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Preliminary Research of Students' Science Literacy on Linear Motion to Design Interactive Multimedia Based on Cognitive Conflict

Willy Octavia[1], Fatni Mufit[2*]

[1,2]Department of Physics, Padang State University, Jl. Prof. Dr. Hamka Air Tawar Padang 25131, Indonesia.

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Correspondence
Email : fatni_mufit@fmipa.unp.ac.id

Phone :

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ABSTRACT

One of the most important ability in the 21st century is scientific literacy. Having good scientific literacy can apply scientific knowledge and problem solving in real life. This study aimed to measure students' preliminary scientific ability in physics, particularly regarding the topic of linear motion. This research employed a quantitative descriptive method with a sample of 28 students from grade XI. Data collection techniques were carried out using questionnaires to teachers and a science literacy test in the form of 10 graded multiple-choice questions. The outcomes from the teacher survey evaluation regarding the use of learning models, namely 54% direct learning, 20% project-based learning models, and 26% other learning models. Furthermore, the use of teaching materials, namely 40% textbooks, 40% student worksheet, and 20% digital teaching materials. The analysis results of students' scientific literacy ability in physics, specifically on the topic of straight motion, indicated that the context aspect scored 44.9%, which falls under the "very low" category. Similarly, the content aspect scored 39.3%, the competency aspect 35.9%, and the attitude aspect 54%, all of which were also categorized as "very low." Overall, the average scientific literacy level in the linear motion material was determined to be in the "very low" category

INTRODUCTION

Education today operates within the 21st century, a period commonly identified as the era of the Fourth Industrial Revolution. Rapid advancements in science and technology characterize this age (Hartono, 2023). In this situation, empowering pupils is the primary objective of education with the knowledge and ability needed to face the changes that continue to take place along with the development of the times (Sutrisna, 2021). Thus, education does not only focus on mastering information, but also on developing abilities that support students' readiness to adapt to global challenges and innovations that continue to emerge (Li, 2020).

Scientific literacy is one of the key ability essential for success in the 21st century (Utama et al., 2019). Students that possess a high degree of scientific literacy are able to solve issues, think critically, understand scientific concepts, and base their conclusions on scientific evidence. (Pratiwi et al., 2019). Students who have good scientific literacy can apply scientific knowledge in everyday life, such as in understanding news about health or the environment (Getman, 2021). In addition, they can be more sensitive to global issues, such as climate change and public health, and have a greater responsibility to contribute to overcoming these problems (Rosidi, 2021). These scientific literacy ability are very important so that students do not only become consumers of information, but also become active and critical individuals in society (Aruta, 2023). Strong scientific literacy empowers students to play an active, responsible, and critical role in addressing global issues in society.

According to the OECD (2016), The ability to use scientific knowledge to interact with the outside world is known as scientific literacy. This includes the capacity to identify scientific questions, make decisions regarding natural phenomena and the effects of human activity, and draw conclusions based on empirical data (Sahyar, 2020). In addition to comprehending scientific theories, scientific literacy also entails having the critical and analytical thinking ability necessary to solve problems pertaining to science on a daily basis (Wulandari, 2021). This ability is essential for addressing global issues like public health, climate change, and technological advancements. The PISA, organized by the OECD, regularly measures students' scientific literacy in various countries. Based on the 2022 PISA survey, Indonesia was placed 63rd among 81 countries that took part, achieving an average score of 383 in science literacy. This score indicates that Indonesia remains in a comparatively low rank compared to other nations that took part in PISA (Andi, 2023). This ranking places Indonesia in the bottom group in terms of science literacy ability, reflecting significant challenges in science education in the country.

This low PISA score indicates that most students in Indonesia still have difficulty in applying scientific knowledge to solve complex problems, especially those related to environmental issues and natural changes (Coppi, 2023). In addition, students in Indonesia are not yet completely capable of analyzing scientific data critically and use scientific evidence as a basis for decision making (Saparini, 2024). Factors such as less interactive learning methods, limited access to quality teaching materials, and lack of science literacy-based learning are some of the causes of low science literacy in Indonesia. This highlights the need for more innovative educational strategies that promote active learning and develop critical thinking skills to better equip students for real-life challenges.

Assessment in measuring scientific literacy ability, there are four aspects, namely 1) Context aspect, namely personal, social, and global; 2) Competence aspect, interpreting data and evidence scientifically, evaluating and designing scientific investigations, and namely explaining phenomena scientifically; 3) Content aspect, namely physical systems, earth, life systems and space systems and technology systems; 4) Attitude aspect, namely related to increasing scientific research, self-confidence, interest in science, and being responsible for the environment (OECD, 2016). The connection between these four aspects is crucial, as the context aspect presents real-life scenarios that allow students to showcase their competencies. Students' ability to demonstrate these competencies is shaped by their attitudes and their foundational understanding of scientific concepts. Scientific literacy emphasizes the importance of being able to think critically and take action to effectively use scientific knowledge in recognizing and addressing social issues (OECD, 2019).

Physics is a branch of science that requires deep understanding because it involves not only conceptual understanding, but also the use of various visual representations such as images and symbols, as well as mathematical equations that are the main tools in describing and analyzing natural phenomena (Pangestu et al., 2018). The combination of conceptual visualization, the use of physics symbols, and the application of mathematics makes physics a complex discipline, where understanding is not only theoretical, but also requires high analytical ability to solve problems through a quantitative approach (Vlasova, 2022). Therefore, scientific literacy in physics is a very important skill for students to master (Sartika, 2023). Scientific literacy regarding physics involves more than simply grasping fundamental ideas, but also includes the ability to interpret symbols, connect physical phenomena with mathematical representations, and apply these principles to address problems encountered in daily life (Morgacheva, 2023). Scientific literacy is essential for developing students' critical, creative thinking ability and analytical, enabling them to answer physics questions in the classroom, but can also connect physics theory with real situations, such as understanding vehicle movement, the behavior of falling objects, or the application of technology in modern life (Ustun, 2022).

The linear motion is one of the physics topics that is highly pertinent to the development of science literacy. Linear motion which includes concepts such as speed, acceleration, and distance traveled, is an ideal example of how physics concepts can be connected to everyday experiences. For example, the concept of acceleration can be applied in understanding how motor vehicles accelerate, while the concept of speed is used to describe how fast an object moves from one point to another. Through understanding the material of linear motion, students not only learn to master physics formulas, but are also trained to think scientifically in analyzing everyday events related to motion. By strengthening scientific literacy in physics, especially in the material of linear motion, students can develop ability to translate real-world events into physics models, analyze motion data using scientific methods, and solve problems that require the application of physics equations. This not only helps them to understand physics lessons better, but also provides important provisions in facing greater challenges in the future , both in the academic world and in everyday life which is full of the application of physics-based technology (Altun, 2021).

Analysis of low scientific literacy ability in the topic of linear motion is further backed by literature studies. In a study conducted by Adani et al. (2018) stated that the percentage of the average value of scientific literacy in linear motion material was 58.5% which is still categorized as low. In addition, Mukharomah et al. (2021) It was also noted that students' scientific literacy in physics, specifically in the kinematics of linear motion, was 57.5%, which falls within the "low" achievement category. This indicates that many students struggle to connect theoretical concepts with practical applications in linear motion, reflecting a gap in their ability to apply scientific knowledge effectively.

One of the factors contributing to the low level of scientific literacy among students is the teaching materials and learning models that are being used (You, 2022). Although teachers have tried to use various types of teaching materials, the results are often not effective enough in improving students' scientific literacy ability. This may be due to the insufficient alignment between the material taught and the needs and interests of students, so that the learning process cannot encourage deep understanding (Çelik, 2024). Using engaging learning materials can help increase students' interest, understanding, feelings, thoughts, imagination, and motivation for learning (Wahab et al., 2021). Positive attitudes from students during lessons can be improved with interactive teaching materials, one example being interactive multimedia. Interactive multimedia is combines images, animations, videos, and sounds in a way that allows students to interact directly, making the lessons more interesting (Kurniawati & Nita, 2018). By offering attractive content, interactive multimedia can reduce the boredom students feel from repetitive lessons, improve their academic performance, and make them more active and motivated during class (Septian, 2019).

The learning model used also affects the level of students' scientific literacy. Although teachers have tried to implement various learning models, the results have not shown a significant increase in students' scientific literacy ability. Learning models that do not facilitate active interaction and critical discussion can hinder students' understanding of science concepts (Indrawati & Sunarti, 2018). Without sufficient interaction, students may have difficulty connecting the knowledge taught to real contexts. Therefore, it is important to evaluate the learning model used so that it can be more appropriate to students' needs, so that it can improve scientific literacy effectively. One effective learning model is the cognitive conflict-based learning model. The implementation of cognitive conflict-based learning can provide opportunities for students to play an active role during the learning process, either by discovering or seeking information regarding theories and concepts, as well as drawing conclusions from the material being studied (Wiranata et al., 2016).

The goal of this study is to analyze students' scientific literacy in physics concerning the material on linear motion. With this analysis, we can obtain useful information to enhance the quality of education and find the right solution. The results of this study are expected to provide guidance for improving scientific literacy in physics, particularly in the area of linear motion.

METHODS

This research is a survey study employing a quantitative descriptive approach. The study aims to measure students' preliminary scientific ability and the implementation of learning strategies that support the enhancement of students' scientific literacy in linear motion material. This study used a sample consisting of 28 students at SMAN 3 Bukittinggi. Data collection was conducted using both questionnaires and tests. The questionnaire was distributed to teachers to assess the implementation of ongoing lessons. The teacher observation questionnaire included 5 statement indicators: the use of teaching models, identification of students' scientific literacy, utilization of teaching materials and media, conducting experiments, and the use of supporting facilities and equipment related to linear motion material. Meanwhile, scientific literacy skills were evaluated through a test consisting of 10 multiple-choice options on linear motion material, focusing on scientific literacy, which were distributed to students. In this study, the aspects of scientific literacy assessed included the context, competency, content, and attitude aspects. (OECD, 2019) .

The final stage of this research is data analysis. The data taken were teacher observation questionnaire data and test result data given to students. The outcomes of the teacher questionnaire were analyzed using the percentage technique with equation 1.

$$Value = \frac{\text{Score obtained}}{\text{Maximum score}}\ x\ 100 \qquad (1)$$

According to the analysis of the data from the teacher questionnaires using percentage techniques, the results obtained can be categorized as in table 1.

Table 1. Value Interpretation Categories

Category	Hose (%)
Very good	80 - 100
Good	61 - 80
Enough	41 - 60
Not good	21 - 40
Very Poor	0 - 20

(Riduwan, 2012)

Student mastery is assessed based on the number of correct and incorrect responses for each question item attempted. The score obtained by students is calculated based on a percentage technique such as equation 2.

$$\text{Score (\%)} = \frac{\textit{The number of correct answers for each indicator}}{\textit{Number of students}}\ x\ 100 \qquad (2)$$

After all the data has been examined based on the aspects of scientific literacy, the next step is to categorize the results of students' scientific literacy proficiency and draw conclusions according to the criteria presented in Table 2.

Table 2. Category for Assessing Students' Scientific Literacy Ability

Category	Mastery Interval
Very high	86-100
Tall	76-85
Currently	60-75
Low	55-59
Very Low	<54

(Purwanto, 2010)

RESULTS AND DISCUSSION

Results

The scientific literacy assessments given to students include 10 multiple-choice questions of varying levels, all related to real-world issues. These questions are delivered in the form of a passage or text, followed by questions that require students to answer based on their comprehension of the material. Analysis of students' scientific literacy aims to demonstrate their ability to understand scientific concepts and apply knowledge in real-life contexts. After the test was conducted, it turned out that the science literacy skills of students at SMAN 3 Bukittinggi were still relatively low. This has an impact on their ability to actively participate in scientific discussions and evidence-based decision-making.

According to OECD (2016) , the assessment of scientific literacy skills involves four interrelated aspects, that are context aspect, competency aspect, content aspect and attitude aspect. The context aspect helps students understand life situations related to global or national issues involving science and technology. Students are expected to realize the importance of science in improving the quality of life. The indicators applied in the scientific literacy questions are personal, national and global. The results of assessing the context aspect in the scientific literacy test results are presented in Table 3

Table 3. Context Indicators in Straight Line Motion Material

No.	Indicator	Question Number	Percentage (%)
1.	Personal	1,2 and 5	33
2.	National	3, 4 and 6	60
3.	Global	7, 8, 9 and 10	42
	Average		**44.9**

Referring to Table 3 above, it is evident that the average student proficiency in physics scientific literacy across all context aspects is 44.9%, which falls within the "very low" achievement category. The personal context indicator occupies the lowest position compared to other indicators with a percentage of 33%. This shows that students' understanding of applying physics concepts in personal life is still very limited. Next, the global context indicator of 42% in the "very low" achievement category, indicating that students are not fully able to relate physics concepts to global phenomena. Meanwhile, the national context indicator of 60% in the "moderate" achievement category, suggesting that students are fairly capable of connecting physics concepts to situations or conditions within the country. This data highlights the need for more targeted interventions to improve students' scientific literacy across all contexts.

The content aspect includes knowledge relevant to understanding real situations. Students are expected to comprehend natural phenomena and the changes that result from human activities. The indicators applied in the scientific literacy questions are the concept of relative motion, GLB, uniformly accelerated linear motion (GLBB), GLBB, vertical motion (GLBB), and motion classification (GLB, accelerated GLBB, and decelerated GLBB). The results of assessing the conten aspect in the scientific literacy test results are presented in Table 4.

Table 4. Content Indicators in Straight Line Motion Material

No.	Indicator	Question Number	Percentage (%)
1.	The concept of relative motion	1	11
2.	Uniform linear motion	2 and 4	80
3.	Uniformly accelerated linear motion graph	3	14
4.	Accelerated linear motion	5 and 6	46
5.	Vertical motion	7 and 8	80
6.	Classification of uniform linear motion, accelerated linear motion, and decelerated linear motion	9 and 10	4
	Average		**39.3**

Referring to Table 4 above, it is clear that the average student proficiency in physics scientific literacy across all content aspects is 39.3%, placing it in the "very low" achievement category. The content indicators for uniform linear motion and uniformly accelerated motion occupy the highest positions compared to other indicators, with a percentage of 80%. This indicates that students have a good understanding of the basic concepts of linear motion and uniformly accelerated motion. However, the content indicator for uniformly accelerated motion only reaches 46%, which is still in the "very low" achievement category. This is followed by the accelerated linear motion graph indicator, which is only 14%, the concept of relative motion at 11%, and the motion classification indicator with the lowest percentage, 4%, all of which are in the "very low" achievement category. This shows that students' understanding of more complex topics, such as relative motion and motion classification, is still very limited.

The competency aspect is fundamental to the definition of scientific literacy, as it includes the scientific ability necessary to understand, apply, and solve problems based on scientific knowledge. The indicators applied in the scientific literacy questions are interpreting data and evidence scientifically, evaluating and designing scientific investigations, and explaining phenomena scientifically. The results of assessing the competency aspect in the scientific literacy test results are presented in Table 5.

Table 5. Competency Indicators in Straight Line Motion Material

No.	Indicator	Question Number	Percentage (%)
1.	Explaining phenomena scientifically	1, 4, 6, 9 and 10	67
2.	Evaluating and designing scientific investigations	2, 7 and 8	11
3.	Interpreting data and evidence scientifically	3 and 5	30
	Average		**35.9**

Referring to Table 5 above, it is evident that the average student proficiency in physics scientific literacy across all competency aspects is 35.9%, which falls within the "very low" achievement category. Among the different indicators, the ability to evaluate and design scientific investigations is the lowest, with only 11% of students demonstrating proficiency in this area. Next, the ability to interpret data and scientific evidence is at 30%, also falling within the "very low" category. However, the ability to explain scientific phenomena is higher at 67%, which falls under the "moderate" achievement category. This indicates that while students struggle with certain aspects of scientific literacy, they have a somewhat better understanding when it comes to explaining basic phenomena.

The attitude aspect is an important part of scientific literacy. It is anticipated that students will develop an awareness of scientific issues and be able to apply scientific and technological knowledge for personal, societal, and global purposes. The indicators applied in the scientific literacy questions are support for scientific investigation, responsibility for the environment and interest in science and technology. The results of assessing the attitude aspect in the scientific literacy test results are presented in Table 6.

Table 6. Attitude Indicators in Straight Line Motion Material

No.	Indicator	Question Number	Percentage (%)
1.	Interest in science	1, 4, 6, and 9	65
2.	Support for scientific research	2, 3, 5, 7 and 8	22
3.	Responsibility for the environment	10	75
	Average		**54**

Referring to Table 6 above, it is clear that the average student proficiency in physics scientific literacy across all attitude aspects is 54%, which falls within the "very low" achievement category. This suggests that students have a limited understanding of the attitudes required for scientific literacy. Among the different indicators, the ability to support scientific investigations is the weakest, with only 22% of students demonstrating proficiency in this area. This indicates that students are not very engaged in or supportive of scientific inquiry. The indicator of interest in science shows a higher percentage at 65%, placing it in the "moderate" achievement category, suggesting that some students are interested in science but still need further encouragement. Similarly, the indicator of responsibility for the environment has a percentage of 75%, also in the "moderate" category, showing that students have a somewhat better sense of environmental responsibility. These findings indicate that while students show some positive attitudes towards science and the environment, their overall engagement with scientific investigations remains quite limited.

The use of models and teaching materials used by teachers can also influence students' literacy levels. This is shown from the results of the analysis of teaching materials and teacher models, as shown in Table 7.

Table 7. Analysis of Learning Models and Teaching Materials Used by Teachers

No.	Indicator		Percentage (%)
1.	Learning model	Direct Learning	56
		Project	20
		Other	24
2.	Teaching materials	Textbook	40
		Worksheet	40
		Digital	20

Referring to Table 7 above, it can be observed that teachers predominantly use direct instruction learning models, accounting for 56%. This results in learning tending to be boring and students only listen to the teacher's explanation. Other learning models used by teachers as much as 24% are discovery learning and project based learning is only around 20% used in learning. It can also be seen in the selection of teaching materials, teachers more often use printed textbooks by 40% and student worksheet by 40% in learning.

Discussion

Based on the results of preliminary research, findings reveal that students' science literacy ability are generally low, with varying levels of achievement across different aspects. In the context aspect, students show moderate ability to relate physics concepts to national issues, but face significant difficulties in connecting these concepts to personal and global contexts. This suggests the need for instructional strategies that integrate physics concepts with real-life applications at the personal and global levels. In the content aspect, students demonstrate better understanding of basic concepts such as uniform linear motion and vertical motion, but their comprehension of more advanced topics like relative motion and motion classification is limited. This highlights the importance of addressing gaps in students' understanding of more complex physics topics. The competency aspect reveals that students struggle significantly in interpreting data and designing scientific investigations. These deficiencies indicate the necessity of approaches that focus on fostering inquiry-based learning to strengthen critical thinking and scientific reasoning. In terms of attitudes aspect, students show moderate levels of interest in science and environmental responsibility, but their support for scientific investigations is weak. This points to the need for strategies that encourage active participation in science through exploration and hands-on experiments.

Research by Dhanil & Mufit (2023) and Putri & Mufit (2023) aligns with these findings, showing that students' science literacy proficiency in the context, content, and competency aspects averages below 36%, which is categorized as low. This indicates that students face challenges in understanding scientific concepts and applying them to real-world situations. Additionally, Saparini (2024) notes that the low ability of physics science literacy in students can be caused by many factors, one of which is that students are not used to solving physics problems based on science literacy. This shows that during the learning process, teachers tend to provide less adequate services and guidance to students in working on physics problems, so that students are not used to solving problems that require science literacy skills.

Learning models and teaching materials also play an important role. Although teachers have implemented various learning models, these models have not been able to train scientific literacy skills significantly. This shows that although there are variations in learning approaches, deeper innovation is still needed in selecting and implementing learning strategies that not only focus on basic cognitive aspects but also on developing more complex scientific literacy skills, such as understanding context, critical analysis, and the ability to connect scientific concepts with real situations. According to Indrawati & Sunarti (2018), such models tend to focus on passive learning, where students memorize information without engaging deeply with the material. This limits their ability to critically analyze and apply scientific ideas in real-world contexts.

The selection of teaching materials is quite important because it can help increase students' desire to learn. The use of teaching materials that can trigger students' interest in solving problems and arouse their curiosity is one effective way to develop science process skills which are an important part of the scientific literacy competency aspect (Nurwulandari, 2018) . Although teachers have utilized various teaching materials such as textbooks and Student Worksheets, these teaching materials are not adequate to support learning that focuses on developing students' scientific literacy.

These factors certainly need to be minimized. Improvement efforts that can be made include providing more interactive and interesting teaching materials, and implementing more effective learning models to train students' scientific literacy. The use of teaching materials equipped with animated videos, simulations, and presentations that combine visual elements with relevant physics concepts can be one solution to help students improve their literacy skills in straight motion material more comprehensively. According to Novitasari et al. (2024), the combination of multimedia elements such as text, audio, images, video, and animation can convey information in an engaging and interactive way, helping students better understand the material. It also aims to improve students' scientific literacy skills in evaluating and designing scientific investigations.

The role of teachers is also very crucial in shaping students' scientific literacy skills. Teachers who do not train students to work on scientific literacy-based questions or problems cause students to not have the habit of dealing with problems related to scientific literacy. This habit is important for honing critical thinking skills and understanding science concepts in depth (Hidayah et al., 2019) . The demands to complete lesson materials according to curriculum targets often result in teachers focusing more on delivering information than ensuring deep understanding. This causes students to only memorize physics concepts without really understanding them, which can ultimately lead to misconceptions or erroneous understanding of the concept. This situation also results in concepts being easily forgotten because there is no reinforcement through problem solving and application in real contexts (Fuadi et al., 2020) . In improving physics science literacy, it is necessary to change the learning approach that does not only focus on delivering material, but also emphasizes the importance of guidance, scientific literacy-based practice questions, and the development of problem-solving skills and science processes. This is expected to build a deeper understanding and prevent misconceptions.

CONCLUSION

According to the data analysis, it was found that the indicator for the context aspect was 44.9%, placing it in the very low category; the content aspect was 39.3%, also in the very low category; the competency aspect was 35.9%, classified as very low; and the attitude aspect reached 54%, still in the very low category. In general, the average scientific literacy of students in the topic of linear motion is considered very low. The overall low scientific literacy in physics may be influenced by several factors, such as the teaching materials and learning models, which have not been effective in developing scientific literacy ability. Therefore, improving students' scientific literacy is crucial by creating teaching materials that incorporate learning models designed to enhance these ability.

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