

A DIGITAL INTERACTIVE MODULE-BASED ON PROBLEM LEARNING IN ENVIRONMENTAL POLLUTION

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DOI: 10.22373/biotik.v11i2.19875

ABSTRAK

Latar belakang penelitian ini adalah masih minimnya media pembelajaran yang inovatif berbasis digital teknologi. belum banyak modul interaktif digital yang telah dikembangkan untuk mendukung pembelajaran. Ketersediaan modul interaktif digital yang terbatas dapat membatasi penggunaan teknologi dalam pembelajaran dan menghambat pencapaian tujuan pembelajaran era revolusi 4.0. Untuk itu perlu dikembangkan modul interaktif berbasis digital yang memberikan kesempatan kepada peserta didik menemukan sendiri konsep yang sedang dipelajarinya. Peserta didik menjadi lebih aktif, mandiri membangun konstruksi pengetahuan. Penelitian dan pengembangan menggunakan model Borg dan Gall yang terdiri dari pengembangan produk, validasi produk, revisi desain, uji coba dan revisi produk. Instrumen penelitian terdiri dari angket validasi modul (konten dan media) serta angket respon. Validasi modul melibatkan akademisi Universitas Teuku Umar yang ahli dibidangnya, akademisi ahli konten dan media. Hasil validasi ahli diperoleh skor gabungan 87,5%, modul dapat digunakan tanpa perbaikan. Uji lapangan produk dilaksanakan pada semester ganjil tahun ajar 2023/2024 pada 60 peserta didik SMP Negeri 1 Aceh Barat. Hasil uji lapangan 91% peserta didik memberikan tanggapan positif terhadap modul. Pengembangan modul interaktif problem based learning berbasis digital memenuhi syarat dan dapat digunakan dalam memfasilitasi pembelajaran yang aktif, kreatif, dan mengarah pada pengembangan keterampilan siswa secara mandiri dan relevan dengan perkembangan teknologi.

Kata Kunci: Modul Interaktif Digital, Problem Based Learning, Pencemaran lingkungan.

ABSTRACT

The background of this research is the lack of innovative digital technology-based learning media. There are not many digital interactive modules that have been developed to support learning. The limited availability of digital interactive modules can limit the use of technology in learning and hinder the achievement of learning goals in the era of Industrial Revolution 4.0. For this reason, it is necessary to develop digital-based interactive modules that provide opportunities for students to discover for themselves the concepts they are studying. Learners become more

active and independently build knowledge. Research and development used the Borg and Gall model, which consists of product development, product validation, design revision, testing, and product revision. The research instrument consisted of a module validation questionnaire (content and media) and a response questionnaire. Module validation involves lectures at Teuku Umar University who are experts in their fields as content and media expert. The experts validation results obtained a combined score of 87.5%, indicating that the module can be used without repair. The product field test was carried out in the odd semester of the 2023–2024 academic year with 60 students at SMP Negeri 1 Aceh Barat. Field test results showed that 91% of students gave positive responses to the module. The development of digital-based interactive problem-based learning modules meets the requirements, can be used to facilitate active, creative learning, leads to the development of students' skills independently, and is relevant to technological developments.

Keyword: Digital Interactive Module, Problem Based Learning, Environmental Pollution.

INTRODUCTION

Current educational development requires student-centered learning and the use of information and communication technology (ICT) as a learning tool. The subject matter is presented in digital form, which allows students to learn actively and independently [1]. Learning design using ICT, such as module development, will increase students' interest in learning, and the material will be easier to remember because students are actively involved in learning [2].

The module developed is a digital interactive module based on problem-based learning. Module development will be carried out on environmental pollution material. The module was developed based on the learning objectives of environmental pollution material, that students can understand, analyses and find solutions to environmental problems [3]. The development of problem-based learning-based interactive digital modules will overcome learning weaknesses by presenting examples, issues, and pollution of the learning environment directly in the classroom [4]. With this module, students can explore and find their knowledge. The module's contents will be designed to contain pictures of environmental problems that can increase students' interest in reading them. Learning is expected to provide opportunities for

students to find their knowledge and issues surrounding environmental pollution according to the characteristics of problem-based learning [5], [6].

Module development follows the educational needs of the industrial revolution era 4.0, prioritizing mastery of technological literacy for students [7]. Mastery of technology is essential. with technology, students can be connected digitally. Learning should confront students with digital technology so that students' skills develop and learning becomes more effective. Technological advances provide new opportunities for developing digital-based learning systems [8], [9]. Learning with digital interactive modules is an innovative learning strategy, making the learning atmosphere more attractive, can overcome the limitations of space and time and trains students to become independent learners [10].

Digital interactive module designs will be aligned with PBL learning objectives. Therefore the module will be developed with the steps of the PBL model that emphasizes students' problem-solving mastery [11], [12]. The

module will confront students with an in-depth exploration of material and analyze various problem situations that require them to be responsible for finding solutions to problem-solving [13]. These environmental problems will be complemented by pictures, videos and illustrations that activate students' imaginations.

Problem-based learning digital interactive modules can include various media types such as video, audio, images, animation and interactive simulations. The use of various types of media will provide an accurate visualization of environmental problems that exist around students [14]. In addition, the module also contains subject matter, LKPD, and practice questions. In the LKPD module section, students will try to plan a solution to the problem by applying the knowledge they have previously obtained. In the exercise section, students will answer a series of questions to test their mastery of environmental pollution by choosing the correct answer alternative. Features on the digital module will provide immediate feedback on the answers that have been selected [15]. This feature

can inform students to discover achievements and subject matter that needs further study.

Several previous studies have researched the development of problem-based learning-based digital modules [5], [10], [16]. However, research and development of problem-based learning-based digital interactive modules on environmental pollution material is minim information. Therefore, this research must be conducted to provide new information and produce technology-based learning media.

RESEARCH METHOD

This research used research and development (R&D) by Borg and Gall model, consisting of the stages of product development, product validation, design revision, trial and product revision [17], [18]. The instrument was module validation questionnaires (content and media) and

student response questionnaires. The module validation questionnaire is used to obtain feedback on the product design being developed and improvements based on input from expert validators [19].

The module validator was a lecturer of Teuku Umar University as content and media expert. Product trials were carried out at SMPN 1 Aceh Barat for 60 students in the odd semester of 2023-2024 to get further responses and input on the modules that have been developed. Module validity data and responses was analyzed quantitatively in percentage to determine whether the module is used or requires further revision [20]. The formula for this research is presented below.

$$P = \frac{f}{N} \times 100\% \text{ [21]}$$

Information:

- P : Final grade
- f : Acquired score
- N : Maximum Score

Table 1. Instrument Validity Criteria

Number	Validity Category
80,01%-100%	Used without repair
70,01%- 80%	used with minor improvements
50,01%-70%	require major repair before use
01,00%- 50%	Should not be used

RESULTS AND DISCUSSION

Product Development

The product being developed is a problem-based learning digital interactive module using Adobe Creative Cloud Animate software. It makes the module design more attractive, with various menu features that make it easier for students to use. In addition, images, illustrations, videos and feedback on learning achievements can be added to modules. The preparation of modules will be adapted to PBL learning which prioritizes solving environmental problems, starting from simple problems to more complex problems that require problem-solving strategies based on scientific concepts [6], [22].

Module development focuses on two aspects, content and media aspects [23]. The content aspect consists of the completeness of the material, up-to-date and scientific systematics. Development begins with analyzing the needs for module development by essential

competencies and indicators of learning objectives on environmental pollution materials such as compiling material systematically, choosing pictures, videos, and illustrations that can explain the concepts being studied as well as worksheets containing environmental problems that must be completed by students based on the concept knowledge. The module also displays new information and facts about environmental pollution that can encourage students' imaginations.

The media aspect consists of design, interactivity and module navigation. The development focuses on media design, such as the ease of using modules and the choice of colors and fonts that are attractive and easy to read. The module also has a hint feature and the availability of menus that make it easy to use, such as a table of contents, materials, LKPD, and evaluation menu that provide feedback on the scores obtained after working on the evaluation.

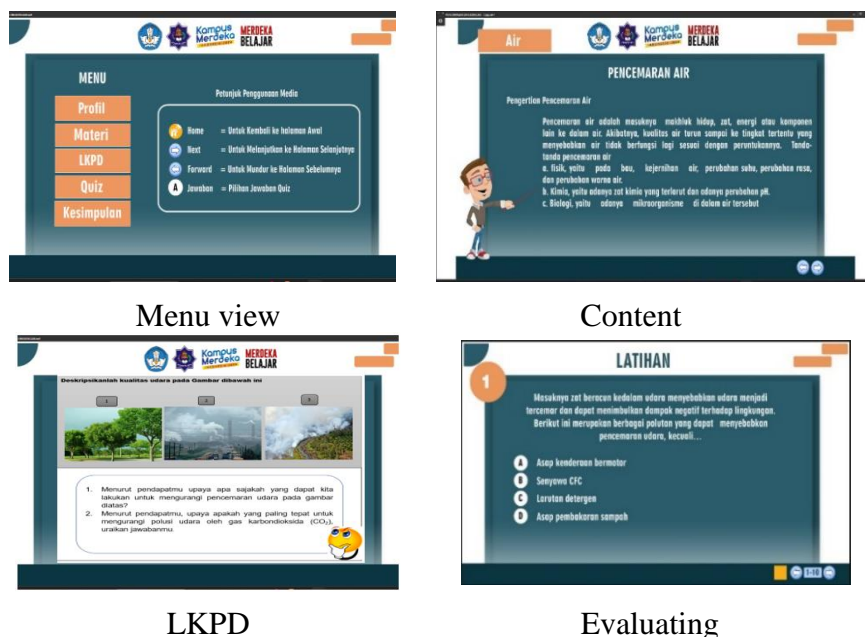


Figure 1. Interactive digital based PBL module design.

Content experts and media experts validate module-based learning digital interactive modules based on assessing the feasibility of

problem-based learning. The results of expert validation can be seen in the below.

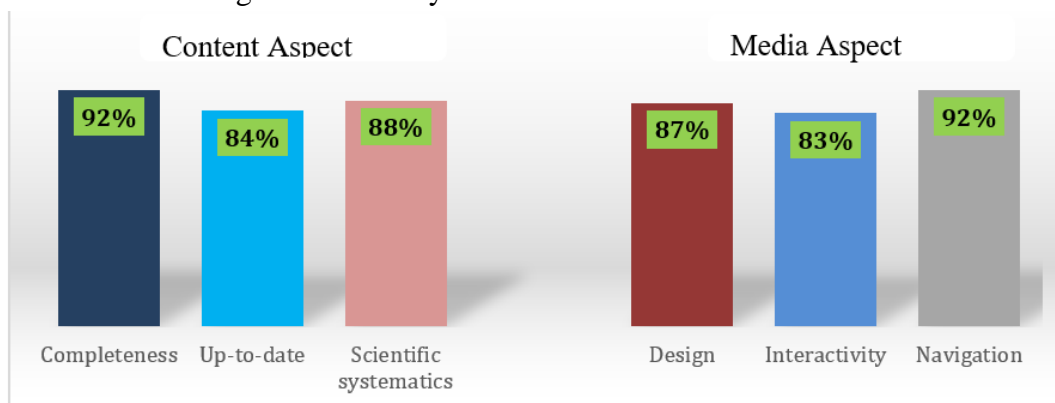


Figure 2. Percentage of module assessment (content & media)

Table 2. Validation Result of Digital Interactive Module Based PBL

Validator	Score			Avarage
	Aspect I	Aspect `II	Aspect `III	
Content Validator	92%	84%	88%	88%
Media Validator	87%	83%	92%	87%
Combined Percentage	87.5%			
Validity Category	Used without repair			

The results of the analysis obtained a questionnaire score of 87,5%% which indicated that the students' responses were very positive towards the module. This shows that the module that has been developed is in accordance with the learning needs of environmental pollution material. The module presents material along with pictures, video illustrations that make it easier for students to understand the subject matter. The appearance of attractive modules based on technology and color selection; the right layout can stimulate student motivation to continue learning with modules. In addition, the module is designed with attention to ease of application. Students can select the menu or move to the desired module

page. The use of this module is expected to stimulate the involvement of students to be active in exploratory learning to find knowledge concepts that are difficult to present in real learning. This is part of the advantages of a media in overcoming the limitations of space and time in a lesson.

Product Test

Field trials aim to see the module's effectiveness as a learning tool from the student's point of view. The response questionnaire was prepared based on the eligibility criteria of the module as a learning medium which includes aspects of presenting the material, display, and module navigation.

Table 3. Percentage of Student Responses to Digital Interactive Module

Aspect	Score
Presentation of material	90%
Appearance	93%
Module navigation	90%
Average Score	91%

The analysis results obtained a questionnaire score of 91%, indicating that the student's responses were very positive towards the module. Shows that the module that has been developed follows the learning needs of

environmental pollution material. The module presents material, pictures, and video illustrations that make it easier for students to understand the subject matter. The appearance of attractive modules based on technology, color

selection, and the proper layout can stimulate student motivation to continue learning with modules. In addition, the module is designed with attention to ease of application. Students can select the menu or move to the desired module page. The use of this module is expected to stimulate the involvement of students to be active in exploratory learning to find knowledge concepts that are difficult to present in authentic learning and the advantage of media in overcoming the limitations of space and time in learning [23].

CONCLUSION

The problem-based learning-based digital interactive module that has been developed has fulfilled the expert validity requirements (content, media) with a score of 87,5% and received a positive response from students with a score of 91%. This module can be used

in the learning process of environmental pollution material to improve the quality of learning to be more active, creative and develop students' skills independently and relevant to technological developments. In addition, it also provides a variety of learning resources that are easily accessible to students.

ACKNOWLEDGMENT

Authors thank the Directorate of Research, Technology, and Community Service (DRTPM) of the Ministry of Education, Culture, Research and Technology Republic of Indonesia, which has provided funding support for the fiscal year 2023, LPPM Teuku Umar University for facilitating and SMPN 1 Aceh Barat as a place for conducting research product trials.

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