is also extremely important for pupils in the 21st century. This is consistent with the main goal of the Independent Curriculum applied in Indonesia, which is to enhance scientific literacy. The introduction of the Independent Curriculum was primarily motivated by Indonesia's underperformance in the 2012 Program for International Student Assessment (PISA). Scientific literacy refers to the capacity to apply scientific information in practical situations to address science-related challenges and enhance the overall standard of living. Nevertheless,

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there is a need for improvement in the scientific literacy skills of students in Indonesia (Aksu et al., 2023). Indonesia obtained a mean score of 403 on the PISA (Program for International Student Assessment) evaluation, whereas the average score for the OECD (Organization for Economic Co-operation and Development) was 493. Indonesia ranks 62nd out of 72 participants.

The scientific literacy abilities of students remain relatively low, as evidenced by the fact that all categories are below 50% (Aiman et al., 2020). The analysis of scientific literacy skills reveals that the identification of scientific problems scored only 19.69% in the poor category. The explanation of scientific phenomena scored 32.19% in the medium category, while the interpretation of data and evidence scientifically scored 33.59%, also falling within the medium category (Hanifha et al., 2023). Moreover, according to Sholikah and Pertiwi (2021), the overall scientific literacy proficiency of pupils is classified as moderate. However, one specific feature, namely the capacity to identify scientific issues, falls into the low category, with a percentage of 37.5%.

The study conducted by (El Islami & Nuangchalerm, 2020) revealed that both educators and students still need to enhance their scientific literacy skills. Furthermore, Haryadi and Pujiastuti, (2020) discovered that pupils possess a deficient level of scientific literacy. Therefore, it is imperative to provide educational instruction to enhance students' scientific literacy. The development of students' strong scientific literacy skills is crucial for effectively addressing everyday challenges and comprehending scientific concepts within their immediate surroundings. The lack of proficiency in scientific literacy among students in Indonesia indicates their inability to effectively solve problems. Indonesia's inability to compete at the international level is implied (Rusmansyah et al., 2023).

Natural Science learning in elementary schools is central to forming a solid foundation of scientific literacy in children. This is because science teaches scientific concepts and develops essential science process skills (Hastuti et al., 2020). Students learn through science to observe, classify, create hypotheses, and conduct experiments, helping them understand how science works in practice (Pramudiyanti et al., 2023; Zulherman et al., 2021). The foundations embedded in science learning prepare students to understand the world around them and equip them with the tools and understanding necessary to face future scientific challenges. Science learning in elementary school not only enriches students' knowledge but also forms a solid foundation for their scientific literacy in the future. Scientific literacy depends not only on understanding scientific concepts but also on mastering fundamental scientific process skills (Perdana Putra et al., 2021; Rorimpandey et al., 2022). Observation, classification, hypothesis generation, and conducting experiments are critical to adequate scientific literacy. However, behind the success of scientific literacy, various determinant factors influence the learning process and student achievement.

Factors that have received significant attention from educators and researchers are the role of the learning environment, the quality of the learning process, the level of motivation, demonstrated interest, and the level of self-efficacy, both in the school environment and outside of school (Darling-Hammond & Cook-Harvey, 2018; Syofyan & Ratih, 2022). These factors play a crucial role in determining students' scientific literacy as they interact and mutually affect each other during the learning process (Abu Bakar et al., 2023). Learning environments that promote investigation, discussion, and practical application in a scientific context can greatly enhance the development of scientific literacy. In addition to the teacher's instructional quality, the amount of student motivation, interest in the learning content, and belief in one's abilities (self-efficacy) are also crucial factors in developing a strong foundation of scientific literacy in pupils (Keller et al., 2017a; Tuan et al., 2005).

Previous studies (Almeida et al., 2023; Tas et al., 2019; van Rooij et al., 2017) highlight that the determinants of scientific literacy still require improvement. Although efforts have been made to understand the factors influencing students' scientific literacy, there is still room for improvement. These findings indicate that certain aspects still need to be fully understood or handled effectively in science learning. Based on researchers' knowledge, research on the determinants of scientific literacy has been carried out comprehensively involving internal and external factors. However, most research tends to focus on high school students. Although this research provides valuable insight into the factors that influence scientific literacy in certain age groups, it needs to be acknowledged that science learning begins well before the high school level.

Elementary school is a critical phase in forming students' educational foundations, including the formation of scientific literacy. Therefore, it is essential to complement research on the determinants of scientific literacy with research that focuses more on elementary school students (Ni'mah, 2019; Shaffer et al., 2019). Teachers can design more effective and inclusive learning strategies by understanding the various determinant factors that influence scientific literacy in science learning in elementary schools (Hughes, & Braun, 2019). An integrated, empirically grounded strategy can facilitate the establishment of a learning setting that fosters the growth of students' scientific abilities, enabling them to confront forthcoming difficulties with assurance and proficiency (Fortus et al., 2022).

Scientific literacy in natural science learning at school is influenced by internal and external factors (Appleton, 2007). Internal student characteristics, including as motivation, curiosity, and self-efficacy, are crucial in influencing the level of student engagement and achievement in comprehending scientific topics. On the other hand, external factors, such as classroom climate, learning quality, and parental support, also play a crucial role in forming a learning environment conducive to developing students' scientific literacy (Bennett, 2010; Harlen, 2003).

The objective of this research is to identify and examine the factors that determine scientific literacy in primary school science education. By gaining a more profound comprehension of these factors, it is anticipated that the study can offer valuable perspectives for policymakers, educators, and educational practitioners to enhance the efficacy of science education at the elementary level. By bolstering our understanding of how factors such as student motivation, quality of education, and parental support impact scientific literacy, we can devise more efficient and inclusive learning approaches to enable every student to achieve their utmost potential in science education. Here are the research questions:

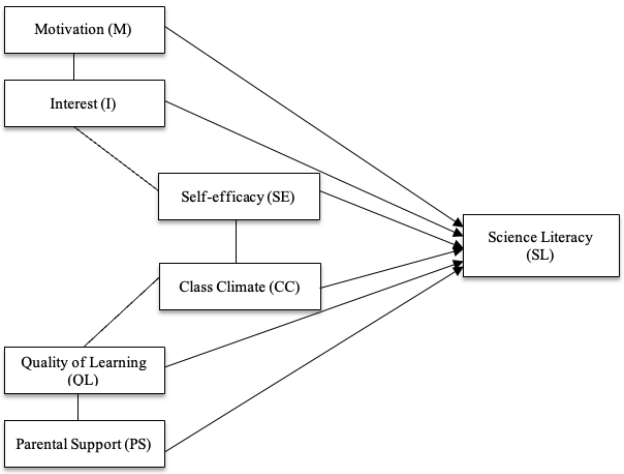
1. Do internal factors such as students' motivation, interest, and self-efficacy positively and significantly influence scientific literacy?
2. Do external factors such as classroom climate, learning quality, and parental support positively and significantly influence scientific literacy?
3. Can internal and external factors influence scientific literacy at the elementary school level?

Methods

Research design

This research uses quantitative methods with an ex post facto approach to analyze variables that can predict specific results (Al-Emran et al., 2019; Teo, 2014). This method allows researchers to collect data on existing variables and then analyze the influence of these variables (Balnaves & Caputi, 2018; Salkind, 2010). The conceptual model of this research is to examine the impact of internal factors (motivation, interest, and self-efficacy) and external (classroom climate, quality of learning, and parental support) on scientific literacy abilities in science learning. The research focuses on understanding how certain factors, both internal and external to students (exogenous variables), influence scientific literacy (endogenous variables). The variables analyzed include internal factors such as motivation, interest, and self-efficacy, as well as external factors such as classroom climate, learning quality, and parental support. By analyzing the influence of these factors, this study aims to provide a deeper understanding of how students' scientific literacy can be effectively improved through appropriate interventions at the primary education level. The research path model can be seen in Figure 1 below.

Figure 1.
Research Path Model



Population and Sampling Techniques

The population in this study consisted of elementary school students in the Jakarta area, Indonesia. From this population, a sample of 513 students was obtained, selected representatively using the cluster random sampling method. This technique involves selecting classes randomly from a number of elementary schools included in the study area. All students in the selected classes were then used as sample members. The data collection process was carried out using an instrument in the form of a questionnaire, which was distributed to students from the specified classes. The selection of elementary school students as research subjects was based on the need to identify and analyze factors that influence their scientific literacy skills. Further information regarding the details of the population and sample can be seen in the following table:

Table 1.
Total Population and Sample of Elementary School Students

School	Gender		N
	Male	Female	
SDN Wijaya Kusuma 02 Pagi	38	89	127
SDN Tanjung Duren Selatan 01 Pagi	61	71	132
SDN Jatipulo 05 Pagi	69	57	126
SDN Tamansari 03 Pagi	63	69	128
SDN Mangga Besar 15 Pagi	54	75	129
Total	285	361	513

*) SDN (term State Elementary School).

Research data collection

This research collects data regarding the determinants of scientific literacy in science learning in elementary schools. The instrument used was a five-point Likert scale questionnaire adopted from previous research. The process of developing this questionnaire refers to each variable in this research: motivation, interest and self-efficacy, classroom climate, quality of learning, and parental support and scientific literacy.

The questionnaire indicators for this research variable consist of 12 statements designed to be easily understood by elementary school students. Each statement uses language and information adapted to the level of understanding and age of children in grades 4, 5, and 6 so that they can answer questions more precisely and accurately. The indicators for each variable are: 1) Motivation: Hard work, task orientation, perseverance, and time use (Syofyan & Ratih, 2022). 2) Interest: feelings of enjoyment, student interest, and student involvement (Tarwiyani et al., 2020). 3) Self-efficacy: curiosity, resilience, learning patience, and learning motivation (Ferrell & Barbera, 2015). 4) Class climate: learning discipline, student involvement, student learning environment conditions, and positive student relationships with teachers (Darling-Hammond & Cook-Harvey, 2018). 5) Quality of learning: enthusiasm in receiving lessons, concentration in learning, activeness in asking and answering teacher questions, and ability to argue (Saleh, 2021). 6) Parental support: moral, material, and appreciation support (Booth et al., 2020). 7) Scientific literacy: identifying scientific questions, explaining phenomena scientifically and using scientific evidence (Masfuah et al., 2021).

The validity of this instrument is based on Piaget's theory, which shows that the cognitive abilities of children in grades 4, 5, and 6 have developed well, and they have sufficient reasoning abilities to understand the information presented in this instrument. Validity and reliability tests were carried out to ensure the validity and reliability of the data. The Likert Scale model questionnaire instrument has been carefully prepared to provide its relationship to scientific literacy skills in science learning. This process involves a review of theory and related literature to ensure that the items in the scale reflect the construct being measured. Reliability is also checked to ensure that the scale provides consistent results when repeated; it can be calculated using Cronbach's Alpha or test-retest. Each question in the research instrument uses a Likert scale with five alternative answers, where respondents can indicate their level of agreement with the statement asked. This Likert scale consists of five answer choices: "strongly agree" with a value of 5, "agree" with a value of 4, "somewhat agree" with a value of 3, "disagree" with a value of 2, and "strongly disagree" with a value of 1.

Research data analysis techniques

Data analysis in this research uses the Partial Least Square (PLS) method from Structural Equation Models (SEM) to analyze the relationship between variable construction, both exogenous and endogenous variables, as well as considering measurement error. The data analysis process is supported by SmartPLS 3.0 software, which is used to test research hypotheses (Memon et al., 2021). PLS-SEM is a model used to analyze the relationship between variables by paying attention to latent variables (constructs) and indicators. PLS-SEM produces path parameter estimates that maximize endogenous variables that exogenous variables can explain through structural models. The outer model (measurement model) in PLS-SEM analysis aims to measure the construct (latent variable) represented by the measurable indicators (Sarstedt & Cheah, 2019). By using this approach, this research can gain a deeper understanding of the relationships between variables in the context studied by considering aspects of accurate measurement.

The outer model is used to test the validity and reliability of the questionnaire indicators in this research and to measure the constructs appropriately. In testing the outer model, the criteria used include loading factor parameters with a value of more than 0.7 and Average Variance Extract (AVE) greater than 0.5. The loading factor and AVE parameters are the factors evaluated in these criteria. Furthermore, in hypothesis testing, the criterion used is the p-value. If the p-value is less than 0.05, the hypothesis is accepted, whereas if the p-value is more than 0.05, the theory is rejected. This hypothesis testing is carried out in the context of an inner model, where the relationships between variables are analyzed in more depth.

Results

Validity and reliability results

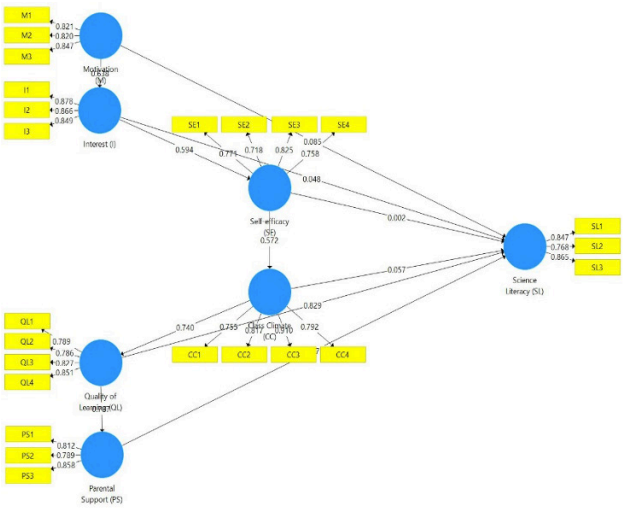
Analysis of validity and reliability tests on the questionnaire for each variable aims to ensure the reliability and validity of the research data. The analysis results show that the calculations that have been carried out meet validity standards (convergent and discriminant) and reliability standards. The factor loading values in this study used Confirmatory Factor Analysis (CFA), which was obtained from Cronbach's alpha, CR and AVE values as needed, as well as the outer model loading value for each factor in the latent variable was more than 0.7. The results of the validity and reliability tests can be seen in Table 2 below.

Table 2.
Results of validity and reliability test analysis of research variables

Variable	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Class Climate (CC)	0.837	0.891	0.673
Interest (I)	0.831	0.899	0.747
Motivation (M)	0.726	0.911	0.688
Parental Support (PS)	0.901	0.860	0.672
Quality of Learning (QL)	0.824	0.877	0.591
Science Literacy (SL)	0.871	0.867	0.685
Self-efficacy (SE)	0.913	0.892	0.591

The analysis results from Table 2 show that the Composite Reliability (CR) value for each variable construction ranges from 0.860 to 0.911, while the Cronbach's Alpha value ranges from 0.726 to 0.913. These figures show that the CR and Cronbach's Alpha values are satisfactory and acceptable, indicating high reliability and strong internal consistency for all formative constructs (Heale & Twycross, 2015). The QL5 indicator must be removed because it has an outer loading of less than 0.6. Composite Reliability (CR) exceeding 0.7 (Bajpai & Bajpai, 2014)indicates that all constructs in the model are reliable, answering the research question about overall construct reliability. The recapitulation results of this research's construction pathway model can be seen in Figure 2 below.

Figure 2.
Significant path coefficient from PLS Algorithm results



This research uses the path coefficient test to analyze the hypothesis. However, before proceeding to the hypothesis testing stage, it is necessary to analyze the fit model of the research data using the goodness of fit test. The results of the normed fit index (NFI) and standardized root mean square residual (SRMR) values are used as a category for whether the model is fit or not. This model fit test is assisted using the SMARTPLS-SEM program. The model is fit if the NFI value exceeds 0.8 and the SRMR is below 0.10. The results of this research's fit model show that the NFI value is 0.814 and the SRMR value is 0.092, so the model of the research variables is declared fit (Hair et al., 2021). Research hypothesis data were analyzed using the bootstrapping test method in SMARTPLS 3.0. This method aims to test hypotheses or obtain estimates of population parameters based on existing samples and test the significance value of each selected hypothesis. The results of the hypothesis analysis using the bootstrapping test method can be seen in Table 3 below.

Table 3.
HTMT Value

Variable	CC	I	M	PS	QL	SL	SE
Class Climate (CC)	0.820						
Interest (I)	0.624	0.864					
Motivation (M)	0.695	0.638	0.830				
Parental Support (PS)	0.693	0.616	0.631	0.820			
Quality of Learning (QL)	0.740	0.703	0.705	0.787	0.814		
Science Literacy (SL)	0.711	0.677	0.695	0.705	0.910	0.828	
Self-efficacy (SE)	0.572	0.594	0.526	0.530	0.631	0.593	0.769

Notes: CC (Class Climate); I (Interest); M (Motivation); PS (Parental Support); QL (Quality of Learning); SL (Science Literacy); SE (Self-efficacy).

Table 4.
Results of hypothesis analysis via SEM

Variable	Original Sample (O)	T-Statistics	P-Values
Class Climate (CC) -> Parental Support (PS)	0.582	18.439	0.000
Class Climate (CC) -> Quality of Learning (QL)	0.740	27.238	0.000
Class Climate (CC) -> Science Literacy (SL)	0.629	15.356	0.000
Interest (I) -> Class Climate (CC)	0.340	9.585	0.000
Interest (I) -> Parental Support (PS)	0.198	7.219	0.000
Interest (I) -> Quality of Learning (QL)	0.251	8.122	0.000
Interest (I) -> Science Literacy (SL)	0.262	5.879	0.000
Interest (I) -> Self-efficacy (SE)	0.594	15.315	0.000
Motivation (M) -> Class Climate (CC)	0.217	7.247	0.000
Motivation (M) -> Interest (I)	0.638	17.922	0.000
Motivation (M) -> Parental Support (PS)	0.126	5.798	0.000
Motivation (M) -> Quality of Learning (QL)	0.160	6.355	0.000
Motivation (M) -> Science Literacy (SL)	0.252	6.163	0.000
Motivation (M) -> Self-efficacy (SE)	0.379	9.567	0.000
Parental Support (PS) -> Science Literacy (SL)	-0.071	1.714	0.087
Quality of Learning (QL) -> Parental Support (PS)	0.787	34.296	0.000
Quality of Learning (QL) -> Science Literacy (SL)	0.773	18.725	0.000
Self-efficacy (SE) -> Class Climate (CC)	0.572	17.096	0.000
Self-efficacy (SE) -> Parental Support (PS)	0.333	10.783	0.000
Self-efficacy (SE) -> Quality of Learning (QL)	0.423	12.721	0.000
Self-efficacy (SE) -> Science Literacy (SL)	0.361	9.211	0.000

The analysis results from Table 3 explain that the HTMT (heterotrait-monotrait ratio of correlations) value is used to measure discriminant validity. As shown in Table 3, the HTMT value must be < 0.85 (Leguina, 2015) to demonstrate adequate discriminant validity. The results of the HTMT values show that all values are below 0.85, which confirms that there are no problems related to discriminant validity (Hidayat & Patricia Wulandari, 2022). Thus, hypothesis analysis using SEM can be continued to analyze the determinants of scientific literacy in science learning in elementary school.

The analysis results in Table 4 explain that each variable can have a direct influence. Exogenous variables, which include internal factors (motivation, interest, and self-efficacy) and external factors (classroom climate, learning quality, and parental support), significantly influence the endogenous variable, namely students' scientific literacy. The *p*-value of 0.000 <0.05 indicates that internal and external factors positively affect students' scientific literacy. However, parental support as an external factor is not included in the variables that have a positive influence because the *p*-value is 0.087 > 0.05.

The R-Square coefficient value of the exogenous variable against the endogenous variable is 0.507, which indicates that 50.7% of the variation in students' scientific literacy abilities can be explained by the internal and external factors used in this research. This increase occurred because factors such as motivation, interest, self-efficacy, classroom climate, quality of learning, and parental support influenced students' enthusiasm for learning science in elementary schools. The hypothesis in this research can be accepted, which confirms that students' scientific literacy abilities can be influenced by various factors, as explained in this research.

Discussion

Scientific literacy is essential and must be instilled in Indonesian students from an early age (Huang et al., 2022; Krajcik & Czerniak, 2018). This is important considering competition in technology and knowledge in the 21st century, which demands the ability of individuals to compete and follow global trends (Bahtiar et al., 2022; Widodo et al., 2020). The focus on science learning as a collection of knowledge aims to enable students to demonstrate, discuss, or ask questions that enable them to remember interrelated facts, events, concepts, principles, laws, and theories (Heliawati et al., 2022; Sun & Chan, 2024). This concept also aligns with research by Kähler et al., (2020), which shows that effective learning occurs when what is learned in class can be applied in everyday life through scientific literacy.

Scientific literacy refers to a person's ability to participate in solving science-related problems and interact with scientific ideas, which in turn forms an individual who is critical and reflective of scientific issues (Kutlu-Abu et al., 2024). A person is considered "literate" in science when he can engage in various aspects of science and technology, demonstrate competence to formulate scientific explanations of phenomena, evaluate information, design scientific research, and interpret and present scientific data and evidence effectively (Nurcahyani et al., 2021; Winarni et al., 2020). Scientific literacy is not only about understanding scientific concepts but also about applying critical and analytical thinking in the context of science, which is crucial to forming a society that thinks scientifically (Adriyawati et al., 2020).

Scientific literacy abilities in natural science learning at school are greatly influenced by internal and external factors for students (Wahyu et al., 2020). Internal factors, including motivation, interest, and self-efficacy, have strongly influenced students' scientific literacy. These three aspects are interrelated in an essential way in encouraging students in the learning process. Motivation provides the drive and energy needed to face learning challenges, while interest enriches the learning experience by generating a deep curiosity about science topics. Furthermore, self-efficacy, or belief in one's abilities, plays a crucial role in determining the extent to which students are engaged and successful in understanding science concepts (Aristeidou & Herodotou, 2020; Wen et al., 2020). With high motivation, interest and self-efficacy, students tend to be more motivated to learn, more active in seeking knowledge, and more confident in dealing with complex science material. Therefore, developing these internal factors is essential in increasing students' scientific literacy (Ke et al., 2021; Queiruga-Dios et al., 2020).

External factors, including classroom climate, learning quality, and parental support, significantly and positively impact students' scientific literacy. These three elements work in synergy to encourage students to become more energetic and active in participating in science learning (Chen et al., 2021). A positive and supportive classroom climate creates a fun and safe learning environment for students to feel comfortable expressing opinions and interacting with teachers and classmates (Saraswati et al., 2021; Suwono et al., 2022). The high quality of learning, with innovative teaching methods and relevant materials, also helps increase students' interest in science and encourages them to be more enthusiastic about learning (Atta et al., 2020; Rosana et al., 2020).

Although the research analysis results show that the variable parental support does not have a significant favourable influence on students' scientific literacy,

it is essential to recognize that parental support remains a significant external factor in forming a supportive learning environment (Pujawan et al., 2022). The support and encouragement provided by parents give students additional confidence and deep motivation to explore science further outside the school environment (Nida et al., 2020; Sholahuddin et al., 2023). The direct impact of the parental support variable may not be significant. However, the role of parents in providing moral support, motivation, and practical assistance in science learning should be addressed (Ayu et al., 2021; S.-Y. Huang et al., 2020). This support not only helps students face challenges and difficulties in learning but also forms a positive attitude towards learning and strengthens students' intrinsic motivation (Jampel et al., 2018).

Previous research (Bryan et al., 2011; P.-S. Huang et al., 2020; Lo et al., 2021) highlights the complexity of the determinants of students' scientific literacy abilities in the context of science learning. Various variables can influence students' scientific literacy, both internal and external, each with different aspects. Internal factors, such as motivation, interest, and self-efficacy, play a key role in determining how well students can master science concepts. Motivation encourages learning, interest enriches the learning experience with deep curiosity, and self-efficacy provides confidence in the student's success (Lestari & Rahmawati, 2020).

External factors also have a significant impact. Parental support and involvement, for example, can provide moral and practical encouragement to students and create an environment that supports learning at home (Keller et al., 2017b; Van Vo & Csapó, 2022). A positive classroom climate and high-quality learning can also influence students' motivation and interest in science. This research confirms that no single factor can fully explain students' scientific literacy. Instead, the interaction between these various internal and external factors provides a more complete picture of how students develop their scientific literacy skills (Darling-Hammond et al., 2020; Kutsyuruba et al., 2015). Educators can better understand these complexities and design more effective and sustainable learning strategies considering all aspects influencing students' scientific literacy abilities (Asano et al., 2021; Christina Ismaniati & Baroroh Iskhamdhanah, 2023; Primasari et al., 2020).

This research highlights the critical finding that internal factors, such as motivation, interest, and self-efficacy, and external factors, such as classroom climate, learning quality, and parental support, significantly shape students' literacy abilities (Harlen & Qualter, 2018; Shernoff et al., 2017). In science learning in elementary schools, the influence of these two types of factors is significant because they interact and reinforce each other, forming a solid foundation for the development of students' scientific literacy. With a better understanding of how these factors influence learning, a more holistic and focused approach can be taken to improve students' scientific literacy in the future.

Conclusion

This research confirms that students' scientific literacy abilities can be influenced positively and significantly by various factors, both internal and external. Internally, students' motivation, interest and self-efficacy are crucial in shaping their ability to understand and apply scientific concepts. On the other hand, external factors such as classroom climate, learning quality, and parental support also significantly contribute to students' scientific literacy. Science learning in elementary schools must be an effective forum for exploring and developing students' scientific literacy. In facing the challenges of the 21st century, scientific literacy abilities cannot be underestimated. Scientific literacy is essential for students to understand and apply scientific concepts in everyday life and adapt to ever-growing technological and information developments. With innovative and technology-based learning strategies, teachers can encourage students to think critically, creatively, and collaboratively. Learning that is interactive and relevant to the real world will help students develop the scientific skills they need to be successful in the future. With the proper support from the learning environment and family, students will be more motivated and confident in exploring the world of science, making them individuals who are scientifically literate and ready to face global challenges.

Research on students' scientific literacy skills in elementary schools needs to be expanded in scope to provide a more representative picture. This study only focuses on one area, namely Jakarta, Indonesia. By expanding the scope of the research area, the results obtained will better describe the actual conditions of students' scientific literacy skills in elementary schools in various regions. Further research is recommended to take samples from various areas, both urban and rural, as well as various provinces in Indonesia. The aim is to provide a more comprehensive understanding of students' scientific literacy skills in elementary schools in Indonesia. With a wider scope, it is hoped to provide a better and more accurate explanation of the variations in students' scientific literacy skills, as well as the factors that influence them in various geographical and social contexts.

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