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Initial Analysis of Students' Scientific Literacy on Dynamics of Particle Motion

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ABSTRACT

One of the most important abilities in the 21st century is scientific literacy. This research is to analyze students' initial physics science literacy abilities in the dynamics of particle motion. The research method used was descriptive quantitative with a sample of 30 students of class XI phase F.7 at SMAN 2 Solok. Data processing is obtained from two categories, namely student tests and teacher questionnaires. From the results of the student test analysis, the indicator for explaining phenomena scientifically is 61% in the "medium" category, the indicator for interpreting data and scientific evidence is 30% in the "very low" category and the indicator for evaluating and designing scientific investigations is 17% in the category “very low”. The overall average in the category of achievement of students' scientific literacy skills is 36% in the "very low" category. The results of the teacher questionnaire on the aspect of the teacher's use of learning models are 26% in the "Rarely" category, the aspect of identifying students' scientific literacy in the material on the dynamics of particle motion is 44% in the "sometimes" category, the aspect of the use of teaching materials and digital learning media is 26% in the "Rarely" category, aspects of carrying out experiments on the dynamics of particle motion, namely 3% in the "Never" category and aspects of the use of facilities and equipment, namely 21% in the "sometimes" category. Based on these results, it can trigger students' low scientific literacy abilities.

Keywords: *Scientific Literacy, Dynamics of Particle Motion, Plomp model*

I. INTRODUCTION

Education is a top priority for someone to gain broad knowledge and be able to answer and solve various problems around them [1]. Basically, education does not only hone academic abilities but also trains physical and mental maturity in facing several challenges in the 21st century [2]. Education is the first step in preparing quality students through the learning process and mature physical and mental development [3]. One of the most important abilities in the 21st century is scientific literacy. Therefore, schools need to improve students' science abilities [4]. This is due to the fact that it is intrinsically linked to students' capacity to comprehend the technologically shaped and scientifically underpinned environmental, health, and economic challenges that contemporary society confronts [5]. Scientific literacy in the independent curriculum helps teachers to develop student-centered learning methods [6].

One definition of scientific literacy is "the capacity to understand and make informed decisions about issues pertaining to nature and the changes that occur in it as a result of human activities by drawing on one's own knowledge of relevant scientific concepts, theories, and research" [7]. In light of the findings from the PISA survey from the year 2022, Indonesia was ranked 63rd out of 81 countries, followed by 383 points [8]. Based on the previous description, it shows that Indonesia is in the lower group among other countries that participated in PISA [9]. Assessment in measuring scientific literacy skills, there are four aspects, namely 1) Context aspects, namely personal, social, and global; 2) Competence aspects, namely explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically; 3) Elements of content, including systems of matter, systems of life, systems of the planet and space, and systems of technology; 4) Attitude aspects, namely those related to increasing scientific research, self-confidence, interest in science, and being responsible for the environment [10].

Physics is a field of science that requires in-depth understanding because it involves many images, symbols and mathematical equations to describe natural phenomena [11]. Therefore, scientific literacy is needed to improve understanding and application in everyday life. One of the physics materials included in scientific literacy is the dynamics of particle motion [12]. Dynamics of particle motion particles are one of the physics materials with difficult concepts, this triggers the low ability of students to connect the theory of particle motion dynamics with applications in everyday life [13]. This problem is certainly related to the level of students' scientific literacy skills in particle motion dynamics material [14].where scientific literacy itself is the ability to understand, apply and communicate material scientifically both in written and oral form so as to improve students' problem-solving abilities [15].

Analysis of low scientific literacy in the material of particle motion dynamics is supported by analysis of literature studies. In research conducted by History and Wisdom in the research of [16] shows that out of 19 students, 63% of students are categorized as still low. In addition, menurut [17] also stated that 41% of students are categorized as having low scientific literacy.

One of the causes of students' low scientific literacy regarding particle motion is the lack of learning models, materials and proof-of-concept practices carried out by teachers during the learning process [18]. Although teachers have tried to use various models and teaching materials, they have not provided effective results [19]. This is because students are less motivated because the learning provided is less in accordance with their needs and the material so that the learning process that takes place is unable to encourage deep understanding for students [20]. In addition, teaching materials that are not conceptual and do not apply experiments in learning can trigger low scientific literacy in particle motion dynamics material, especially in Newton's laws [21]. Without sufficient interaction, students will find it difficult to connect the material taught with real phenomena. Therefore, it is important to adjust and evaluate the models and teaching materials used by teachers to effectively improve students' scientific literacy skills [22].

This study aims to analyze students' physics science literacy skills on the material of Particle Motion Dynamics. With this analysis, useful information can be obtained to improve the quality of education and find the right solution. The results of this study are expected to be used as a guide in efforts to improve physics science literacy skills on the material of particle motion dynamics.

II. METHOD

The type of research used is observational research and journal analysis which is the initial stage of development research. This research uses the plomp model. The plomp model consists of 3 stages including: (1) preliminary research, namely needs analysis and literature review, (2) development or prototyping phase, namely the stage of designing products and revising prototypes, (3) assessment stage, namely the testing phase and evaluation of practice.

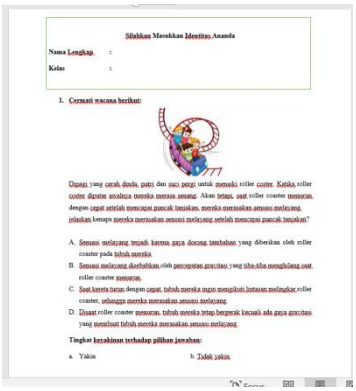
In the initial stage, researchers collected information about the implementation of learning at SMAN 2 Solok carried out by teachers and students, especially regarding the dynamics of particle motion. In addition, the researcher also analyzed journals related to the level of students' scientific literacy abilities that occurred in the material of particle motion dynamics. The stages of the preliminary research were by distributing questionnaires and tests. The distribution of questionnaires was given to teachers. The questionnaire consisted of several questions related to several aspects, namely: (1) the use of learning models in the material of particle motion dynamics, (2) Identification of students' scientific literacy in the material of particle motion dynamics, (3) Use of teaching materials and learning media in the material of particle motion dynamics, (4) Implementation of experiments in the material of particle motion dynamics and (5) Use of supporting facilities and equipment, with 5 answer categories in table 1 as follows.

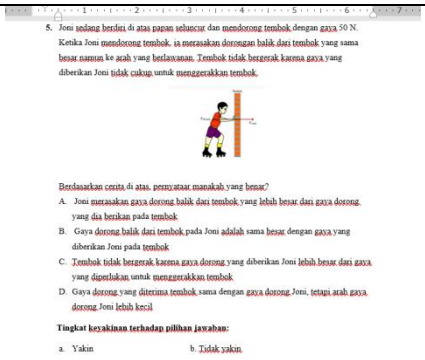
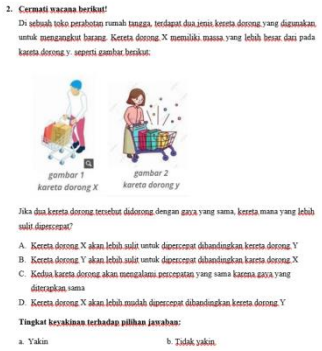
Table 1. Teacher Questionnaire Answer Categories

Evaluation	Answer categories
1	Never did as stated (0%-20%)
2	Rarely do as stated (21%-40%)
3	Sometimes does as stated (0%-20%)
4	Often do as stated 61%-80%
5	Always make statements (81%-100%)

Students were also given a 10-question test based on scientific literacy that included topics related to particle motion dynamics. The competence component of scientific literacy was the focus of this research. The competency element includes indicators such as: (1) providing a scientific explanation of a phenomenon; (2) assessing and planning a scientific research; and (3) providing a scientific interpretation of facts and evidence [23]. Table 2 contains a grid of questions designed to test students' scientific literacy as they relate to the topic of particle motion dynamics.

Table 2. Grid of scientific literacy questions on the material on particle motion dynamics

Competency Aspects	No question	Question indicator
Explaining phenomena scientifically	1	Given a discourse about roller coaster games, students determine the law of inertia in the body that occurs when the roller coaster is at its peak. 
	3	Given a discourse about Mr. Yusuf's family going on vacation using a car, students determine the position of objects on the car when the car is braked.
	6	Given a discourse about fishermen on a boat, students are asked to determine the actions and reactions between the boat and the water.
	9	Students are asked to determine the force acting on the bicycle and what makes it stop.
Evaluating and designing scientific investigations	4	Given a problem about throwing 3 balls of different types (ignoring air friction), students are asked to guess which ball will fall first if the ball is thrown from the same height and at the same time?
	5	Presented with a discourse about someone pushing a wall, students are asked to choose the correct statement according to the picture shown.

		
	10	Presented with a discourse about dropping 2 blocks with different masses from the same height and time, and students are asked to guess which object will reach the ground first?
Interpreting data and evidence scientifically		Given that 2 strollers (X and Y) have different masses, students determine which stroller is difficult to accelerate.
	2	
	7	Given a statement about two types of toy cars with different masses being pushed at the same time, students determine which vehicle is faster.
	8	Given a discourse on the Experiment of observing the movement of two toy cars. Students are asked to determine the condition of the cars when they collide.

The final stage of this research is data analysis. In data analysis, the data taken are statement data from the questionnaire answers given by the teacher and the results of the test questions given to students. A student's proficiency score is calculated based on the number of correct and incorrect answers for each question answered. The scores obtained by students are calculated based on the equation technique such as equation 1:

$$\text{Score (\%)} = \frac{\textbf{\textit{Maximum Score}}}{\textbf{\textit{Number of Students}}} \text{x } 100$$

After all data is analyzed based on the aspects of scientific literacy competency. The next step is to group the results of students' mastery of scientific literacy and conclude based on the criteria presented in table 3.

Table 3. Criteria for assessing students' scientific literacy skills

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

III. RESULTS AND DISCUSSION

Results

Based on the analysis of the questionnaire that was given to teachers at SMAN 2 Solok, several problems that triggered low scientific literacy in students were revealed, some of which are listed in Table 4.

Table 4. Implementation of learning carried out by teachers (in the material on particle motion dynamics)

No	Question aspects	Evaluation	Answer categories
1	Use of innovative learning models	26%	Seldom
2.	Identification of students' scientific literacy in the material on particle motion dynamics	44 %	Sometimes
2.	use of teaching materials and digital learning media	26%	Seldom
3.	Experiment implementation	3%	Never
4.	Use of supporting facilities and equipment	21%	Seldom

Table 4 shows that teachers use innovative learning models for particle motion dynamics material only occasionally, even rarely. Open materials and digital learning media for particle motion dynamics material are still conventional, such as textbooks, ppt, and most recently only LKPD and E-modules. No experiments were carried out on the dynamics of particle motion, in order to decipher scientific proof and data. There is an impact on pupils' scientific literacy as a result of this circumstance.

In addition, the analysis of student needs also revealed problems with students' scientific literacy. Of the 30 students, 67% of students thought that the material on particle motion dynamics was one of the materials with difficult concepts to learn so that every test question given was only sometimes read carefully by students. In addition, 60% of students were not interested in the teaching materials and learning media provided by the teacher. And 60% of students also understood better the learning explained using ppt media equipped with images, videos and audio. However, the available PPT media only contained material concepts in the form of writing and mathematical equations. However, sometimes some supporting images were added, even though they were quite rare.

Students' lack of proficiency in locating scientific concepts is exacerbated by this problem. Capabilities in data presentation, experimentation, and explanation are the building blocks of basic scientific literacy [7]. Students are presented with ten graded multiple-choice questions that pertain to real-world issues and assess their scientific literacy. These questions are presented in the form of discourse or text that is equipped with statements that must be answered based on students' understanding of the discourse. Table 5 shows the indicators of the scientific literacy competency aspects as follows:

T**able 5.** Students' scientific literacy skills

No	Competency aspect indicator	Results (%)	Category
1.	Explaining Phenomena Scientifically	61	Currently
2.	Evaluating and designing scientific investigations	17	Very low
3.	Interpreting data and evidence scientifically	30	Very low
	Students' scientific literacy skills	36	Very low

Based on table 5, it can be seen that students' physics science literacy skills in the overall competency aspect are 30% in the "very low" achievement category among the three competency aspect indicators, the higher result is the indicator explaining phenomena scientifically 61% in the "moderate" achievement category. In addition, 30% of students came up in the "very low" achievement area when it came to understanding facts and scientific evidence. However, 17% of students fall into the "very low" achievement level when it comes to assessing and developing scientific projects.

Discussion

The low level of physics science literacy among students is caused by various factors, one of which is the students' unfamiliarity in solving physics problems that contain students' science literacy [24]. This shows that during the learning process, teachers do not provide adequate services and guidance to students in working on physics problems, so that students are not used to facing problems that require science literacy skills [25]. Apart from that, students' inability to keep up with developments in the surrounding environment is another factor that contributes to students' low scientific literacy. Observing phenomena that occur in everyday life is the same as that. Applying scientific knowledge by dissecting happenings based on ideas, principles, theories, laws, and facts [26]. Thus, students do not have the literacy skills needed to address issues in the actual world [27].

Teachers play a crucial role in addressing pupils' lack of scientific literacy by imparting this knowledge to them. According to [28], teachers have the power to impart methods and stimulation through the media and educational materials they utilize. Having said that, in actuality, educators solely focus on enhancing the learning results for their students. According to [29], they fail to prioritize the explanation of scientific phenomena that are relevant to the student's context. Due to the lack of reinforcement through problem-solving and real-world application, the concepts taught are readily forgotten [30].

So, to improve students' physics literacy, teachers must change the way they teach. They should not only concentrate on improving student learning outcomes, but also provide adequate guidance and assistance to solve physics problems. Students must also critically view events in their environment that relate to physics literacy, and they must have sufficient teaching materials to encourage them. Therefore, a teaching material design is needed with a learning model that trains students' science literacy skills in the hope of improving their science literacy skills in the material on particle motion dynamics.

IV. CONCLUSION

Based on data analysis conducted at SMA N 2 Solok, In terms of competence, the findings revealed that pupils' scientific literacy levels were the lowest.Seventeen percent are deemed to have a "very low" level of scientific interpretation of facts and evidence. Among the many factors that cause students to fail in understanding physics, including the models used and the teaching materials used, efforts need to be made to improve students' ability to understand and understand the dynamics of particle motion.

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