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Development of Physics E-Module Based on Discovery Learning to Improve Students' Scientific Literacy

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Abstract: The education system in the current era of globalization has changed due to the COVID-19 pandemic. Learning takes place in the new normal transition period using the blended learning method. Blended learning that emphasizes students to study offline and online can lead to a lack of student scientific literacy. This study developed an e-module of physics in health to facilitate student learning that can be used for offline and online learning. This study aims to describe e-modules based on discovery learning about hydrostatic pressure submaterial. This type in research by adapting 4-D development model (define, design, develop, desseminate). The research instrument used was the media questionnaire, student response sheets, and scientific literacy questions. The results showed that the priority of the experts was 94% very well. Student responses to the e-module obtained a value of 90% very good category. The N-Gain value was obtained at 0.4 in the medium category. Based on the results of this study, it can be said that the e-module based on the discovery learning is effective in improving students' scientific literacy skills.

Keywords: E-module; Physics; Scientific literacy

Introduction

Education is a place to find knowledge for students which is structured in an education system. In education, there is interaction between teachers and students who are reciprocal to study a field of science. A coherent education system can be a measure of student success in understanding a problem and the material presented by the teacher (Atuhurra & Kaffenberger, 2022). Education plays an important role in preparing the nation's golden generation. One of the subjects studied by students is natural science education (Serevina et al., 2018). Science education is divided into sub-disciplines, namely biology, chemistry, physics and earth sciences (Muggler et al., 2022). Learning science is the result of continuous integration between scientific fields (Darmaji et al., 2019). Students' ability to integrate each field requires skills in social interaction, numerical calculations, reading literacy, and higher-order thinking skills. PISA carries out an assessment based on this aspect. Learning science requires a combination of various student skills, both in terms of psychomotor and affective aspects. Teachers can improve scientific literacy with the abilities possessed by students.

Based on the 2018 PISA results, Indonesia is in position 71 of 77 countries (OECD, 2018). The PISA assessment was obtained based on three aspects, namely reading, mathematics, and scientific literacy. Indonesia is in a low position in the field of scientific literacy. This happens due to the lack of learning in emphasizing the concept of scientific literacy. In line with Fuadi (2020) research stated that students in Indonesia there was no significant increase in scientific literacy. In Hasasiyah (2020) research it is stated that student literacy is in the low category because of the limited ability of students in the aspect of understanding and interpreting basic statistics. Students' scientific literacy skills can increase if students make reading habits (Yanti et al., 2021).

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Improving students' abilities in the scientific literacy aspect requires collaboration between teachers and students in order to realize science learning well.

Education is currently undergoing changes due to the COVID-19 pandemic. Learning activities which are basically face-to-face direct between teachers and students have changed with an online learning system. The development of education is now entering a new normal transition period. Blended learning is currently being applied in the new normal era, which is a combination offiline and online learning using technology (Ariawan, 2020; Jumaini et al., 2021; Sari, 2021). Blended learning assisted by technology support distance learning (Salonen et al., 2021). The goal with the implementation of this learning can help teachers improve the competence of the learning process. Teachers are expected to have skills in organizing e-learning and preparing digital references that can be a reference for students (Hima, 2016).

Conceptual integration is a skill that students use as a prerequisite for knowledge in certain sciences when studying a concept or topic in other science subjects (Hamza et al., 2022; Tuysuz, 2016; van Uum et al., 2016). Physics is one of the science sub-discipline (Fadieny & Fauzi, 2019). Physics is an empirical science. Instruments developed in the field of physics can be applied in other branches of science. The integration between physics and health, one of which is found in the pressure material in the infusion. Learning physics in health is an abstract object and it is necessary to have a technology intermediary to facilitate students in learning the material.

Physics in health is combination concepts about physics and health. This e-module explains about integration between hydrostatic pressure and infusion devices. Hydrostatic pressure is a pressure in a liquid that affected by density, gravity, and altitude (Cui et al., 2021). The concept formula hydrostatic that is emphasized with infusion is very related. The higher infusion will greater pressure applied (Tworkoski et al., 2018). This is because the hydrostatic pressure is directly proportional to the height of an object.

Facts on the ground show that the implementation of technology in learning is still in the low category. Implementation of technology in learning can increase students' cognitive knowledge (Irdalisa et al., 2020). In this research, it can be an innovation in science learning that applies technology to make it easier to implement in learning. Development of e-modules can make one of the provisions of students to increase scientific literacy. The lack of application of technology in several schools and the lack of interest in student literacy makes it important to conduct this research. The hope is that it can provide insight to teachers to develop better learning innovations in order to achieve the goals of Indonesian Education.

One of the roles of technology in helping implement the application of online learning is by developing e-module learning media. Electronic-based learning can improve students' cognitive abilities (Alenezi, 2020; Klement et al., 2014). E-modules can help teachers apply learning using electronics (Kuncahyono, 2018). E-module is a type of electronic book in which there are several components to support the continuity of students when carrying out a practicum. The application used in this e-module is Kvisoft Flipbook Maker. That is technology version book for application (Fahmi et al., 2019). Kvisoft flipbook maker make it easy to design book graphics (Suyasa et al., 2021).

Physics e-module there is pressure material that is integrated with the concept of health in infusions. Students are expected to know the integration relationship between the concept of hydrostatic pressure and the infusion used in the health sector. In physics e-module, there are several complementary components such as images, video and audio to attract students' attention in learning. Physics e-module is designed to attract students' attention. E-module physics that can present the message and stimulate students to learn (Perdana et al., 2017).

The physics e-module is integrated with the discovery learning. Contents in e-module there are instructions for carrying out about discovery learning. Students learning by using the physics e-module can practice scientific literacy skills. In this new normal transition condition, using electronic media is one solution in overcoming learning problems. Therefore, the authors are interested in researching "Development of discovery learning-based physics e-modules to improve students' scientific literacy". The aims of this study were: (1) to determine the feasibility physics e-module regarding pressure in the infusion, (2) to determine student responses about physics e-module, and (3) to determine students' scientific literacy skills when given the physics e-module.

Method

This type of research is development research using the 4-D development model (four-D Models). According to Thiagarajan (1976) states that the 4-D development model consists of four stages. The stages of this model is define, design, develop, and disseminate. Development e-module physics in terms of effectiveness.

The research flow is based on the development design, namely the define, design, develop, and disseminate stages. The first stage is define, the researchers conducted observations and interviews with teachers about the condition of the school both in terms of curriculum, facilities and infrastructure, availability of teaching staff, and so on. Then at the design stage, the researcher implements the idea based on the problem in

the first stage which is outlined in the form of an e-module design. The third stage is develop, researchers develop products that have been made in junior high school students. In the final stage, namely disseminate, the researcher disseminates the results of the e-module to schools and writes the research results in scientific journals.

The effectiveness of the e-module is the real result obtained by the e-module based on the discovery learning in submaterial about hydrostatic pressure on infusion medical devices to improve students' scientific literacy skills. The level effectiveness e-module is determined based on results student's scientific literacy ability test and the student's response about e-module. Based on students' literacy tests were analyzed using the N-Gain score criteria (Hamsir, 2017). Value obtained from calculation N-Gain score can determine the level of scientific literacy ability.

One group pretest-posttest design is used in this research. The research steps are tests before physics practicum, after that physics practicum implementation using e-module, then posttest after learning about physics in health. The data collection instruments were the scientific literacy ability test, the e-module feasibility questionnaire sheet, and the student response questionnaire. Data collection in this study was by applying a limited-scale trial, due to the limitations of the face-to-face learning process because it was still in the pandemic period, so it was still using a hybrid system in schools. The research subjects were 20 students of class VIII E at SMPN 5 Jombang, East Java.design and method should be clearly defined.

Result and Discussion

Description of the results of the 4D development model

The development model in this study uses 4-D. The description 4-D development model in design of health physics e-modules with discovery learning to improve students' scientific literacy is as follows: (1) Define is the defining stage to find facts, potentials, and problems as well as alternative problems. Researchers collect information by conducting interviews with teachers related to educational problems in terms of facilities, student characteristics, and learning processes, (2) The design stage is the stage where researchers design e-module media to overcome the problems that have been analyzed in the previous, (3) Develop is realization product e-module physics in health that has been made, in this case the researcher uses a limited scale trial using discovery learning. At this stage, students conduct experiments on the pressure in the infusion and use e-modules to help implement the practicum learning. (4) the disseminate stage in this study by distributing the e-module physics product in health to teacher and student.

This physics learning e-module in Health is designed to increase student interest in participating in practical activities. In e-module physics there are several instructions that have been linked to the discovery learning. When students carry out practicum activities, students are very enthusiastic in participating practicum activities using e-module already connected to android in smartphone. The contents of e-module contain videos, pictures, audio, and student activities that make students not bored when using e-module physics. The appearance e-module physics is shown in Figures 1 and 2.

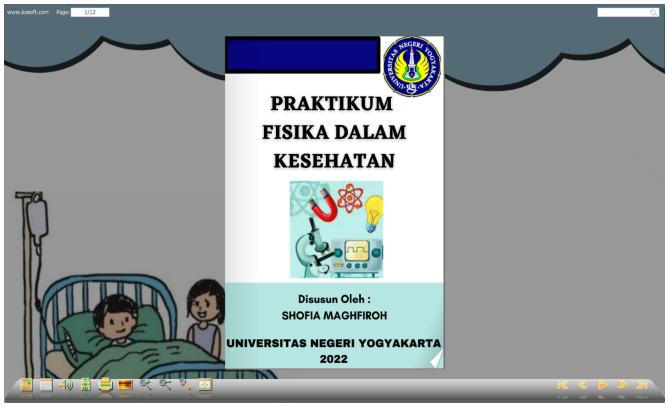

Figure 1. Cover e-module

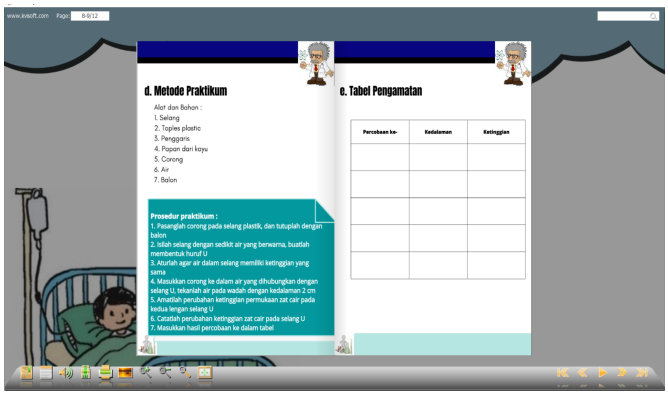

Figure 2. The contents of e-module

The feasibility assessed from validator

Feasibility assessment result about e-module physics in Health was converted based on scale of 4 according to (Mardapi, 2018). The reference for changing the score a scale of four can be seen in Table 1. The data obtained were analyzed and described to describe the state research subjects.

Table 1. Value Conversion Four Scale Score

Value Interval	Range	Percentage (%)	Score	Category
X > (Mi+1.5.SDi)	X ≥ 3	X ≥ 75	A	Very good
(Mi+1.5.SDi) > X ≥ Mi	3 > X ≥ 2.5	75 > X ≥ 50	B	Good
Mi > X ≥ (Mi-1.5.SDi)	2.5 > X ≥ 2	25 > X ≥ 50	C	Less
X < (Mi-1.5.SDi)	X < 2	X < 25	D	Very less

Description :
X = Respondent
Mi = Mean / ideal mean
SDi = Ideal standard deviation
Mi = ½ (Xmax + Xmin)
SDi = 1/6 (Xmax - Xmin)

Based on the results data obtained from experts' assessment, the average feasibility level of the e-module media is categorized as very good. Aspects assessed by experts are the appropriateness of content, language and images, presentation, and graphics. There are four experts in the field of media and theory. It can be concluded that discovery learning-based e-module media is very well used in the learning process. The following is the data on the feasibility results of the e-module contained in Table 2.

Table 2. E-Module Feasibility Data

Aspect	Percentage (%)	Category
Content Eligibility	95	Very good
Language and Pictures	96	Very good
Presentation	93	Very good
Graphic	95	Very good
Average	94	Very good

Student responses about the use of physics e-module

Student responses were obtained using a student response questionnaire which contained 4 components, namely construction requirements, technical requirements, conformity with the discovery learning model, and conformity with aspects of scientific literacy ability. Student responses to the e-module based on the discovery learning model are shown in Table 3.

Based on Table 3, the results obtained an average percentage of 90% with a very good category. Positive responses indicate that learning using e-modules based on the discovery learning on hydrostatic pressure is easy for students to understand. This is because students find their own knowledge or concept through a series of experiments. To create meaningful learning, students must personally find and apply complex information, checking new information against old rules and correcting old rules.

Table 3. Results Response Student

Observed Aspects	Percentage (%)	Category
Conformity with construction requirements	89	Very good
Conformity with technical requirements	91	Very good
Conformity with the discovery learning model	92	Very good
Conformity with asoects of scientific literacy	89	Very good
Average	90	Very good

The results of students' scientific literacy skills

Based on the results of the study, data were obtained from the results of students' scientific literacy abilities. There is a significant increase after research using discovery learning-based e-modules has been carried out on a limited scale trial practicum. This was obtained based on the data from the students' scientific literacy test results. The test given is a scientific literacy ability test which consists of three aspects, namely aspects of science content, scientific processes, and the context of science applications. The three aspects of scientific literacy are adjusted to the learning indicators. The science content aspect, consists of three learning as follows : (1) Identifying hydrostatic pressure through experimental design, (2) Analyzing hydrostatic pressure formula from an experiment that occurs in daily activity after that integrated with the concept of infusion in health, and (3) Completed calculation about hydrostatic pressure formula through in case study experiment.

Based on learning outcomes using discovery learning. At the stimulation stage, students are given a paragraph about phenomena related to hydrostatic pressure in everyday life so that they want to investigate themselves. The second stage is problem identification based on the results of the analysis in stage one. The third stage, students do hydrostatic pressure practicum using a simple tool to measure water and oil pressure on a tool that has been designed. The fourth stage, namely data processing, students calculate the results of the practicum which is correlated with the hydrostatic pressure formula. The fifth stage is proof, students prove the data that has been obtained with the theoretical study literature. In the generalization stage, students are directed to draw a conclusion based on the practicum that has been done.

Knowledge about science education not only limited in curriculum school, but also includes knowledge that can be used interactively in developing ideas to explain natural phenomena that occur around (OECD, 2018). The application of e-modules based on discovery learning can improve aspects of scientific literacy skills. Based on the research that has been done, students are given scientific literacy questions during the pre-test and post-test. The problem of scientific

literacy is based on five indicators including understanding of scientific concepts; Understanding of scientific viewpoints; Understanding of Nature of scientific research, experiment, probability; Rejection of superstition as a scientific attitude; Engagement with public scientific affairs (Gu et al., 2019). The graphs of pre-test and post-test results for each indicator of scientific literacy are shown in Figure 3.

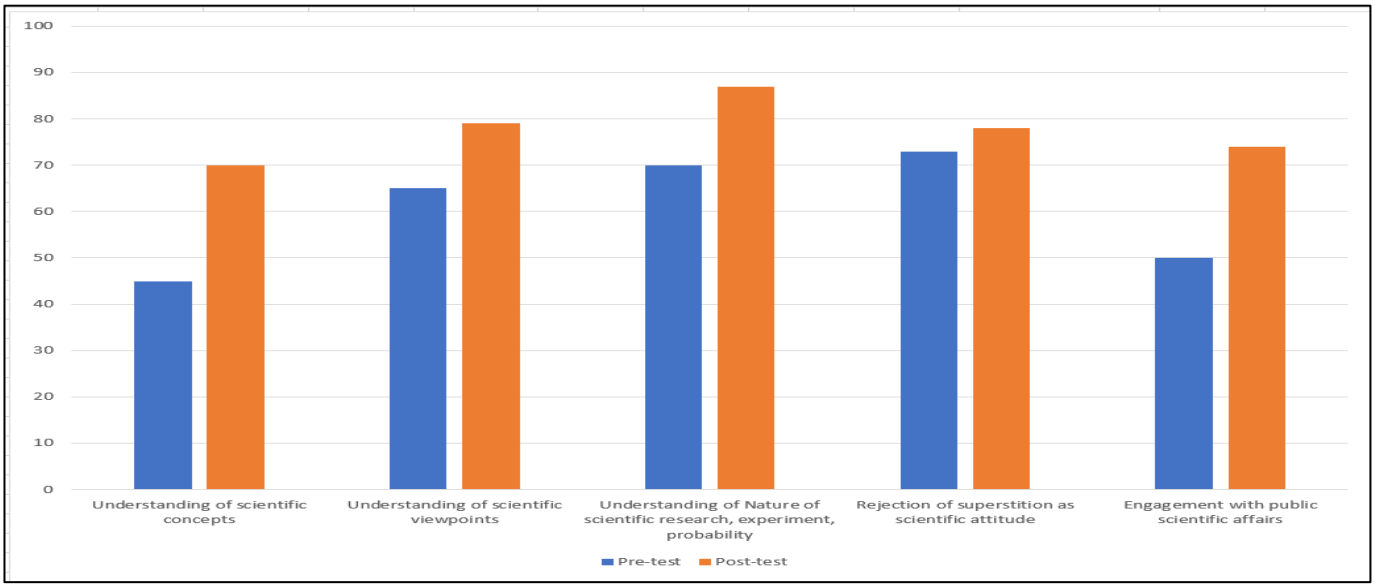

Figure 3. The Graph of Pre-test and Post-test Score Results for Each Scientific Literacy Indicator

Based on the graph, the first indicator is the understanding of scientific concepts. The average result of the students' pre-test was 45 and the post-test result was 70. Based on the results of the pre-test and post-test scores, it can be seen that there was an increase when students used the e-module before using the e-module. This is because students' ability to understand material about physics in health is very enthusiastic in listening to material on electronic devices.

The second indicator is understanding of scientific viewpoints. Based on the results, the average pre-test score is 65 and the post-test score is 79. The difference in score increase is 24 points. Shows that students are able to understand the context of physics material in Health.

The third indicator is Understanding of the Nature of Scientific Research, Experiment, Probability. The average result of the pre-test score is 70 and the post-test score is 87. The third indicator shows the highest increase. This is because the e-module guides students to be active in participating in practicum. The practicum carried out leads students to the ability to solve problems, discover new things, and practice the ability to experiment in the field of science in health.

The fourth indicator is rejection of superstition as a scientific attitude. The average value of the pre-test was 73 and the post-test was 78. The fourth indicator also experienced an increase. Learners are trained in being scientific which is obtained from the results of students participating in practicum projects based on the e-modules that have been provided.

The fifth indicator is Engagement with public scientific affairs. The average value of the pre-test was 50 and the post-test was 74. There was a high increase of 24 points. Shows that students are able to develop their thoughts into project assignments carried out based on the instructions for using the e-module.

Based on these five indicators, the overall average score for the pre-test results was 60.6 and the post-test score was 77.6. The results of the comparison between pretest and posttest were calculated using the N-Gain score. The N-Gain score obtained from 20 students averaged 0.4 in the medium category. There were 8 students who got the N-Gain score in the low category, 11 students who got the N-Gain score in the medium category and 1 student who got the N-Gain score in the high category. The average score of students before the learning process was 60. Meanwhile, the average score of students after the learning process was 77. The results of calculation N-Gain averages are then interpretes using criteria presents in Table 4 (Apriyani et al., 2019).

Table 4. Criteria N-Gain

<g>	Category
≥ 0.7	High
0.7 < g ≥ 0.3	Medium
< 0.3	Low

Results average score was 0.4 in the medium category. The increase in students' scientific literacy skills which are categorized as moderate is due to the limitations of learning facilities when the online learning system is online. The existence of e-modules that can be

accessed on students' cellphones can make it easier for students to understand and learn aspects of discovery learning-based science. In addition, due to time constraints when studying with the practicum system. Based on this, it is necessary to innovate technology related to the concept of science, in order to improve students' scientific literacy spirit.

Conclusion

Based on the results of the study, it can be concluded that the e-module physics based on the discovery learning that was developed is declared feasible based on the assessment of experts, which is 94% in the very good category. Based on the students' responses to the physics e-module, they got a score of 90% which was categorized as very good. The physics e-module can improve students' scientific literacy skills by obtaining N-Gain score of 0.4 in the medium category. Results analysis data obtained show that e-module physics of pressure in infusion can be used in the science learning process class VIII Junior High School.

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