

# Initial Ability Of Students' Science Literacy On Optical Material In Senior High School

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## ABSTRACT

Science literacy is one of the keys to facing today's era development. The importance of science literacy ability makes Indonesia take part in assessments conducted by international institutions. Based on the report of the international study conducted by PISA, it shows that the literacy of science from students in Indonesia is still lack and far from the average international score. The research purpose to reveal the initial literacy of science from students on the material of optical devices in senior high school. This research method used a descriptive with an approach in quantitative with a sample of 31 students in senior high school. The research results shown that the average value literacy of science from students in the aspects of context, competence, and knowledge aspects is still lack. The context aspect research results on personal, local, and global indicators obtained average scores of 47.75, 18.27, and 25.68. While the competency aspect on indicators of give explanation for phenomena of science, making evaluation and design for research, and making interpretation data and evidence of scientific obtained an average value of 28.57, 32.04, and 29.08, while the knowledge aspect on content, procedural, and epistemic indicators obtained an average value of 42.67, 32, and 16.53. Overall, the average student score is 30.58 which is categorized as low. Thus, there is a need for learning designs that apply science knowledge in life that can improve science literacy ability and assessment instruments to evaluate related science literacy ability.

**Keywords:** Initial Ability; Optical material; Science Literacy.



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## I. INTRODUCTION

Science literacy is one of the keys to facing the development of today's era. Various activities in daily life are related to science, so it is important to train science literacy ability. Science literacy, in particular, can aid in the creation of mindsets and attitudes, as well as the development of human character to care for and be responsible for themselves, society, and the cosmos, as well as the problems encountered by a model society that is heavily reliant on technology [1]. Science literacy is considered to be a key competency that is very important to build human welfare at any time both now and in the future [2].

According to the Program for International Student Assessment (PISA), science literacy is a person's skills as a reflective citizen to engage with scientific-related topics and the concept of science. A person who has science literacy is willing to engage in scientific and technological reasoning discourse, which necessitates the ability to explain phenomena scientifically, evaluate and design scientific research, and interpret data and evidence scientifically [3]. Science literacy based of PISA 2015 have four interrelated aspects, namely context, competence, attitude, and knowledge. Science literacy based of PISA 2015 can be defined based on the four interrelated aspects as shown in Table 1.

**Table 1.** The literacy of science assessment framework aspect based of PISA 2015

Contexts	Personal, local/national, and global challenges, both current and historical, necessitate knowledge of science and technology.
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Knowledge	An comprehension of the fundamental facts, concepts, and explanatory hypotheses that underpin scientific knowledge. Knowledge of nature and technical artifacts (content knowledge), knowledge of how such ideas are formed (procedural knowledge), and a comprehension of the reasons underlying these procedures and justifications for them are all examples of such knowledge. use (epistemic knowledge).
Competencies	The ability to scientifically explain events, analyze and design scientific investigations, and scientifically interpret data and evidence.
Attitudes	A collection of attitudes toward science characterized by an interest in science and technology, understanding of the scientific method of investigation, and awareness of environmental issues.

(Source: [4])

The relationship between the four aspects literacy of science ability is shown in Figure 1.

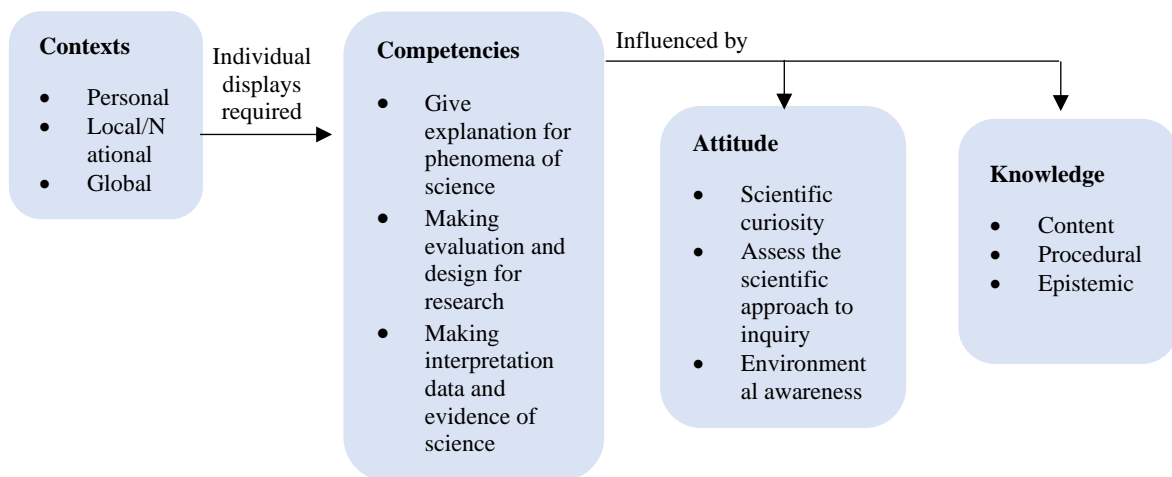


Fig 1. The relationship between the four aspects of science literacy [4].

Science literacy is critical for everyone to learn since it is strongly tied to how a person understands problems associated to the environment and difficulties related to modern society's life, which is heavily reliant on the advancement of science and technology, as well as social concerns [5]. The importance of science literacy skills makes Indonesia take part in assessments conducted by international institutions. Based on the international study report conducted by PISA, the literacy of science assessment is more than just a measurement of the level of understanding of scientific knowledge; it is also a measurement of students' understanding of various aspects of the scientific process, as well as their ability to apply scientific knowledge and processes in real-world situations faced by students as individuals, members of society, and citizens. [6]. The PISA assessment not only determines whether students can construct knowledge, but also how well students can extrapolate from what they have learned and apply that information both inside and outside of school [7]. Based on PISA data in 2018, Indonesia have rank 70th from 78 country although a literacy of science value is 396. We can shown that the literacy science from students in Indonesia is still lack and still far from the average international score [8].

In the education world, science literacy has a extremely crucial role because it can produce quality students, reliable, and able to compete with the international world. Science literacy is a basic ability that students must have in science learning, one of which is in physics learning [9]. Physics learning is a learning process that finds out about natural phenomena and events that occur in everyday life [10]. The physics learning objectives contained in the 2013 curriculum framework are related to science literacy, which provides direct experience to students to train their ability to link physics concepts with natural phenomena around them [11]. Physics subjects describe all of nature's occurrences, so the problems associated with physics we often encounter in life. Thus the role of physics learning purpose to prepare students to master physics information, concepts, and principles, as well as scientific skills and skills in process of science [12].

The nature of physics informs good physics learning; students must master the process and products of physics. Physics products in this case include theories, principles, laws, and others. While the process is how the product can be found further in applying these products in everyday life [13]. In this case, it means that Physics does not simply include theories and formulas to be memorized but physics also contains concepts that must be

understood in depth. Therefore, students learning physics must be able to build their knowledge while taking an active role in the process of learning [14].

In physics learning, science literacy has an important role. This is because science literacy can support physics learning, for example in finding problems and exploring sources to solve problems. In addition, science literacy also improves students' ability to understand physics in terms of concepts, principles, and applications of physics in industry and other fields [10]. Therefore, We require a method of instruction that can equip students to have good competency and scientific and technology literacy, as well as the ability to think logically, critically, creatively, appropriately argue, communicate, and interact. Science literacy is defined as the ability to understand science, communicate science (oral and written), and apply science skills to solve problems in such a way that they have a positive attitude and are sensitive to themselves and their surroundings when making scientific decisions [15].

Physics is a challenging subject to grasp. One of the physics materials that are considered difficult by students is optical equipment material. Based on research conducted by Mulyani in 2020 [16], shows that one of the most difficult physics materials for students to understand is optical devices. This shown by the mastery of optical equipment material percentage in the 2018 UN in Aceh, student scores for the school level 35.33%, for the city/district level 37.42%, provincial level 34.33%, and national level 40.61% [16]. In addition, research conducted by Ainiyah, Yuliati, and Parno in 2020 also shows that optical equipment material is challenging subject to grasp. In this material students also have difficulty in conducting experiments on optical devices, researching optical devices in and out of the classroom, comprehending the use of optical device materials in daily life, making diagrams of the course of light on the reflection and refraction of light and in solving problems mathematically [17].

This research purpose to analyze the initial literacy of science ability from students on optical devices in senior high school. This initial analysis is very important for it can be used as a guideline and reference for teachers in designing activities of learning that can improve literacy of science ability from students, especially the material of optical devices. In addition, with the initial analysis in this study, a student picture who have high and low literacy of science ability can be obtained.

## II. METHOD

This research used a method in descriptive although an approach in quantitative. Research with this method is used to explain the situation under study with the support of literature studies so that the results obtained are made based on research analysis supported by literature studies [18]. The research was carried out during the even semester of the 2023/2024 school year at the senior high school. The sample in this research was 31 of class 11 in senior high school students. The use of instrument in the research is a test instrument literacy of science ability from students in the aspects of context, competence, and knowledge. This instrument is in the form of essay questions totaling 10 questions on the material of optical devices. The instrument used was taken from Sayari's research question instrument in 2022 with a reliability value of 0.91 which is categorized as having very high-reliability criteria and has been declared fit for use [19].

The techniques for data collection used in the research were conducted by distributing questions directly to class 11 in senior high school students. After the data is obtained from the test that has been scored then converted into values. The conversion of scores into grades can use the learning outcome value formula [20]. The science literacy scores obtained were then interpreted using criteria such as Table 2.

**Table 2. Science literacy achievement criteria**

No	Value Range	Criteria
1	67 - 100	High
2	33 - 66	Medium
3	<33	Low

(Source: [21])

## III. RESULTS AND DISCUSSION

The initial literacy of science ability from students was conducted by giving a written test in the form of description questions. This test question uses Sayari's 2022 research question instrument which has been declared suitable for use in research [19]. The test questions used include aspects of context, competence, and knowledge of optical equipment material. This test question is made based on indicators or aspects of the PISA

framework [4]. The profile of the instrument for assessing students' initial science literacy on optical equipment material shown in Table 3.

**Table 3.** Profile of students' initial science literacy assessment instrument

Indicator	Science Literacy Skills		
	Context	Competence	Knowledge
Explaining the potential involvement of knowledge about eyewear in society	Global	Explaining scientific phenomena	Procedural
Propose a way to investigate questions about cameras scientifically	Global	Evaluate and design scientific research	Procedural
Provide reasons that support or reject a formulation of conclusions regarding Camera	Local	Evaluate and design scientific research	Procedural
Designing a simple Lup	Personal	Evaluate and design scientific research	Procedural
Analyze and interpret data for draw the right conclusions about the lupus	Personal	Interpret data and evidence scientific	Content
Recall and apply knowledge about microscopes according to specific situations	Global	Explaining scientific phenomena	Content
Propose a way to investigate questions about microscopy in a scientific manner	Personal	Evaluate and design scientific research	Content
Choosing alternative conclusions based on evidence science about microscopy	Global	Interpret data and evidence scientific	Epistemic
Provide reasons that support or rejects a formulation of conclusions about binoculars	Personal	Interpret data and scientific evidence	Content
Propose a way to investigate scientific question about binoculars	Local	Evaluate and design scientific research	Epistemic

Based on the table, the questions used to determine the initial literacy of science ability from students are questions that cover aspects of context, competence, and knowledge based on PISA 2015. The questions in the literacy of science instrument are on aspects related to individuals or groups of individuals (personal), the scope of the community (local), and the scope of the world (global). In the competency aspect, the questions used consist of give explanation for phenomena of science, making evaluation and design for research in science, and making interpretation scientific data and evidence. Meanwhile, the knowledge aspect have content, procedural, and epistemic.

The initial ability of students' science literacy is important to know because based on the initial picture obtained can help teachers in designing the process of learning. This is in line with Rizkita, Suwuno, and Susilo's research that initial studies can be used to determine learning strategies that can affect science literacy [22]. This research is also supported by Palennari, Safitri, and Arifin's research that the profile of initial literacy of science ability can provide an overview literacy of science ability so that it is necessary to maximize the use of learning strategies capable of training literacy of science ability from students [23]. The answers results to the literacy of science test questions on optical equipment material shown in the table which broadcasts the average student value and the value received by students in response to questions according to literacy of science indicators.

1. Context Aspect

Literacy of science ability from students in the context aspect shown in Table 4.

**Table 4.** Students' science literacy skills in the context aspect

Contextual Aspect Science Literacy Indicators	Maximum Average Score	Average Score	Value
Personal	4	1,91	47,75
Local	7,50	1,37	18,27
Global	4,75	1,22	25,68
Mean	5,42	1,5	30,57

The analysis results from Table 4 show that the category of science literacy ability of high school students in the context aspect of personal indicators is in the medium category, while local and global indicators are in the category in low. The average literacy of science ability from students is more dominant in personal indicators with a value of 47.75. This shown that students tend to understand contextual problems that are close to their surrounding environment. Overall the average value of the context aspect is

30.57 which is categorized as low. Permatasari and Fitriza said, The low level of science literacy in the context element indicates that students have not been able to apply what they have learnt in their daily lives [24]. This research is also related to research of Nofiana's that the lack of context emerges because school curriculum tends to apply more content than its application [25].

## 2. Competency Aspect

Literacy of science ability from students in the competency aspect shown in Table 5.

**Table 5.** Students' science literacy skills in the competency aspect

Science Literacy Indicators Competency Aspects	Maximum Average Score	Average Score	Value
Explaining scientific phenomena	3,50	1	28,57
Evaluate and design research	5,40	1,73	32,04
Interpret data and scientific evidence	5,33	1,55	29,08
Mean	4,74	1,43	29,90

The analysis results from Table 5 show that the category of science literacy ability of high school students in the competency aspect on all indicators is in the category in low. However, the average literacy of science ability from students is more dominant in the indicator of evaluating and designing research with a value of 32.04. This shows students' tendency to understand questions that require investigation and exploration related to scientific research. Overall the average value of the competency aspect is 29.90 which is categorized as low. Permatasari and Fitriza said, the low literacy of science ability in the competency aspect is because learning in schools generally does not emphasize the process [24]. The results of this study are supported by Nofiana, the low literacy of science ability in the competency aspect is due to the process of learning which is still a transfer of knowledge and less emphasis on the scientific process [25].

## 3. Knowledge Aspect

Literacy of science ability from students in the knowledge aspect shown in Table 6.

**Table 6:** Students' science literacy skills in the knowledge aspect

Knowledge Aspect Science Literacy Indicators	Maximum Average Score	Average Score	Value
Content	3,75	1,60	42,67
Procedural	5,00	1,60	32
Epistemic	7,50	1,24	16,53
Mean	5,42	1,48	30,40

The analysis results from Table 6 show that the category of science literacy ability of high school students in the knowledge aspect of the content indicator is in the medium category, while the procedural and epistemic indicators are in the low category. The average literacy of science ability from students is more dominant in the content indicator with a value of 42.67. This shown the tendency of students to understand knowledge that is relevant to real-life situations. Where the problems given are interrelated between the theory in learning and everyday life situations. Overall the average value of the knowledge aspect is 30.40 which is categorized as low. According to Fauziyah, Prasetyaningsih, and Biru, the low knowledge aspect of science literacy shows that students have not properly grasped concepts, facts, and ideas regarding natural events that occur in their surroundings, as well as scientific research [26]. This is supported by Pantiwati and Husamah's research that the lack literacy of science ability in this aspect of knowledge is due to the process of learning which is facts that must be memorized continue to dominate [27].

Based on the data analysis results obtained, literacy of science ability from students in the aspects of context, competence, and knowledge is still still lack. This shown by the average score obtained of 30.58. The lack initial literacy of science ability from students is due to the lack of maximum application of science knowledge in everyday life. This is relevan with Zainab's research that the low initial literacy of scientific ability from students is because students have less training in dealing with challenges caused by the features literacy of scientific [28]. Then, Angraini's research states that students' low science literacy ability is due to subject matter them are not used to working on science literacy questions, and the learning method does not support them in improving literacy of science ability from students [29]. According to Sustrisna, students' low science literacy ability is also caused by activities of learning that were not oriented toward developing science literacy [21]

This research has been done as much as possible, but there are still obstacles to conducting this research. The obstacles encountered in conducting research are limited time in conducting science literacy tests. To

overcome this obstacle is by asking permission from the next hour's teacher to add physics learning hours at that time.

#### IV. CONCLUSION

The research results shown that the average value of the initial of literacy of science ability of high school students on the optical devices material is 30.58 which is categorized as low. The research results can be used as a reference for further research. Therefore, It is essential to have a learning design that applies science knowledge in life that can increase literacy of science ability and assessment instruments to evaluate related science literacy ability.

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