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# Improving Science Literacy Skills through Interactive Physics E-Learning for students at Lapandewa High School

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**Abstract**

This study aims to develop physics e-learning to improve students' science literacy skills at SMAN 3 Lapandewa. This research uses the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The analysis stage involves conducting observations and in-depth interviews at school; the design stage involves designing the initial e-learning product; and the development stage involves developing the e-learning product. The implementation stage involves implementing the developed product, while the final stage involves evaluating the product and its impact on learning outcomes. The determination of research samples involves the use of random sampling techniques and a specific research design. Pretest-Posttest Control Group Design. The research sample amounted to 25 respondents in the control class and 29 respondents in the experimental class. Three validators declared the analysis of science literacy-based teaching materials on temperature and heat feasible, citing easy-to-understand criteria with an average readability of 74.11%. The increase in science literacy skills of students who use science literacy-based teaching materials is higher than that of students who use teaching materials used at school. The increase in science literacy skills among students who use science literacy-based teaching materials is 0.63, compared to 0.38 for students who use traditional school books. Therefore, we can conclude that e-learning enhances students' science literacy abilities.

**Keywords**: e-learning, Physics, science literacy, ADDIE

## INTRODUCTION

In the 21st century, the Ministry of Education and Culture formulated that the 21st century learning paradigm emphasizes students' expertise in searching for knowledge in various sources, formulating cases, thinking analytically, and working together in solving a case. With the progress in the 21st century, people are required to keep up with the development of science and technology, especially in the world of learning (Millenia & Sunarti, 2022). Competition in the Revolution 4.0 era requires all humans to compete globally because better communication technology will open up broad access to competition from all corners of the world (Savitri et al., 2021). The demands of the globalization era with the development of information technology can be utilized for educational development so that this development has changed the paradigm of the younger generation in seeking and obtaining information (Nurhasanah, 2020). One of the closest examples is how when Indonesia faced the covid 19 pandemic, various hoaxes about covid 19 and vaccines appeared. This will certainly complicate

efforts to deal with the pandemic, because hoax news can cause public distrust of these efforts (Amarulloh, 2022).

Educating the nation is one of the goals of the Government of Indonesia. This goal is enshrined in the preamble of the 1945 Constitution and is one of the objectives of national education in Indonesia as stipulated in the Law of the Republic of Indonesia Number 20 of 2003 (Bashooir & Supahar, 2018). Physics learning can be defined as the process of studying natural phenomena (Nurwulandari, 2018). Science literacy requires understanding science concepts, the ability to apply them based on a scientific perspective, and thinking about evidence (Afriana et al., 2016). Science literacy includes the field of Natural Sciences (IPA), one of which is physics, which has an important role in the advancement of science and technology. Developing students' expertise in physics is one of the keys to success in improving skills to familiarize themselves with entering the world of technology (Millenia & Sunarti, 2022).

The purpose of learning physics is to form the ability to reason in students which is reflected through the ability to think critically, logically, and systematically, and to have objective, honest, disciplined nature in solving a problem both in physics, other fields of science, and in everyday life (Irwan, 2020). Physics is considered a difficult and scary subject. This is because in physics there are many mathematical equations and students assume that these mathematical equations must be memorized (Istiyono et al., 2018). Physics is included in the scope of science literacy. Physics is a branch of science that investigates natural phenomena, including disasters. One method to integrate natural phenomena into physics learning is to integrate them into physics enrichment books. This integration helps in contextualizing learning (Mulyana & Desnita, 2023).

The results of PISA (Program for International Student Assessment) in 2009 showed the acquisition of science literacy scores of Indonesian students aged 15 years of 383, where the average of all participating countries is 500. These results indicate that the acquisition of science literacy scores of Indonesian students is still far below average. In 2012, the science literacy score decreased further, to 382 with a rank of 64 out of 65 participating countries (Fatkhurrohman & Astuti, 2017). Science literacy comes from Latin, literatus, and scientia, literatus means marked letters, literate or literate, while scientia means knowledge (Husna et al., 2022). Science literacy is the ability to understand and apply scientific knowledge with scientific conceptions. According to FISA (2015), science literacy is defined as the ability to engage in problems related to science, and with scientific ideas to become a reflective society (Saputra et al., 2017). One factor that can cause a lack of learning that trains science literacy is the lack of learning resources that can support teachers in training science literacy in the classroom. The learning resources used do not support science literacy and the presentation of material in the book is not in accordance with the level of student understanding (Amarulloh, 2022).

Learning models in 21st century education must accommodate changing times and student needs by utilizing technology, collaboration, and other 21st century skills to prepare students to become competent and highly competitive individuals in the global era (Sukma & Ibrahim, 2016). Learning models and approaches that are contextual and contextual and emphasize inquiry are part of efforts to master students' science literacy (Dhanil & Mufit, 2023). E-learning is a solution in offering various social networking possibilities so that in this way teachers can keep various records of learner interactions in collaborative learning, just like conventional classes the activities that can be done through e-learning are forums, chats, modules, assignments, and quizzes (evaluations). Through this media, various multimedia services can be transferred easily, such as audio, video, and graphics that have high resolution so that the thinking process can lead to concrete thinking (Budiyanto et al., 2019). Learning media using gadgets has the opportunity to help improve the quality of student performance in the form of learning outcomes. Learning media using Android allows learning not limited by time and place with interesting applications (Muzijah et al., 2020). E-learning is one form of learning model that is facilitated and supported by the use of information and communication technology. E-learning has characteristics, including 1) having content relevant to learning objectives; 2) using instructional methods, such as presenting examples and exercises to improve learning; 3) using media elements such as words and images to convey learning materials; 4) allowing direct learning centered on the teacher (synchronous e-learning) or designed for independent learning (asynchronous e-learning); 5) building understanding and skills related to learning objectives both individually and improving group learning performance (Herayanti & Fuadunnazmi, 2017).

Several studies conducted previously mentioned that using Moodle-based e-learning can increase student learning independence. Research conducted by Anggraini (2019) concluded that Moodle-based learning media applied in biology subjects proved effective and easy to use by students. In addition, users of the media are also proven to be able to improve students' science literacy skills and learning independence. Another research conducted by Gamage's research (2022) suggests that the development of Moodle-based e-learning can increase students' learning independence in Biology class XI. Based on previous research, the researcher will certainly raise again the importance of physics learning by utilizing e-learning. Xhomara (2023) found that Moodle-based e-learning media is effective and efficient learning and can support the learning process, so that it can increase student learning independence. Based on previous research, the researcher will certainly raise again the importance of physics learning by utilizing e-learning.

## METHODS

This research uses the development research method (research and development). Development research is a method used to verify and develop a product and test the validity or effectiveness of the product (Anshar et al., 2023). The ADDIE model is the development model used in this R&D research for e-learning development. The developed ADDIE model consists of five stages, namely Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). The following relationship between the stages in the ADDIE development model can be described as shoen in FIGURE 1.

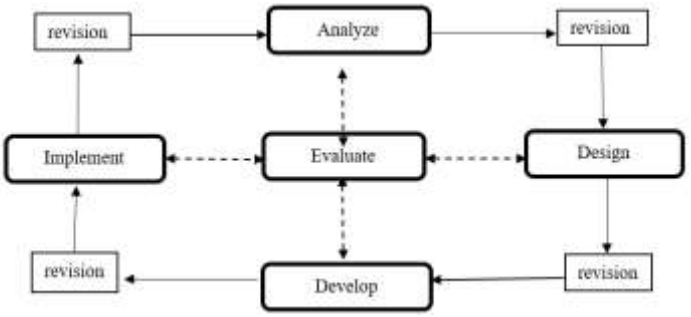


**FIGURE 1.** ADDIE Stages

Product validation is carried out through two stages, namely design validation and product validation. Design validation was carried out by Supervisor I and Supervisor II as experts. This validation is judgment experts (Suryandari et al., 2018). Furthermore, product validation was carried out by one Physics lecturer and two high school Physics teachers. The validation of e-learning was carried out by media and material experts, while the validation of science literacy skills questions was carried out by testing the validity of products and questions using a teaching material feasibility questionnaire to assess the suitability of material content, material presentation, language, graphics, and science literacy content.

The research was conducted at SMA Negeri 3 Lapandewa. The first step is to conduct an equality test of two variances to determine the homogeneity of the population. Because the population is homogeneous, the sample was selected using a simple random sampling technique. XI MIA 1 class as the control class and XI MIA 2 class as the experimental class. The initial product trial was in the form of a readability test using a random test with 27 students of class XI MIA 3 as respondents. The final product trial was conducted with Pretest-Posttest Control Group Design.

After selecting the research sample, a pretest was conducted on 25 students as the control variable in class XI MIA 1 and 29 in class XI MIA 2 as the experimental class. The pretest questions consisted of 20 multiple-choice questions. The results of this pretest are used to determine the initial ability of students. In the next stage, the experimental class conducted learning using physics e-learning teaching materials to test science literacy skills, and the control class used teaching materials used at school.

The increase in students' science literacy skills was tested using effect size based on the pretest and posttest scores of the control class and experimental class. The normality test results will show that the data is normally distributed so that the hypothesis analysis uses parametric statistical techniques. Hypothesis testing was carried out with the two means equality test (right side t-test) to determine the

difference in the improvement of students' science literacy skills between the experimental and control classes.

## RESULTS AND DISCUSSION

This research produces science literacy-based e-learning teaching materials on temperature and heat material used by students in class XI at SMAN 3 Lapandewa. The characteristics of science literacy-based teaching materials, the results of the feasibility test of teaching materials, the results of the readability test of teaching materials, and the results of the analysis of students' science literacy skills are all part of the research data. The material on temperature and heat is included in the developed science literacy-based teaching materials. This includes the subjects of temperature and thermometers, expansion, heat and changes in the form of substances, and heat transfer. TABLE 1 shows the composition of each aspect of science literacy.

**TABLE 1.** Composition of Science Literacy Aspects in E-learning

| Aspects of Science Literacy | Temperature and Thermometer | Expansion | Caloric Form of Substance | Heat Transfer | Average |
|---|---|---|---|---|---|
| Science body of knowledge | 36.18% | 40.29% | 32.43% | 42.12% | 37.75% |
| Science to investigate knowledge | 32.31% | 25.74% | 21.18% | 9.66% | 22.22% |
| Science as a way of critical thinking | 20.17% | 24.53% | 18.87% | 27.53% | 22.78% |
| Science as technology in Society | 19.38% | 19.53% | 32.67% | 28.36% | 24.99% |

The comparison of science literacy content in the developed teaching materials, which consists of science as a body of knowledge, science as a way of investigating, science as a way of thinking, and the interaction between science, and technology in society is 37.75%, 22.22%, 22.78%, and 24.99%.

Wilkinson (1999) examined the content of physics textbooks in Victoria, Australia, from 1967 to 1997. The study found that the science literacy content in the books varied, but was relatively balanced: 42% saw science as a body of knowledge, 19% saw science as a way of investigating, 19% saw science as a way of thinking, and 20% saw the interaction between science, technology and society. Overall, this ratio was 2:1:1 (Husna et al., 2022).

In his research, he developed science literacy-based teaching materials. According to Wilkinson's research, the three lesson materials produced from this research have an almost balanced ratio of science literacy content. Based on these three studies, it can be said that the materials developed in this study have a balanced composition of science literacy content (Sarnou & Sarnou, 2021).

The feasibility level of teaching materials was test using a teaching material feasibility questionnaire. The indicators of book feasibility assessment refer to the criteria of the National Education Standards Agency, namely aspects of content feasibility, presentation techniques, language assessment, and graphics (BSNP, 2007) and one aspect of science literacy (Aini et al., 2023). Questionnaires were given to 3 experts, namely one lecturer and two high school teachers. The results of the feasibility test of teaching materials can be seen in TABLE 2.

The analysis of the readability level of science literacy-based teaching materials was carried out using the overlap test involving 38 experimental class students as respondents. The results of the readability test showed that the teaching materials used had easy-to-understand criteria with an average readability of 74.11%. Easy-to-understand criteria indicate that students understand the meaning of sentences written in teaching materials.

**TABLE 2**. Feasibility Test Results of Teaching Materials

| NO | Code | Content Feasibility | Presentation Feasibility | Language Assessment | Graphic Feasibility | Science Literacy |
|---|---|---|---|---|---|---|
| **1** | V-1 | 90.63 | 92.50 | 94.23 | 93.18 | 87.03 |
| **2** | V-2 | 84.34 | 88.75 | 84.62 | 88.64 | 89.81 |
| **3** | V-3 | 93.75 | 93.75 | 92.30 | 90.90 | 85.18 |
| **Average** | | 89.58 | 91.67 | 90.38 | 90.90 | 87.34 |
| **Criteria** | | **Highly Feasible** | **Highly Feasible** | **Highly Feasible** | **Highly Feasible** | **Highly Feasible** |

Although the results of the readability of teaching materials have easy-to-understand criteria, 5 students only meet the readability requirements. The different results of each student are influenced by several factors. This fact is in line with the opinion of Keller (1983) in (Agussuryani et al., 2022) which explains that learning outcomes are a function of personal input and input that comes from the environment (environmental input). Personal input consists of (1) motivation or values, (2) expectations to succeed (expectancy), (3) intelligence and initial mastery, and (4) cognitive evaluation while input that comes from the environment includes: (1) motivational management, (2) management of learning activities, and (3) management of reinforcement (Abidin et al., 2017).

To increase the level of readability, it is necessary to improve teaching materials by re-examining words or sentences in teaching materials. Sakri argues that readability depends on the vocabulary and sentence structure chosen by the author for his writing (Kemdikbud, 2012). The use of uncommon vocabulary will be more difficult to understand than those using familiar vocabulary. In addition, long and complex sentence structures will make it difficult for readers to understand the reading. Therefore, words or sentences that were answered incorrectly by most students were then corrected or replaced with more familiar words and more effective sentences. This improvement aims to make the developed teaching materials easier for users to understand.

The developed science literacy-based teaching materials were tested for effectiveness by conducting a post-test. This aims to determine whether the increase in science literacy skills of experimental class students is higher than the control class. Data testing using the gain test is based on the pretest-posttest scores of control class and experimental class students. The results of improving students' science literacy skills are shown in TABLE 3.

**TABLE 3**. Results of Improvement in Students' Sais Literacy Skills

| Result | Experiment Group | Control Group |
|---|---|---|
| **Gain Test** | 0.63 | 0.38 |
| **t-Test** | 7.5739 | |

Based on the analysis of the equality test of two means obtained tcount = 7.5739 and ttable = 1.665 with $\alpha = 5\%$ and dk = 76-2 = 74. The data obtained shows that the value of tcount is outside the Ho acceptance area so Ho is rejected and Ha is accepted. Thus it can be interpreted that the increase in science literacy skills of students who use elearning teaching materials developed is higher than students who use teaching materials used in schools. The results of science literacy skills of control and experimental class students are shown in FIGURE 2.

The highest aspect of science literacy in the experimental class is technology and society while the second rank is on science interaction, the third rank is science as a way to think and the lowest is science as a way to investigate. The aspect of technology and society that occupies the first position with a percentage of 89.51% shows that students already have the skills to use science at various events in life. These results are by research (Dhanil & Mufit, 2023) which shows that the use of science, technology, and community learning models can improve science problem-solving skills in everyday life. The American National Science Teachers Association (NSTA) even considers that the interaction between science, technology, and society is the basis of science education because it emphasizes the importance of teaching the interactive relationship between science, technology, and society in making decisions on everyday problems (Sáenz et al., 2020).

Based on the analysis of the control class post-test results, the highest aspect of science literacy is science as an investigation. The results of this analysis reflect that the use of science material as material

for investigation or research in a learning case as demanded by PISA (Irwan, 2020). These results are in line with research conducted by Ibda (Ibda et al., 2023) on the analysis of high school physics textbooks in the Pati district based on science literacy content. The study shows that the textbooks in circulation contain a lot of knowledge, while the activities of thinking, investigating, and interaction with science, technology, and society are very few.

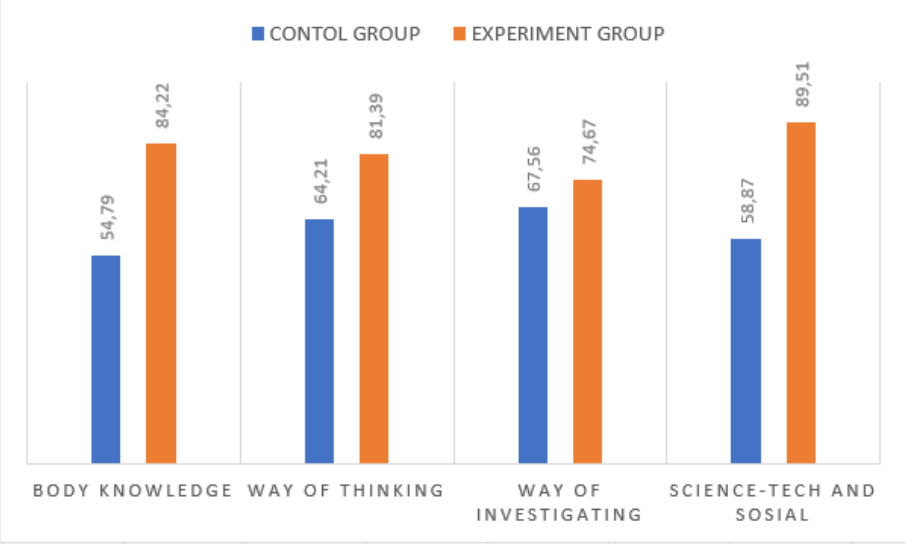


**FIGURE 2**. Ability of each aspect of science literacy in control and experimental classes.

Students' ability in the aspect of science as a way of thinking is still relatively low because the practice questions contained in the textbook used in the control class mostly ask students to do calculations using formulas directly, or as if students only enter known quantities into existing formulas and then calculate them. Questions that require the use of concepts are still lacking so students are not accustomed to answering post-test questions with these types of questions. Therefore, to improve learning outcomes, habituation is needed as stated by Herayanti (2017) that to develop students' ability to construct concepts cannot be done spontaneously. To develop a concept map, students need to be given practice or habituation first. Branch (Branch, 2009) also stated that the more often students learn about a topic, the better they can think about that topic. Thus, the more often students are exposed to problems of analysis and use of concepts, the better their abilities will be. Nevertheless, the percentage of science literacy skills of experimental class students was higher than in the control class, both in the aspects of science as a body of knowledge, science as a way to investigate, science as a way to think, and the interaction of science, technology, and society. Several studies conducted previously mentioned that using Moodle-based e-learning can increase students' learning independence. Moodle-based learning media applied in Physics subjects proved to be effective and easy to use by students. In addition, users of the media are also proven to be able to improve science literacy skills, when compared to conventional learning in the past. With e-learning, students are more independent in learning and the atmosphere is more active because they have studied before the learning begins. then this e-learning is more effective and efficient applied in classroom learning.

## CONCLUSION

Based on the results of the study, science literacy-based teaching materials on temperature and heat materials developed have the characteristics of science literacy content that are very suitable to be applied in learning Physics. Science literacy-based teaching materials on temperature and heat materials were declared feasible by three validators and had easy-to-understand criteria with an average readability of 74.11%. The increase in science literacy skills of students who use science literacy-based teaching materials is higher than students who use teaching materials at school. The increase in science literacy skills using science literacy-based teaching materials is 0.63 while students who use books used at school are 0.38. It can be concluded that the application of learning with e-learning can improve the science literacy of students. However, researchers still get some obstacles, namely the problem of

learning facilities and internet signals that are not sufficient enough, so this will be a special concern for further research.

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