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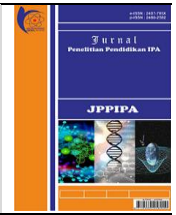
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# Developing Science E-Modules based on Scientific reasoning Skills for Primary Education Course

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**Abstract:** This research was conducted to answer the need for teaching materials in natural science education lectures in elementary schools due to the importance of teaching materials that can answer the challenges of technological advances. Where at this time technology is needed to support learning in the classroom so that it is more interactive, interesting, fun and can be done anywhere and anytime. Based on the needs analysis, lecturers have not fully used electronic-based media in lectures, and have not been fully able to produce good and correct electronic-based media or teaching materials. In addition, there is still a lack of teaching materials that can improve students' scientific reasoning abilities. This study aims to develop electronic modules (E-Modules) based on scientific reasoning in natural science education lectures in elementary schools in the Elementary School Teacher Education Study Program. The research design used is research and development with the stages of the ADDIE model which consists of the stages of Analysis, Design, Development, Implementation and Evaluation. The findings of this research are products in the form of Scientific Reasoning E-Modules for natural science education lectures in elementary schools in the Elementary School Teacher Education Study Program. Based on the results of the validation test by the team of experts, the module was declared fit for use and met the criteria as an online teaching module. Based on the test results of the implementation of the use of the module, the module was declared feasible for use and able to facilitate the improvement of students' scientific reasoning abilities based on the results of the pretest and posttest, the t test results showed that t-count was greater than t-table which was ( $8.30 > 1.691$ ). Therefore it can be concluded that the developed e-module is very useful and can meet the criteria for the need for natural science education lectures in elementary schools.

**Keywords:** E-Modules; Scientific Reasoning; Natural Science Education

## Introduction

Learning materials are not only in the form of books or worksheets based on print media. Non-print-based learning materials are also very possible to be used in learning, for example in the form of electronic-based teaching materials. Today electronic-based learning materials can be easily obtained because of the presence of information technology network devices. Through electronic networks, learning will become easier and more practical. The development of the progress of the education system in Indonesia and even the world

requires teachers or lecturers to continue to develop their teaching abilities and improve their teaching methods.

In teaching in basic education study programs, especially science courses for elementary schools, it is still very manual to use in learning because most of the teaching materials are in the form of books or printed modules. The printed module is actually very limited in terms of the amount of material that can be loaded, and it is also very difficult or inflexible for students and lecturers because of its printed form which makes it not easy to carry anywhere, not easy to access anytime and

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anywhere and not easy to use in all situations. In fact there are still many lecturers who use teaching materials or printed modules for learning materials. Even though the teaching module is one of the instruments that has a major role in developing students' 21st century skills (Febrina et al, 2020).

Electronic-based teaching materials are also still very limited for teachers and lecturers. Where most of the teaching materials are still in the form of pdf files, MS Word and PPT. This is of course still not very varied and sometimes not well documented. In addition, teaching materials like this are still very limited in their implementation. Because teachers do not understand how to use digital teaching materials. This is indicated by the findings of previous researchers which stated that some teachers still do not fully understand the creation and use of digital teaching materials (Hämäläinen et al., 2021; Mailizar et al., 2020; Mailizar & Fan, 2019; Adri, 2021). Natural Science Education in Elementary Schools is one of the subjects taught in the teacher education study program. Natural science education in elementary schools is a very important subject (Ramadhani, et al, 2021). Natural science education is a very objective knowledge of the natural surroundings and their contents (Samatowa, 2010). Susanto (2015) states that Natural Science is a human effort in understanding the context of the universe through an observation that is right on target, and also through procedures and can be explained by logical thinking so as to obtain a conclusion. Natural Sciences (IPA) is very closely related to the science of systematically finding out about nature, so that this science is not only the mastery of all knowledge in the form of facts, concepts, or principles but also a process of discovery (Saputro, 2017).

In this study teaching materials will be developed that use electronic or online media in learning in the form of E-modules. The use of learning media in the learning process is able to increase teacher access to new paradigms about education, such as how to learn, how to access information that is difficult to find, classification of foreign terms or each concept that is difficult to interpret, and how to present any information using different learning media (Teguh, 2020). The use of online learning media is very important, this has been proven by the findings of previous researchers. The current use of online media is a solution that can help students understand the subject matter well (Mustakim, 2020; Mulyati, et al, 2020). IT tools that are integrated into all learning components (such as teaching materials) will also play an important role in adapting technology-based distance learning (König et al., 2020). Electronic modules are proven to be able to increase student enthusiasm for learning (Inanna,

et al., 2021). E-modules can control the material that students access and study because they are designed by the lecturers themselves, so they can adapt to the planned curriculum (Tsai, Lin, & Lin, 2018). In fact, it is found that there are many situations that require education to keep up with the times by totally switching from face-to-face learning to online learning (Bao, 2020). Teaching modules are one of the keys in helping teachers when designing their learning (Pepin et al., 2017). Ningsih (2020) although sometimes online learning that does not vary will make learning unattractive for students (Ningsih, 2020). Therefore it is very necessary to vary online learning media. One of them through this electronic module.

Scientific reasoning is when a logic is applied to the scientific process, looking for evidence to explain phenomena, when doing hypotheses, when solving problems, conducting experiments, controlling variables, and analyzing a problem (Wenning & Viera, 2015; Rusmiaty, 2020; Dorfman & Fortus, 2019). Scientific reasoning is a thinking process in which humans not only involve physical skills in learning about nature but also use their common sense to think deeply (Adri et al., 2019; Van der Graaf et al., 2015; Köksal-Tuncer & Sodian, 2018.). Scientific reasoning is an ability to think systematically and logically in solving problems using scientific methods including the stages of evaluating data, conducting hypotheses, controlling variables, designing experiments and conducting experiments themselves, collecting data, and analyzing data and drawing conclusions (Purwana, 2016 ; Koenig, 2012). The importance of scientific reasoning in learning has been proven by several researchers. Scientific reasoning is a process of analyzing using logical thinking (Herawati, 2015; Osterhaus, C., & Koerber, S, 2020). Scientific reasoning is an ability that is really needed for students to be able to take part in scientific learning (Handayani et al., 2020; Van de Sande, et al., 2019).

## Method

This research was conducted to develop lecture modules in natural science education courses in elementary schools based on scientific reasoning. The product to be developed is an online learning module with the theme of Natural Science education in elementary schools which can facilitate the development of students' scientific reasoning abilities. The method used is R&D (research and development) in the ADDIE development model with stages starting with analysis, design, development, implementation and evaluation (Osterhaus, C., & Koerber, S, 2021). This method was chosen because researchers will develop a product,

namely an electronic module. The following is an overview of the ADDIE Research and development model design as Figure 1.

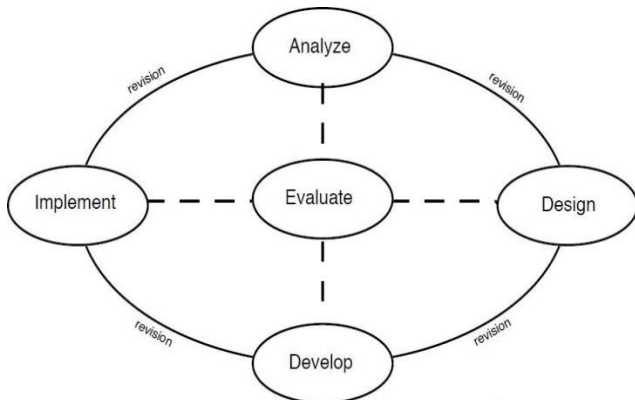


Figure 1. ADDIE model design

The picture shows the ADDIE model design for e-module development. This design starts with a needs analysis and design, then continues with making menu and display designs as well as the e-module system, then module development is carried out including the menus in it which are implemented from the developed prototype, then the e-module is used for students and finally is the evaluation stage to prove the usefulness and readability of the e-module.

## Result and Discussion

Based on the design that has been prepared, the following is the data obtained from the development steps carried out,

### Stages of needs analysis

Based on the results of field observations, it was found that there is a great need for electronic-based teaching modules in improving the thinking skills of elementary school teacher education students, especially in science education courses in elementary schools. In the plan to build a teaching E-module, data obtained according to the opinion of experts regarding the analysis of the needs of the E-module so that the product criteria that the author will develop is obtained, namely an online E-module based on scientific reasoning for students. The criteria given by the expert are that the module must be clear in terms of color display and menu shape, clear in terms of the usability of each menu, the module must be easy to use and have a good impact on the user. In addition, e-modules must also be able to improve scientific reasoning abilities and can also test or evaluate these abilities as evidenced in the evaluation column and results recapitulation.

### Stages of module development design

The following are the stages of the E-module menu prototype design that will be developed as Figure 2.

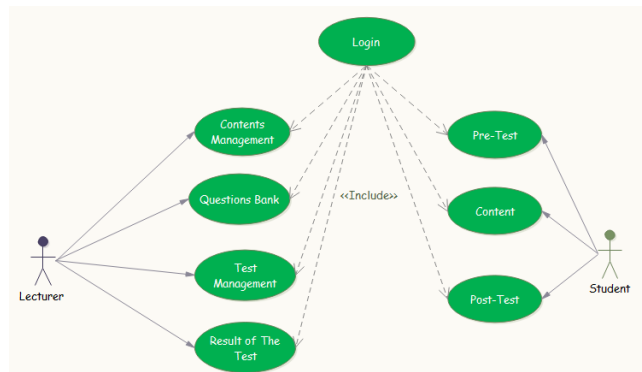


Figure 2. Use case diagram of the E-Modules Application System

In the figure 2 we can see all the modules that will be developed in this e-module. In the diagram it can be seen that the lecturer can access several menus including the material management menu, question bank, test management, test results recapitulation funds. Meanwhile, from the student side, students are able to see a menu that suits their needs, namely being able to access material and evaluation. The following is an overview of the menu display that will be accessed from the lecturer's side as the organizer of the lecture.

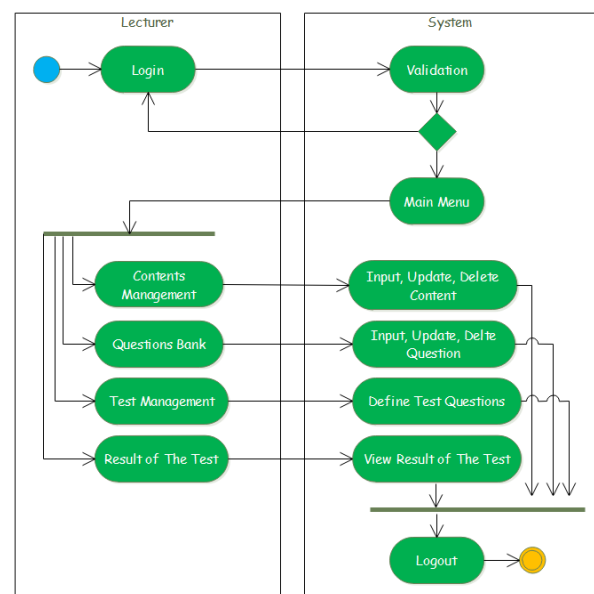


Figure 3. Flowchart Activity Diagram

In Figure 3 the activity diagram shows more detail for the menus that will be accessed by lecturers starting from login to logout. This design was made with the assumption of simplification so that it is easily used by all lecturers. This display will be adjusted to the needs of

lecturers as organizers of lecture activities. The following is the display design from the student side as a user:

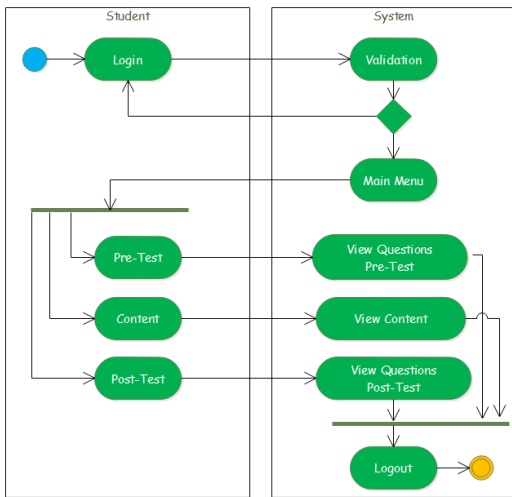


Figure 4. Flowchart Activity Diagram for students

Figure 4 shows the view from the student's side where they carry out activities from logging in to logging out. the display of the student menu is simpler than the menu that can be accessed, this is due to adjustments to the needs. students only need an accessible menu to get material and take exams. while lecturers need a menu to be able to upload material, fill in various files and also need access to be able to see the results of evaluation recapitulation.

Stages of module development

The menu that was first compiled to access the e-module is the login menu for lecturers and students. The following is the display of the login menu:

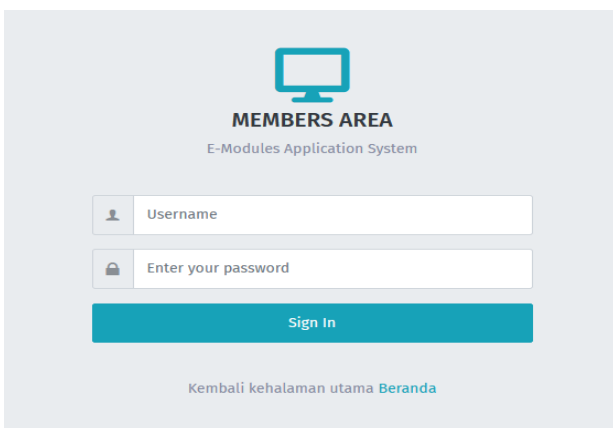


Figure 5. Login Page

In Figure 5, you can see the login menu after the e-module was developed in the real form of the prototype that had been designed. The following is an image of the display material that students can access for learning:

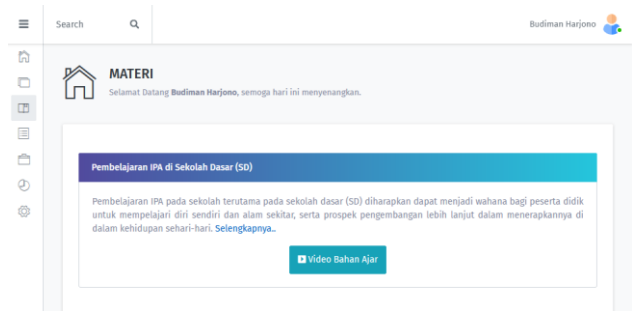


Figure 6. Display of Material on Students

Figure 6 shows the display of material that can be accessed by students both while studying in class and studying from home. This menu can make it easier for students to study anywhere and anytime they need. Because the e-module can be accessed online. The material displayed must support the development of students' scientific reasoning abilities. because of that a menu is also provided for uploading material in the form of videos, to make it easier for lecturers to give questions that are phenomenal in nature that must be solved through problem-based learning to support the improvement of scientific reasoning abilities.

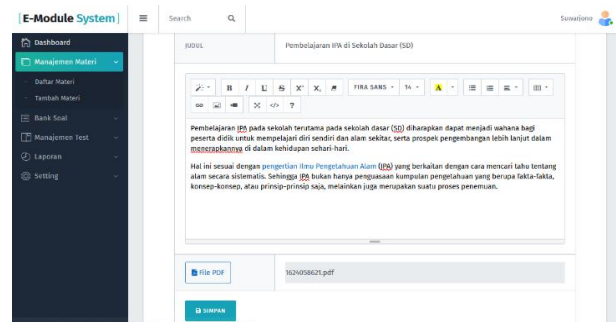


Figure 7. Display of Material Management by Lecturers

The next menu can be seen in Figure 6, which is a menu that can be accessed by lecturers to upload material. This menu is needed by lecturers to organize lectures at each meeting. In this menu, lecturers can upload various types of files according to the needs of each lecturer. Menu is the Evaluation menu display. here is an overview as Figure 8.

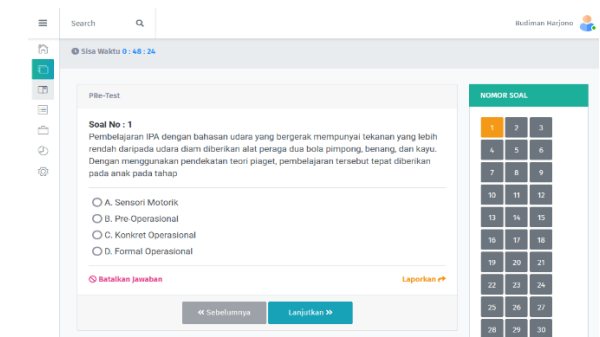
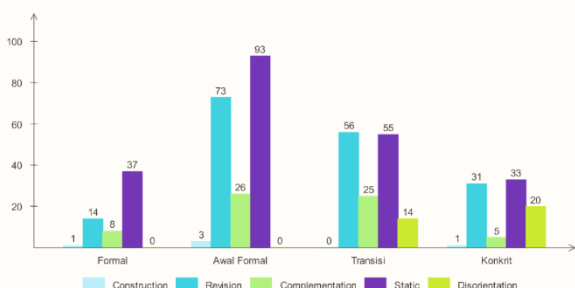


Figure 8. Display of Test Questions

In Figure 8 we can see the test display menu which can be seen from the sides of both sides, namely the lecturer and student sides. This menu is accessed by students to work on evaluation questions. Evaluation questions can be in the form of essays or multiple choice as seen in the picture above. The advantage of the developed e-module is that lecturers can immediately find out the recapitulation of the results of the evaluations carried out.

*Module Implementation Stages*

The modules that have been developed based on the prototype are then implemented through the steps of learning activities using the modules that have been designed. The results of the lectures that use the module can be accessed directly from the recapitulation results of the evaluation results through the recap menu. The following is an example of a direct recapitulation of evaluation results in graphical form with a separation of each level of scientific reasoning.



**Figure 9.** Graphic Display of Data from Test Results Recapitulation

The display of the evaluation results menu is shown in Figure 9, where the data reflects students' scientific reasoning abilities tested based on the level of ability to understand the concepts given. In this case the system has been running well according to the prototype.

*Evaluation Stage*

To test the effectiveness of the e-module as a learning resource that can improve the quality of learning outcomes and students' scientific reasoning abilities, a test was carried out to find out whether there was a significant increase between the pretest and post-test. -test using the -t test. Based on the calculation results, the t count is 8.3. Furthermore, with a 95% confidence level or the price of t for the one-way test of the t distribution with  $db = 35 - 1 = 34$ ,  $t_{table} = 1.691$  is obtained. This shows that the value of t count  $>$  t table ( $8.3 > 1.691$ ) so because t count is greater than t table, it can be concluded that there is a significant difference so that the online module of the lecture learning system is

said to be effective in improving the quality of learning in Science Education courses in Elementary schools use e-modules based on scientific reasoning.

**Conclusion**

The results of a needs analysis conducted at Djuanda University in the Bachelor of Elementary School Teacher Education study program in Science education courses in Elementary Schools obtained information stating that the program is currently in dire need of a system that can assist online/electronic learning activities to motivate students learn and keep abreast of technological advances. Through this e-module, students can learn both classically and classically. This activity is also a form of support for the Ministry of Education and Culture's efforts to develop technology-based learning. Based on expert validation and also trials on students, the data shows that this scientific reasoning ability-based E-module can be categorized as capable of assisting students in improving their scientific reasoning abilities, especially in natural science education courses in elementary schools.

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The author (H.T A and S.) is involved in the overall making of this article.

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**Conflicts Interests**

The authors declare that there is no conflict of interest regarding the publication of this paper.

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