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by Joko Siswanto

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The Barriers to Developing Students' Scientific Literacy in Learning Physics of Quantities and Measurements

Joko Siswanto*[1], Suyidno[2], Saiyidah Mahtari[2], Fitriyani[2], Winda Febriani[2], Era Sari[2]

[1]Universitas PGRI Semarang, Jl. Sidodadi Timur No. 24 Semarang, Jawa Tengah, Indonesia

[2]Universitas Lambung Mangkurat, Jl. Brigjen H. Hasan Basri, Pangeran, Banjarmasin Utara, Kota Banjarmasin, Kalimantan Selatan, Indonesia

*Email: jokosiswanto@upgris.ac.id

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Abstract. Teaching scientific literacy in schools is not easy, even though it is needed in education in the industrial era 4.0. This study aims to analyze the level of students' scientific literacy abilities and their obstacles at school. This research was conducted on class X high school students in Banjarmasin. The total sample of 60 students was taken using the cluster random sampling technique. Methods of data collection using tests and interviews. Data analysis using descriptive quantitative and qualitative. The results of the analysis show that the students' ability to explain phenomena scientifically, design and evaluate scientific inquiry, interpret data and scientific evidence in each school is not good (score < 40), except for explaining phenomena scientifically. in group 1 with good enough criteria (value = 52). The existence of these obstacles is believed to interfere with students' ability to understand scientific literacy. These obstacles stem from internal student factors (student readiness in STEM, process skills, conducting scientific investigations, and scientific projects) and are exacerbated by external factors, namely the readiness conditions of teachers and schools that do not support the development of scientific literacy.
Keywords: barriers, scientific literacy, physics learning

Introduction

The development of technological products and the nation's civilization is strongly influenced by the mastery of the scientific literacy of the people (Mawartiningsih & Zulaikha, 2021; Suwono et al., 2022). Scientific literacy skills are one of the skills needed in the 21st century. Scientific literacy has received significant attention in education (Salamon, 2007). A person must have scientific literacy skills in order to be able to live well, including using scientific information to determine the choices they face. In addition, scientific literacy has also become increasingly important in the workplace. More and more jobs are demanding high-level skills, requiring people who are able to learn, reason, think creatively, make decisions, and solve problems. Understanding science and its processes contribute in a special way with respect to these skills. Therefore, scientific literacy is the main goal of science learning in various parts of the world (Kite et al., 2021). Students must possess up-to-date science and technology literacy skills. In this case, scientific literacy is a determinant of the quality of education graduates which is a key factor to be able to face the opportunities and challenges in the industrial era 4.0 (Gusmaweti & May, 2021).

Many countries are investing heavily in creating societies that can work with scientific and technological literacy. This is done in order to be able to compete with other nations. Of course, the condition is that every citizen must have the same capabilities. Every citizen at various levels of education needs to have scientific literate knowledge, understanding, and abilities which is a necessity. Students cannot achieve high performance without the guidance of skilled and professional teachers, sufficient study time, space to move, and learning resources around them. All of this is inseparable from the support of the science education system. Learning with an emphasis on the scientific process is seen as providing more skills for students such as making observations, inferences, experimenting, and inquiry is the center or core of science learning. By conducting the inquiry, students describe objects and events, ask questions, construct explanations, test their explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by combining their knowledge with their reasoning and thinking skills.

Understanding of science and ability in science will increase students' capacity to hold important and productive jobs in the future. Students who have the knowledge to understand scientific facts and the relationship between science, technology, and society, and are able to apply their knowledge to solve real-life problems are called scientifically literate people (Bond, 1989). Scientific literacy is the ability to use knowledge to identify problems and draw conclusions based on evidence in order to understand and make decisions about nature and the changes made to nature through human activities. Scientific literacy is one of the skills needed in the 21st century. Scientific literacy is the ability to think scientifically and critically and to use scientific knowledge to develop decision-making skills. Scientific literacy means appreciation of science by increasing the learning component within oneself so that it can contribute to the social environment (Holbrook & Rannikmae, 2009). Based on this statement, scientific literacy has a broad meaning and everyone can contribute in providing explanations. There are two main groups that have views on scientific literacy. The first group views that the main component of scientific literacy is content understanding (basic concepts of science). Meanwhile, the second group views scientific literacy as being in line with the development of life skills, recognizing the need for reasoning skills in a social context. In addition, the second group also emphasizes that scientific literacy is intended for everyone, not just people who choose a career in science or are specialists in science (Holbrook & Rannikmae, 2009; Rychen & Salganik, 2003). Given the importance of scientific literacy, educating students to have scientific literacy is the main goal in any science education reform (DeBoer, 2000).

Science education is currently directed at preparing students to successfully live in the 21st century. Based on the previous explanation that one of the skills needed in the 21st century is scientific literacy and it is the foundation for everyday life (Gultepe & Kilic, 2015). This is actually nothing new in the world of education. However, in the last two decades it has become a major topic in every discussion regarding the goals of science education in schools. The literature in the field of science education also shows that scientific literacy is increasingly being accepted and valued by educators as an expected learning outcome or as one of the learning objectives that must be achieved, in particular, to equip students to be able to live and compete in their era.

Schools began to expand access to education in the 21st century, literacy was defined as learning to read, a set of technical skills that individuals will acquire once in a lifetime to process knowledge. For most individuals in the industrialized world, reading skill techniques can be widely recognized. However, the literacy requirement in question has shifted towards the ability to understand, identify, interpret, create, and communicate knowledge, using written materials in a variety of situations. These skills are a general requirement to be successful in the industrial world (Schleicher et al., 2010). One component that can be measured to access students' scientific literacy skills is access inquiry abilities. Scientific literacy ability can be known by measuring students' inquiry abilities (Wenning, 2006). The ability of inquiry means the ability to investigate. Scientific literacy is also related to knowledge and understanding of scientific concepts and processes needed by a person in decision making, community and cultural participation, and productivity. Scientific literacy states that one can identify national issues and decisions locally. A literate society will be able to evaluate the quality of scientific information on the basis of the sources and methods used for it. Scientific literacy can also express the capacity to evaluate arguments based on evidence and draw conclusions.

Scientific literacy is important for students to have because understanding it offers personal fulfillment and joy that can be shared with anyone, and their lives. require information and scientific thinking to make decisions. According to Zainuri (2022), scientific literacy is one of the most important skills needed by every individual to improve the quality of life and master the development of science and technology. Therefore, it is necessary to train scientific literacy students from an early age for the next generation in the future. One effort that can be done is to create learning that supports the creation of scientifically literate human resources. If students master it, they will be able to keep up with technological developments, be able to study other disciplines, and have opportunities to develop productive careers (Fausan et al., 2021; Yuenyong, 2013; Blyznyuk, 2019; Masriani et al., 2022).

Literacy is a complex skill consisting of science and technology as an effort to acquire knowledge and information (Ibda, 2018). Scientific literacy includes knowing nature and appreciating its unity; recognize some of the important ways in which mathematics, technology, and science depend on one another; understand some of the main concepts and principles of science; have the ability to think scientifically; know that science, mathematics, and technology are human endeavors, and know what their strengths and limitations are; and able to use scientific knowledge and ways of thinking for personal and social purposes (Laugsch, 2000; Salamon 2007; Babalola & Ogunkola, 2013).

The global community believes scientific literacy is a necessity for every human being who moves with the times. Literacy is a human right of every citizen and it is obligatory for the state to facilitate it, including Indonesia which has launched a literacy movement in schools (Masitoh, 2018). Literacy skills in science, language, and mathematics are a measure of the quality of a country's education (Permanasari et al., 2021). This program is organized by the program for international student assessment (PISA) through the organization for economic co-operation and development (OECD) to measure students' math, science, and reading literacy skills every three years. This PISA assessment is used as a reference and evaluation of the education quality of a participating country from PISA (participants in 2018 were 79 countries). Indonesia is one of the participants in the PISA assessment to find out the role of education in helping children to have math, science, and reading literacy in accordance with international community standards (Hewi & Shaleh, 2020; Sutrisna, 2021).

Scientific literacy skills have an important role in the success of the younger generation. The younger generation who have good scientific literacy skills will easily understand information both verbally and in writing (Budiarti, 2021; Jannah et al., 2021). In this case, mastery of scientific literacy really supports the development of the competence of the younger generation in their lives. The younger generation is becoming more proficient in selecting and sorting out information that supports a successful life and career in society (Puspita et al., 2021). Some literature shows that scientific literacy consists of several levels. The lowest level in practical scientific literacy is placing individuals as consumers of science and technology products to fulfill their basic needs of life in the form of food, health, and housing. While the highest level is decision-making skills in social life, culture, and economic growth (Narut & Supardi, 2019).

Students must understand the concepts and processes of science, as well as their use in solving problems of everyday life. Science literate students are expected to be able to: (1) appreciate and understand the impact of science and technology in everyday life; (2) make informed, personal decisions about matters involving science, such as health, and the use of energy resources; (3) read and understand the main points of media coverage on matters relating to science; (4) critically reflect on the information included in, and omitted from the report; and (5) taking part in discussions with others on issues involving science (Babalola & Ogunkola, 2013).

Scientific literacy is the capacity to use scientific knowledge, the ability to identify questions and draw conclusions based on scientific considerations so that problems regarding ethics, morals and global issues due to rapid changes in the field of science and technology can be resolved (Yuliati & Syahputra, 2019). A new generation that has positive thinking and a strong scientific attitude can be built by applying scientific literacy directly (Linder et al., 2014).

Scientific literacy uses scientific knowledge to identify questions and to draw evidence-based conclusions in terms of understanding and making decisions. There are 4 aspects that are assessed in scientific literacy, namely: (1) Aspects of the context of science, namely the assessment of the competence and knowledge of students in certain contexts/situations; (2) The competence aspect consists of explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically; (3) the knowledge aspect, namely the assessment of students' understanding of the main facts, concepts, and theories that form the basis of scientific knowledge; (4) Attitude aspects, showing interest in science, support for scientific inquiry, and motivation to act responsibly towards, for example, natural resources and the environment (OECD, 2013; Narut & Supriadi, 2019; Sutrisna, 2021).

The development of student literacy in Indonesia needs serious attention from the world of education due to the low PISA results from year to year. Indonesia is at level 74 out of 79 participants, so these results indicate that the quality of education in Indonesia is lower than in other PISA participating countries (OECD, 2013). This is supported by several previous studies which showed that the profile of scientific literacy skills of SMAN Sragen City students, in general, was still low (Bagasta et al., 2018). Science literacy skills of high school students in Kendari City obtained a percentage value of 50.85% in the low category (Erniwati et al., 2020), where the content value was 61.43 (good enough), the process value was 45.81 (low), and context value 45.32 (low). The scientific literacy of students in Sungai Penuh City is in a low category (Sutrisna, 2021). This is influenced by several factors, namely students' low interest in reading, evaluation tools that have not led to the development of scientific literacy, and the lack of mastery of teaching scientific literacy. Not only that, there are other inhibiting factors, namely the education system in schools, the selection of models, approaches, methods, learning strategies, learning resources, infrastructure, assessment, and evaluation that do not support scientific literacy (Aprilia et al., 2021). In this case, information about students' scientific literacy skills and their obstacles in school is very important for teachers in overcoming problems in the world of education. Therefore, the purpose of this study was to analyze students' scientific literacy skills and their barriers.

Methods

This research is classified as a descriptive study using a scientific literacy test and in-depth interviews. Through tests and in-depth interviews, more meaningful data will be obtained (Fraenkel & Wallen, 2009). The study was conducted on grade X students in two schools in Banjarmasin. The sample in group A was 44 students of class X in one of the SMAN Banjarmasin City who applied the driving curriculum and in group B were 26 students of class X of SMAN City of Banjarmasin who applied the 2013 curriculum. This sample selection used cluster random sampling. This technique was chosen because it is easier to do and apply so it does not take time (Fraenkel & Wallen, 2009).

The data collection method used in this research is through tests. The test instrument is prepared using aspects and indicators of scientific literacy competence consisting of (1) explaining phenomena scientifically: (a) remembering and applying appropriate scientific knowledge; (b) identifying, generating, and producing clear models and representations; (c) explain the potential implications of science for society; (2) explain the potential implications of science for society: evaluate ways of scientifically exploiting the questions given; (3) Interpreting data and evidence scientifically: (a) interpreting data and evidence scientifically; (b) analyze, interpret data and draw appropriate conclusions (OECD, 2012; Bybee, 2009). Learning is carried out for the material of magnitude and measurement. This test consists of 6 questions that have met the criteria of validity and reliability as a research instrument. In addition, in-depth interviews were conducted with several students to explore students' obstacles in learning scientific literacy at school, especially in learning physics.

The data on the results of the scientific literacy test were analyzed descriptively quantitatively, namely the student's answer scores were calculated using an assessment rubric. The total score obtained is divided by the maximum score multiplied by 100. The results obtained are then adjusted according to the assessment criteria: 100 ≥ very high > 85, 85 ≥ high > 70, 70 ≥ moderate > 55, and 55 ≥ low > 40, and 40 ≥ very low > 0 (Suyidno et al., 2020). Meanwhile, the data from the interviews were analyzed descriptively qualitatively, namely, the data collected, then reduced, processed, and presented.

Results and Discussion

In this research, scientific literacy tests were carried out on students and the results are presented in Table 1.

Table 1. The results of the student's scientific literacy competency test

Science Literacy Competence		The Score of Group A		The Score of Group B	
Aspect	Indicator	Indicator	Aspect	Indicator	Aspect
Explaining phenomena scientifically	Remembering and applying appropriate scientific knowledge	60.23		61.54	
	Identify, generate and produce clear models and representations	56.82	51.90 (Low)	34.62	37.18 (Very Low)

	Explain the potential implications of science for society	38.64		15.38	
Design and evaluate scientific inquiry	Evaluate how to scientifically exploit the given question	26.14	26.14 (Very Low)	21.15	21.15 (Very Low)
Interpret data and evidence scientifically	Interpret data and evidence scientifically	31.82	23.30 (Very Low)	30.77	17.31 (Very Low)
	Analyze, interpret data and draw appropriate conclusions	14.77		3.85	

Table 1 presents the results of students' scientific literacy competency tests in explaining phenomena scientifically, designing and evaluating scientific inquiries, and interpreting data and evidence scientifically. The ability of group A students in explaining scientific phenomena in the low category (score 51.90), design and evaluate scientific inquiries in the very low category (score 26.14), and interpret scientific data and evidence in the very low category (score 23.30). Meanwhile, group B's ability to explain scientific phenomena in the very low category (score 37.18), design and evaluate scientific inquiries in the very low category (score 21.15), and interpret scientific data and evidence in the very low category (score 17.31).

In group A, most of the students' knowledge was still at the level of remembering and explaining the right units for measuring water, followed by indicators of identifying, producing, and producing explicit models and representations. Students are able to determine how much water is needed to cook fluffier rice as indicated by the total scores per indicator obtained from both schools of 56.82 and 34.62 with sufficient and not very low categories, while indicators explain the potential implications of knowledge for the community. in groups A and B in the very low category. Thus, students can remember and explain better by connecting their knowledge with various other science concepts and applying them directly in everyday life. In this case, students have not been able to explain what measuring tools are used to cook rice according to their knowledge.

The ability to design and evaluate scientific investigations in groups A and B were 26.14 and 21.15, respectively, in the very low category. This means that students are not used to answering scientific literacy questions that require students to issue creative ideas in overcoming the problems posed. In this case, students' problem-solving skills are still lacking because students are not able to solve the problem of what measuring instrument is suitable for use by the seller to measure rice and the reasons why they choose the measuring instrument. The ability to interpret data and evidence scientifically is 31.82 and 30.77 with a very low category. In this case, students have difficulty interpreting the data by calculating the micrometer screw in the picture accompanied by scientific evidence on how to read the measurement results with a micrometer screw. The students' ability in analyzing, interpreting data, and drawing the right conclusions was 14.77 and 3.85 with very low categories. Students are not used to working on questions containing text or stories. Problems require students to analyze the problems around them. Students only work on questions in a simple form without requiring analysis to answer the question and provide conclusions on the results of the analysis that has been done. In this case, there are still many students who have not been able to read the measurement results with a caliper, then analyze the results of both bottle and coin measurements which then concludes.

Scientific literacy is one of the most important abilities needed by every individual to improve the quality of life and master the development of science and technology (Zainuri, 2022). Scientific literacy views the importance of thinking and acting skills which involve mastering thinking and using scientific thinking. Scientific literacy is important for students to understand the environment. In addition, it is necessary to deal with and keep up with increasingly sophisticated technological developments (Fausan et al., 2021), being the basis to study many other disciplines (Blyznyuk, 2019), and have a great opportunity to be involved in productive career (Yuenyong, 2013; Kamil et al., 2021). Therefore, measuring scientific literacy is important to determine the level of scientific literacy of students in order to achieve high or good scientific literacy so that the quality of education in Indonesia can improve and be able to compete with other countries. Seeing the test results presented in Table 1 shows that students' scientific literacy is still low. This reinforces the results of previous research, that the scientific literacy ability of high school students is still low (Fausan et al., 2021).

Table 2. Student 's scientific attitude

No	Indicator	Group A		Group B	
		Score	Category	Score	Category
1.	Support for scientific inquiry				
	a. Appreciate different views and scientific opinions (open-minded) to conduct investigations	56.34	Medium	57.12	Medium
	b. Support the use of factual information and rational explanation to avoid bias	42.22	Low	40.68	Low
	c. Demonstrate an understanding that a critical and careful process is required in drawing conclusions	44.62	Low	46.12	Low
	Average	47.72	Low	47.97	Low
2.	Self-confidence as a science learner				
	a. Confidence in dealing with difficulties in solving problems	54.34	Low	52.24	Low
	b. Confidence in demonstrating high scientific ability	57.12	Medium	59.68	Low
	c. Indicates curiosity about science, science issues and practicing science	62.36	Medium	60.12	Medium
	d. Demonstrate a desire to acquire additional scientific knowledge and expertise, using a variety of sources and scientific methods	55.82	Medium	55.22	Medium
	e. Demonstrate a desire to seek information and have an ongoing connection to science, including developing a science-related career	58.44	Medium	56.24	Medium
	Average	57.61	Medium	56.7	Medium
3.	Responsibility for resources and the environment				

a. Demonstrate a sense of personal responsibility to care for the environment	62.24	Medium	61.68	Medium
b. Shows concern for the consequences of human activities on the environment	50.88	Low	49.88	Low
c. Shows a desire to take part in natural resource conservation activities	40.58	Low	46.28	Low
Average	51.23	Low	52.61	Low
Average student 's scientific attitude	52,19	Low	52.42	Low

Table 2 presents the science attitude scores of students in groups A and B, which are 52.19 and 52.42 on average in the low category. The support for scientific inquiry indicator score for group A is 47.72 in the low category and group B the average score is 47.97 in the low category. The self-confidence as a science learner indicator score for group A is 57.61 in the medium category and group B the average score is 56.70 in the medium category. The responsibility for resources and the environment indicator score for group A is 51.23 in the low category and group B the average score is 52.61 in the low category. In learning physics, it is necessary to increase scientific literacy and students' scientific attitude. If it can be realized, it will support the achievement of student learning outcomes. There is an increase in students' scientific literacy after learning with the information search strategy even though it is in the low category (Wakhidah et al., 2022). In addition, students can also use STEM-based student worksheets (Arrohman et al., 2022).

As has been revealed by many experts that the physics learning process includes 3 dimensions, namely scientific attitude, scientific process, and scientific product. Based on these three dimensions, learning is not only about acquiring knowledge, but also training students' reasoning skills through literacy as part of the science dimension. The low ability of students' scientific literacy (Table 1), may be due to the limited ability to convey ideas or thoughts in writing. This is in accordance with the factors that cause students' low scientific literacy including the selection of textbooks, misconceptions, non-contextual learning, and students' reading ability, the ability to convey ideas, reasoning abilities, misconceptions, learning environment and climate, school infrastructure, human resources and school management (Fuadi et al., 2020; Suparya et al., 2022)

The results showed that students' scientific attitudes were still low (Table 2) and students' scientific literacy was also low (Table 1). Scientific literacy is closely related to scientific inquiry. In scientific investigations, proper description, explanation and prediction skills are needed (Siswanto et al., 2018). In addition, the process of description, explanation and prediction requires a scientific attitude. Scientific attitude will control the process and results of scientific investigations. Scientific attitudes affect students' scientific literacy skills. Competence in scientific literacy domains will have a better insight into students' scientific literacy levels (Fadilah et al., 2020; Henukh et al., 2021; Noor, 2021).

The low ability of students' scientific literacy can be due to obstacles that interfere with students' learning of scientific literacy. In the learning process, to be able to achieve goals in learning students are often faced with obstacles that can affect the implementation of the learning process and have an impact on learning outcomes. There are 3 factors that cause learning barriers, namely tactical barriers (due to teacher teaching), ontogeny barriers (mental readiness to learn), and epistemological barriers (student knowledge that has a limited application context (Brosseau, 1997). Barriers to learning scientific literacy in this study were identified based on the results of the interview the results of the interview on student learning barriers in learning scientific literacy are presented in Figure 1.

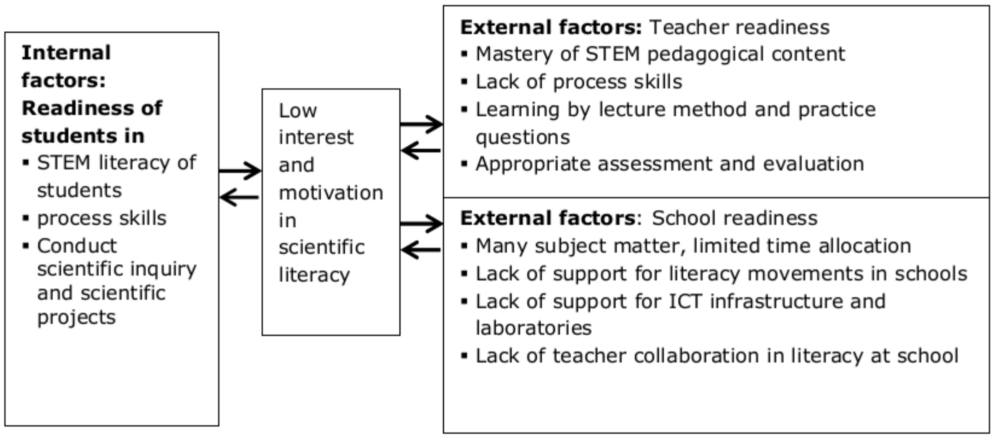

Figure 1. The Barriers in Learning Scientific Literacy

Based on Figure 1, although scientific literacy skills are very important for students to master, they feel that learning scientific literacy is not easy. Students experience obstacles while learning scientific literacy that comes from internal factors (in students themselves). This is in accordance with the cognitive theory that when students come to school, they already have initial knowledge and initial skills, including scientific literacy (Moreno, 2010). However, in reality, the initial ability of scientific literacy and process skills is in the category of not yet good or very low. This condition will directly or indirectly affect students' interest and motivation in scientific literacy. This condition is exacerbated by obstacles from external factors, namely the readiness of teachers and schools. Not all teachers master the pedagogical content of scientific and mathematical literacy well, especially technological and engineering literacy, which is known by the abbreviation STEM. Supposedly through STEM literacy, students are not only equipped with the fields of science and mathematics but also the use of technology and product engineering to strengthen students mastery of scientific literacy.

In learning scientific literacy, science process skills can be considered in determining the assistance that will be provided by the teacher to students. It can be a scaffold. Scaffolding is giving some assistance to students during the early stages of learning, then reducing assistance and providing opportunities to assume greater responsibility after they are able to do so (Moreno, 2010; Siswanto et al., 2018). Scaffolding is assistance given to students to learn and solve problems in learning. This assistance can be in the form of instructions, encouragement, warnings, describing problems into solving steps, giving examples, and other actions that enable students to learn independently. In addition, teachers also need knowledge and understanding of scientific literacy skills in order to design learning that aims to train scientific literacy skills.

Based on Table 1 and Figure 1, the scientific literacy competence of group A is higher than group B. The application of the driving school curriculum places more emphasis on habituation of scientific literacy and student-centered learning, while schools implementing the 2013 curriculum have too much science material, less time allocation so that teachers apply more teacher-centered learning, are accustomed to lecture methods and practice questions, and tend to avoid scientific inquiry and science projects. In addition, learning in group B, the teacher only delivers teaching materials by E-learning on the Google Classroom application and is confirmed using Google Meet. Students are still fixated on the material in the textbooks used and do not use other learning resources. Meanwhile, learning in group A was more interesting for students. They are accustomed to studying the provided textbooks accompanied by learning videos, then the teacher gives instructions to students to study teaching materials (from existing teaching materials and provided learning videos) as well as other teaching materials on the internet in accordance with their competence and learning objectives.

Scientific literacy in both schools for aspects of scientific literacy competence, namely designing and evaluating scientific investigations by interpreting data and scientific evidence, is low because interest in reading and repeating learning material is still a factor causing students' low scientific literacy. In addition, it is influenced by the teacher's knowledge of scientific literacy so that it does not facilitate or direct learning that can increase scientific literacy. This reinforces the results of previous research that low scientific literacy can be caused by passive learning that does not facilitate or direct students in planning good problem solving or investigation (Bellová et al., 2017).

The teacher's understanding in developing scientific literacy is by providing opportunities for students to read the teaching materials provided and then ask questions about the material that they have not understood (Salamon, 2007; Sari & Nurwahyunani, 2017; Sutrisna, 2021). Scientific literacy is not only reading and understanding material but also applying scientific knowledge in various situations and is associated with students' problems in everyday life (Narut & Supriadi, 2019; Yuliati & Saputra, 2019; Kusuma & Fatih'Adna, 2021). In addition, students are not familiar with scientific literacy questions so students feel awkward with questions that are different from what teachers usually give at school (Sumanik et al., 2021). The habit of memorizing subject matter makes students less understanding and applying science material in everyday life (Huryah et al., 2017; Putri, 2021; Putri, 2022). Assessments and evaluations that do not meet the PISA criteria result in learning outcomes that do not meet the scientific literacy criteria set by PISA (OECD, 2013). In addition, assessment questions are usually in the form of multiple choices and do not involve students' reasoning in solving the questions given (Babalola & Ogunkola., 2013; Sumanik et al., 2021), a proper assessment model is needed according to PISA in order to increase scientific literacy (Rosana et al., 2020). In addition, this condition is exacerbated by the lack of STEM content readiness and pedagogic teachers, low scientific attitudes, low stakeholder support, minimal use of technology in learning and not involving students in scientific inquiry, let alone scientific projects (Talukder, 2021).

Conclusion

Based on research data and discussion, it can be concluded that students' scientific literacy skills are classified as low. The low scientific literacy ability is caused by obstacles in its development, namely: (1) student internal factors, which consist of student readiness in STEM, process skills, conducting scientific investigations, and scientific projects; (2) external factors, consisting of teacher readiness and school readiness. Teacher readiness is related to mastery of STEM pedagogical content, low process skills, learning using the lecture method and practice questions, assessment and evaluation. School readiness is related to the large number of subject matter, limited time allocation, low support for literacy movements in schools, low support for ICT and laboratory infrastructure, and lack of teacher cooperation in literacy in schools.

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