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Effectiveness of Contextual Phenomena-Based Learning to Improve Science Literacy

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ABSTRACT

Objective: This study aimed to determine the effectiveness of contextual phenomena-based learning to increase scientific literacy in three Basic Physics materials.. **Method:** This research method is descriptive and quantitative with the type of Pre-Experimental research. The subjects of this study were 27 students of Physics Education class A at Surabaya State University class of 2022. **Result:** The results of the data analysis showed that learning based on contextual phenomena to increase scientific literacy was an excellent category to apply. This is shown by implementing learning on the three materials with suitable criteria. Student activities for each material are in very good criteria. Moreover, the average N-gain value obtained through the Pre-test and Post test scores on the third material is in the high category. As well as the results of the average student response to the learning that is applied is also in the high category and gets a positive response from students. From the four results of data analysis, it can be interpreted that learning based on contextual phenomena effectively increases scientific literacy. **Novelty:** The application of contextual phenomena-based learning in the materials on Works and Energy, Momentum, and Fluids at the college level to improve scientific literacy

INTRODUCTION

Technology, information, and communication sophistication in the 21st century are developing very fast and rapidly. This development requires a person to have several abilities to compete in the 21st century. Physics students who are prospective educators prepared to face the challenges of the world of education in the 21st century are no exception (Sartika et al., 2018). Physics student prospective educators must develop logical thinking, creative thinking, problem-solving skills, and critical thinking and master technology against the times (Mujajir, 2021). It is hoped that they will become human beings who are entirely literate in science and technology so that they can grow into human beings who have scientific literacy skills.

Scientific literacy is one of the skills needed in the 21st century among the 16 skills identified by the World Economic Forum (2015). According to PISA, Scientific literacy is how humans get to know the universe and are aware of some of the essential ways in which mathematics, technology, and science depend on one another. Scientific literacy is the ability to interact with various aspects of the world in a way consistent with the values underlying knowledge (Laugksch, 2017). Scientific literacy can also train students to have high sensitivity to themselves and the environment in dealing with daily problems, make decisions based on scientific knowledge, and provide simple recommendations (Yacoubian, 2017; Indana, 2018). Scientific literacy also makes a concrete contribution to the formation of life skills.

Scientific literacy measures three scientific competencies, which are described as follows. First, identify scientific issues (problems), namely recognizing possible problems for scientific investigations, identifying keywords to search for scientific information, and recognizing key features of scientific investigations. Second, explaining scientific phenomena, namely describing and assessing scientific investigations and proposing ways to answer questions scientifically (Sunarti et al., 2020). Third, using data and evidence scientifically, namely interpreting scientific evidence, making conclusions and communicating, identifying assumptions, evidence, and reasons behind conclusions, and reflecting on the social implications of science and technological development (Hernandez et al., 2015; Putri et al., 2018; Wen et al., 2020).

Since 2000 Indonesian education has participated in the PISA assessment program to measure students' abilities and skills in dealing with problems in everyday life (Nasution et al., 2019). One of them is scientific literacy. According to the OECD report on PISA results for four consecutive times, Indonesia was in 60th position in 2009 at the world level, 50th out of 65 countries in 2012, 64th out of 72 countries in 2015, and 70th out of 78 countries in 2018 (OECD, 2018; OECD, 2019). These results show that Indonesia still needs to improve scientific literacy skills (Sartika et al., 2018; Nasution et al., 2019; Mujajir et al., 2021). This shows that the quality of Indonesian education, especially in terms of scientific literacy skills, needs to be improved to reach the average value of the PISA standard. In solving these problems, it is necessary to develop a culture of scientific literacy for students at school.

As a facilitator in the learning process, the teacher plays an important role in developing scientific literacy. Skilled and professional teacher candidates are needed to make students achieve higher performance. In producing prospective educators with qualified scientific literacy skills, it is necessary to cultivate scientific literacy during lectures (Sartika et al., 2019). Scientific literacy-oriented learning is learning that is relevant to everyday life or based on contextual phenomena (Yaumi, 2017). This is to research conducted by Mujajir et al. (2021), which revealed that to improve student scientific literacy, it is necessary to improve learning activities that focus on developing student scientific literacy. Contextual-based student-centered learning, problem-solving, STEM, and inquiry can be an alternative to increase student scientific literacy (Saraswati et al., 2021). According to Srikandi et al. (2017), one way to improve scientific literacy skills is through contextual-based learning. Contextual-based learning emphasizes the full involvement of students in finding concepts that can be learned and connected with real-life phenomena so that learning can be more meaningful. Students can apply what they have acquired (Srikandi, 2017).

Physics is part of Natural Science which functions to develop inductive and deductive analytical thinking skills in solving problems related to natural events. The nature of physics material is abstract, which is challenging to visualize and makes it difficult for students to study physics concepts (Rahmawati, 2021). So that in learning physics, it is necessary to relate it to everyday life or real life (Sugianto, 2017). However, from the direct observations of researchers in class, there is still a physics lecture process that is carried out using one-way learning, which places more emphasis on delivering theoretical and mathematical learning material. This background encourages researchers to research the effectiveness of contextual phenomenon-based learning in physics education class A students class of 2022 who are programming Basic Physics 1 courses. In this application, it is hoped that students can improve their scientific literacy skills as prospective teachers for the next generation.

RESEARCH METHOD

General Background

This type of research is Pre-Experimental. Pre-Experimental research does not use a control class or a comparison class; the sample is not chosen randomly (Sugiyono, 2016; Fatmala, 2017). This research also uses descriptive quantitative research, research that analyzes data by describing or describing the data that has been collected as it is, which aims to determine student success after participating in learning and tracking student achievement (Sugiyono, 2017).

Sample / Participants / Group

The subjects of this study were 27 students of Physics Education class A class of 2022 who had programmed the Basic Physics 1 course. This research was conducted at the Physics Education Study Program, Department of Physics, Faculty of Mathematics and Natural Sciences Surabaya State University in October 2022.

Data Processing

This research includes three stages, namely the preparation stage, the implementation stage, and the final research stage. The research flowchart is shown in **Figure 1.**

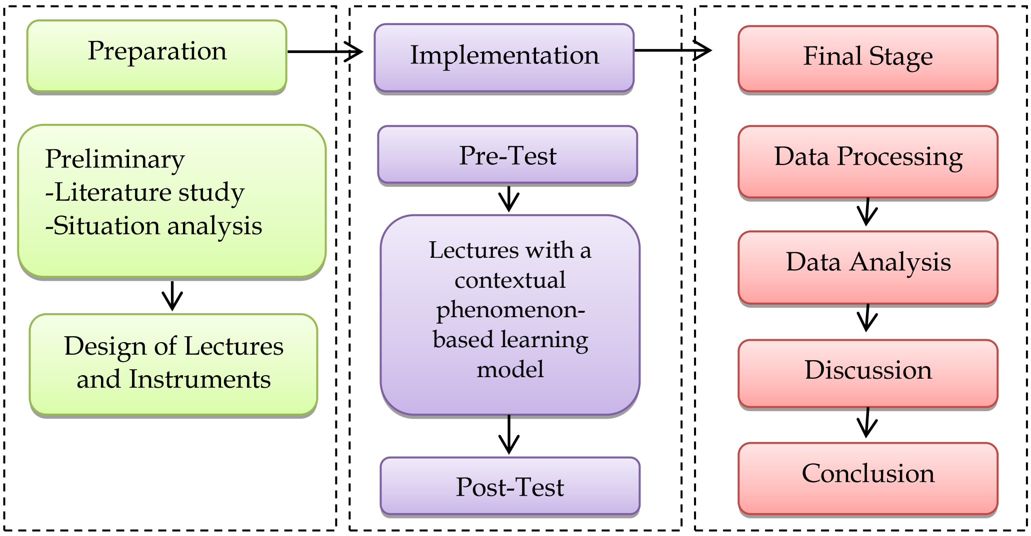


Figure 1. Research flowchart.

The preparation stage of this research was a preliminary study by conducting a literature study on theories relevant to the learning model and conducting a situation analysis of the place to be studied. Then design lecture devices in the form and instruments for learning. The implementation stage is carried out to obtain research data; at this stage, data collection techniques are used, which include observation techniques consisting of observing the implementation of learning, which aims to obtain data about the implementation of the learning process based on contextual phenomena (Efrina, 2021). The learning was carried out in three meetings on three materials: Work and Energy material at the first meeting, Momentum material at the second meeting, and Fluid material at the third meeting. In addition, observations were made of student activities carried out during learning. Using a pre-test and post-test, the test technique is used to obtain data about increasing student scientific literacy. Questionnaire techniques are used to obtain data on student responses to the application of contextual phenomenon-based learning in class. The final stage is data analysis, which includes analysis of the implementation of learning, student activities, student scientific literacy, and response questionnaires.

RESULTS AND DISCUSSION

Results

Implementation of the Learning Process

The implementation of the learning process was carried out in three meetings, including the first meeting with the topic of Work and Energy, the second meeting with the topic of Momentum, and the third meeting with the topic of Fluids. The three materials are carried out with contextual phenomenon-based learning. Observational data on the implementation of the learning process were obtained from two lecturers directly teaching Basic Physics 1 during lectures in class. Overall, observers assess the implementation of learning in the good category. This is based on the average percentage of learning value; successively, the average value of the three materials is 70.0% in the Work and Energy material, 70.0% in the Momentum material, and 71.6% in the Fluid material. Observer scores on the implementation of learning are presented in **Table 1.**

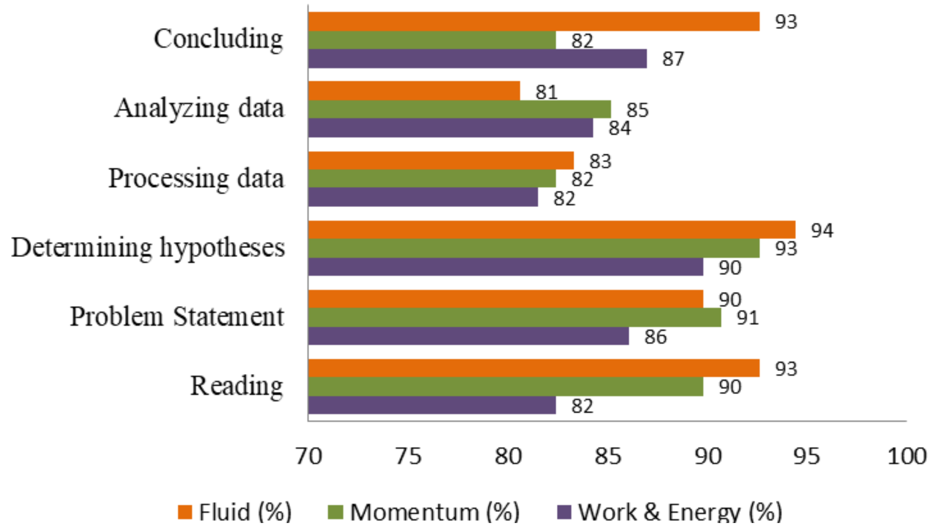
Table 1. Observation of the implementation of the learning process.

Indicator	Observer Score (%)		
	Work & Energy	**Momentum**	**Fluid**
Introduction Activities			
1. Stimulation	80.0	70.0	80.0
Core Activities			
2. Statement Problem	70.0	70.0	70.0
3. Data Collection	70.0	60.0	70.0
4. Data Processing	60.0	70.0	70.0
5. Verifiability	4.00	70.0	70.0
Closing Activities			
6. Conclusion and Evaluation	60.0	80.0	70.0
Average	**70.0**	**70.0**	**71.6**

The learning stages in the introduction include greeting activities, checking student attendance, conveying learning objectives, and stimulating students for initial motivation. All aspects of implementation at this stage obtained scores with very good criteria in all three materials. The core stages of learning consist of presenting problems, data collection, data processing, and verification. All aspects of the core stages score with good criteria for each material implemented. Moreover, the last stage is the closing of learning which consists of conveying conclusions and evaluating learning. All aspects at this stage get scores with very good criteria for Momentum material and good criteria for Fluid, Work, and Energy material.

Student Activities

Student activities in applying contextual phenomenon-based learning are given in three materials, Work and Energy, Momentum, and Fluid, which are given the same activity. The three materials are in the very good category, with detailed value data at each stage shown in Figure 2. The results of observations on student activity in the three materials obtained successive percentages of 85.2% for Work and Energy material, 87.2% for Momentum material, and 88.9% for Fluid material.



Average	88.9	87.2	85.2

Figure 2. Student activities in contextual phenomenon-based learning.

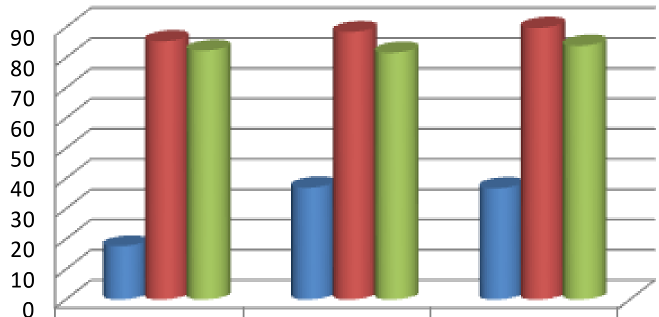
Student activities start with reading scientific issues related to natural phenomena in everyday life per the material provided. The principle of contextual phenomena-based learning helps students understand the subject matter and expands their creative thinking to connect knowledge with real life (Hasani, 2016). Student activities are carried out through group discussions divided into seven groups, each consisting of 4 to 3 students. At this stage, students respond to articles that have been read in their entirety, which are carried out very well. However, only one group actively responded when reading the discussion results on the Work and Energy material. This is because students need to get used to reading activities. Finally, the researcher asked each group to present the results of their discussion in turn. In the next lesson, students began to be active in giving responses. The reading activities these students provide will increase their scientific literacy.

The stage of formulating a problem is indicated by a question that requires students to formulate a problem based on the reading given in the previous stage. Formulating problems takes experience and knowledge that students have gained (Alfina et al., 2020; Arbabifar, 2021; Cao & Shi, 2021). Of the three materials implemented, students are in the very good category at this stage in formulating problems. This is shown through the variety of questions or problems raised by students. They pose problems that are very close to problems that are often encountered in everyday life. Students also showed this in the next stage, namely, compiling hypotheses. They develop hypotheses by associating existing physics concepts with the experiences they encounter in everyday life. Students who can formulate hypotheses in a good and easy way are students who can create good conceptual knowledge (Mourugan & Sethuraman, 2017; Al-Hadabi, 2020)

Next is the stage of processing and analyzing data; at this stage, students are given student activity sheets about experiments using virtual experiments contained in phet simulation. This stage provides several advantages for students; they become active and responsible. It is also hoped to guide students in designing and conducting experiments so that they can find concepts independently (Alfina, 2020). Furthermore, the last stage is concluding. In this stage, students are allowed to present the results of the data obtained. In the activities at this stage, very good criteria were obtained from each of the three materials provided.

Student Science Literacy

The level of effectiveness of contextual phenomenon-based learning is obtained through the average normalized gain value from the results of the pre-test before the application of learning and the results of the post-test after learning ends. The average normalized gain values for the three materials obtained successive values of 82.3% in the Work and Energy material, 81.6% in the Momentum material, and 83.9% in the Fluid material. The following is a graph of the acquisition in **Figure 3**.



	Work & Energy	Momentum	Fluid
Pre-test	17,59	37,04	36,81
Post-test	85,42	88,44	89,84
N-gain (%)	82,31	81,64	83,92

Figure 3. Normalized gains in student science literacy.

The average results of the students' scientific literacy pre-test scores from the three materials obtained show that the average student is still at level 2. This suggests that level 2 is the basis of students' scientific literacy skills, who are starting to demonstrate conceptual science that allows science to participate effectively and productively in situations related to science and technology (Yaumi, 2017). While the average post-test scores of students' scientific literacy of the three materials obtained show that the average student is at level 5, which means that students can identify the scientific components of many complex life situations so that they can select and evaluate appropriate scientific evidence to respond life situations (Yaumi, 2017).

So from the achievement of student scientific literacy, applying contextual-based learning tools to these three materials has proven to help increase student scientific literacy results. This increase in using contextual phenomenon-based learning was emphasized by Wahyanti (2013), who argued that this contextual phenomenon-based learning could improve students' scientific literacy skills (Cano & Lomibao, 2023; Pratiwi et al., 2021; Waki'a & Sunarti, 2021). This was also revealed by Sugianto (2017) that teachers who apply contextual phenomenon-based learning could improve scientific literacy skills.

Student Response

The effectiveness of implementing contextual phenomenon-based learning is also shown through the results of student responses given at the end of each lesson. The average result of the percentage of students' responses to the learning given in the

Business and Energy material was 85.6%, in the Momentum material was 88.1%, and in the Fluid material was 88.7% which indicated the very good category of students. **Table 4** shows the results of student responses.

Table 2. Result of student response**.**

Statement	**Student Response (%)**		
	Work & Energy	**Momentum**	**Fluid**
Learning makes students easy to understand the material	87.0	91.7	92.6
The lessons provided are fun and not boring	88.9	93.5	91.7
Learning is related to everyday life	93.5	95.4	95.4
Learning makes students actively involved during class discussions	77.8	79.6	83.3
Learning makes students active in asking and answering	80.6	80.6	80.6
Average	**85.6**	**88.1**	**88.7**

Student responses have yet to show 100.0% of the contextual phenomenon-based learning implemented in the three materials. However, the results show that applied learning is generally effective and is shown by the positive response from students. This is also in line with Fatmala's research (2017) that contextual phenomenon-based learning is effective in increasing scientific literacy because contextual-based learning emphasizes student participation in understanding the material being studied and encourages students to apply it by associating the material with their own lives (Servitri, 2017; Sari, 2022).

Discussion

Scientific literacy is suitable and essential for developing physics learning so that the knowledge possessed by students can be applied to solving various problems in everyday life (Pertiwi et al., 2018). Scientific literacy is a necessary ability to understand science and apply the concept of everyday life as a primary capital and the potential to face challenges in the 21st century, which has entered the era of the industrial revolution 4.0 (Muliani et al., 2021). Therefore, as physics teacher candidate students, they must have scientific literacy skills as introductory provisions or capital for teachers so that it is hoped that they can also increase science ratings for prospective students.

Students need scientific literacy to implement their knowledge of skills in everyday life (Shohib et al., 2021). This is per contextual phenomenon-based learning, which emphasizes creating links between what is learned and its application in everyday life. Based on the research results, this contextual phenomenon-based learning effectively trains the scientific literacy of physics teacher candidates. In addition, this learning also helps facilitate students' understanding of concepts and theories.

Physics is a subject that does not only memorize mathematical formulas but requires an understanding of concepts and theories that are easy for students to understand (Sari, 2022). This contextual phenomenon-based learning gets a positive response because this learning relates problems from phenomena in everyday life by using simple investigations through a virtual laboratory. With the help of a virtual laboratory, students are happier learning and understanding material quickly, and motivating students who are less motivated to learn in the initial meeting become motivated too. Favorable psychological conditions can increase student understanding (Yusuf, 2018).

CONCLUSIONS

Fundamentals Finding: From the results of the implementation of learning, student activities, student literacy tests, and student responses to Basic Physics learning on the material Business and Energy, Momentum, and Fluid by applying phenomenon-based contextual learning showed effective results to improve students' scientific literacy. **Implication:** Students give a very positive response to the application of this learning; it is easier for them to understand the material because it relates to the phenomena of everyday life. **Future Research**: Learning based on contextual phenomena can be applied to all physics material related to everyday life. However, for researchers who wish to apply this contextual phenomenon-based learning, combining it with a learning model or approach appropriate to the material is advisable. To further refine their research, they should consider its advantages and disadvantages.

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