

Development of Guided Inquiry-Oriented Science Interactive E-Module on Wave and Disaster Themes

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Prasetyaningsih Prasetyaning¹, Mudmainah Vitasari^{2*}, Insih Wilujeng³

^{1,2}Department of Science Education, Faculty of Teacher Training and Education,
Universitas Sultan Ageng Tirtayasa, Serang, Indonesia

³ Department of Science Education, Faculty of Mathematics and Natural Sciences,
Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

Corresponding Author: *mdvitasari@untirta.ac.id

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Abstract

This research aims at measuring the validity product of the developed science interactive e-book. The research method used is research and development, with a 3-D development model which is a modification of the 4-D model proposed by Thiagarajan (1974). The stages used are defining, planning (design) and developing (develop). To measure the product validity, a validation questionnaire assessed by two expert lecturers and three science teachers was employed. The development of teaching materials in the form of science interactive e-books is scored 81% and is considered valid to be limited trial test in junior high school level. The limited trial test is scored 34.55 which is considered as good category. Therefore, the developed e-modules can be used as learning resources on wave and disaster themes.

Keywords: Science Interactive e-Module, Guided Inquiry, Waves and Disasters

INTRODUCTION

Learning at school during the Covid-19 pandemic requires the holding of distance learning (Yekefallah, et al., 2021) (Chakraborty, 2021) (Bakhmat, 2021). Learning carried out in the network relies on information technology as a bridge between lecturers and students. Furthermore Song, et al. (2021) stated that learning integrated with technology bridges the digital divide that hinders students from accessing education by providing flexibility.

One of the communication efforts built is to develop effective and learner-centered learning resources. Learner-centered learning will be more fun (Yoon, et al., 2020) and increase learning motivation (Yoon, et al., 2020) (Tran, 2019) (Puspitarini & Hanif, 2019). Effective communication in learning is able to increase the achievement of student learning outcomes. Therefore, a learning guide is needed that is able to activate students in learning. Among the learning guides that allow for improving student learning outcomes and prioritizing the active independence of students are electronic modules (Herawati and Muhtadi, 2018; Istuningsih, 2018; Jaenudin & Murwaningsih, 2017).

Electronic modules are innovative media that can increase student interest in learning (Serevina, et al., 2018)

(Suryadie, 2014). In addition, the electronic module is more practical because it can be accessed with any device. As an effort to adapting the changing times, e-module is made in electronic form so that it's more practical, flexible and independent (Kimianti and Prasetyo, 2020) and efficient; Warsita, 2017). E-modules are defined as learning media using computers that display graphic and presentation in the learning process (Nugraha, et al., 2015). E-books inserted with multimedia features can develop the book reading experience if used properly Smeets and Bus (2014), can contribute to improving reading comprehension and reading interest, capable of improving learning outcomes (Nugraha, et al., 2018).

Integrated science learning is a science learning approach that connects or integrates various science studies into one unified discussion (Kemendiknas, 2011). Learning Natural Sciences at SMP in Serang City currently has not applied integrated learning (Prasetyaningsih, et al, 2017). These competencies require teachers to have abilities related to the content of science material and how to teach science. Science learning that puts forward proof by self-discovery (inquiry) requires the implementation of practicum as a consequence. Inquiry is a process for students to solve problems, plan and

conduct experiments, collect and analyze data, and draw conclusions. So, in inquiry-based learning, students are involved mentally and physically to solve problems given by the teacher (Khalaf & Zin, 2018) (Deák, et al., 2021). In other words, students will become accustomed to behaving as scientists (objective, honest, creative, and respecting others). Inquiry-based learning had a significantly improved conceptual understanding (Borovay, et al., 2019) (Rahayu, et al., 2018) and understanding and motivation (Srisawasdi & Panjaburee, 2019).

Efforts to teach science to inquiry-oriented students need to be carried out in an integrated and simultaneous manner at various levels and involve educators at various levels (Artayasa, et al., 2018) (Nasution, 2018). Inquiry should not be viewed and applied simply as a method, approach or learning model (Morse, 2020) (Af'idayani, et al., 2018), but is viewed and applied as an ability that needs to be improved and measured on the part of students who are learning and especially on themselves first. The ability to inquiry will be a provision for prospective teachers, teachers, other level educators to develop themselves and learn for life (Jefford, et al., 2021). In other words, the ability of inquiry that is internalized in a person will encourage that person to continue to search (ask)

and try to find the answer by doing (reading, trying alone, collaborating).

Based on the results of monitoring in Science Education students have difficulty understanding science lecture material. Science courses and Science Learning in the 2019 Science Education PS Curriculum are contracted in the third and fifth semesters after in the first year. There are several factors that cause students' difficulties in understanding the material, one of which is the unavailability of textbooks that can help students construct knowledge and train students in making learning assessment instruments. The books used today are still more dominated by the presentation of material, causing students to be inactive in forming their knowledge.

The province of Banten, which is geographically located on the western tip of the island of Java, is very close to the very active tributary of Mount Krakatau. In addition, the southern position which is in the Indian Ocean is prone to high waves and tsunamis. Based on the curriculum analysis, the theme of waves and disasters is deemed appropriate to develop inquiry learning through student-centered and disaster risk management. This has led to research to develop an interactive Science Electronic Module oriented to Guided Inquiry for prospective science teacher students with the Waves and Disasters themes. With

this, it is hoped that students can actively learn independently in the online learning process at class.

METHOD

The research approach used in this research is development research with the aim of producing science interactive e-book for preservice science teacher. The development model that will be used in this research is the 4D development model (Thiagarajan, et.al, 1974), includes four stages: define, design; develop; and disseminate. The last stage of this development is the dissemination stage, at this stage the activities carried out are limited trials.

The first stage is defining, namely by conducting a preliminary study with interviews and observations, curriculum analysis, material analysis, student analysis, and formulating learning objectives.

The second stage is planning, which is planning the initial design of the e-module from the results of the analysis of the material, curriculum, and learning objectives. At this stage also actualized the preparation instruments, media selection, and start designing e-modules.

The third stage is development, namely e-module testing by three lectures, two lectures material experts, and one lecture media expert. Material experts assess the feasibility aspects of

the content and linguistic aspects of the e-module, while media experts assess the presentation and graphic aspects of the e-module.

The trial was limited to 40 students to determine the readability. Responses to e-modules include categories of material feasibility, presentation, language, and graphics.

The types of data used are qualitative and quantitative data. Qualitative data in the form of input data from experts, teachers, and students in the e-module. While quantitative data in the form of data from the assessment of experts and students.

The data accumulation technique used is a questionnaire. The instrument used for data collection is a check list questionnaire with a Likert scale for media and material experts with answer choices.

Interpretation or interpretation with percentage categories based on the modified scale classification criteria from Riduwan (2013) is presented in Table 1.

Table 1. Criteria for Interpretation of Questionnaire Scale Scores

Criteria	Classification
$0\% \leq p \leq 20\%$	Very Weak
$20\% < p \leq 40\%$	Weak
$40\% < p \leq 60\%$	Enough
$60\% < p \leq 80\%$	Strong

Criteria	Classification
80% $p \leq$ 100%	Very Strong

RESULTS AND DISCUSSION

A learning media can help teachers and students with learning activities (Feri & Zulherman, 2021). This study aimed to development of Guided Inquiry-Oriented Science Interactive –Module on Wave dan Disaster Themes. The development process is described at each stage of development according to Thiagarajan, et al (1974) namely Define, Design, and Development. The three stages are described as follows:

The definition stage is the initial stage to determine and find problems or obstacles that occur in Integrated Science courses. The definition stage includes five main steps, namely:

a. Front End Analysis (Needs)

Front end analysis is an explanation of the problems faced by students. This analysis is used to find possible alternative solutions (Thiagarajan, et al, 1974). In this research, front-end analysis purposes to identify the problems faced by lecturers in teaching science in an integrated or integrated manner. The front end analysis was carried out through a Focus Group Discussion (FGD) team of lecturers who support Integrated Science courses. The discussion indicators are: student reactions during the learning process;

student learning outcomes in science 1 course; steps taken by lecturers to increase student activity, motivation and interest during lectures; alternative media to facilitate student understanding in lectures; learning resources that support learning process activities; and alternative independent learning resources for students.

The implementation of integrated science course learning is based on the demands of science learning competencies in junior high schools. Learning in schools currently uses the curriculum 2013, which is a curriculum that is in accordance with national learning implementation standards (Majid and Rochmah, 2013). Science learning in junior high school according to Rahayu (2012) must be implemented in an integrated manner. Integrated, namely learning science that connects the fields of physics, biology, chemistry, and earth science. The lack of varied learning resources and increasing students' interest in independent learning is still lacking. Therefore, there needs to be the development of interesting and interactive learning resources so as to increase student self-study interest

b. Student Analysis

Student analysis is an analysis carried out by characterizing and identifying students to design and develop learning (Thiagarajan et al,

1974). The analysis in this research was conducted to determine the response of students to the learning resources to analyze the obstacles faced. The analysis of these students is known by conducting FGDs of the team of lecturers who support courses and filling out questionnaires by prospective science teacher students.

Based on the results of FGD analysis and questionnaires, there are still many Science Education PS students who have difficulty understanding science lecture material. Science courses and Science Learning in the 2019 Science Education PS Curriculum are contracted in the third and fifth semesters after in the first year students study four science studies, namely physics, biology, chemistry and IPBA separately. This causes students to be confused when they are required to integrate the four fields of science studies into one scientific study. There are several factors that cause students' difficulties in understanding the material, one of which is the unavailability of textbooks that can help students construct knowledge and train students in making learning assessment instruments. The books used today are still more dominated by the presentation of material, causing students to be inactive in forming their knowledge. Students should have involvement in learning so that students understanding of

concepts can increase and learning becomes more meaningful (Sadler, 2004).

c. Task Analysis

Task analysis was carried out to identify the main tasks carried out by students. This analysis helps teachers to determine the media to be used (Thiagarajan, et al., 1974). This task analysis was carried out by analyzing the tasks given to prospective science teacher students.

The results of the FGD and questionnaires have not found an integrated and interactive learning resource that can increase students' interest in learning independently. Based on the analysis of the tasks carried out, it is known that there are no textbooks that are integrated, interesting, interactive and can increase students' motivation to learn independently. Science learning emphasizes Science learning emphasizes direct experience to develop competencies in order to know the surrounding nature scientifically.

d. Concept Analysis

Concept analysis is carried out based on Study Program Learning Outcomes and Science Course Learning Outcomes and Science Learning (Integrated Science). The competencies to be achieved refer to the Core Competencies of the Junior High School Science Curriculum 2013 and Basic

Competencies that have been determined. Learning by using themes makes it easier for students to integrate science.

The province of Banten, which is geographically located on the western tip of the island of Java, is very close to the very active tributary of Mount Krakatau. In addition, the southern position which is in the Indian Ocean is prone to high waves and tsunamis. Based on the curriculum analysis, the waves and disasters themes are deemed appropriate to develop inquiry learning through student-centered and disaster risk management. It was determined that classroom teachers have knowledge and awareness about the concept of disaster. Disaster education is an urgent necessity, and indispensable for preparing for disasters. In addition, it was stated that disaster education should be given through doing-living experiences and should be applied and made permanent. Technology-supported disaster education provided using different teaching methods-techniques should not be limited to classrooms and be benefited from other environments (Avcı, 2022).

Children, school-aged are the most vulnerable to natural disasters, through education to prepare respond to disasters. Disaster education is essential to raise awareness among students and their communities and to encourage

preparedness action (Boon & Pagliano, 2014).

With this, it is hoped that students can actively learn independently in the distance learning process. The integration model used is a webbed. This model has a characteristic when there are several concepts/competencies that are not interrelated, after being appointed as a new theme, the concepts that support the theme are shown to be related. This thematic learning model departs from a theme chosen and developed by the teacher with students (Harfiyani et al, 2018). The advantages of this learning are can motivate students to learn and help students to see an idea. The weakness, is very dependent on the selection of learning themes. The selection of appropriate theme will lead the students to understand the competencies (Prayuda, & Ratnawulan, 2019).

The Basic Competencies analysis of wave and disaster themes from the junior high school science curriculum is presented in Table 2:

Table 2. Core Competencies and Basic Competencies (KI-KD) on the Wave and Disaster Theme.

Core Competencies	Basic Competencies
KI-3: Understanding the knowledge (factual, conceptual, and procedural) based on their curiosity about science, technology, art, culture related to visible phenomena and events. (Class VIII)	3.10 Explain the layers of the earth, volcanoes, earthquakes and risk reduction actions before, during, and after disasters according to the threat of disasters in their area.
KI-4: Trying, processing, and presenting in concrete (using, parsing, assembling, modifying, and creating) and abstract (writing, reading, counting, drawing, and composing) according to what is learned in school and other sources the same in point of view/theory. (Class VII)	3.11 Analyzing the concepts of vibration, waves, and the earth in everyday life, including the human hearing system and the sonar system in animals. 4.10 Communicating efforts to reduce the risk and impact of natural disasters as well as self-rescue actions in the event of a disaster according to the type of disaster threat in the area.

e. Learning Objectives Analysis

Determination of learning objectives is done after conducting task analysis and concept analysis. From the results of the analysis that have been determined, an interactive Science Electronic Module with Guided Inquiry orientation is produced for prospective science teacher students with the theme of Waves and Disasters. With this, it is hoped that students can actively learn independently in the distance learning process.

Students are conditioned to be able to interact with learning materials actively and carry out various learning activities and get feedback about what

they are learning (Ruffi, 15). The applied guided inquiry-based learning on the module provides better students' learning outcomes value (Irwan et al, 2019). In addition to overcoming the difficulties of students, the inquiry learning model is suitable to be applied to linear programming material because this material is one of the materials related to problems in everyday life (Opticia et al, 2022).

Stage of Design (Design)

The Design Phase aims to design and development of science-oriented interactive electronic module guided inquiry wave and disaster theme. The product design stage is as follows.

a. Media Selection

At this stage, the researcher determines the appropriate and appropriate Electronic Module to present the theme of Waves and Disasters according to the Guided Inquiry orientation. The selection of the Electronic Module is adjusted to the needs of lecturers and students and in accordance with the developed theme. Electronic Module which will be developed using the Flip Book application. Presentation of the content of the theme of Waves and Disasters with this Flip Book becomes more flexible, by presenting materials, videos, and evaluation of learning interactively side by side. The guided inquiry-based

electronic module was created using the Inkscape design program to create pages and content in the electronic module (Khairi, M.A. & Ikhsan J, 2022)

b. Format Selection

The components that make up the Electronic Module adapt the components that make up the book which consist of: (1) Opening Display (Title Page, Preface, Table of Contents, List of Figures, List of Tables, Instructions for use); (2) Core Display (Introduction, core competence, basic competence, Indicators, Concept Maps, Learning Materials, Practice Questions); and (3) Closing View (Summary, Evaluation Questions, Bibliography, Developer Profile).

c. Initial Design

The initial design is presented in a storyboard. Storyboards are used to create sketches that are useful for describing the flow of the product that the researcher makes so that they can easily imagine the final product. In the context of guided inquiry learning on science-oriented interactive electronic module, researchers adapted from the phases of guided inquiry learning activities into core activities in lesson plans, which includes: (1) goal setting phase, (2) problem formulation phase, (3) hypothesis formulating phase, (4) experiment design phase, (5) data collection phase, (6) data analysis phase,

and (7) formulating phase (Vajoczki et al, 2011).

Development Stage (Develop)

a. Expert Validation

Expert Validation carried out to review the product. the e-module is validated by experts to find out whether the e-module developed is feasible to be used as teaching material in learning activities (Liana et al, 2022).

1) Material Expert Validation

Material expert validation aims to assess the content of the material, seen from several sub-components in the learning materials presented in the e-module.

The validation of material experts was carried out by three experts who were lecturers of Science Education at three universities in Indonesia. Based on the average recapitulation of the assessment results of the material expert validation test, it got a score of 83.45% with a very strong category. So, it can be concluded that the material in the Electronic Module is valid to be used as teaching material in learning the theme of Waves and Disasters. At this stage there is a revision of the validator, namely increasing the appearance of local wisdom content in explaining the material so that it is more contextual to students who study it. Another revision is the inclusion of videos in the Electronic Module selected from official sources.

Table 3. Material expert validation results

No	Category	Percent age	Sub Component
1	The suitability of the material description with KI, KD and Learning Indicators	85%	Valid
2	Material accuracy	83%	Valid
3	Material suitability learning support	87%	Valid
4	The suitability of the material with guided inquiry phases	85%	Valid
5	The suitability of the material with wand disaster theme	83%	Quite Valid
6	Completeness of presentation	87%	Valid
7	Useful Languages straightforward	84%	Valid
8	Use of language according to the level of students	83%	Valid
Total		83,45%	Valid

2) Media Expert Validation

Media expert validation aims to assess the appearance of the media, seen from several sub-components of learning media presented in e-books. The cover and content of the e-module can be seen in Figure 1.

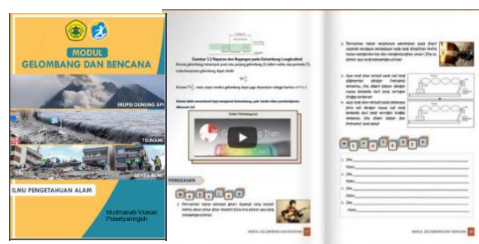


Figure 1. Display of the cover and contents of the e-module

The material expert validation was carried out by 3 experts who were lecturers of Science Education at Trunojoyo University, lecturers of Science Education at Serang Open University and lecturers of Physics Education at Lambung Mangkurat University. Based on the average recapitulation of the media expert validation test results, the media received a positive response from the validator with a score of 89% with a very strong category. So, it can be concluded that the media in the Electronic Module is valid for use as teaching materials in learning the theme of Waves and Disasters.

At this stage, there is a revision of the validator, namely adding a video with an explanation of the lecturer, virtual can use applications such as screen cast-Omatic so that it is more interactive. Another revision of the cover does not represent the theme of waves and disasters, it needs to be changed according to the theme so that it can describe the contents of the module.

Table 4. Media expert validation

No.	Rated aspect	Percentage
1.	Presentation	89%
2.	Graphics	85%
3.	Language	93%
Total Score		89,00

Limited Trial

After going through expert validation of both material and media and the revision process, the guided inquiry-based science e-module product with the wave and disaster theme was tested on a limited number of 40 students to determine their readability. Responses to e-modules include aspects of material feasibility, presentation, language, and graphics.

Data on student responses to guided inquiry-based science e-modules on the theme of waves and disasters as a result of development are presented in Table 5.

Table 5. Data on Student Responses to e-module in Limited Trials.

No.	Rated aspect	Score
1.	Material eligibility	9,00
2.	Presentation	11,17
3.	Language	3,05
4.	Graphics	11,33
Total Score		34,55

A limited trial was conducted on students taking Science two courses to collect information as input for improving products and operating e-module. The results of the limited test obtained a total score of 34.55 and were categorized as very good with some

comments and suggestions including being happy to watch videos in e-modules and having difficulty logging in if internet access is weak. According to Ilma (2020), student responses to science learning with guided inquiry learning model through the developed flipbook media was very good. Comments and suggestions have been improved.

The purpose of the limited trial was to collect inputs to improve products and operate a guided inquiry-based science e-module. The results of the test scored 34.55 and categorized as very decent. According to Irma (2020), student responses to science learning with guided inquiry learning model through the developed flipbook media was very decent. Based on the validation results, the guided inquiry-based science e-module is feasible to use both in terms of material and media and is feasible in limited trials. This research explained that an e-learning media that has developed could be applied in teaching and learning activities compared to ordinary learning (Ahsan, 2016). Various research results show that the application of guided inquiry-based learning has a positive trend in learning that emphasizes the active participation of students in thinking and concluding (Vlassi & Karaliota, 2013). The guided inquiry learning can improve the understanding

of students' concepts to improve learning outcomes (Bilgin, 2009).

CONCLUSION

Based on the results of the research that has been described, it can be concluded that this research resulted are material expert validation obtained a percentage of 83.45% with a very strong category with few revisions. The results of media expert validation, the media got a positive response from the validator with the percentage of validity obtained by 89% with a very strong category with little revision. The results of the limited test obtained a total score of 34.55 and categorized as very good. Thus the developed e-module can be used as a learning resource.

The need for teaching materials is getting higher with the ongoing online learning. Supported by the many applications in making Electronic Modules that are growing so that they can be used to develop modules with other themes needed in the learning process.

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