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Implementation of E-Module for Soil Material and Soil Characteristics in the Soil Mechanics Course

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Abstract: The presence of technological innovation in education is an effort to enhance the effective delivery of materials to students. E-modules are one of the technological innovations. In this study, the application of e-modules will be carried out for teaching soil and soil characteristics to determine whether the material in the e-module can assist students in improving their learning outcomes. The method used is the design one group pretest posttest method. Implementation will be conducted by administering pretests and posttests as well as discussing the materials provided in the e-module. Based on the research results, it is shown that the implementation of the e-module, which was carried out using pretests and posttests, resulted in an improvement in students' learning outcomes, as measured by the N-Gain formula. An N-Gain value is considered high if G > 0.7, indicating significant improvement, while if the value of G < 0.3, it indicates low improvement. A value of 0.72 was obtained, which falls into the high category. This means that the implementation of the e-module led to a significant improvement and aided the learning activities related to Soil Mechanics.

Keywords: E-module, Soil Mechanics, Applications, N-Gain

Introduction

In education, the selection of appropriate technology is necessary to create various alternative facilities that can aid teaching and learning activities. The presence of technological innovations in education leads to an innovation in the interaction between educators and learners (Santika & Sylvia, 2021). This progress in education is essential for effective learning. The development of information and communication technology in education is marked by the emergence of e-learning, which has facilitated changes in learning through audiovisual media and the internet (Jamun, 2016). To promote innovation in teaching and learning activities, an increasing number of instructional media facilities are being used to assist in teaching and learning processes. These instructional media play a crucial role in the learning process (Azhar, 2020). Instructional media is a tool that facilitates the delivery of material in teaching and serves as a learning aid for participants in the learning process (Negara et al., 2019). Many educators have already adopted e-modules to assist in teaching and learning activities. E-modules are interactive teaching materials that are typically developed with text content, images, videos, and accompanied by formative tests or quizzes (Sugihartini & Jayanta, 2017). According to Nisa et al. (2020), the advantages of e-modules include efficiency in learning as they can be accessed from anywhere, cost-effective production, and a long usable lifespan. In (Mutmainnah et al.'s study, 2021), the advantages of e-modules in learning are outlined as follows: (1) They can motivate learners. (2) They provide evaluations to help educators and learners identify incomplete or completed topics. (3) Learning materials can be organized throughout a semester for better distribution. (4) Learning materials can be tailored to academic levels. (5) E-modules are more interactive compared to static printed modules. (6) They can incorporate video, audio, and animations.

Learning media is a tool used as an intermediary between the teacher and the students to facilitate the learning process (Hasan et al., 2021). According to Negara et al. (2019), learning media are tools that make it easier for educators to facilitate learning for students.

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As cited in Rohani (2020), learning media are used as a means to convey messages that can stimulate the thinking and learning motivation of students, thereby fostering the learning process in students.

According to the Indonesian Dictionary, "penerapan" means the act of applying. According to Mclaugin, as cited in Usman (2012), "penerapan" is an activity, action, or the existence of a mechanism in a system. In Suryana and Pratama (2018), "penerapan" is an effort to translate a written document into a series of activities to achieve a goal. According to Lukman Ali (2017), "penerapan" is the act of practicing or applying, and it can also be interpreted as implementation. Based on the explanations of "penerapan" above, it can be understood that in the context of education, "penerapan" refers to the active execution of planned teaching and learning activities aimed at achieving the goals of the learning process.

An e-module is a module presented in electronic format that can be operated using a computer, displaying text materials, images, animations, or videos (Mutmainnah et al., 2021). According to a journal by Alif et al. (2017), an e-module is a systematically designed learning material that aligns with a specific curriculum and is presented through electronic devices like computers or androids. In the journal by Saprudin et al. (2021), an e-module is an electronic module that can combine text, images, videos, animated simulations, quizzes, and evaluations, making it possible for learners to interact more actively with the learning materials. From these various viewpoints, it can be understood that an e-module is a systematic learning resource containing curriculum-based learning content and can be accessed through electronic devices.

Soil Mechanics is one of the supporting sciences for the implementation of construction projects (Schipper, 2018). According to Darwis (2018), Soil Mechanics is one of the main disciplines in civil engineering used to predict the performance characteristics of soil using techniques such as statics, dynamics, fluid mechanics, and other technologies. In the journal by Revalandro et al. (2022), Soil Mechanics is described as a part of geotechnical engineering that applies soil mechanics, geology, and hydraulics to analyze construction projects.

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From the explanations above, it can be concluded that Soil Mechanics is an engineering geotechnical science used to support the analysis of construction projects. The e-module for the Soil Mechanics course developed by Anna Elvarita covers 9 teaching materials, namely: 1) Soil and Soil Characteristics; 2) Soil Compaction; 3) Groundwater; 4) Effective Stress; 5) Stress Distribution in Soil; 6) Consolidation Settlement; 7) Lateral Earth Pressure; 8) Soil Bearing Capacity; 9) Slope Stability. The content of the e-module is based on the learning outcomes of the course created by Santoso Sri Handoyo (2018).

Soil Mechanics is a mandatory course in the Bachelor of Building Engineering Education program at the Faculty of Engineering, Jakarta State University. In the Soil Mechanics course, students are required to memorize various types and characteristics of soils and perform calculations to determine soil classifications and other related aspects. Understanding the concepts in the course is also essential for problem-solving (Revalandro et al., 2022).

Based on limited questionnaire results conducted among students from the 2020/2021 academic year who have already taken the Soil Mechanics course, it was found that the learning materials primarily consisted of presentation slides, and students expressed interest in using e-modules as a learning tool to aid their studies. To address this need, an e-module-based teaching material has been developed for the Soil Mechanics course to assist in teaching and learning activities.

To assess the impact of using the e-module and measure potential improvements in learning outcomes, research will be conducted on the implementation of this e-module titled 'Implementation of E-Module on Soil and Soil Characteristics in the Soil Mechanics Course, Building Engineering Education Program, Faculty of Engineering, Jakarta State University'.

Method

The research on the e-module teaching material was conducted in the Bachelor of Building Engineering Education program at the Faculty of Engineering, Jakarta State University, located at Jl. Rawamangun Muka, RT 11/RW 14, Rawamangun, Pulo Gadung district, East Jakarta, Special Capital Region of Jakarta, 13220. This research took place for one week, starting from August 6, 2023, to August 13, 2023.

The subjects of this research are students from the Building Engineering Education program, Faculty of

Engineering, Jakarta State University, who belong to the 2022 cohort, totaling 78 students.

In this study, a Design One Group Pretest-Posttest design will be employed and administered to the students. One group pretest posttest" is a type of research that measures the dependent variable as a single group before (pretest) and after (posttest) the treatment is administered, and then compares the values before and after the treatment (William & Hita, 2019). Following the intervention, students will be given a posttest consisting of 20 items. The calculation of the learning outcomes score will be analyzed using the Normalized Gain Score (N-gain) formula. The N-Gain score will be used to calculate the improvement in student learning outcomes by comparing the pretest scores taken before students use the e-module with the posttest scores obtained after using the e-module (Guntara, 2021).

The types of instruments used for data collection in this study are questionnaires and tests/examinations. A questionnaire is a data collection technique involving a form containing questions directed at an individual or a group to obtain answers or responses that will be analyzed for specific purposes (Cahyo et al., 2019). Tests and examinations will also be administered to students to measure their understanding of the material after using the e-module. These questionnaires and tests will be given to the students of the 2022 cohort in the Building Engineering Education program, Faculty of Engineering, Jakarta State University.

Data collection will be conducted using the pretest and posttest methods on the students. After the data is collected, the scores from the pretest and posttest will be calculated using the N-gain (Normalized Gain Score) formula

$$G = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$

The results of these calculations will indicate the improvement in student scores before and after the implementation of the e-module in learning and will be used as data in this research. According to Meltzer (as cited in Irawati et al., 2023), the determination of N-Gain values is as follows:

PERCENTAGE	INTERPRETATION
G <0,3	Low
0,3 ≤ G ≤ 0,7	Average
G > 0,7	High
G ≤ 0	Failed

Result and Discussion

This phase begins with discussions and consultations with the instructor of the Soil Mechanics course to understand the research needs and potential within the course. It also involves conducting a literature review to identify relevant research that can be applied to the Soil Mechanics course. Additionally, limited interviews in the form of questionnaires are conducted during this phase to identify any challenges in teaching and learning Soil Mechanics.

Firstly, this limited questionnaire was administered to students who have taken the Soil Mechanics course, specifically the 2020 and 2021 cohorts in the Building Engineering Education program at Universitas Negeri Jakarta. The questionnaire was conducted on August 9, 2023, using Google Forms, consisting of four brief questions regarding the Soil Mechanics course. The key questions in the questionnaire covered the available learning materials in the course, the media used during instruction, whether students felt the need for different learning materials, and the students' understanding of the content with the current instructional media.

The limited questionnaire revealed that students' understanding of the content with the current instructional media was lacking, and there was a need for the implementation of teaching materials using a different instructional media. The chosen instructional media for implementation is an e-module developed by Anna Elvarita, a student from the 2015 Building Engineering Education cohort, covering the topic of Soil and Soil Characteristics.

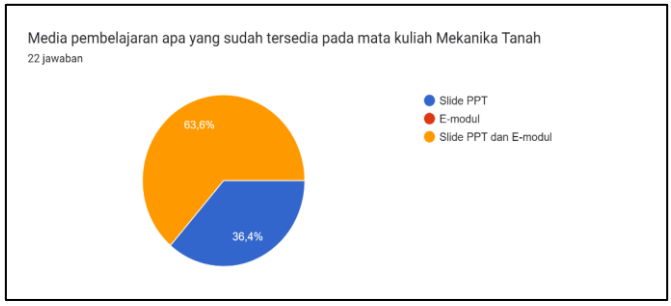

Figure 1. questionnaire data

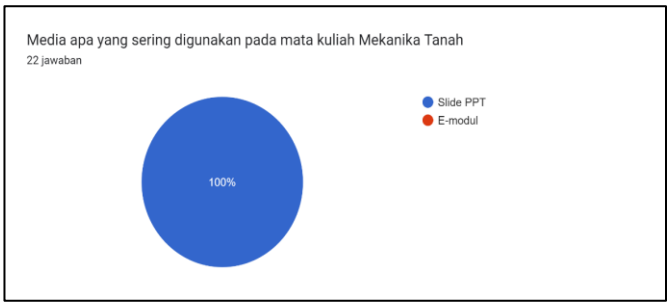

Figure 2. questionnaire data

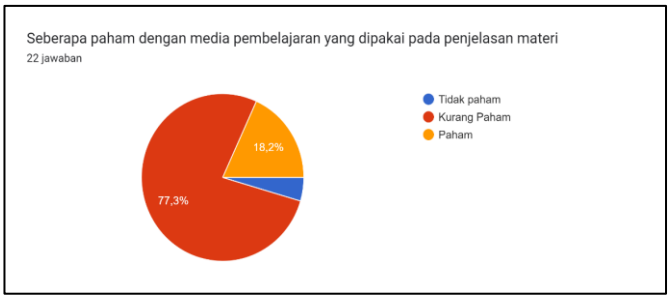

Figure 3. questionnaire data

After obtaining data from the limited questionnaire, the implementation phase was carried out to determine whether the e-module could assist students in their learning activities. The implementation was conducted using the One Group Pretest-Posttest method and involved students from the 2022 cohort in the Building Engineering Education program at Universitas Negeri Jakarta who had not yet taken the Soil Mechanics course. This phase was conducted online via Zoom meetings and included 24 students from the 2022 Building Engineering Education cohort on August 13, 2023.

Before the learning activities, a pretest was administered to assess the students' baseline knowledge before engaging in the learning process. The pretest lasted for 30 minutes and consisted of questions provided in Attachment 3. The results of the pretest were less than satisfactory. Out of the 24 students, 8 scored above 40, while 16 scored below 40, with an average score of 32.5.

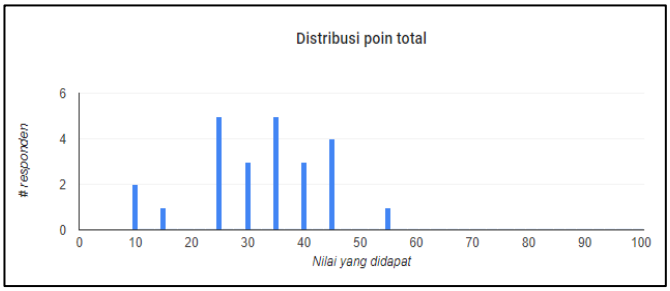

Figure 4. Pretest Score

After the pretest, a discussion of the material covered in the pretest questions took place. The material discussion was conducted using the e-module and lasted for 30 minutes. Following the material discussion, a posttest was administered to assess whether students had gained an understanding of the material presented in the e-module. The posttest also lasted for 30 minutes and included the same questions as the pretest, with the question order randomized.

After conducting the posttest, an improvement in scores was observed. Out of the students, 23 scored above 75, while 1 student scored below 75, resulting in an average score of 81.

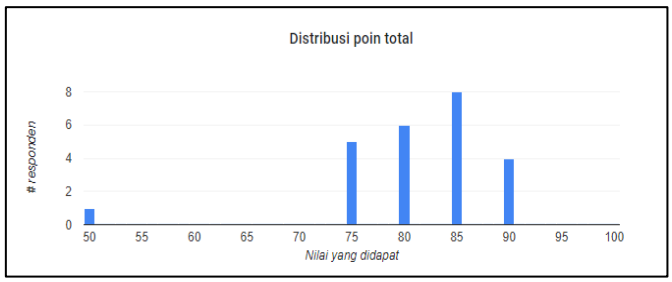

Figure 5. Posttest Score

The research on the implementation of the e-module for the teaching of Soil and Soil Characteristics in the Soil Mechanics course is conducted with the aim of assisting students in understanding the learning material using e-modules in the Soil Mechanics course within the Building Engineering Education program at Universitas Negeri Jakarta. The method employed for this research on the implementation of teaching materials is the Design One Group Pretest-Posttest. Classroom interventions will be conducted through pretests and posttests, and the data obtained from these tests will be calculated using the Normalized Gain (N-Gain) formula.

The use of e-modules is advantageous because it can enhance student motivation to learn, provide more evenly distributed teaching materials, and be structured according to academic levels (Mutmainnah et al., 2021). E-modules are also considered one of the interactive teaching materials that have been developed, equipped with text content, images, videos, and formative tests or quizzes (Sugihartini & Jayanta, 2017). Additionally, e-modules are more practical compared to printed modules because students can access them from anywhere and can use them for an extended period (Nisa et al., 2020).

The teaching material for Soil and Soil Characteristics was implemented in the Soil Mechanics course using an existing e-module developed by Anna

Elvarita, a student of the Building Engineering Education program from the 2015 cohort. During the implementation, pretests and posttests were administered to 24 students from the 2022 cohort of the Building Engineering Education program, and the pretest results were obtained as follows:

Numb	Reg Numb	Pretest Score	Posttest Score
1	1503622003	30	90
2	1503622004	35	80
3	1503622007	35	75
4	1503622012	35	85
5	1503622017	10	85
6	1503622018	35	80
7	1503622020	55	75
8	1503622021	45	80
9	1503622022	15	50
10	1503622023	25	75
11	1503622027	25	80
12	1503622029	45	90
13	1503622030	40	85
14	1503622031	25	90
15	1503622032	40	85
16	1503622034	45	80
17	1503622044	25	85
18	1503622045	35	85
19	1503622046	25	75
20	1503622057	40	75
21	1503622062	35	85
22	1503622063	30	90
23	1503622064	10	80
24	1503622071	45	85
Average Score		32,5	81

Next, data analysis will be performed using the N-Gain formula to determine the extent of improvement in students' understanding. The formula used for this analysis is as follows:

$$G = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$

$$G = \frac{81 - 32,5}{100 - 32,5}$$

$$G = 0,72$$

G = Gain
Pretest Score = Average score of students before receiving the e-module
Posttest Score = Average score of students after receiving the module
Maximum Score = The highest score that students can achieve

The result obtained from the calculation of the N-Gain value is 0,72. In the journal (Irawati et al., 2023), it is stated that when the N-Gain value is G > 0.7 (greater than 0.7), it is considered a high level of improvement, while if the value of G < 0.3 (less than 0.3), it is considered a low level of improvement. Based on the calculation results above, a result of 0.72 (greater than 0.7) was obtained, indicating that the implementation of the e-module in the teaching materials on Soil and Soil Characteristics has significantly improved students' understanding and learning outcomes, reaching a high level of improvement.

In this research, there are limitations in the implementation of the study as follows:

1. The implementation was carried out only for one subject, which is the Soil and Soil Characteristics material.
2. Only one session of implementation was conducted due to time constraints.
3. The implementation was done online via Zoom meetings, and the discussion of the material was limited to 60 minutes.

Conclusion

Based on the research data, the implementation of the e-module has yielded significant results in improving students' learning outcomes in the subject of Soil and Soil Characteristics. This is evidenced by the results obtained using the N-Gain formula. The N-Gain formula yielded a result of 0.72 based on the average scores of students' pretests and posttests. This value is considered high as it exceeds 0.7. Therefore, it can be concluded that in this study, the e-module for Soil and Soil Characteristics has a positive impact on students' understanding and their overall learning improvement. Additionally, e-modules can assist educators in achieving their predefined learning objectives.

The research results on the implementation of e-modules for soil material and soil characteristics in the Soil Mechanics course suggest that the existing e-module should continue to be used for teaching and learning activities in the Soil Mechanics course. Furthermore, this research can be extended to cover other topics available in the Soil Mechanics e-module using different research methods.

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