Module Electronic Sound and Light Wave Developed By Scientific Approach For Improving Science Literacy

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Abstract. The purpose of this study is to develop a physics learning media for Sound and Light wave physics learning in high school students. The research method used Analyze, Design, Development, Implementation and Evaluate (ADDIE) with one group pretest-posttest design method to improve scientific literacy. The research participants are students in grade eleven of high school students. The E-module was validated by experts and the results showed 84.59% for media expert, 83.49% for material expert, and 79.75% for learning expert with very proper category. The instrument validation results for high school students were 84.27% with the very proper category. Based on the results of scientific literacy for high school students, the normalized gain score 0.79 with a effective category means E-module can improve students' Science Literacy. So it can be concluded that, there is improving scientific literacy in students using the sound and light wave e-module based on a scientific approach.

1. Introduction
The scientific learning approach provides an opportunity to use logic, discuss, formulate simple questions that provide guidelines for solving main problems, formulate theories or several possible ways to solve a problem or several solutions, to conduct experiments and to draw conclusions based on data collected or experimental results [1]. The utilization of the scientific approach in learning has a moderate effect on student’s scientific literacy skills [2]. Therefore necessary the Factors that can influence students' scientific literacy results are the selection of textbooks, worksheets, learning models, and scientific literacy-based evaluation tools [3]. Based on the learning resources are needed. E-modules are non-printed teaching materials that can be used to assist students in the teaching and learning process. These teaching materials can help the role of educators in the classroom, so that students can learn anywhere and anytime [4]. E-modules are needed to complete student handbooks, one of the characteristics of media learning materials that motivated and generated student’s curiosity [5]. The implementation of interactive e-modules can improve self-directed learning of students with self-confidence, high motivation, initiative and learning outcomes [6].

Assessment of learning outcomes in Indonesia consists of literacy, numeric and character assessments. Scientific literacy is related to understanding scientific concepts, knowledge and processes for making decision [7]. Scientific literacy is not just an ordinary thinking ability, but an ability that can solve problems using scientific concepts [8]. Scientific literacy gives students instruction to apply their scientific knowledge and recognize to solve the real problem in their life [9]. Scientific literacy shows that science is a contextual factor that underlies the emergence of analysis. Student’s scientific literacy
includes several aspects, namely explaining phenomena scientifically, evaluating, interpreting, designing and average scientific literacy [10].

Based on the results of research conducted by Linda, it shows that the increase in the student’s self-directed learning processes before and after using e-modules increased with medium category [6]. Elizar's research results from the development, scientific approach module effectiveness have an influence on learning outcomes [11]. Preliminary research shows about 71.6% of students experience learning difficulties. Students difficult to understand their textbooks on sound and light waves in physics learning. Based on the preliminary research, it is necessary for development sound and light wave e-modules based on a scientific approach to improved science literacy.

2. Methods
This study aims to develop the sound and light wave e-module based on a Scientific Approach to improve scientific literacy skill of the students. The subjects used in this study are thirty students of class XI from the same school. The research method used is Analyze, design, Development, Implementation and evaluation (ADDIE) which is evaluation is carried out at each stage before moving on to the next stage. The ADDIE model is one of the systematic instructional designs which has five stages, namely, Analyze, design, Development, Implementation and evaluation, with a diagram in figure 1

![Figure 1. ADDIE Model Flow](image-url)

Figure 1 is the ADDIE model flow. The explanation of the ADDIE model is as follows:

2.1. Analyze
Analysis in the ADDIE model is to collect data and initial information to identify problems and needs in schools in physics learning, find out the material that is in accordance with the developed media, and find out the opinions of teachers and students about the development of e-modules.

2.2. Design
The design in the ADDIE model is the preparation of e-modules using applications to create e-modules. Then design the e-module as a companion to the teaching materials needed by students in order to demonstrate competence after participating in the learning process.

2.3. Develop
Development in the ADDIE model is developing, namely developing product designs that have been made by making e-modules using software. The developed e-module consists of the material content of sound waves and light waves. After making the e-module, then the product validation test is carried out to media experts, material experts, and learning experts assess the e-module product with the aim of obtaining input and improvement.

2.4. Implementation
The implementation of the ADDIE model is implemented for high school students in class XI by conducting field tests, students fill out student validation of the e-module product that has been developed. The results of the questionnaire are used as the basis for evaluating e-module products.
2.5.5. Evaluation

The evaluation of the ADDIE model is the evaluation of the e-module product by testing the effectiveness of the e-module product that has been developed in helping to improve the scientific literacy of high school students.

One group pretest-posttest design method to improve scientific literacy, before and after the using of E-modules. The results of the pretest and the posttest literacy data analysis were tested for normality. The data collection was carried out by giving a pretest and posttest, which contents were done after the learning process. The pretest and posttest values obtained were then analyzed using n-gain score was developed by (Hake, 1999) with following formula [12]:

\[ N\text{-gain} = \frac{S_{\text{post}} - S_{\text{pre}}}{S_{\text{max}} - S_{\text{pre}}} \]  

(1)

The N-gain obtained is then interpreted based on the criteria in table 1.

### Table 1. Criteria for the N-gain Value

| N-gain score | Grade Level          |
|--------------|----------------------|
| 0.70 > N-gain| Effective           |
| 0.30 ≤ N-gain≤ 0.70 | Effective Enough   |
| N-gain< 0.30  | Less Effective       |

3. Result and Discussion

The sound and light wave e-module with a scientific approach can make students learn more independently. This is because the e-module is presented with attractive illustrations. E-modules can be accessed online, so students can study independently. The topic of sound and light waves in the e-module is developed based on the stages of a scientific approach that leads students to think scientifically. The stages of the scientific approach to the sound and light wave e-module are clearly written so that they can help students in the thinking process. Sound and light wave e-module based on a scientific approach applying the five components of a scientific approach that is observing, questioning, experimenting, associating, and communicating. At the observing stage, students observe or watch video shows and relate them to the topic being studied. In the questioning stage, students click on the e-module and ask questions about the video being shown. At the stage of experimenting, students learn the topics that are already in the e-module and make groups to do the practicum contained in the e-module. At the associating stage, students relate the information obtained with the lessons learned. At the communicating stage, students draw conclusions and communicate them directly or students can write on e-modules. There are evaluation questions at the end of each sub-topic that can be used as an evaluation by students after studying sound and sound waves. In addition, the developed e-modules are presented comprehensively in accordance with the basic competencies that students must have. Following are some examples of sound and light wave e-module based on scientific approach shown in Figure 3.
Figure 2. is the home page, on the home page there are several tools and covers of the e-module. The tools on the home page are as follows: scrolling the e-module page, zooming in to enlarge and reducing
the e-module size, thumbnails to reduce the e-module size, auto flip to move the e-module automatically, Backward, First to return to the e-module, first page, previous page, next page, last to go to the last page, forward, print, full screen, share and select text.

Figure 3. is a learning activity contained in the e-model. In learning activities there is a scientific approach. Figure 3 shows several stages of the scientific approach. At the observing stage, students observe or watch video shows and relate them to the topic being studied. In the questioning stage, students click on the e-module and ask questions about the video being shown. At the stage of experimenting, students learn the topics that are already in the e-module and make groups to do the practice contained in the e-module.

Figure 4. shows several stages of the scientific approach and evaluation questions. The scientific approach in Figure 4 is At the associating stage, students relate the information obtained with the lessons learned. At the communicating stage, students draw conclusions and communicate them directly or students can write on e-modules. There are evaluation questions at the end of each sub-topic that can be used as an evaluation by students after studying sound and sound waves.

The results of the e-module products validation are carried by 3 validator experts included, namely material experts, learning experts and media experts. The results of the material expert of e-module validation can be seen in the table 2.

**Table 2. Material Expert Validation Test Results**

| Assessment Aspect    | Results  |
|----------------------|----------|
| Self Instruction     | 80.21%   |
| Self Contained       | 85%      |
| Adaptive             | 87.5%    |
| User Friendly        | 81.25%   |
| Mean                 | 83.49%   |

The average result of material expert validation is 83.49% on the very proper interpretation.

3.1. Learning Expert Validation Results

Learning validation is carried out to find out how proper the e-module is to be used in learning. The results of the validation of the learning expert e-module can be seen in table 3:

**Table 3. Learning Expert Validation Test Results**

| Assessment Aspect      | Results  |
|------------------------|----------|
| Contents               | 93.75%   |
| Usefulness             | 75%      |
| Scientific approach    | 75%      |
| Serving Eligibility    | 75%      |
| Mean                   | 79.75%   |

The average result of the validation of learning experts is 79.75% on the very proper interpretation.

3.2. Media Expert Validation Results

Media expert validation is carried out to find out how proper e-module is as a medium in learning. The results of the media expert e-module validation can be seen in table 5:
Table 4. Media Expert Validation Test Results

| Assessment Aspect | Results  |
|-------------------|----------|
| Display           | 82.81%   |
| Programming       | 86.36%   |
| Mean              | 84.59%   |

The average result of media expert validation is 84.59% on the very proper interpretation.

3.3. Trial

Trial of e-module on small group and big group of high school students. The students used E-Module based on scientific approach was conducted to see how feasible the e-module was used in learning. Trials were carried out by teachers and students. The test results can be seen in table 5:

Table 5. Test Results

| Assessment Aspect       | Results  |
|-------------------------|----------|
| Small group of students | 91.56%   |
| big group of students   | 84.27%   |
| Teacher                 | 88.75%   |

Based on the experimental results of thirty students, pretest and posttest were analyzed by normalization test. Pretest and posttest analysis showed normal results. The pretest and posttest have the average N-gain score was 0.79 with an effective interpretation. So it can be concluded that there is improving scientific literacy in students using the sound and light wave e-module based on a scientific approach.

4. Conclusion

Based on the result and discussion, it can be concluded that e-modules have been developed based on a scientific approach. The sound and light wave e-module has been developed in the proper categories for materials, media, and self-directed learning. Overall the development of the light and sound wave E-Module based on a scientific approach can improve the scientific literacy of students in high school.

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