Development of E-Module with A Scientific Approach To Improve The Student’s Critical Thinking Skills At Class Xi Student High School In Optical Tools Material

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Abstract. This research aims to produce a physics learning media in the form of e-module with a scientific approach to learning physics on the optical instrument material for SMA / MA students. The subjects of this research were 46 students of class XI SMA Muhammadiyah Kota Bima. This developmental research refers to the method developed by ADDIE (Analysis, Design, Development, Implementation, Evaluation). Quasi-experimental method used in this research to test the effectiveness of the product with a research focus on e-module optical tools with a scientific approach to help improve students’ critical thinking skills. The results of e-module validation by media experts showed 87.5%, material expert validation 82.78%, and learning expert validation 83.84%. Based on validation by media, material, and learning experts, it shows that this e-module in terms of several indicators used for validation has very feasible outcome criteria. Based on the results of trials in small and large groups of students, it was obtained that the average total aspect score of 88.78% and 86.6% was categorized as very feasible and the impact was measured on students’ critical thinking. Based on the results of the D'Cohens test, users of e-module optical tools can provide effectiveness in improving students' critical thinking skills by 0.83 in the moderate category. So, it can be concluded that the e-module that has been developed by researcher can improve the students' critical thinking skills at SMA / MA.

1. Introduction

Education in schools is directed not only at mastering and understanding scientific concepts, but also at improving students' thinking abilities and skills, especially higher-order thinking skills, namely critical thinking skills, teachers need to teach their students to learn and think (teaching of thinking). [1].

The learning process that is often carried out by teachers is still dominant in the aspects of knowledge and understanding the concepts, so as a result, students do not develop critical thinking skills as desired. The lack of critical thinking skills of students can be seen from the 2015 PISA (Program for International Student Assessment) report which shows that Indonesia can only be ranked 62 out of 69 countries in the field of science [2]. When compared with the other countries.

One of the students' thinking skills can be developed by using assistive media in the learning process and the teacher can choose the right media. According to [3], Students 'critical thinking skills can be developed with the use of appropriate learning media, the selection of appropriate learning media can determine the success of developing students' critical thinking skills.

E-Module Assisted Guided Inquiry to Improve Critical Thinking Skills, the results of the analysis of increasing critical thinking skills showed that both classes were able to improve students' critical
thinking skills, but the experimental class was more effective than the control class. The conclusion of this study is that learning with e-module assisted inquiry guide can improve students’ critical thinking skills [4]. The development of web-based e-modules to improve the competence attainment of physics knowledge in high school static and dynamic electricity material, this research shows that the development of web-based e-modules on static electricity and dynamic electricity can be used as multimedia learning and can increase the achievement of students' knowledge competencies. [5]. The effect of the Problem Based Learning (PBL) learning model and the ability to think critically on the learning outcomes of junior high school students 'ecosystem material, it is obtained information that there is an influence of the Problem Based Learning model and the ability to think critically on the learning outcomes of junior high school students' ecosystem, there is an interaction between Problem Based Learning learning models and the ability to think critically on the learning outcomes of junior high school students' ecosystem material [6]. The development of a physics e-module based on Problem Based Learning (PBL) on temperature and heat material to improve the science process skills of high school students "shows that this e-module in terms of the indicators used for trials has very good criteria and is suitable for use as learning teaching materials [7].

Based on the research results of Ismi Rahayu, Sukardi with the title “The Development Of E-Modules Project Based Learning for Students of Computer and Basic Networks at Vocational School”*The effectiveness of e-module project-based learning is stated to be effective in improving learning outcomes [8]. The results of research by Imron Hamzah and Sriyani Mentari “Development of Accounting E-Module to Support the Scientific Approach of Students, Grade X Vocational High School” from the result, it can be concluded that the scientific approach to supporting accounting e-module is appropriate and able to improve students learning motivation and result [9].

Based on the description above, motivated research examines the reality conditions faced by students in physics lessons. The research with the title "the Development of e-Module with a Scientific Approach to Help the Critical improve Thinking Skills of Senior High School Students class XI in Optical Instrument Material".

2. Method
The research method used is the research and development (R&D) method, which is a method used to develop and validate a product used in learning. The development model that will be used is the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model. ADDIE model contains learning activities that are deliberately designed and developed to create a learning process in students through, in this process, students will have the ability include the knowledge, skills, and attitudes which needed to carry out tasks and jobs [10].

This stage begins with the Analyze stage by identifying the problems in research and knowing what students and educators need in learning physics, knowing the problems that occur in the field, both students and educators, especially learning resources and learning media that are appropriate, easy to use, anytime and anywhere. Initial research is carried out, namely needs analysis.

Design Phase Planning for the development of e-module physics with a scientific approach to increase critical thinking is prepared by compiling an e-module requirement plan, namely determining the e-module material, analyzing the characteristics of students who will use the e-module, dividing and conceptualizing the material into sub-material, determining content in the e-module (text, pictures or graphics, video, animation, and evaluation), write the e-module script, determining the e-module media instrument (media validation sheet and rubric, material validation sheet and rubric, student response questionnaire, response questionnaire teacher).
Table 1. Steps of scientific approach and delivery of E-module material

| Learning Steps       | Summary                                                                                                                                                                                                 |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Observe              | This stage begins with basic questions related to the lesson to be learned. In the e-module, this section is displayed in the form of images, videos or animations related to the examples or events and is followed by several questions. |
| Ask                  | Teachers and students will provide each other with information or questions according to the problems given at the observing stage.                                                                         |
| Gathering Information| At this stage, students collect a number of information or facts in order to answer questions and problems posed by previous students. You do this by reading the material in the e-module, or an experiment that will be monitored by the teacher. |
| Associate            | At this stage, students process information or problems that have been collected by discussing them with friends in a group.                                                                             |
| Communicating        | At this stage, each group conveys the results of learning activities to others clearly both orally and in writing.                                                                                       |

Development stage This stage carries out development activities, namely combining material content such as writing titles, writing text and creating pictures using Microsoft Office Word 2007 and Corel Draw X5, making the front and back covers of e-modules using Microsoft Office Word 2007 and storing them in PNG format, Editing video and pictures supporting material using AVS Video editor 6.5 software, Creating questions using Google Form software, Making formative evaluations, Combining all e-module content (text, pictures or graphics, video, animation, and evaluation) using Flip PDF Professional and include it in the 3D Pageflip Professional Software.

The revised e-module implementation phase, according to the results of the validation and small group testing will then be tested on large groups, namely students of SMA Muhammadiyah Kota Bima. Large group trials were carried out during the e-module implementation process in the experimental class. Furthermore, students will get learning using e-modules. After learning is complete, students are given a large group trial questionnaire.

Evaluation Stage In the evaluation stage, which aims to determine the feasibility of the product and the effectiveness of the product that has been developed in helping to increase critical thinking. The resulting data obtained from the validation of media experts, material experts, and learning experts.

The d'cohens test aims to test whether the e-module with a scientific approach is effective for improving critical thinking skills, according to the Effect Size Criteria. From the results of the evaluation and data analysis, d'Cohens is categorized as moderate. So it can be concluded that the developed e-module is effective for learning physics.

3. Result and Discussion
This research was conducted to develop a product in the form of an e-module with a scientific approach to the subject matter of optical devices. e-module developed has been tested for its feasibility by media experts, material experts, and learning experts. The results of the developed e-module validation are as follows:

Table 2. The Result Of The Media Expert Validation Test

| Aspect Assessment  | Result  |
|--------------------|---------|
| Display Aspects    | 87.5 %  |
| Programming Aspects| 87.5 %  |
Table 3. The Result Of The Material Expert Validation Test

| Aspect Assessment      | Result  |
|------------------------|---------|
| Self Instructional     | 84.78 % |
| Self Contained         | 87.5 %  |
| Stand Alone            | 75 %    |
| Adaptive               | 79.16 % |
| User Friendly          | 87.5 %  |

Table 4. The Result Of The Learning Expert Validation Test

| Aspect Assessment | Result  |
|-------------------|---------|
| Contents          | 81.73 % |
| Strategy          | 84.37 % |
| Evaluation        | 85.42 % |

Based on the results of expert testing, the average percentage of assessment given by material experts in all aspects is 87.5% as shown in table 1 above, while the average percentage of assessment by media experts and learning experts as shown in tables 2 and 3 is 82.78% and 83.84% with very good interpretation. This shows that the e-module developed is suitable for use in learning physics. The following image shows a page view showing of the final developed e-module.

Figure 1. Display of e-module Development Results

Table 5. Indicators of Critical Thinking Skills

| Critical thinking indicator       | Critical thinking sub indicator                                      |
|-----------------------------------|-----------------------------------------------------------------------|
| Give a simple explanation         | Focusing the question, Analyzing the argument, Answering a question   |
| (elementary clarification)        | (elementary clarification)                                            |
| basic support                     | Adapting to the source                                                |
| Inference                         | Induce and consider the results of induction                          |
| advanced clarification            | Define terms and consider them                                        |
| strategy and tactics              | decide/determine actions and Interact with others                     |
Based on the results of trials on physics teachers and students, data is obtained as shown in the graph as follows.

Based on the results of the teacher trials, the average percentage of the assessment given by the physics teacher was 87.1% with a very decent interpretation. This shows that the e-module developed is suitable for use in learning. All input from the teacher is accepted, then the e-module is revised and added according to the advice of the teacher.

Figure 2. Percentage of Physics Teacher Testing Results

Figure 3. a) Percentage of Student Small Group Trial Results. b) Percentage of Student Large Group Trial Results
An average of 87.1% in all aspects including the feasibility of material, media, e-module learning and graphics is calculated as the result of the physics teacher trial as shown in Figure 2.

In general, the total average of 88.78% and 86.6% for all related aspects is calculated from all the results of the validation of teacher and student validators, it is stated that e-module with a scientific approach can be interpreted as a suitable learning medium for use in the learning process. teaching on optical instrument material.

To find out the increase in differences in students who use e-module with a scientific approach with students who do not use e-module with a scientific approach to the optical instrument material. The t test is used to determine the hypothesis whether $H_0$ is rejected or accepted. The hypothesis is:

- $H_0 = $There is no increase between the gain value of the control class and the experimental class.
- $H_1 = $There is an increase between the gain value of the control class and the experimental class.

From the N-Gain t test, it was found that the value of $t$ count = 2.94 > $t$ table = 2.01 with a significant level of 5%. Then $H_0 = $ rejected and $H_1 = $ accepted. So it can be said that the results of the experiment carried out have an influence on the experimental class.

D'Cohens' test was carried out to test its effectiveness. The d'Cohens test result is 0.83, categorized as moderate according to the following standards [11]. As shown in Table 6 below.

| Effect Size | Category |
|-------------|----------|
| $D < 0.2$   | Small    |
| $0.2 < D < 0.8$ | Medium   |
| $D > 0.8$   | Big      |

Then the e-module with the scientific approach is interpreted in the medium category. This e-module can be used as a source of independent learning for students so that students can develop critical thinking skills independently. Based on the description above, it can be concluded that there has been an increase in students' critical thinking skills using teaching materials in the form of e-modules with a scientific approach.

### 4. Conclusion

Based on the results of the research and discussion of the development of optical e-module with a scientific approach, the following conclusions can be drawn:

1. The results of the validation of material experts obtained an average percentage of all aspects of 82.78%, media experts 87.5%, and learning experts 83.84%. While the overall average percentage of these experts was obtained at 84.70%. The results of the feasibility test indicate that the optical instrument e-module developed is categorized is very feasible to use as a learning resource in learning physics.

2. The results of the D'cohens test using e-module optical tools provide an effective contribution to students facilitate in improving critical thinking skills by 0.83 in the moderate category, it can be concluded that the e-module that was developed can improve the critical thinking of Senior high school students.

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