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THE DEVELOPMENT OF E-LEARNING USING MULTIMEDIA-BASED GIS E-MODULES

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Abstract

The aim of this research is to develop an interactive, interesting, effective, and fun multimedia-based e-module for the Geographic Information Systems (GIS) course, which can be accessed online so that it can improve student learning outcomes in e-learning via Moodle LMS. The research method employed is the Research and Development (R&D) method. The research method used is the research and development method, which has been modified by Sukmadinata and consists of a preliminary study stage, a model development stage, and a model test stage. The data used in this research is primary data, a population of teaching lecturers who are experts in teaching Geographic Information Systems courses as an e-module trial. The second primary data is the respondent population of ITB STIKOM Bali students who took the Geographic Information Systems course. The sample used in this study was a simple random sample of students registered to take these courses. The data collection technique used in this research used a Likert scale questionnaire instrument for e-module testing. The questionnaire analysis technique uses the feasibility percentage formula. To determine the effectiveness of the e-module, give a test to a sample of students before and after using the e-module by using the N-gain formula in data analysis. The research findings indicate that the e-module is suitable for use as a learning resource, as it received a positive evaluation from the lecturers who used it, with an average score of 48.5 or 88.2% in the "excellent" category based on Likert scale responses in the questionnaire. Additionally, the e-module is effective for student learning, as evidenced by the N-Gain score of 0.74, with a value greater than 0.7, indicating a high level of effectiveness.

Keywords E-Learning, E-Module, Geographic Information Systems, Moodle LMS, Multimedia

INTRODUCTION

In the current digital era, Information Technology is experiencing rapid development from year to year. In this digital era, all data and information are spread worldwide, allowing everyone to easily access the information they desire. Technology has a significant impact on 21st-century education in facing the challenges of the fourth industrial revolution, which is the ability to conduct digital learning processes. Educational technology refers to the use of tools, technology, processes, procedures, resources, and strategies to enhance the learning experience in various settings, such as formal learning, informal learning, non-formal learning, lifelong learning, on-demand learning, workplace learning, and just-in-time learning (Ronghuai Huang, 2019). Every campus is adapting to the current digital era, and ITB STIKOM Bali is currently facing an issue, which is the lack of digital media in the delivery of digital map materials because they have not been utilizing interactive media, especially in the implementation of digitalization steps for digital mapping in the GIS (Geographic Information System) course. Based on this issue, an e-learning module in the form of a multimedia-based GIS e-module was developed. The electronically-based module (e-module) to be developed can be accessed without limitations in terms of space and time. Multimedia-based e-modules are very helpful and beneficial in the field of education due to their characteristics of interactivity, flexibility, and integration of various media that can support learning (Brink, 2013). Multimedia combines text, audio, video, animations, and more to make learning more enjoyable. The research method used is the Research and Development (R&D) method. The Research and Development method consists of two stages: the research stage and the development stage, which is further modified into three stages: Preliminary Study Stage, Model Development Stage, and Trial Stage. The activities in each stage of the modified Research and Development method are as follows (He et al., 2020). The software used to create multimedia learning is Adobe Captivate. The testing will be conducted by two lecturers teaching GIS courses and 20 students for a limited trial to test the effectiveness of the multimedia-based GIS e-module on learning outcomes by providing a pre-test before using the multimedia-based e-module and a post-test after using it. This research aims to determine the feasibility of using e-modules as interactive and enjoyable learning resources and to measure the effectiveness of e-modules as a learning resource for students, thus enhancing their motivation to learn, especially in digital map digitization in the GIS course, enabling students to learn independently through this Moodle-based e-learning as one of the Learning Management System (LMS) platforms. II. Literature Review A. E-Learning Concept In terms of strengths, e-

learning allows learners to study independently whenever they want. This can also reduce learner expenses, such as travel costs. Meanwhile, e-learning reduces face-to-face contact between learners and instructors (Latip, 2022). E-learning has become an important form of learning in both formal and informal education. In a technology-enhanced learning environment, learners produce various learning outcomes influenced by the technology around them (Lin, 2023). Following the priority definition, this section discusses common teaching strategies applied by higher education institutions globally during school closures due to COVID-19, such as real-time live video conferences, the adoption of virtual learning platforms, social media platforms, and lecture video recordings (Chen, 2022). E-learning is usually provided on specialized platforms and designed for educational purposes (Babay, 2023). E-learning, short for "electronic learning," emerges as the name of progress achieved in education through the use of Information and Communication Technology (ICT), particularly the Internet. E-learning continues to be present in today's educational discourse, thanks to technological advances, learning methodologies, public policies or organizations, and various other factors (Tibana-Herrera, 2018). E-learning can provide benefits to educators and students. The advantages for educators include facilitating teaching anytime and anywhere as long as they are connected to the internet, uploading materials only once accessible to all students, recording audio if the material is theoretical and for practical purposes, creating video tutorials that can be shared with students to play the role of facilitator. The advantages for students are that they can learn anytime, without space and time restrictions, in line with their schedules, meaning they are free to choose when to study because the materials are provided on the LMS. The e-learning in this research is asynchronous, in the form of e-modules in the Geographic Information System (GIS) course, which can be accessed by students through the Moodle LMS.

The E-Module is a digitally packaged and interactive module because the content can be presented in various formats such as PDF files, audio, video, animations, and more, enabling students to actively and independently engage in learning. E-modules are electronic versions of modules that are accessed and used through electronic devices such as computers, laptops, tablets, or even smartphones. E-modules are self-designed and systematic teaching materials in specific learning units presented in electronic formats. In every learning process, they are linked with interactive elements such as audio, video, and animations to enrich the learning experience of students (Dermawan & Fahmi, 2020). The content within the e-module covers GIS course materials. Geographic Information System (GIS) is unique compared to other information systems because it

uses both spatial and non-spatial data that are integrated and processed in a computerized database, allowing the generation of large-scale digital maps. E-modules are innovative and interactive e-learning tools that can motivate students to learn. When designing modules, the main idea is to keep cognitive load low for usability and learning effectiveness because working memory is a crucial factor. Users should not be overwhelmed with irrelevant content or information processing. Instead, they should be allowed to interact with the user interface accompanying the targeted content (Tasir, 2015).

Multimedia is used as a delivery medium for students to make Geographic Information System (GIS) content more interesting, interactive, and enjoyable. Multimedia consists of elements such as text, images/photos, graphics, sound, animations, and video that are digitally manipulated (Ediansyah, 2022). Multimedia learning (computer-assisted) is a type of e-learning where instruction/learning is delivered through a computer with learning content (text, images, graphics, audio, video, animations, etc.) stored/presented in CD-ROM or computer files (Sundari & Utomo, 2020). Multimedia-based GIS e-modules in the GIS course are packaged with three cognitive processes (Talan & Widayati, 2023).

Cognitive process that considers designing learning in accordance with student behavior. The foreign cognitive load depends on how the content is presented for learning. If the material presentation is not well-designed, irrelevant and inefficient cognitive processes may occur. The cognitive process that serves to represent essential learning materials. Presenting complex and detailed material to students can burden their cognitive load. The cognitive process can be achieved by creating an engaging learning environment, such as a narrator using a conversational style with polite speech. If students can engage essentially and generatively, they are more likely to build meaningful learning, leading to good retention and knowledge transfer performance.

LMS (Learning Management System) is software designed for administration, documentation, reporting activities, teaching and learning activities, online activities (connected to the internet), e-learning, and training materials, all of which are done online (Simanullang & Rajagukguk, 2020). Moodle LMS, as an online education management tool, can utilize the event log discussed in this research to explore the sample learning process for decision-making in online education development planning (Anake Nammakhunt, 2023). The Learning Management System, or LMS, has grown and evolved in line with the current digital era. Its features continually change to meet user needs. The benefits of using LMS include providing a deeper understanding to students

as learning content can be accessed repeatedly until students grasp the material. LMS can enhance collaboration and social interaction between students and educators, which can be done online without limitations of space and time. LMS can promote self-directed learning, allowing students the freedom to explore their abilities, think creatively, and innovate. In general, LMS facilitates content sharing and online interaction between instructors and students (H.Fibriasari, W.Andayani, 2023). In 2002, open-source LMS emerged, with Moodle being a notable example. Moodle stands for Modular Object-Oriented Dynamic Learning Environment.

Previous research regarding Moodle LMS, namely that the use of the Moodle application is very helpful, especially in the midst of the Covid-19 pandemic situation, which requires maintaining distance or social distancing, this Moodle application can be used as a solution so that teaching and learning activities continue to run as they should (Ervan. J. W et al., 2020). Moodle provides a section for entering material, discussions, assignments, and quizzes so that teachers can arrange time to access them. Class participants are students who are registered and have been given access rights. Students who have access rights can access all activities contained in the course on a meeting basis. Students can also communicate with teachers or fellow students via the chat menu or forum menu that has been prepared by the teacher as a communication medium (Sara et al., 2020). Moodle can help manage media and assessments well, up to automatic scoring. This is because Moodle matches media participants' answers with answer keys that have been prepared by the question maker, thereby saving time and especially not requiring paper (Kurniawan et al., 2020). Previous research aimed to describe the validation results of LMS-based E-modules with Moodle on dynamic electrical material with the results of the analysis of science teachers' validation assessments of learning e-modules showing an average percentage of 85% with very valid criteria. Moodle LMS-based e-modules were declared valid (Lovenia et al.,2022). Using the right media can be one solution to completing the right learning strategy. One media that is suitable in the current era of digitalization is the e-learning module. Based on the research results, it was found that the e-learning module test was proven to be valid and practical for use in learning simulation and digital communication, so it can be concluded that this e-learning module can be used as a learning medium for simulation learning and digital communication (Yetti and Ahyanuardi, 2020).

Based on the results of previous research, it can be concluded that an open-source web-based application called Moodle LMS can be used effectively to deliver online learning that can be accessed by students via the Internet. Technology is very influential for the 21st-century education world in

facing the challenges of the Industrial Revolution 4.0 era, namely that the learning process can be carried out digitally. Every campus is improving itself to face the current digital era, and the ITB STIKOM Bali College is currently experiencing problems, namely the lack of digital media in the process of delivering material so that it is having difficulty studying the material by digitizing digital maps as geographic visualization into digital maps with the previous media in the form of textbooks, material files, and Microsoft PowerPoint in learning. The multimedia-based Geographic Information System e-module distributed via Moodle LMS developed in this research is interactive, effective, interesting, and fun, so it can improve student learning outcomes as a novelty from research compared to previous research.

The aim of this research is valid, practical, and effective. Produce a multimedia-based Geographic Information System (GIS) e-module using the Pedicref approach (Passion, Discovery, Creative, and Fun Learning) and a constructivist approach, which can be accessed by students online via Moodle effectively to increase motivation and learning outcomes. Knowing the responses from students/students and providing satisfaction to students/students regarding multimedia-based e-modules for the Geographic Information Systems (GIS) course as a substitute for the face-to-face learning process to asynchronous online learning.

METHOD

The research method used is the Research and Development method. Sukmadinata's modified research and development method, which is the research methodology employed in this research, consists of three stages: preliminary investigation, model development, and model test (Sukmadinata, 2011).

1. Preliminary Study Stage

The preliminary study stage is the initial phase or preparation stage for development. This stage consists of three steps: literature review, field surveys, and the preparation of the initial product.

a. Literature Review

Literature review, namely examining student characteristics and analysis of RPS (Semester Learning Plan), which consists of learning outcomes, subject matter, learning techniques, learning activities, learning media, and analysis of assessment indicators.

b. Field Surveys

The field survey was carried out by distributing questionnaires to even semester 2022/2023 students who had taken Geographic Information Systems courses regarding motivation for learning resources that had been and distributing questionnaires to lecturers with the aim of obtaining information related to the material on the learning resources used so far and to find out the opinions of lecturers regarding the development of learning resources in the form of multimedia-based e-modules to be developed.

c. The Preparation of The Initial

This stage is to collect Geographic Information System course materials by identifying materials for each meeting in 14 meetings developed in the form of multimedia-based e-modules.

d. Expert validation

In the preparation of the initial product, content/material expert validation was carried out by two experts, media experts were carried out by two experts, one learner, a small group consisting of 8-20 students, and field trials conducted by students and lecturers. Testing with several experts aims to make the e-module feasible to use as a learning medium.

2. E-Module Development Stage

The model development stage is the stage for testing the product development. In this stage, two steps are taken: limited testing and broader testing, with the difference being the number of data sources used.

a. Limited Testing

At this stage, the semester course plan was tested against the content of the Geographic Information System (GIS) course, literature review, and preparation of materials to be presented in the e-module.

b. Abroader Testing

At this stage, testing was carried out with students to be accessed online through collaboration using a Moodle-based Learning Management System (LMS). Students are given the freedom to learn online, accessing e-module content without space and time restrictions, as long as they are connected to the internet.

3. Testing Stage

The testing of the e-module product is the stage for evaluating the effectiveness of the resulting product. The testing phase was carried out by lecturers teaching Geographic Information

Systems (GIS) courses, and at ITB STIKOM Bali, there are two lecturers teaching this course. Then, the testing was conducted on ITB (Institute of Technology and Business) STIKOM Bali students, totaling 78 people who had taken Geographic Information Systems courses. Testing was carried out by distributing learning motivation questionnaires and cognitive learning outcomes from the pre and post-tests given. The questionnaire consists of several positive and negative statements with five answer options filled in by respondents. The answer/response criteria from respondents consist of 5, namely Strongly Agree (SS), Agree (S), No Opinion (TB), Disagree (TS), and Strongly Disagree (STS).

The location of this research is at the ITB STIKOM Bali Campus. The data used in this research is primary data. For the e-module trial, a population of lecturers who are experts in the field of Geographic Information Systems is used to test the effectiveness of the e-module for the population of ITB STIKOM Bali students taking the Geographic Information Systems course in the odd semester 2022-2023. Sampling from the student population used a simple random sampling method. The sample used in this study amounted to 78 respondents/students. The data collection technique in the e-module test uses a Likert scale questionnaire instrument. The data analysis technique in the e-module trial is the feasibility percentage formula. Primary data on students is obtained by asking knowledge questions about the material through tests before (pre-test) and after using e-modules (post-test) in e-learning. The pre-test and post-test data analysis technique uses the N-Gain formula. The hypothesis of this research is the development of e-learning using multimedia-based GIS e-modules can improve the learning outcomes of Geographic Information Systems students, ITB STIKOM Bali.

FINDINGS AND DISCUSSION

Findings

The results of this research are the construction of an e-module, the testing of the e-module by GIS lecturers, and the results of the pre-test and post-test by students as users of e-modules in e-learning. The research steps conducted based on the stages of the Research and Development model are as follows:

1. Preliminary Study Stage

The initial stage in the modified research and development method is the preliminary survey. In this stage, needs analysis is conducted through a literature review and field studies

(empirical research). The literature review examines student characteristics and analyzes the Course Learning Plan (CLP), which consists of learning outcomes, course content, teaching techniques, learning activities, learning media, and assessment indicator analysis. The results of the study show that students at ITB STIKOM Bali have characteristics, namely a visual learning style, easy to learn by providing tutorials and preferring to learn with interactive, interesting, and fun media. The preliminary survey is conducted through interviews with students and distributing questionnaires to lecturers with the aim of obtaining information about the learning materials used so far and understanding the opinions of the lecturers regarding the development of multimedia-based e-modules. The results of interviews with several students stated that they really need interactive, effective, interesting, and fun learning media. Based on the results of distributing questionnaires to teaching lecturers, it was stated that around 7.6% stated that lecturers agreed to create e-learning learning modules for the Geographic Information Systems course.

2. E-Module Development

In this stage, an analysis of the semester's course plan for Geographic Information System (GIS) course content, literature review, and the preparation of materials to be presented in the e-module is carried out. The materials are designed to match the characteristics of interactivity, flexibility, and integration of various media that can support learning. Next is the design process, which involves creating a storyboard. A storyboard is a series of manual drawings depicting the flow of learning, originally in written language, transformed into visual language, thus illustrating a story. The storyboard elaborates on the designed learning flowcharts, containing learning information, procedures, and instructional guidance (Darmawan, 2015). At this stage, a storyboard is prepared as the design of the e-module to be presented at each session of the learning process. The storyboard includes the layout of animations, text, audio, learning videos, and more. Figure 3 is an example of a storyboard created for the development of a multimedia-based GIS e-module. This multimedia GIS e-module consists of learning outcomes, learning materials, and quizzes as a form of assessment in the learning process.

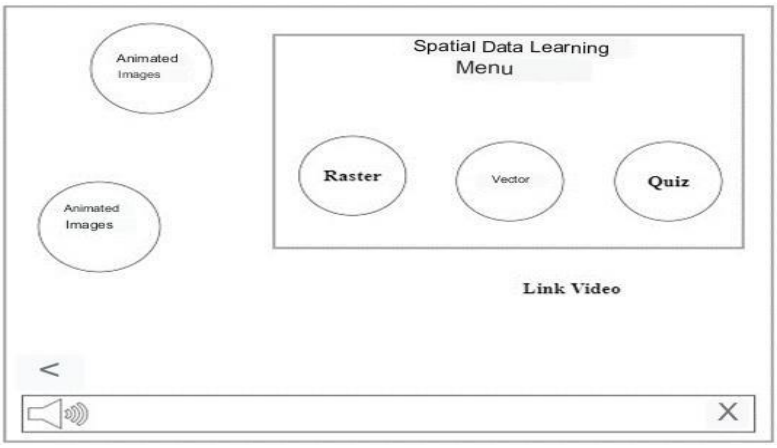

Figure 1. Storyboard

In this stage, the development of the GIS e-module is carried out using Adobe Captivate multimedia-based software.

Figure 2. E-Module Interface

In this stage, the implementation of the e-module that has been developed using Adobe Captivate software for multimedia learning is performed. It is then distributed to students for online access through collaboration using the Moodle-based Learning Management System (LMS). Students are given the freedom to learn online, accessing the e-module content without restrictions on space and time, as long as they are connected to the internet. Online learning services are conducted using e-service learning, with the application of social constructivism theory emphasizing social interaction in the educational environment and training for knowledge transmission to others (Ni Nyoman Parwati, 2020). The implementation of the GIS course e-module distributed online using Moodle LMS can be seen in Figure 3.

Figure 3. Implementation of E-Module with Moodle LMS

3. Testing Stage

The testing stage is conducted by the lecturers teaching the Geographic Information System (GIS) course, and at ITB STIKOM Bali, there are two lecturers for this course. The e-module trial phase carried out by lecturers who teach geographic information systems courses consists of several aspects, namely: interesting, suitability of material, practice, activeness, suitability, learning products, learning products, and learning substance. Below are the results of the testing conducted by the GIS course instructors. Assessment is carried out by providing answers to several questions in the form of a Likert scale ranging from 1-5 in the provided questionnaire.

Table 1. Results of the E-Module Trial by GIS Teaching Lecturers

Statement	Respondent	
	First Lecturer	Second Lecturer
Interesting learning	4	5
Learning materials are appropriate to student needs	4	5
The material supports students' practice	5	4
The material supports students to ask questions	4	4

Material supports students in discussion	4	4
The material supports students to learn independentl y	5	5
Learning suitability	4	4
Learning products are easy for lecturers to use	4	5
Learning targets are in accordance with the learning substance	4	4
Increase understandi ng through tests	5	5
Potential media to use	5	4
Total	48	49
Ideal Score	55	55
%	87	89
Category	Very good	Very good

Minimum score: 11

Maximum score: 55

Maximum-minimum = 55-11 = 44

Interval: 44/5 = 8.8 = 9 (rounded)

$P = \frac{\Sigma x}{\Sigma y} \; x \; 100 \; \%$

Information:

P: Percentage of Suitability

∑x: Sum of Respondents' Answers

∑y: Total Maximum Score

Based on Table 1, the results of the e-module trial by 2 GIS teaching lecturers found that of the 12 statements, the first lecturer gave a score with a total of 48 (87%), so it was included in the very good category. The second lecturer gave a score of 49 (89%), so it was included in the very good category. Thus, both GIS lecturers gave a very good assessment of the e-module trial.

Table 2. Categories and Frequencies

Likert Scale	Category	Interval Value	Percentage	Frequency
5	Very Good	48-56	86%-100%	2
4	Good	39-47	70%-85%	0
3	Enough	30-38	54%-69%	0
2	Not good	21-29	37%-53%	0
1	Very bad	11-20	<= 36%	0

Lecturer 1 and lecturer 2 are expert lecturers in the field of media and experts in the field of content in the Geographic Information Systems course for validity tests. Based on the Likert scale calculation of the responses from the two lecturers, the first lecturer obtained a total score of 48 with a response percentage of 87%, which falls under the "excellent" category, as seen in Table 2. The second lecturer received a total score of 49 with a percentage of 89%, also falling under the "excellent" category when referring to the table. The average score from the e-module testing by the lecturers is 48.5, or 88.2%, which falls within the "excellent" category, as shown in Table 3.

Table 3. Average Test Results by GIS Lecturers

Information	Lecturer 1	Lecturer 2
Value	48	49
Percentage	87 %	89 %
Average value	48.5	
Percentage of Average Value	88.2 %	
Category	Very good	

The graph of the Likert scale calculation results as an assessment from the lecturers teaching the GIS course can be found in Figure 4. These calculations indicate that the multimedia-based Geographic Information System (GIS) e-module, according to the course instructors, is valid or suitable for use as a learning resource for students.

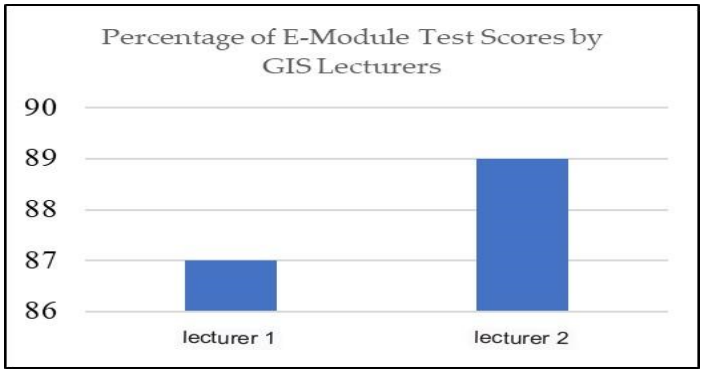

Figure 4. Graphic Evaluation Results of SIG E-Module by Lecturers

The effectiveness testing phase involves assessing the student's learning outcomes, including a pre-test before using the e-module and a post-test after using the e-module. Table 5 presents the effectiveness testing results, showing the pre-test and post-test scores of 20 students in the limited trial. The data is processed using the N-gain formula.

N-Gain Formula (Meltzer, 2002):

$$V - Gain = \frac{PreTest\ Score - PreTest\ Score}{Ideal\ Score - PreTest\ Score}$$

Table 4. N-Gain Categories

Value N-Gain	Category
g > 0,7	High
0,3 ≤ g ≤ 0,7	Currently
g < 0,3	Low

The categories for the score acquisition from the pre-test and post-test results using the N-Gain formula can be seen in Table 4.

Table 5. Student Learning Outcomes

Student	Pre-Test	Post-Test	N-Gain
1	75	90	0,60
2	80	100	1,00
3	70	95	0,83
4	75	100	1,00
5	70	90	0,67
6	75	80	0,20
7	80	90	0,50
8	80	100	1,00
9	80	100	1,00
10	80	95	0,75
11	70	90	0,67
12	75	100	1,00
13	90	95	0,50
14	80	90	0,50
15	85	95	0,67
16	80	90	0,50
17	80	100	1,00
18	85	100	1,00
19	75	100	1,00

20	80	90	0,50
Average	78,25	94,5	0,74

On average, the N-Gain learning outcomes of 20 randomly selected students are 0.74, based on the category table. Because 0.74 > 0.7, this value is categorized as high. Therefore, the use of e-modules as a learning resource for the Geographic Information Systems course is effectively employed in the learning process.

Discussion

The product produced in this research is a multimedia-based e-module to meet the needs and the characteristics of students at ITB STIKOM Bali, especially for students who take geographic information systems courses as respondents to this research. This e-module is used as a medium to deliver material about GIS in accordance with the campus curriculum in interactive, interesting, effective, and fun e-learning. The product produced in this research as a good quality learning media was, of course, tested by teaching lecturers as media experts and GIS content experts to test the feasibility of the product and the effectiveness of the e-module. The results of tests by lecturers as media experts and content experts using the feasibility percentage formula stated that the e-module was feasible and valid to be used as an e-learning learning medium for Geographic Information Systems courses based on several aspects, namely attractiveness, suitability of material, practice, activeness, suitability, learning products, learning products and learning substance. This is supported by preliminary research stating that teachers' assessment of e-module learning media with an average percentage reached 95% with very interesting criteria (Hayanum et al., 2022).

The effectiveness of the e-module is tested through student learning outcomes by providing a pre-test and post-test. The pre-test was carried out before using the e-module as a learning medium, and the post-test was carried out after using the e-module as a learning medium. The analysis technique used in processing learning outcome data is the N-Gain formula. The average pre-test score is 78.25, the average post-test score is 94.5, and the average N-Gain value is 0.74 in the high category. Based on the results of this analysis, it can be concluded that the e-module is able to improve student learning outcomes. The completeness of learning outcomes was also found by (Fitriani, 2023) in the results of his research regarding the influence of Indonesian language e-modules on the learning outcomes of Undikma educational technology study program students, with learning outcomes categorized as good.

CONCLUSION

A multimedia-based e-module for the Geographic Information Systems course has been successfully developed and is accessible online via Moodle, which is one of the suitable learning management systems for use as a learning resource for the Geographic Information Systems course. This e-module is deemed appropriate for student learning resources after being assessed by the instructor, with an average rating of 48.5 or 88.2% in the 'excellent' category based on a Likert scale questionnaire. The effectiveness of this e-module as a learning resource can be observed through student learning outcomes, including pre-test scores before the module's use and post-test scores after the module's use, with an N-Gain score of 0.74, which falls into the 'high' category as per the criteria.

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