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Development of Web-Based Physics Learning E-Modules to Improve Science Literacy

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Abstract

This study aimed to develop a web-based physics learning e-module using the content management system WordPress to help improve the science literacy of SMA Negeri 4 Empat Lawang students for the 2022/2023 academic year. The background of the problem in this study is in the form of low science literacy caused by the lack of variations in the use of other learning resources used by teachers during the learning process; teachers only use printed books provided by schools as learning resources, in addition to using methods in learning. Also, they only use the conventional lecture method, which tends to attract students' attention and has been going on for approximately the last three years. This type of research used a research and development method or Research and Development with the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), then for the evaluation stage using formative evaluation, according to Tessmer. The population for this study consisted of 43 students consisting of 13 students in the one-to-one and small group stages, and 30 other students for the evaluation stage. The results of this development are e-modules that have been validated by experts and are declared valid with an average of 84.9%. Then, the e-module developed was also declared practical with an average score of 78.9% in the one-to-one and small group stages. And for the effectiveness of the developed e-module, it got an N-gain score of 0.70 for increasing students' science literacy in the high category.

Keywords: CMS Wordpress; E-Learning Module; Science Literacy

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INTRODUCTION

Physics is quite a fun subject because the learning discusses the symptoms and properties of objects in the surrounding environment that are easily found in everyday life (Winda & Dewi, 2019). However, in practice, this is not the case; many students think physics is difficult and boring. This is due to students' low motivation in learning and the use of methods and media used by teaching teachers, which have not been able to stimulate students' abilities in learning. Giving motivation to a student means that we must move students to do something or want to do something. Therefore it is

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important to create a learning atmosphere that can foster motivation to continue learning, one of which is science literacy. Science literacy can develop students' abilities to understand the basic principles and processes of scientific phenomena in everyday life (Lestari et al., 2021; Mahtari et al., 2019; Sharon & Baram-Tsabari, 2020). The data from the Program for International Student Assessment (PISA) is an assessment program for international students held every three years. Students' mathematical literacy ability in Indonesia is still classified as low based on the results of research conducted by Trend in International. The latest data from PISA show that Indonesia is in the bottom 10 of the 79 participating countries. The average reading ability of Indonesian students is 80 points, far below the average. The ability of Indonesian students is also still below the achievement of students in ASEAN countries. Indonesian students' average reading, math, and science skills are 42 points, 52 points, and 37 points below the ASEAN average. From these data, we can see that Indonesian students' science literacy is generally low. This condition encourages the need for efforts to improve science learning in schools gradually and continuously. Efforts to improve the quality of learning in schools need to be supported by information about the extent to which students' science literacy achievements are viewed from its aspects and must also be adjusted to the goals of Indonesia's national education.

To understand science literacy, students must first have the motivation to learn. One way to foster student learning motivation is to use the right media. Teachers can create and develop learning media for students, but the use of the right media will affect the learning process of students during learning; for that, a teacher must be able to have or choose the right learning media to use during the learning process (Hartini et al., 2017; Sabaryati, 2019; Zainuddin et al., 2019).

The advancement of technology and information in this century has had a significant impact and influence on the world of education, especially in Indonesia. According to Solihudin (2018), one way that can be done to improve the quality of Indonesian education is by utilizing technology and information in learning. According to Muzijah et al. (2020), one of the media that has the opportunity to improve the quality of education is by developing a media using a gadget in the form of a website-based e-learning module designed by the teacher to be studied by students independently with teacher guidance and presented systematically.

One of the e-modules that can be developed is an e-module based on the WordPress CMS. CMS allows web creation without having to change document formats into web formats such as HTML so that documents can be uploaded in word or PowerPoint format and so on, making CMS efficient to use (Nuraini et al., 2022; Saprudin et a., 2021; Suyoso & Nurohman, 2014) .

The innovation raised by the researchers in this development is using the discovery learning model for the implementation stage in the classroom at the time of learning for teaching materials to be developed. discovery learning is a learning model that can be used to train and develop active learners' ways of learning (Handayani et al., 2017; komariah et al., 2017). Discovery learning requires the active role of students to participate directly in discovering the concept of knowledge. In addition, students can practice analytical thinking and try to solve existing problems. Discovery learning is a learning strategy that guides students to find concepts with guidance from the teacher and perfects the concepts obtained from the theory being studied

(Mastuang et al., 2017; Pratiwi et al., 2017). Discovery learning is a series of learning activities in which the teacher presents teaching materials that provide students opportunities to seek and find their concept of the material being studied (Sari & Lubis, 2021). According to Aprillia & Asri (2017), using the Discovery learning model can produce a good impact by increasing students' science literacy. One of them is to train students to understand the concepts and principles of material directly based on their learning experience so that some indicators of science literacy can be fulfilled. Discovery learning guides students to identify what they want to know independently. Then students will organize and construct information obtained and understood into other forms and produce final concepts.

From the results of the survey and interviews conducted by researchers with the school, which in this case is the teaching teacher, the results are in the form of low science literacy of students. This is evidenced by the results of the teacher's information and the initial survey conducted; for the level of science literacy, students were given questions as a pretest, and the average score was 45.8 in the low category. When surveying the classroom, the researcher found many students with little motivation to be actively involved in learning. Many students were noisy and could not focus on the learning process. One of the factors causing this low motivation to learn is because the method used by the teacher is still using the conventional method in the form of the lecture method, which has been carried out for approximately the last three years both online and now through face-to-face learning again.

With the problems found at SMAN 4 Empat Lawang, the researchers tried to provide a solution by developing a web-based physics e-module using the WordPress CMS. The reason for using a CMS-based web (Content Management System) in this development is that it is easier and simpler to use and manage and does not require special knowledge of programming languages. Based on the background description, the researchers intend to study the "Development of Web-Based Physics Learning E-Modules to Improve Students' Science Literacy". This study aimed to develop a web-based physics learning e-module using the content management system WordPress to help improve the science literacy.

METHOD

This study used the research and development (R&D) method and the ADDIE model with steps (Analysis, Design, Development, Implementation, and Evaluation). In the evaluation stage, this study uses Tessmer's formative evaluation, which consists of the self-evaluation stage, expert review, one-to-one, small group, and field test. The use of Tessmer evaluation is considered more effective because this evaluation can be carried out in more detail at each step by determining the success criteria so that it can proceed to the next stage of ADDIE development (Figure 1).

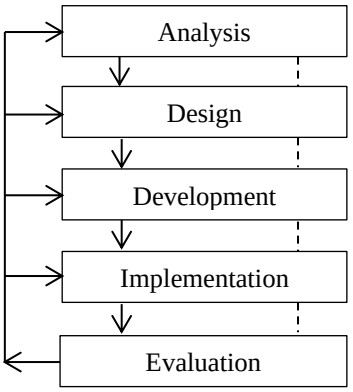

Figure 1 ADDIE stage chart with the R & D method

In this study, the implementation of the ADDIE model consisted of: (1) The analysis phase was carried out at the initial stage in the form of surveys and interviews, which became the initial basis

for the need for development in this research. (2) design, at this stage, the researcher prepares the e-module design that will be developed in the study, which consists of learning strategies (using discovery learning models for application in learning), selecting e-module designs, planning designs, making documents for e-modules, and design evaluations conducted by researchers. (3) Development, at this stage, after the researcher has made and determined the design of the e-module to be made, the researcher then carries out the development stage by making the e-module according to the previous design and will then be reviewed by supervisors 1 and 2 Further revisions will be made by the researcher if there are things that need to be corrected from the supervisor's input. After this stage, prototype one will be obtained, which will proceed to the expert review stage. (4) Implementation, at this stage, the e-module that has passed the self-evaluation stage and is assisted by a supervisor who is then revised further will be validated by experts; in this case, there are three experts, namely material, language, and design experts to obtain product criteria in the valid category. (5) Evaluation, after the e-module is declared valid and feasible to be tested in the next learning, an evaluation stage will be carried out. This evaluation stage uses formative evaluation, which begins at the self-evaluation stage in the previous stage.

In this study, a test instrument was used in the form of science literacy questions consisting of 20 questions referring to the TIMSS indicator or Trend in International Mathematics and Science Study (Gusliana et al., 2019). Data analysis techniques in the study consisted of walkthrough data analysis, questionnaire data, and test data. The walkthrough data analysis technique is one of the methods used to measure the validity and practicality of a product in development, which involves several experts. The walkthrough analysis was carried out by giving validation sheets to the experts, which would then be analyzed descriptively with a recap of the results scores of each validator by category; very good (5), good (4), quite good (3), not good (2), and very bad (1). The average value obtained will be categorized as follows on Table 1.

Table 1 Validation aspect intervention

Category	Range
Very Valid	(81-100%)
Valid	(61-80%),
Moderate	(41-60%)
Invalid	(21-40%),
Very Invalid	(0-20%)

(Pangestu et al. , 2019)

Questionnaire data analysis is one of the data collection techniques that give questions in the form of oral or written to be answered by respondents (Sugiyono, 2019). This data analysis determines the practicality of a product being developed. At this stage, the questionnaire data analysis was carried out at the one-to-one and small group stages with student responses in categories; very good (5), good (4), quite good (3), not good (2), and very bad (1). It is adjusted to the criteria of practicality on Table 2.

Table 2 Practicality criteria

Category	Range
Very Practical	(81-100%)
Practical	(61-80%),
Quite Practical	(41-60%)
Impractical	(21-40%),
Very Practical	(0-20%)

(Dwiningsih & Latifah, 2018)

Test data analysis is a procedure or method used to measure something in a predetermined way and rules. This analysis was carried out at the field test stage by giving questions in the form of a pretest and posttest to be answered by students. This analysis was conducted to measure the students' science literacy. The increase in students' cognitive results can be seen from the n-gain value of the students' pretest and posttest results. N-

gain score was then categorized for high (N-gain > 0.7), moderate (0.3 N-gain 0.7), and low (N-gain < 0.3) criteria (Yektyastuti & Ikhsan, 2016).

RESULT AND DISCUSSION

Results of the analysis stage

At this stage there are several steps taken by researchers in analyzing, the first stage begins with; a) Needs analysis, this analysis is the basis for the need for this development. This stage is an initial study conducted by researchers and the result is the need to develop learning media as teaching materials considering that so far there has been no variation in use by teachers. b) Media analysis, for the media to be used, namely smartphones by utilizing the WordPress CMS which will be used as a forum to create web-based learning e-modules. c) Student analysis, at this stage the researcher identified the class of students who would receive treatment in this study, and the results for the subject of this study were class XI IPA, which amounted to 47 people with details of 13 students in class XI IPA 1 for the one-to-one trial stage. one and small group, and 30 students of class XI science in the field test stage. d) Content analysis, at this stage the researchers reviewed the syllabus, core competencies/basic competencies, and learning indicators and obtained results for the material to be developed later, namely the wave material in the light wave sub-discussion. e) Structural analysis, at this stage the researcher determines what commands will be used in the web-based e-module that will be developed later. The command submenu that will be made is the menu for the material, learning videos, practice questions, student worksheets, assignment collection, bibliography, and author profile.

Results of the design stage (design)

The second stage of the ADDIE development model is “design”; At this stage, the researcher makes an e-module design that will be developed based on the results of the previous analysis stage, and the results of the design stage can be seen in Figure 2.

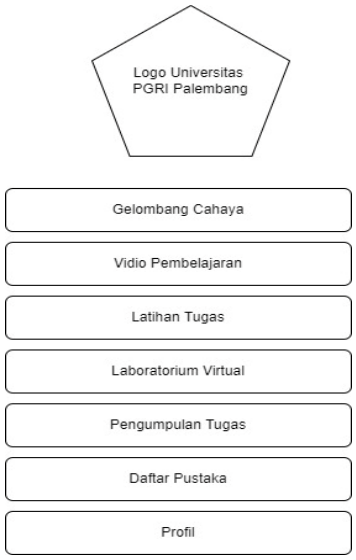

Figure 2 E-Module design

Results of the development stage (development)

Based on the design made in the previous stage, the researchers then developed and produced web-based e-modules using the WordPress CMS. The following are the results of the development of a draft e-module based on the design that has been made. The initial display of the e-module is based on the design that has been made, this display will appear on the initial menu when students access the learning e-module (Figure 3).

Figure 3 Initial view of e-module menu

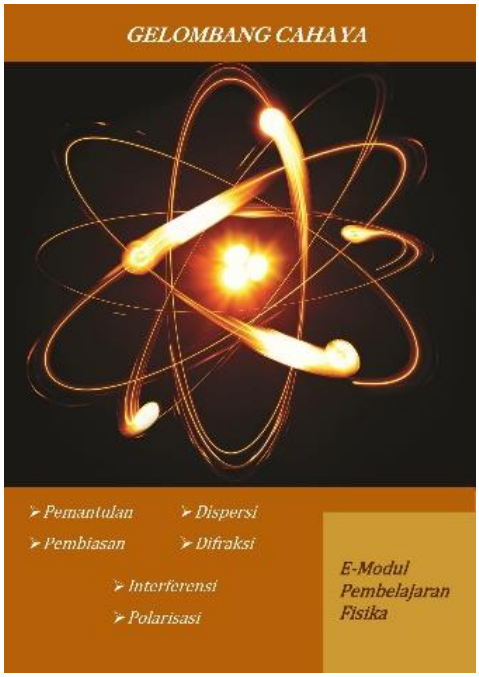

Figure 4 Light wave material menu home screen

The initial display on the learning material menu in the e-module, this menu contains learning materials that will be used during the teaching and learning process in class. Display a learning video menu that can be accessed by students in addition to learning material about light waves (Figure 5).

Figure 5 Light wave material learning video start menu display

The display provides the menu of practice questions and assignments as an evaluation to measure the extent to which students' understanding of the material provided.

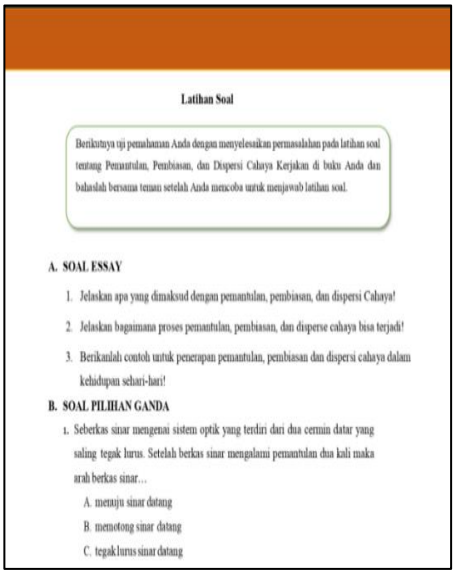

Figure 6 Evaluation exercise start menu display

Initial display for student worksheets as a guide for students in conducting experiments using a PhET simulation rock virtual laboratory (Figure 7).

Figure 7 Initial menu display of student worksheets for practicum

The initial display for the Phet simulation virtual laboratory menu is a place for students to conduct experiments, students can access performance doing practicum by clicking

on the link provided, then students can do practicum by following the steps in the student worksheet (Figure 8 and 9).

Figure 8 Start menu display for virtual laboratory

Figure 9 Initial menu display for collecting task results and evaluation exercises

The task collection menu displays as a place for students to collect assignments that have been given by the teacher.
For clarity of the images displayed, please visit the site: *rolirikewordpress.com*
After the development stage is completed and the final result of the developed product is obtained, the product will then be validated by experts consisting of material experts, linguists, and design experts. From the validation process by these 3 experts, the average score is 84.9% in the very valid category because it scores 81%-100% with a very valid category, with details of material aspects at 86.6%, language aspects at 84.7%, and design aspects at 83.6%.

Implementation stage results

The next stage after the e -module has been validated by experts and declared valid will be tested at the one-to-one stage or individual and small group trials or small group trials. At this stage, a one-to-one trial was carried out involving 3 students and *a small group* involving 10 students. In this stage, the results were obtained, namely for the *one-to-one stage* with an average score of 76.6% which was included in the practical criteria, and for *the small group* the average score was 81.2% also in the practical criteria.

Evaluation stage results

At this evaluation stage or field test, the e-modules that have been developed and tested at the one-to-one and small group stages will be used during classroom learning. This evaluation stage will measure the extent to which the level of science literacy and student motivation after receiving treatment using a physics learning module using WordPress CMS on light wave material. As a comparison in measuring the level of students' scientific literacy for this evaluation stage, previously the researchers had given questions and questionnaires to students when conducting a field survey which was then calculated as a pretest score, then the researchers gave the same questions to students after they received treatment using e-mail. The physics learning module is developed, and the results are then calculated as posttest scores which can be seen in Figure 10.

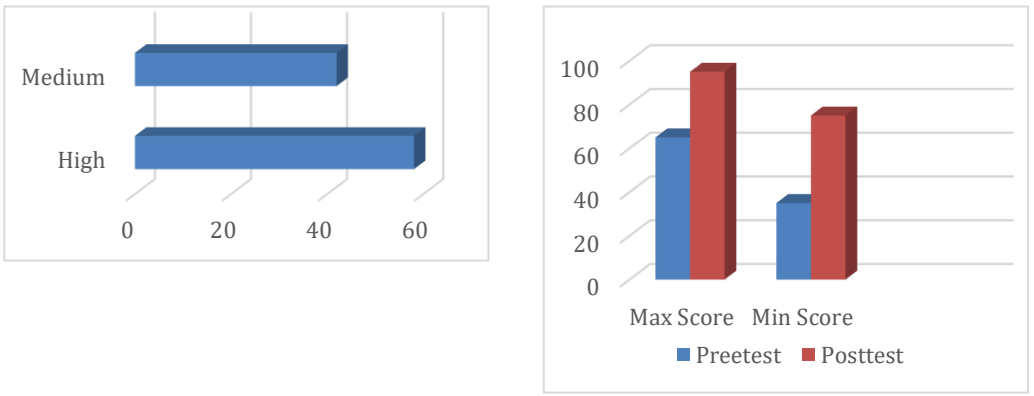

Figure 10 Science literacy N-gain value and results of pretest and posttest scores

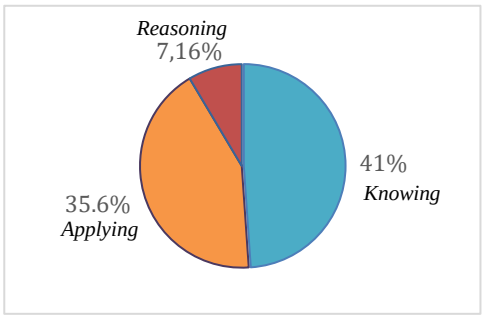

Figure 11 Graph of student indicator

From the graph above, it can be seen that the average pretest score of students is 45.8, while the posttest score obtained by students is 83.7. From the pretest and posttest scores obtained by students, it will then be calculated again to get the N-gain value as shown in Table 3.

From these data, it can be seen that of 30 students, 13 students are in the medium category and 18 students are in the high category. So it can be concluded that the students' science literacy have increased. The data will then be recalculated for the acquisition of student scores per indicator which can be seen in the following graph.

Table 3 N-gain value

The mean value of *pretest*	***Posttest* mean score**	***N-gain***	**total students**	**Percentage**	**Category**
		N-gain > 0.7	18	58	Tall
45.48387	83.70968	0.3 N-gain 0.7	13	42	Currently
		N-gain < 0.3	0	0	Low

Based on Table 3, the comparison of the data obtained at the pretest and posttest stages for the level of science literacy can be seen. Factors that affect students' science literacy in learning are the material developed which is then taught using the discovery learning model and provides examples of real problems in everyday life.

In addition, the e-module being developed is flexible enough to use because it can be accessed using Android or a laptop/computer, as research has been conducted by Winda & Dewi (2019) that e-learning-based learning can be used anytime and anywhere. After all, it does not limit the scope of students learning by accessing it without knowing the time.

According to a literature study by Saprudin et al. (2021), e-modules are currently widely used in physics learning. E-modules can be designed using professional 3D page flip software, Adobe Animate CC, Sigil, Kvisoft Flipbook Maker, Exe-Learning,

Android-based applications or CMS WordPress application integration, YouTube video sharing sites, and QMS class markers. The development of e-modules in physics learning is aimed at improving critical thinking skills, improving science process skills, science literacy, motivation, and increasing student learning outcomes, and all of this has been tested to deserve an average score in the category of valid, practical, and also has an effect potential.

An electronic module or e-module is one of the teaching materials considered capable of being used as learning materials that can improve science literacy (Nurjannati et al., 2017). According to research conducted by Oksa (2020), using e-module products is quite effective for increasing student learning motivation. The results of the validity, practicality and potential effects of the e-module were obtained from data obtained by researchers through expert response questionnaires, student response questionnaires, and student test results. The development of this e-module begins with the researcher conducting interviews with the teacher concerned to discover the school's problems.

Previous research conducted by Nuraini et al. (2022) regarding the development of teaching materials in the form of electronic modules with the title "Development of WordPress CMS-Based Physics E-Modules on Material Concepts and Quantum Phenomena of Class XII High School Quantum" produced e-modules that were feasible or valid with the average percentage of 85.9%. The similarity of this research is that they both use WordPress CMS to develop learning e-modules.

This research is supported by Muzijah et al. (2020), whose results show that web-based developed e-modules are appropriate for training students' science literacy. The increased learning outcomes can see after using the e-module to train students' scientific literacy in class XI MIPA 4 SMAN 8 Banjarmasin. In addition to this research, research conducted by Karlina et al. (2021) shows that using web-based e-modules as teaching materials are more effective in increasing student motivation than using teaching materials in the form of books.

CONCLUSION

This research produced a product in the form of a web-based physics learning e-module using WordPress CMS on light waves material for class XI SMA which was declared valid, practical, and had a potential effect to be used and applied in the learning process. This can be seen in the validation data by experts who have obtained an average score of 84.9%. This validation includes material experts who are carried out to see the suitability of the e-module and indicators of learning achievement with the material to be taught, validation by linguists related to aspects of the relevance of the language used in the e-module, and design expert assessment is carried out to see the completeness of the information, the use fonts, layouts, photo image illustrations and display designs. Furthermore, an average value of 78.9% was obtained in the practical category for practicality from the one-to-one and small-group trial results. For the effectiveness of the e-module, the students' N-gain score was obtained at the evaluation stage with a score of 0.70 for the students' science literacy level in the high criteria category.

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