

Research Article

Development of Digital Modules in the Environmental Toxicology Course at the Undergraduate Level in the Biology Program Study

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Abstract.

The need for digital modules is required in the implementation of distance learning. This study aims to develop a digital module in “environmental toxicology” lectures at the undergraduate level of the Faculty of Mathematics and Natural Sciences Education. The existence of this digital module can support the implementation of the Independent Learning Program - Independent Campus (MBKM) in the FPMIPA. The method used in this study was a case study with a descriptive approach. Learning media was developed through the ADDIE approach, which consists of 5 stages: analysis, design, development, implementation, and evaluation. This study involved two experts as digital module validators and 10 students involved in learning environmental toxicology through learning management system (LMS). At the end of the implementation, students were evaluated to determine the level of student understanding during the online independent learning process. The results of this development were in the form of a digitating of 14 meeting materials, mid-term; final exam; content on the SPADA-UPI Learning Management System; and IPR Digital Module Innovation. Based on the validation and reared validation and readability test results, digital modules can be used to support online learning of environmental toxicology.

Keywords: digital modules, environmental toxicology, biology program study

1. INTRODUCTION

The teaching materials (printed or digital modules) are needed for students’ learning process [1]. Teaching material is designed to transfer the message of learning from the teacher to the students to stimulate thoughts, feelings, interests and the willingness of students to learn. recent decades, Information and Communication Technologies (ICT) have been) is applied in varied formal educational contexts [2]. In 2020, World Health

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Published: 26 April 2024

Publishing services provided by Knowledge E

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Selection and Peer-review under the responsibility of the ICMSCE Conference Committee.

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Organization O) declared a global pandemic outbreak [3]. It affected various sectors for more than 2 years in the field of education. Therefore, to ensure human safety and maintain all education activities, all learning processes are adjusted [4]. Online learning is the only strategy to overcome that aim. To conduct online learning, teaching material needs to be prepared. Teaching material as a digital module stimulates students to learn independently.

There were some benefits indeed of online learning, such as (1) the flexibility of location and time; (2) reaching out wide audience; (3) the availability of a large number of courses and contents; and (3) providing immediate feedback [5]. However, there are some limitations of the online learning process, such as (1) some technical difficulties; (2) different levels of learners' competencies and confidence; (3) time management issues; (4) high adaption of technology-based media devices; (5) readiness of teachers and students; (6) distractions, confusion, and even frustration [5, 6]; (7) demands student independence. Therefore, digital learning modules design and implementation of learning online need to be done to minimize or overcome the disadvantages of online learning.

Digital modules of Biology sciences are increasingly introduced in both high school and higher education, such as biotechnology and molecular life sciences [7–10]; biology cell [11]; human auditory system [12]; and kingdom protest [13]. Media education becomes fundamental for the skills development to accomplish tasks and to lead people to operate at higher levels in the continuum of media literacy [14].

The challenge in opening the course in higher education worldwide is offering it to the university. ICE Institute is the Indonesia Cyber Education Institute, an online learning center accredited by the Ministry of Education and Culture. ICE provides a variety of online lectures from many universities and online learning providers throughout Indonesia. The main objective of the ICE Institute is to facilitate the provision of quality education while ensuring the quality of online learning and distance education services. Through the ICE Institute, users will find it easier to choose the right online courses for career development in the industry 4.0 Era.

ICE Institute is the answer to meet the era of the industrial revolution 4.0, which has changed the perspective on education. The changes made are not just the way of teaching but are far more essential, namely changing the perspective on the concept of education to be holistic, no longer partial. In the industrial revolution 4.0 era, everything becomes borderless with unlimited computing power and data. This happens because it is influenced by the development of the internet and massive digital technology as the backbone of the movement and connectivity of humans and machines. In order

to meet the need for online learning by ICE, the media digital online of Environmental Toxicology is designed. This paper will discuss how to develop digital media for environmental toxicology using ADDIE and identify students' learning processes in academic achievement.

2. RESEARCH METHOD

The method in this study was a case study with a descriptive approach. The complexity of students' experiences during online learning under pandemic circumstances will be discussed. Research subjects or participants involved in this study were 10 students from ICE Institute. These students came from other University. They enrolled the course of Environmental Toxicology in Biology study program. Due to the Independent Learning Program - Independent Campus (MBKM) in the FPMIPA UPI, students may follow the online course.

Therefore digital learning system on Environmental Toxicology was designed. Development of learning media was carried out through the ADDIE approach which consists of 5 stages, namely analysis, design, development, implementation and evaluation. The development stage consisted of flowchart and storyboard making, supporting data collection, development of learning media, as well as early product validation and revision. Two experts of content materials and media joined the validation stage. The material expert was asked to score the early product's validity while the media expert validated the product's practicality. The validity aspects included content feasibility and presentation. Meanwhile, the practicality aspect covered the program quality, ease of use, graphic design, aesthetics; and influence on individuals. After that, the digital media were applied to ten students who enrolled in the ICE Institute. The evaluation was performed employing questionnaires so that qualitative data were obtained. The results were then analyzed by converting the data.

3. RESULTS AND DISCUSSION

3.1. The Validation of Learning Content Materials and Media

The validation results (95%) show that material content was suitable for the level of undergraduate students in Semester 6, because this course is multidiscipline science. Students should have a basic course of Biology to support this advance course. There were 14 subject matters or 14 meetings and two meetings for mid-final exam. The

learning media was design using application PPT-PDF (Fig. 1), Infographic (Fig. 2), Explainer Video (Fig. 3), Motion Graphic (Fig. 4), and Text Book (Fig. 5). The validation of the learning media was 90%. Some recommendation for the learning media from the expert that, every meetings should have a greeting and introduction. It will show the interaction with students in the platform online. The number of video is still limited to give an example of the case study. Less animations and virtual laboratory performed in the learning media. Those recommendations will be improved for the next revision.

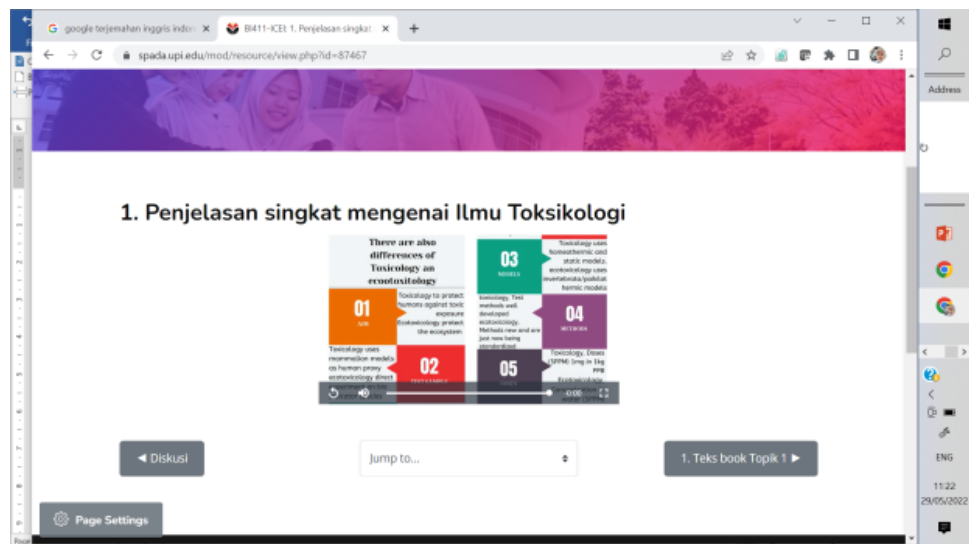


Figure 1: PPT-PDF.



Figure 2: Infographic.

All types of materials developed are categorized as microlearning materials. Microlearning is learning through bite-sized, well-planned modules and short-term learning activities [15]. Microlearning is an alternative to designing full online and hybrid

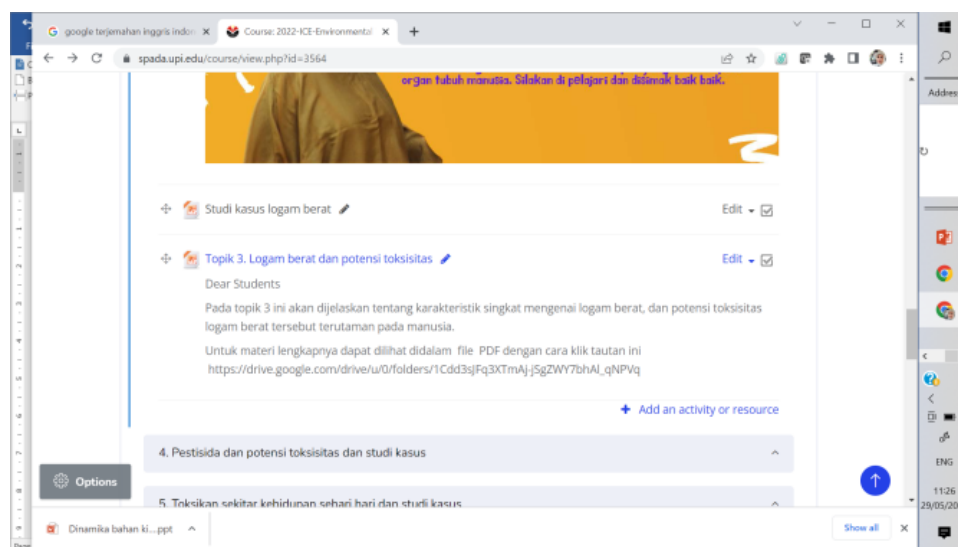


Figure 5: Text book.

problem, asynchronous is needed. It means students can also follow the lecture using the Zoom platform and WhatsApp.

Based on Table 2 shows that, in general, students gave an agreed response to 10 statements after using the environmental toxicology digital module, which was applied in the learning process. It can be seen that the average category of student statements is the highest, namely choosing to agree as much as 72.9%, and the second largest category of student statements strongly agrees, namely 21.4%, while students choosing the disagree category only 5.7% and 0 % for the category of students who chose strongly disagree. This shows that students respond positively to environmental toxicology digital modules and like the use of environmental toxicology digital modules that are applied in the learning process.

The advantages of this environmental toxicology digital module include being able to help facilitate students in learning, especially in online learning. Because they can access material that will be presented repeatedly, anywhere and anytime, it makes it easy for students to submit assignments. It can see directly the results obtained after doing the assignment. The material presented in this environmental toxicology digital module has clear and very interesting references because it provides examples of cases that occur in the environment that guides students in adding insight and knowledge about the environment and making it easier to explore the material provided. The tasks given in this module are in the form of analysis that can improve students' critical thinking skills so that students can develop and combine chemical engineering knowledge with environmental toxicology.

TABLE 1: The responses from ten students in using media digital.

No.	Question	Answer
1.	Can you use the applications installed on your laptop or mobile phone?	Yes
2.	What is your view on the education system so far since the pandemic?	There are problems with laptops, cell phones, and internet
3.	What are the advantages and disadvantages of the current education system compared to before the pandemic?	Time management and independent
4.	Are you able to access the internet smoothly? if not, what's the problem?	Yes
5.	Do educators always use learning media in the learning process?	Yes
6.	Do educators use other learning media besides books? If yes, what form?	Video and module
7.	Do you think it would be easier if the learning media could be accessed via a laptop or mobile phone?	Using laptop
8.	What are the advantages and disadvantages of learning media that educators usually use in the classroom?	Using video
9.	Have teachers used digital media in the form of a learning management system in teaching in the classroom? If yes, what form?	Yes, SPADA
10.	Do you think that learning using digital media will be more interesting?	Less understanding
11.	Do you think learning will be more fun if there are images, audio, video, learning management systems or links that can be accessed?	Yes
12.	Do you think that using digital media can increase your motivation in learning?	Yes
13.	Will you be more active in learning if digital media is used in the learning process?	Yes
14.	If given a digital media in a learning management system (LMS), can you use it?	Yes

The drawback of this environmental toxicology digital module is that the module display is in the form of a PowerPoint or, like, a paper, and the content of the material provided is still incomplete or not yet specific, making it difficult for students to understand the content. Digital modules will be very good if the explanation of the material can be packaged in more detail or specifically in detail so that students can understand the material presented well. It would be better if the digital module could be accessed online or offline, and there is access to download the module.

TABLE 2: The percentage responses from ten students about learning media.

No.	Statement	Response			
		NA	LA	A	SA
1	The digital module makes it easier for me to understand Environmental Toxicology material.	0	14.3	42.9	42.9
2	After studying the Environmental Toxicology digital module, I gained new insights.	0	0	42.9	57.1
3	The Environmental Toxicology digital module facilitates my self-study.	0	0	100	0
4	The content of experimental or research results in the Environmental Toxicology digital module increases my interest in learning.	0	0	100	0
5	The case content or contextual discourse in the Environmental Toxicology digital module increases my curiosity in learning.	0	0	85.7	14.3
6	After studying the Environmental Toxicology digital module, my awareness of environmental issues is getting honed.	0	0	85.7	14.3
7	After studying the Environmental Toxicology digital module, I got an idea about alternative solutions to environmental problems.	0	0	71.4	28.6
8	The Environmental Toxicology digital module is appropriate for use in online learning platforms.	0	0	85.7	14.3
9	Discourses or problems in the Environmental Toxicology digital module made me actively involved in online discussion forums.	0	28.6	71.4	0
10	Recommend future learning with digital modules through online learning platforms.	0	14.3	42.9	42.9

Note:
 NA = not agree
 LA = less agree
 A = agree
 SA = strongly agree

4. CONCLUSION

Based on the findings of this study, the development of digital media and interactive media learning processes is very important to help students learn a subject matter. It is recommended that digital media be developed using other applications. So students will get interested in studying independently.

Acknowledgments

We want to thank all students at ICE who were willing to participate in this course’s online lecture. Also, thank you to Muhtiara Yaser and Rajib for helping us prepare digital media.

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