Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index

Vol. 10, No. 4 : December 2024
E-ISSN: 2442-7667
pp. 1451-1460
Email: jklppm@undikma.ac.id

Development of Disaster Mitigation E-Module Based on Physics Concepts

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Abstract: This study aims to develop a disaster mitigation e-module based on physics concepts for students. The study used the 4D method for research and development but only covered development. The researcher analyzed the situation, students, concepts, tasks, and learning objectives during the definition stage. A questionnaire was given to validators and students for a limited trial. The product design stage involved gathering references, choosing media options, selecting images and videos for the e-module, and creating the e-module's cover content. In the third stage of development, researchers carried out validation and limited trials. The data obtained were analyzed descriptively. The experts in the field of materials and media conducted a comprehensive evaluation of the e-module, and their findings indicated that the module was of a high standard in all aspects. This e-module received positive feedback from the students based on the average response score obtained of 3.45. The score is categorized as very good. Therefore, creating an e-module on disaster preparedness using physics concepts is a feasible option for use in learning, especially related to contextual-based physics learning.

Article History
Received: 01-10-2024
Revised: 04-11-2024
Accepted: 25-11-2024
Published: 21-12-2024

Key Words:
E-Module; Disaster Mitigation; Physics.

How to Cite: Anggraeni, F., & Prihandono, T. (2024). Development of Disaster Mitigation E-Module Based on Physics Concepts. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran, 10*(4), 1451-1460. doi:https://doi.org/10.33394/jk.v10i4.13374

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Introduction

Indonesia is located at the intersection of three tectonic plates, making it highly vulnerable to natural disasters (Djalante & Garschagen, 2017; Purnama et al., 2021). Natural disasters are events which are the result of natural phenomena (Mareta, 2018). The causes of natural disasters can be classified into two categories: geological (causing earthquakes, tsunamis, and volcanic eruptions) and hydromete-orological (causing floods, landslides, tidal waves, drought, forest and land fires, and tornadoes) (Setyowati, 2019). As natural disasters can happen unexpectedly, frequently, and sometimes cannot be predicted, it is essential to reduce the risk by making necessary efforts.

In accordance with the stipulations outlined in Law No. 24/2017 on Disaster Management, all individuals are entitled to receive education, training, counseling, and instruction in the implementation of disaster management measures, both in the absence of an actual disaster and in the event of a potential disaster. Through education, it is expected that the target of disaster risk reduction can be broader. The step that needs to be taken is integrating material about disasters and their mitiga-tion and management into learning materials (Fauza et al., 2022; Septaria et al., 2020; Setyowati, 2019). This integration must be implemented at all levels of the Indonesian education system, spanning primary and secondary education through to tertiary education and higher education. One form of integration is to incorporate disaster material into physics concepts.

Physics studies how to observe and comprehend the functioning and interactions of different components in the universe. In the study of physics, it is of paramount importance for students to maintain a connection with the phenomena that occur in the universe,

particularly those that are directly relevant to their daily lives (Yuliani & Wahyono, 2021). An example of applying physics concepts in everyday life is the presence of nature (Fauza et al., 2023). The field of physics plays an essential role in the reduction of risk associated with natural disasters and the promotion of disaster education. These benefits highlight the importance of integrating physics learning into natural disaster management efforts. Additionally, it provides prospective physics teachers with a deeper understanding of the practical applications of physics concepts in daily life. Integrating physics concepts with natural disaster mitigation can be achieved through teaching materials, such as a module.

The module helps students to understand the material on their own (Putri & Afrizon, 2020; S.Sirate & Ramadhana, 2017). The existence of the module is expected to foster students' curiosity. This curiosity will increase motivation and learning outcomes (Zaputra et al., 2021). Modules can be prepared in print and digitally. Digital modules are commonly referred to as electronic modules (e-module). The usefulness of the e-module is analogous to that of the printed module, namely, facilitating students' ability to engage in independent learning (Haspen, 2019; Haspen & Syafriani, 2022; Haspen et al., 2021). E-module has the advantage of being used as distance learning media and can be accessed anywhere (Rahmadhani & Efronia, 2021). Its utilization can be opened via laptop or smartphone. It can be integrated with the internet so that students can access links related to the material's content, for example, access to online videos to support the material's content (Fitri et al., 2022). With this ease of access, the e-module is very suitable for the development of students because it utilizes technology in it. The utilization of e-module in physics learning can help educators in the delivery of material. Additionally, students can reap the benefits of studying with e-module, including developing critical thinking abilities, diminished dependence on educators, and simplified learning material (Triandini et al., 2021).

The researcher conducted a study to develop a disaster mitigation module rooted in physics concepts for university students. Maintaining a balanced and appropriate approach to disaster mitigation and related concepts is essential solely for the benefit of students' education. Therefore, this research aims to support disaster education integrated with physics materials at the university level. In previous studies, the integration of disaster mitigation into e-modules is aimed at teachers and students but there is rarely research for physics concept-based disaster mitigation e-modules targeting students in universities. As in research Fauza et al., (2023) obtained the results that physics teachers need material related to the integration of physics concepts for disaster mitigation. Then research by Labibah et al., (2020) regarding the integration of landslide disaster into physics learning for high school students, the results of which stated that high school students still have a weak understanding related to disaster mitigation. However, there is also research aimed at students but the material contained in the e-module is only for earthquake disasters (Purnama et al., 2021).

Based on this, this e-module has a difference from the previous one where in this e-module three disasters are studied based on their physical concepts and descriptions related to the forms of mitigation that need to be done. This e-module focuses on earthquakes, volcanic eruptions, and landslides which are the most common disasters in Indonesia. Disaster mitigation e-modules that are linked to physics concepts are needed. This is because e-modules can improve students' understanding of physics concepts and disaster literacy which plays an important role in supporting disaster mitigation efforts.

Research Method

The research conducted followed the R&D development model using the 4D framework consisting of defining, designing, developing, and disseminating (Pathoni, 2023).

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In the define stage, learning criteria were established and observations were made, including analysis of the situation, analysis of the student, analysis of the concept, analysis of the task, and analysis of the learning objectives. At the design stage, the researchers created the product. The product design phase includes the following stages: preparation, reference preparation, media selection for design, video selection for inclusion in the e-module, and e-module cover-content design. Following this, the development stage includes evaluating materials and media by experts, then revisions and development tests for students. Lastly, the dissemination stage is the fourth stage. However, the stages are carried out only up to the development stage.

The research subjects were physics education students of Jember University. The instrument used in the study was a questionnaire to determine the feasibility of e-modules. The questionnaire was given to materials and media experts to assess the feasibility of e-modules prior to testing. In addition, the questionnaire was also given to students who were the study respondents. The scoring of the questionnaire was based on a Likert scale. The data obtained were analyzed descriptively to calculate the average value of each aspect. The analysis technique based on Arikunto for determining the final score assessment of each questionnaire item is carried out by dividing the number of scores obtained by the number of respondents who completed the assessment questionnaire (Pusparini & Sari, 2020). The resulting average value is converted qualitatively based on Table 1 below.

Table 1. Category criteria for e-modules

Average score	Category
$3.25<X\leq4.00$	Excellent
$2.50<X\leq3.25$	Good
$1.75<X\leq2.50$	Poor
$1.00<X\leq1.75$	Very poor

(Widoyoko, 2016)

Results and Discussion

Research on developing a disaster mitigation e-module based on physics concepts has been completed. This research is an R&D research with a 4D model. However, due to time constraints, the research was carried out with only three stages. The following are the results of the research that has been done.

Definition Stage

At the definition stage, researchers conducted a needs analysis. The activities carried out were situation analysis, analysis of the student, analysis of the concept, analysis of the task, and analysis of the learning objectives. From this stage, it was found that due to students' understanding of physics concepts that occur in everyday life, especially regarding natural disasters and lack of learning in using the case method, a contextual-based e-module was developed.

Design Stage

The product design step, a crucial phase in the e-module development, involves preparing references, selecting media to design, choosing images and videos for the e-module, and designing the cover content. The preparation stage, where researchers meticulously gather what's needed for the e-module design, is a pivotal part of this process. It's during this stage that references are prepared, software is selected, and Canva is chosen for content and cover design. Furthermore, researchers also determine the videos inserted in the e-module to attract student's attention and increase their understanding, as well as the selection of appropriate and suitable images to be displayed in the content.

The developed physics concept-based disaster mitigation e-module consists of an opening component consisting of a cover page, preface, and table of contents; learning activities consisting of learning outcomes, material descriptions, summaries, formative tests, and enrichment; closing, which contains a bibliography and glossary. Videos also complement e-modules compiled in addition to containing text. The e-module developed is in the form of a flip book which is accessible online.

This e-module contains four learning activities. Learning Activity 1 is about the concept of disasters, Learning Activity 2 is about earthquakes, Learning Activity 3 is about volcanic activity, and Learning Activity 4 is about landslides. In these learning activities, especially for learning activities 2 to 4, in addition to explaining material related to how the process of disaster occurs, it is explained how mitigation needs to be done and what physical concepts exist in the disasters studied. In each chapter, there is a formative evaluation to measure student understanding. In addition to formative evaluation, there are also enrichment questions.

Development Stage

The next phase is the development phase. In this stage, validation was conducted by material experts and media experts (Hamdani et al., 2019). After the validation was declared, a trial was carried out on students to determine how the user responds to the e-module. Validation is conducted to state the feasibility of the product with predetermined indicators (Fadieny & Fauzi, 2021; Irawan et al., 2020; Mastuang et al., 2020). The results of the validation activities are presented in Tables 2 and 3 below.

Table 2. Result of material expert validation

Aspect of Assessment	Average Score	Category
Content feasibility	3.78	Excellent
Presentation feasibility	3.67	Excellent
Language feasibility	3.88	Excellent
Contextual feasibility	3.83	Excellent
Total Aspect	3.79	Excellent

Table 3. Result of media expert validation

Aspect of Assessment	Average Score	Category
Display design	3.67	Excellent
Convenience	4.00	Excellent
Utilization	3.67	Excellent
Consistency and format	3.40	Excellent
Total Aspect	3.69	Excellent

From the table, the chart of the results can be made as shown in Figure 1 and Figure 2.

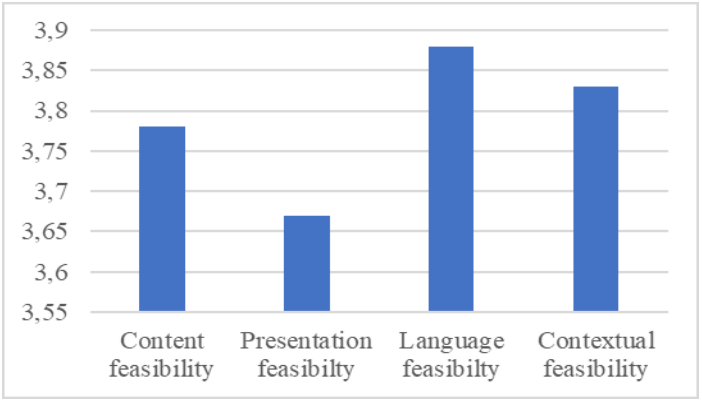

Figure 1. Chart result of material expert

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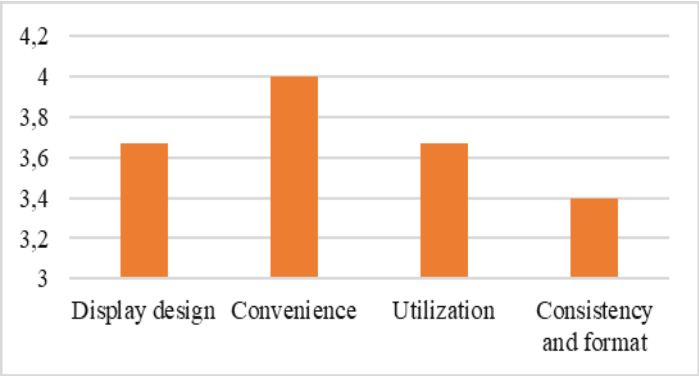

Figure 2. Chart result of media expert

The validation of the e-module material consists of four aspects of assessment, namely content feasibility, presentation feasibility, language feasibility, and contextual feasibility. Based on Figure 1, the content feasibility results have an average score of 3.78, which belongs to the "excellent" category, indicating that the content is highly feasible for the intended purpose. The presentation feasibility results also scored 'excellent', with an average of 3.67, meaning the presentation is highly feasible. Language feasibility received a score of 3.88, also categorized as 'excellent', suggesting that the language used is highly feasible. Finally, contextual feasibility received an average score of 3.83, which is also 'excellent'. These results suggest that the material experts' validation of the e-modules was excellent.

Validation was also conducted by media professionals, assessing display design, convenience, usage, consistency, and format. The display design of the e-module got an average score of 3.67, with an 'excellent' rating. The convenience aspect received a 4.00 average rating in an 'excellent' category, while the utilization aspect received an average rating of 3.67 in an excellent category. The consistency and format aspect had an average rating of 3.40, with an 'excellent' category. These results indicate that media experts have validated that the e-module is categorized as excellent.

Following the successful validation by material and media experts, the e-module is now ready for a limited trial at Jember University for Physics Education students. The tests have shown a favorable outcome among students, as reflected in Fig. 3. Each statement's score column presents the average rating from the student answers. The content assessment received a rating of 3.47, falling in the 'excellent' category. The language usability assessment received a rating of 3.46, also in the 'excellent' category. The e-module utilization assessment received an average rating of 3.43, again in the 'excellent' category. The graphics assessment received an average rating of 3.45, also in the 'excellent' category. Based on the positive feedback from the students, these results validate the module's effectiveness and potential impact.

Based on the results of validation by materials and media experts, the e-module is suitable for use. Therefore, a limited trial can be conducted for Physics Education students at Universitas Jember. Limited tests with students showed an excellent response. These results are seen in Table 4.

Table 4. Students' response to the e-module

Aspect of Assessment	Average Score	Category
Content feasibility	3.47	Excellent
Language feasibility	3.46	Excellent
Feasibility of Utilization	3.43	Excellent
Graphical feasibility	3.45	Excellent
Average	3.45	Excellent

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The number obtained in the score column for each statement is the average of student answers. Assessment of the content obtained a value of 3.47 with a excellent category, an assessment of the language feasibility obtained a value of 3.46 with a excellent category, an assessment of the utilization of e-modules got an average value of 3.43 with a excellent category, and an assessment of the graphical obtained an average value of 3.45 with a excellent category. These indicators can be depicted on the chart in Figure 3.

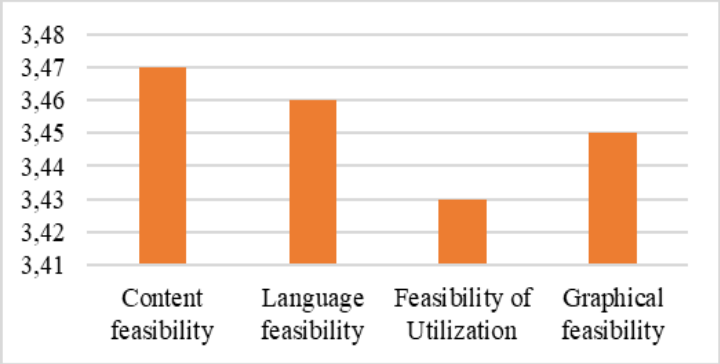

Figure 3. Student's response to the e-module

Discussion

The findings of this research are crucial as they reveal the current state of physics learning and the need for improved disaster education. The first step is defining which conducts situation analysis, student analysis, concept analysis, task analysis, and learning objective analysis (Permata et al., 2021). In the situation analysis, it was found that physics learning with the case method in Physics Education Universitas Jember was still lacking. In addition, the situation analysis was also carried out on national news about disasters that occurred in Indonesia. Student analysis also found that learning outcomes and understanding of physics concepts were still low.

Furthermore, the concept analysis identifies what essential concepts will be compiled in the e-module. This analysis obtained three kinds of natural disasters and their physics concepts: earthquakes, disasters due to volcanic activity, and landslides. In the concept analysis, each of these disasters is analyzed for its physical concept. For example, in the event of an earthquake, there is the concept or material of waves and energy in it. Then, in volcanic disasters, the concept of heat can be studied, as well as landslides; there are concepts of force and motion in it. The next step is task analysis. In this step, identification was carried out related to what kind of task so that students can achieve the desired learning objectives. In the e-module, the tasks given were formative and enrichment questions, with each in the form of essays. Next is the analysis of learning objectives. This step determines what goals students can achieve when learning through this e-module. The learning objectives of this e-module, in general, are to improve the understanding of physics concepts in everyday life and as disaster literacy for them.

In the design stage, various preparations were made, such as selecting references for the content in the e-module, designing the content and cover, selecting images and videos. Through an attractive design, it will create an innovative learning module that is able to attract attention, increase students' concentration and comprehension, and build students' independence (Anggraeni et al., 2022). The design was done using a web-based application, Canva. This is because Canva has many interesting templates that are easy for researchers to use (Roma et al., 2023). After the page-by-page design was complete, it was inserted into the HeyZine Flip Book. The choice of flipbook form is because this form feels more interesting

like flipping a book in real life (Latifah et al., 2020). From this stage, an e-module containing four learning activities was developed. The developed physics concept-based disaster mitigation e-module consists of an opening component consisting of a cover page, preface, and table of contents; learning activities consisting of learning outcomes, material descriptions, summaries, formative tests, and enrichment; closing, which contains a bibliography and glossary.

At the development stage, researchers validated material experts and media experts. After the e-module was declared valid, the e-module could be tested on a limited basis. Limited trials were conducted on 17 Physics Education students at the University of Jember. The validation assessment by material experts obtained an average category of four aspects, which is excellent. The results for feasibility in terms of language have the highest average value compared to other aspects. This means that the language and sentences in the e-module are excellent, so it should be able to be read and understood easily by students. The contextual aspect has the second-highest average value. This shows that the material in the e-module is contextual because it integrates the material with daily life. E-modules should indeed be contextual with learning materials close to students' lives (Fourilla & Fauzi, 2019). The results of the assessment by media expert validators also obtained an average category of four aspects, which is excellent. The assessment aspect regarding the ease of using e-modules obtained the highest average value among other aspects, namely 4.00. This shows that e-modules are easy to use. Students only need to use a smartphone to study the e-module. Students can also use a laptop for a larger display. The material and media experts' validation results show that the e-module is suitable for use. The next step is to conduct a limited trial for students. After the e-module trial, the researchers distributed response questionnaires to students using Google Forms.

Student responses to the e-module showed excellent results. This result states that the e-module provides positive value for learning. In terms of content, it is categorized as excellent, which means that the content of the e-module is by the objectives. Pictures and even videos help students learn the contents of the e-module, and the e-module is very interactive. In terms of language, it is categorized as excellent because it is communicative, and students can easily understand sentences.

Regarding utilization, e-modules enable students to learn independently and are interested in learning. Then, in terms of graphics, it was categorized as excellent. It means that the e-module is feasible to use in appearance. Using e-modules can be used as one of the innovations in learning that can attract students' attention and also encourage students to learn independently without having to depend on the main source of learning (Sari et al., 2022). In addition, applying this e-module is expected to increase disaster preparedness and innovation in learning (Sumarmi et al., 2021). Thus, mitigation against disasters, incredibly natural disasters, can be integrated through physics learning as a pedagogical approach and teaching materials such as e-modules.

The provision of e-modules provides experience and additional knowledge to fully understand the implementation of physics concepts, especially those around them. This research can show how physics concepts can be applied to real-life problems, particularly natural disasters. For example, understanding physics concepts in earthquakes, volcanic eruptions, and landslides can lead to better preparedness strategies. By linking physics principles such as force, energy, wave propagation, fluid dynamics, and material strength with disaster mitigation, this research can be a step in how scientific knowledge can improve safety measures in disaster mitigation.

The development of e-modules signifies that learning needs to be innovative, interactive, and technology-based. Integrating multimedia tools (such as simulation, video, and audio) into teaching can enhance the learning experience and student engagement. E-modules can offer a more accessible and dynamic way to teach disaster science to make it easier to understand by presenting it visually and interactively. Therefore, as lecturers, we should always provide innovations related to learning and insert physics knowledge into things that are around them.

Conclusion

The development of disaster mitigation e-modules based on physics concepts is feasible to use. This statement was obtained based on material and media experts' validation results, who obtained excellent results from all aspects of the assessment. In addition to the validation results, feasibility was obtained based on student responses through limited trials. The responses show that the e-module is excellent for students to use in learning. Therefore, this e-module can be said to be suitable for use in the teaching of physics in higher education. Through this e-module, students can not only understand the concept of physics based on contextual life, but can also add insights related to mitigating disasters caused by earthquakes, landslides, and volcanic activity.

Recommendation

The recommendation from this research is that disaster mitigation e-modules based on physics concepts need to be used as contextualized teaching materials. In addition, this e-module can help in terms of adding insight into disaster mitigation for students. For lecturers, compiling e-modules that discuss physics concepts applied to everyday life and the use of technology, is expected to be able to improve the understanding of concepts and learning in accordance with students' development.

Acknowledgment

We would like to thank you for funding this research. This work was supported by Penelitian Dosen Pemula Grant, Provided by Research and Community Service of Universitas Jember.

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