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(REVIEW ARTICLE)

Development of e-modules for science subjects based on artificial intelligence technology to improve concept mastery and self- efficacy of students of grade IV elementary school

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Abstract

The study aimed to test the validity, practicality, and effectiveness of e-modules of science subject content based on Artificial Intelligence (AI) technology to improve concept mastery and self-efficacy of 4th-grade elementary school students. This research and development model uses Thiagarajan's (1974) development model of Define, Design, Development, and Dissemination, abbreviated as 4D. The data analysis technique used is data analysis of validity, practicality, and effectiveness tests of e-modules, which are processed into quantitative and qualitative data. The results showed that the feasibility of e-modules was categorized as very good, as evidenced by the construct validity test, which obtained a feasibility percentage of 94.16% with the category of "very feasible." The content validity test obtained a feasibility percentage of 80%, classified as "feasible." The practicality of using e-modules through limited trials on a group of students using student and teacher observation sheets obtained a percentage of 93.75% with the category "very practical." The results of learning observations by teachers obtained a percentage of 96.05% with the category "very practical." The effectiveness of the e-modules on concept mastery using pretest-posttest instruments obtained an N-gain of 0.762, categorized as "high." Furthermore, the testing of students' self-efficacy using a questionnaire instrument obtained a percentage of 70.23%, categorized as "effective." Based on the results, this e-module is declared feasible and effective in improving students' concept mastery and self-efficacy in the science subject of grade IV elementary science.

Keywords: Artificial Intelligence; Concept Mastery; Self-Efficacy

1. Introduction

Learning in the current era is expected to be TPACK-based, which is a learning model that uses technology to make it more effective and exciting. In Permendikbud No. 22 of 2016 on process standards for primary and secondary education, one of several process standards is the use of information and communication technology to improve the efficiency and effectiveness of learning. The use of technological media in the world of education not only makes it easier for teachers but also improves students' understanding of the learning process (Futrisari, 2024: 78). One application that is currently a phenomenon is Artificial Intelligence, abbreviated as AI. Artificial intelligence is a computer program that has human-like intelligence so that it can do work that is normally done by humans. Artificial Intelligence (AI) is a modeling of human intelligence applied in a machine to make intelligent machines. The development of artificial intelligence will be very helpful in the field of education in the process of daily activities including teaching and learning (Tjahyanti, et al, 2022). By using AI capabilities, teachers can now create a variety of media and other learning tools that can increase the effectiveness of learning by teachers and are attractive to students. The current Merdeka Belajar curriculum positions the teacher as a facilitator who enables students to learn independently or student-centered

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learning. With the help of AI, the teacher's need to make learning fun can be realized. Teachers can easily provide an attractive visual display and add other media such as audio and video to help students better understand concepts.

Observations in one of the schools in Gorontalo City show that the presentation of material in conventional books does not attract students' interest and motivation to master concepts independently, unless it needs to be explained again by the teacher. In addition, the materials produced can only be accessed and used by teachers, which means that they cannot be used by students independently. This conventional teaching material can be developed or modified with the help of AI into an e-module that has more advantages, so it can be an effective solution to improve students' concept mastery. Yerimadesi, et al. (2023) suggested that e-modules can also improve students' conceptual understanding, critical thinking skills, and learning outcomes. Therefore, in this study, researchers developed e-modules or teaching materials in electronic form with the help of various applications and websites based on artificial intelligence technology to design displays and add various forms of media to provide a more attractive appearance and easy access for students to improve concept mastery and self-efficacy in elementary school students.

2. Methods

The type of research method used is the research and development method. Maydiantoro, A. (2021) stated that research and development is a research method used to develop and test products that are usually developed in education. There are several development research models, one of which is the 4D development model of Thiagarajan (1974). This development model consists of four stages, namely (1) define, (2) design, (3) develop, and (4) disseminate. The research instruments used were validation sheet, observation, pretest-posttest, and self-efficacy questionnaire. The data were analyzed into quantitative and qualitative data.

3. Results and discussion

3.1. Validity of e-Modules for Science Subjects Based on Artificial Intelligence Technology

This validity test is part of the process of developing this science e-module, namely, to conduct expert appraisals to get suggestions for improving this e-module. With these suggestions, the e-module is revised again to make it suitable for use. In this validity test, researchers tested the product in 2 aspects, i.e. construct validation and content validation. The researchers first created construct validation sheet instruments and content validation sheet instruments and then identified the validators who would assess the feasibility of the developed products. This developed e-module can be accessed by the students online through their respective gadgets. The following is a picture of the e-module designed using Artificial Intelligence technology.

Figure 1 Design of Science e-Module

Once the e-module design phase is complete, the e-module is ready to be evaluated by the validator. The following is a summary of the results of the construct validation and content validation.

Table 1 Summary of e-Module validation results

No.	Types of Validation	Percentage (%)	Description
1	Construct Expert	94.16	Very Eligible
2	Content Expert	80.00	Eligible

Based on the results of the e-module validation in two aspects, namely construct and content, the e-module validity test obtained results very feasible to use according to the suggestions of each validator. Suggestions from the validators include presenting the text according to the age level of the students and adding sound to help students understand the material in the e-module. The suggestions from each validator were then accepted by the researcher to make improvements to the e-module according to the suggestions given so that the e-module becomes very feasible to be implemented by students and teachers.

3.2. Practicality of e-Modules for Science Subjects Based on Artificial Intelligence Technology

To determine the level of practicality of the developed product, it was tested using a student and teacher observation sheet. In this instrument, there are several indicators to see the implementation of the learning process carried out by students and teachers using the developed product. This practicality test was carried out by conducting a limited trial using science e-modules as teaching materials as well as media for teachers to provide material to students. The topics included in the developed e-module are the topic of Five Senses and Material Changes. These two topics are the topics that were studied by students in the first semester. This limited study was conducted in Al Azhar 43 Gorontalo Islamic Primary School. In the school, there are 2 study groups of class IV, namely class IV As Salam 1 and class IV As Salam 2. In this limited trial, it was conducted only in one study group, which is Class IV As Salam 2 students totaling 13 students and taught by 1 homeroom teacher as a researcher's material to develop the product. This experimental process was carried out in 4 sessions within 2 weeks. The reason why the researcher chose this school is that the average student has a gadget, so it supports the TPACK-based learning process. In addition, the parents' support for digital-based learning is certainly very helpful for the researchers in developing products because they get permission and support from the parents. The teacher of class IV As Salam 2 is also a teacher who participates in the teacher training program (PGP), so in the process of developing this e-module, the teacher can carry out the learning using the independent curriculum very well, as evidenced by the teacher observation score which gets the category of "very practical", and as a validator, the teacher is also able to provide guidance suggestions on how to compile teaching modules for the limited trial process of the e-module. Based on the results of student observations at the limited trial stage, the percentage of practicality was 93.75% and categorized as "very practical". Based on the results of teacher learning observations, the percentage of practicality was 96.05% and categorized as "very practical".

As for the results of observing the students while learning to use this science e-module, it showed that they were very enthusiastic because, in addition to using the gadgets, the students were also curious to see the contents of the e-module. This e-module does not require any download or installation but can be accessed through a link. In addition, this e-module also contains videos, images, and audio that can help students learn independently, unlike previous e-modules that only contain images. This e-module is also equipped with games and quizzes to make the students' self-learning process more challenging and fun. The material presented is also packaged in more effective sentences so that students immediately know the essence of the material. Students also seem to actively discuss and learn together with the e-module. Especially when playing games and taking quizzes, students look very happy because of the excitement and appearance of the word wall and quiz platform. Students look challenged and compete with each other's knowledge when doing quizzes. From the trial process, it was observed that students had good self-efficacy to work on questions. Thus, the results of student observations also get the category "very practical". The weaknesses of this experimental process are the capacity of the devices and unstable networks, which cause delays in accessing and opening the e-modules, so they tend to require patience.

3.3. The Effectiveness of e-Modules for Science Subjects Based on Artificial Intelligence Technology to Improve Students' Concept Mastery and Self-Efficacy

The final stage of this research is to test the effectiveness of e-modules in improving students' concept mastery and self-efficacy after learning with the use of e-modules in limited trials. The usefulness of research results is the goal of any research, so this science e-module is also expected to be able to improve students' concept mastery and students' self-efficacy.

To find out the effectiveness of e-modules in improving concept mastery, the researchers used a pretest-posttest method with 20 multiple-choice questions to test the students' concept mastery of the two topics in the developed e-module, namely the topic of Five Senses and Material Changes. This pretest was conducted at the beginning of the first session before the experiment to find out the students' initial knowledge related to the topics to be studied, and from the pretest results, the average score of the students was 53.46. In the learning process during the e-module experiment, the students have the flexibility to access the material at any time, or in other words, to learn anytime and anywhere. So, in addition to learning at school, students can also review at home. In addition, this e-module provides examples of the process of material changing, with examples of images and videos of material changing, so that students can understand the concept of each topic. This can be seen in the last session after students learn using the e-module on a limited trial, then a final knowledge test is carried out using a post-test, and the average score of students is 91.15. Based on the effectiveness test of students' concept mastery using the pretest-posttest, it was found that there was an increase in knowledge with an N-gain value of 0.762, categorized as "high".

Researchers measured the effectiveness of self-efficacy using a questionnaire containing 25 statements derived from three indicators of self-efficacy, i.e., level, strength, and generality. This questionnaire was given to students at the end of the session after they had learned to use the science e-module in a limited trial. Based on the results of the data analysis of the self-efficacy questionnaire, an average percentage value of 70.23% was obtained and is classified as "effective". Based on this result, it can be assumed that the development of science e-modules can increase students' self-efficacy with an increase in mastery of the concepts of the topics learned.

4. Conclusion

Based on the objectives to be achieved in this study, it can be concluded that the e-module of science subject content based on Artificial Intelligence technology is suitable for students and teachers to use in school as teaching materials as well as media to understand the material better independently, anywhere and anytime, so that in this study it is stated that the e-module is effective in improving mastery of concepts and self-efficacy of 4th-grade students in elementary schools. Researchers suggest that teachers as facilitators in the learning process should be able to develop more e-modules and learning media by using various platforms that are widely available today to present learning that can improve students' mastery of concepts in subject matter and students' self-efficacy to become a more courageous, confident and optimistic person and do anything.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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