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[Research Article]

ANALYSIS OF SCIENCE LITERACY ABILITY OF HIGH SCHOOL STUDENTS ON WORK AND ENERGY CONCEPT

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ABSTRACT

This study aims to determine the scientific literacy ability of class XI IPA students at SMAN 3 Kota Cilegon on the concept of work and energy. The method of the research used the descriptive quantitative method. The subjects of this study consisted of 145 students of class XI IPA. The research instrument used was a written test in the form of a description. Data analysis to find out the level of the student's scientific literacy ability is done by giving them a raw score first on the whole question. The raw scores acquired by the students are then changed into percentages. The results of this study found that the scientific literacy ability of class XI IPA students in the three domains of context, competencies, and knowledge was 51,76% with a very low category, then in the domain of attitudes got a percentage of 66,95% with a good attitude category. This study can help physics teachers measure the scientific literacy ability of students, so the information gained from this study can become an evaluation and an improvement in the study of physics at school.

Keywords: *Scientific literacy, framework PISA 2015, work and energy*

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1. INTRODUCTION

The development of the current era has entered the 21st Century, which shows that many changes and developments are getting faster and more complex with the aim that the quality of life of modern society can improve (Pratiwi et al., 2019). In addition, the 21st Century offers a life without borders. Technology is developing very rapidly, and globalization, so the dissemination of information will be wider, which will have an impact on the country, especially in the economic, cultural, educational, and political fields (Turiman et al., 2012). In the 21st Century, it demands quality human resources so that they can respond to various challenges and changes that occur quickly. The formation of quality human resources can be done through professional institutions so as to produce superior human resources in their fields. One example of the development of the 21st Century that has now begun to emerge is some jobs that are replaced by machines or robots (Wijaya et al., 2016).

Along with the rapid progress of the times, the current education system must also be able to provide the 21st-century skills that students need. This is due to the increasingly tight challenges of social life in facing global life (Pratiwi et al., 2019). In addition, the educational system must have a targeted vision and mission to create up-to-date education that is capable of changing times. Education has become one of the important needs in the surrounding community and can be used as an investment tool in improving the quality of individuals (Rawung et al., 2021).

According to the World Economic Forum, 16 abilities must be possessed in the 21st Century that are divided into three categories, namely foundational literacies, competencies, and character qualities. Basic literacy explains how students can apply their various abilities in everyday life. The abilities included in this category are numeracy literacy, science literacy, ICT literacy, financial literacy, financial literacy, and finance. The competency category describes how students approach solving complex challenges. There are four abilities included in this category, namely critical thinking, creativity, communication, and collaboration. Character qualities describe how students approach or respond to changes in their environment. In this category, there are six abilities, namely curiosity, initiative, persistence, adaptability, leadership, and socio-cultural awareness. Based on these 16 abilities, science literacy is included in one of the abilities that students must have in the 21st Century, namely basic literacy. Literacy explains how learners apply their various abilities in daily life (World Economic Forum, 2015).

Currently, several international studies are believed to be instruments to test global competencies, one of which is PISA. The Programme for International Student Assessment (PISA) is a program that aims to monitor the results of the education system in terms of student achievement through an internationally agreed framework. PISA is organized by the Organization for Economic Co-operation and Development (OECD), and its implementation is carried out every three years. PISA assesses the extent to which 15-year-old learners who are nearing the end of their compulsory education have acquired knowledge and skills essential for full participation in modern society (OECD, 2017). PISA does not only assess how students express the knowledge they have. Moreover, assesses how students analyze and apply their knowledge within the school environment and outside (Pusat Penilaian Pendidikan Balitbang Kemendikbud, 2018).

Indonesia has been participating in PISA since 2000, and every implementation of PISA has the main domain. In PISA 2006 and 2015, science literacy became the main domain. There have been several changes in PISA 2006, namely that the "aspect of scientific knowledge" has been divided into two components, namely procedural knowledge and epistemic knowledge. In addition, the aspect of support for the scientific inquiry has been changed to assess the scientific approach to the activities of the investigation. Then, in the context aspects that were originally in PISA 2006, namely personal, social, and global, it has been changed to personal, local/national, and global. In the PISA 2015 framework, there is a development

to assess collaborative problem-solving (OECD, 2017).

Science literacy comes from two combinations of Latin words: literatus and Scientia. The word literatus means literate or educated, while Scientia means knowing. Science literacy is a person's ability to understand science, communicate, and apply it in everyday life. Moreover, it can also overcome problems in everyday life with the concept of science (Toharudin, Uus; Hendrawati, 2011). According to KBBI, scientific literacy is the ability to understand natural and social phenomena as well as the ability to make scientifically correct decisions to be able to live more comfortably, healthily, and well (Pusat Perbukuan, 2023)

According to the 2015 PISA framework, science literacy is a platform to engage with science issues, and scientific ideas, as a reflective citizen. Seseorang yang melek sains bersedia terlibat dengan hal – hal yang berkaitan dengan sains dan teknologi, yang mana membutuhkan kompetensi menjelaskan fenomena secara ilmiah, merancang dan mengevaluasi penelitian secara ilmiah, dan menginterpretasikan data dan memberi bukti secara ilmiah (OECD, 2017). PISA not only assesses the knowledge of learners but reflects knowledge and experience on the problems of daily life (Lie & Kjærnsl, 2007). According to John D. Miller, Science literacy is a concept of the level of understanding of science and technology needed by citizens in modern industrial society (Miller, 2002).

Based on the 2015 PISA framework, science literacy has four domains, namely context, competencies, knowledge, and attitudes. The scope of context in PISA 2015 consists of health and disease, natural resources, environmental quality, hazards, and the limits of science and technology. Then, the domain of competence consists of three aspects necessary for scientific literacy, namely explaining phenomena scientifically, designing and evaluating research, interpreting data, and providing scientific evidence. In this domain of knowledge, there are three types of knowledge, namely content knowledge, procedural knowledge, and epistemic knowledge. In the 2015 PISA assessment, there were three areas evaluated related to students' attitudes toward science. These attitudes include an interest in science and technology, environmental awareness, and assessing the scientific approach to inquiry (OECD, 2017)

Scientific literacy skills are important for students because they can form human resources who are literate in science so that they can answer various challenges or changes that are accelerating caused by advances in science, technology, and biotechnology (Anelli, 2011). In addition, with science literacy, students are expected to have sensitivity in solving global problems such as environmental, health, and economic problems. This is because the understanding of science offers solutions to these problems (Yuliati, 2017). Science literacy skills are used as the ability to provide a broad understanding of science and rapidly developing scientific developments (DeBoer, 2000).

Physically, work can be defined as something that manifests due to a force on an object that causes the object to move a certain distance (Giancoli, 2014). Mathematically, the work for constant force can be written as follows:

$$W = \mathbf{F} \cdot \mathbf{s}$$

If an object is located on a flat area with a force ***F*** that forms an angle to a horizontal angle, the object moves as far as ***s*** (see Figure 1).

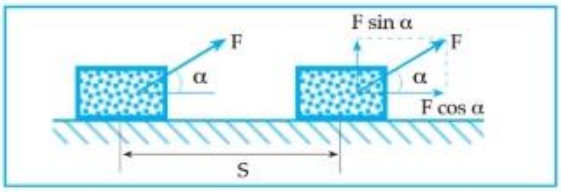

Figure 1. An object located in a flat area with F force and moves as far as s

Then, the work can be written as follows:

$$W = F \cdot s \cos \alpha$$

Work can be zero if the displacement is zero or the object does not move when forced. In addition, the work can be zero if the force

exerted is perpendicular to its displacement (Abdullah, 2016).

Energy is an important part of daily life. Energy has various meanings, but the energy in question is related to work. Energy can then be defined as a measure of the changes given to a system. If a force exerts an act on an object, then energy can be transferred to that object (Bueche, Frederick J; Hecht, 2006).

Based on the First Law of Thermodynamics (conservation of energy), energy cannot be created or destroyed but can change from one form to another. Thus, energy can be realized in various forms, namely thermal energy, mechanical energy, chemical energy, electromagnetic energy, and nuclear energy (Alatas, Fatiah; Nurlela, 2015).

Education is inseparable from the role of teachers in planning, designing, implementing, and assessing the results of science learning. In this case, teachers are one of the components that greatly influence the creation of good and quality education (Rohman et al., 2017). Therefore, to help improve science literacy skills, it is necessary to have learning that directs students to science literacy skills (Imani, Hajar Adha; Sari, 2016). One of the materials tested on scientific literacy is physics, which is a subject that examines various natural phenomena and plays an important role in the development of science and technology. Physics literacy is essential for life in the era of modern science and technology due to its application in industry and other fields, so every learner needs to be given the opportunity to acquire some concepts, principles, and skills (Nurhasanah et al., 2020).

Based on the results of interviews with physics teachers, information was obtained that the teacher had never made questions such as the type of science literacy because the questions made referred to UTBK. In addition, in the learning process, teachers have never applied science literacy in the classroom. In the learning process, there are already students who show their science literacy skills, but the number is relatively small, and it is only seen in students whose cognitive abilities are high and their interest in learning is high. In addition, teachers have also never measured the science literacy ability of class XI students, and there has never been any research on science literacy on the concept of work and energy. Researchers hope that this research can help physics teachers in measuring the science literacy ability of students. Then, the information obtained from this study can be material for evaluation and quality improvement in physics learning in schools.

2. METHOD

This research was conducted at SMAN 3 Cilegon City. The study was conducted from 20 August 2021 to 25 September 2021. The consideration is based on A-accredited schools located in one of the sub-districts in Cilegon. This research was conducted on 145 students of class XI science who had received work and energy materials.

The research method used is descriptive. Descriptive research is a research method that explains or describes a phenomenon or something that is studied today or in the past. This study describes a condition as it is both a condition in individuals and groups (Sukmadinata, 2012).

The steps of this research are divided into three steps, namely, the preparation, the implementation, and the final step. The research preparation step begins with conducting literature studies related to science literacy skills through journals, theses, books, and other kinds of literature. The next step is conducting online interviews with physics teachers, compiling research instruments in the form of essay questions on science literacy skills and attitude aspect questionnaires, and validating research instruments with experts. Subsequently, the instrument was revised with expert advice. After the instrument is appropriate, instrument validation is carried out for class XII science students. The implementation step of this research is by conducting science literacy ability tests and attitude aspect questionnaires to grade XI science students. The science literacy ability test takes 60 minutes. The final step of this research includes data processing activities, in

which the data is analyzed and interpreted with theory. After that, the data is concluded.

2.1 Data Collection

In this study, the test used was an essay test for science literacy skills. The essay test consists of 8 questions that have been validated by experts and have been tested on non-sample students. Essay tests are used to measure science literacy skills in the domains of competence, knowledge, and content. Dalam setiap soal terdiri dari tiga domain tersebut.

In addition, in this study, interviews were also conducted, which were used to find out things from respondents in depth for research purposes. Then data collection is also carried out through a questionnaire, which is used to measure science literacy skills in the attitude domain. The domain of this attitude consists of 18 statements in aspects of interest in science, four statements in aspects of assessment of scientific approaches to investigative activities, and four statements in the aspect of awareness of the environment. Environment.

The process of collecting data in the form of tests and questionnaires was carried out through the Google form platform because, at that time, it was in a COVID-19 condition, while interview data collection was carried out through an online meeting platform.

3. RESULT AND DISCUSSION

The instrument used in this study is a matter of science literacy, which was made referring to PISA 2015, which focuses on physics content. The materials used in this question instrument are the materials of work and energy. In addition, this study also used a non-test instrument in the form of a questionnaire, which was used to measure the attitude domain.

3.1 Science Literacy Ability is based on three domains (Context, Competence, and Knowledge)

The essay test consists of 8 questions, and each question consists of three domains of science literacy, namely, the domains of context, competence, and knowledge.

Question number 1 presents a narrative of the daily activities. Students are asked to determine activities that belong to work and not to work. It questions consist of aspects of explaining phenomena scientifically, aspects of personal context, and also aspects of content knowledge. The percentage of correct answers of students is 56.14%, which is included in the category of less. There are still many students' answers to these questions without being accompanied by physics concepts, such as just guessing. In addition, students also still do not understand the concept of physics.

Question number 2 presents information about an object that falls from a certain height. Students are asked to determine the energy and types of energy at specific positions. It question consists of aspects of interpreting data and evidence scientifically, aspects of personal context, and also aspects of procedural knowledge. The answer of students to question number 2 is that there are still many students who do not understand how to connect data with their physics concepts. This can be seen based on the percentage of correct answers in question number 2, which is 37.08%, which is included in the category of very low.

Question number 3 presents a picture of the two tracks of marbles. Students are asked to determine which marble from two tracks will go first to the end of the track. It questions consist of aspects of explaining phenomena scientifically, aspects of personal context, and also aspects of epistemic knowledge. The percentage of correct answers to this question is 45.48%, which is included in the category of very low. This percentage illustrates that the students' answers to this question are still very lacking. This is shown by students who are still not right in answering questions based on their physics concepts. Then, the reasons given by students on this question are still not related to their physics concepts, and there are even students who give answers that are not accompanied by the underlying reasons.

Question number 4 presents a variety of work displacement graphs. Students are asked to determine the graph that is suitable for the work. It consists of aspects of interpreting data and evidence scientifically, aspects of personal context, and aspects of procedural knowledge. The percentage of correct answers to this question is 43.64%, which is included in the category of very low. Similar to question number 2, the student's answer in number 4 also illustrates that students still cannot connect the data presented with their physics concepts. In addition, there are still many students who are not right in doing the steps in answering their questions.

Question number 5 presents the information about the slingshot game. Students are asked to analyze the conclusion of the slingshot game. It question consists of aspects of evaluating and designing scientific research, aspects of personal context, and also aspects of content knowledge. The percentage of correct answers to this question is 50.56%, which is included in the category of very low. Students' answers to this question, there are still many who are not right in making conclusions because students also still do not understand the concept of physics.

Question number 6 presents information about two buses that use different fuels. Students are asked to analyze the truth regarding the conclusions of the society against one of the use of bus fuel. Its questions consist of aspects of evaluating and designing scientific research, aspects of local/national contexts, and aspects of content knowledge. The percentage of correct answers to this question is 49.16%, which is included in the category of very low. In this problem, there are still many students who are not right in evaluating or making conclusions about a phenomenon based on their physical concepts.

Question number 7 presents information about fossil fuel and biofuel and related images of the process. Students are asked to analyze the impact of fossil fuel and biofuel use on the environment. Its questions consist of aspects of explaining phenomena scientifically, aspects of the global context, and also aspects of content knowledge. In this question, there are still many students who have difficulty understanding the reading text, so in answering the question, there are still many answers that are not correct. This is indicated by the percentage of correct answers obtained, namely 50%, which is included in the category of very low.

Question number 8 presents data about fossil fuels and biofuel. Students are asked to analyze the impact of fossil fuel and biofuel use on the environment. Its questions consist of aspects of interpreting data and evidence scientifically, aspects of local/national contexts, and aspects of procedural knowledge. The percentage of correct answers to this question is 70.34%, which is included in the sufficient category. This percentage shows that the students' answers to this question are quite capable of connecting data with their physics concepts.

Based on three domains, namely knowledge, context, and competence, the science literacy ability of class XI science students is shown in Figure 2.

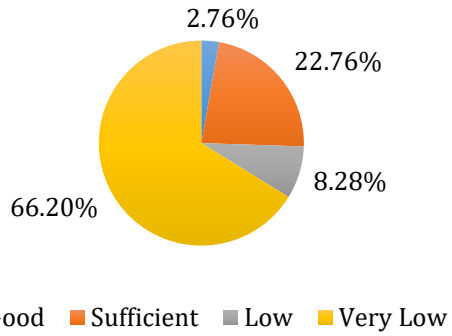

Figure 2. The percentage of science literacy ability students is based on three domains.

Overall, the average percentage of science literacy ability of class XI science students falls into the category of very low. This can be seen from the percentage of correct answers from each number, namely, as many as six questions are included in the very low category, 1 question is included in the low category, and 1 question is included in the sufficient category.
Based on the results of interviews with physics teachers, students are not used to doing science literacy-type questions whose scope is complex. Then, with the conditions of distance learning,

many students do not understand the physics material, and only a few people ask if there is something that is not understood. The low science literacy ability of students is closely related to the low of each aspect of science literacy ability. So, when one aspect of science literacy is low, it will affect other aspects of science literacy (Erniwati et al., 2020). In addition, students still have limitations in expressing thoughts in writing form, students' reasoning ability is still very low, and students are not used to connecting information in text form and then expressing it in the form of new expressions to answer questions (Andriani et al., 2018).

Furthermore, the results of other interviews also stated that the cognitive abilities that are often trained are from C2 to C3, so students are not familiar with question types such as PISA because the questions made tend to be calculated questions and are not familiar with questions that contain long narratives. If the teacher makes a question with C4 cognitive ability or the question is changed from the example, there are still many students who are confused in the process of answering it. The low science literacy of students is because they are not familiar with science literacy-based learning. In addition, learners should be motivated to apply the concepts or materials that have been learned in solving problems both in personal and global contexts. Thus, it will be something new for learners when tested using science literacy-based questions (Siagian et al., 2017).

3.2 Science Literacy ability is based on the domain of attitudes

The domain of attitude consists of aspects of interest in science, assessment of scientific approaches to investigative activities, and awareness of the environment. The domain of this attitude consists of 25 statements. The following is the average percentage value of each aspect in the attitude domain, as seen in Table 1.

Table 1. The percentage of each question based on the three domains

The aspects	Percentage	Average	Category
Interest in science	66,54%	68,86%	Good
Assessment of scientific approaches to investigative activities	71,78%		
Awareness of the environment	68,23%		

The domain of attitude consists of aspects of interest in science, assessment of scientific approaches to investigative activities, and awareness of the environment. The first aspect, namely interest in science, measures how an interest in science shows students' attitudes towards science. To find out these aspects, a questionnaire was made consisting of 11 positive statements and six negative statements. The results obtained in this aspect are to show the category of good scientific literacy attitudes. Then, in the aspect of scientific approaches to investigative activities, the questionnaire consists of 3 positive statements and one negative statement. The results obtained showed in the category of good scientific literacy attitudes.

Furthermore, in the aspect of awareness of the environment, it measures how the attitudes of students are related to concern for their environment. The questionnaire on this aspect consists of 2 positive statements and two negative statements. The results obtained on the aspect of environmental awareness show the category of good scientific literacy attitudes.

Overall, the science literacy ability of class XI science students in the attitude domain belongs to the category of good attitudes. These results are shown in Figure 3.

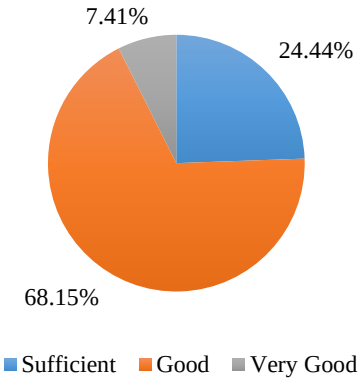

Figure 3. Percentage of science literacy ability in the attitude domain.

Based on the assessment of science literacy ability in the attitude domain shows that there is already potential in students. It is just that it needs to be accustomed to being given questions related to science literacy and habituation to activities that improve science literacy skills. Research by Sukowati et al. (2017) explained that students' attitudes towards science also affect the level of science literacy ability. The attitude here tends to the interest of students. The existence of an interest in learning will show good results so that students will be more motivated to get good results. The intensity of a learner's motivation will largely determine the achievement of his learning achievements. Students' interests can arise from influences within themselves and from outside, such as the surrounding environment (Sukowati & Rusilowati, 2017).

4. CONCLUSION

Based on the results of the research and discussion obtained, it can be concluded that the assessment of the science literacy ability of class XI science students with three domains (context, competence, and knowledge) obtained an average percentage of 51.76%, which is included in the category of very low. The results of science literacy ability class XI science in the attitude domain obtained an average percentage of 66.95%, which belongs to the category of good attitudes. Furthermore, there are several suggestions that researchers submit, namely the existence of learning methods/models that can improve science literacy skills. Students need to be familiarized with the provision of science literacy questions.

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