Development of an Electronic Module with Project Based Learning

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Abstract

Background: Educators in the 21st century are challenged to integrate technology into the learning process. One example is by using an electronic module (e-module). The electronic module is an innovative learning media presented digitally, including text, images, and video. This study aims to develop a valid and practical e-module based on project-based learning. **Methods:** The research and development (R&D) method was used in this study by adopting the Alessi & Trollip development model. Alessi & Trollip's model has three stages: planning, design, and development. **Results:** The results of e-module validation based on content experts show a value of 4.39 with a very valid category, and the percentage of validator assessment is 87.71%, which means that e-module is in the very feasible category. The media expert validator's assessment was 4.48, which means it is in the very valid category. The presentation of the validator's assessment was 89.58%, meaning that the e-module is suitable for use in the learning process. Student response to e-module based on project-based learning was 4.35 and categorized as very good. The percentage of student interest in the e-module is 86.90%. This value indicates that the e-module based on project-based learning meets the criteria of practicality and is feasible for students to use in the learning process. **Conclusions:** The e-module based on project-based learning developed in this study shows valid validity and practicality, So the e-module is appropriate for use in the learning process. The use of e-modules based on project-based learning also has the potential to increase students' critical thinking skills.

Keywords: Development, E-module, Project-based Learning

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Introduction

Education in the 21st century is essential in preparing a generation that can be competitive globally. Educators and educational institutions must produce a generation that can master 21st-century competencies (Mulhayatiah et al., 2019; Sagita et al., 2021). In the 21st century, four competencies must be possessed: the ability to think critically and problem solve, creative and innovative abilities, collaboration with others, and good communication skills. (Haka et al., 2022; Van Laar et al., 2020). Among these skills, critical thinking skills are considered the most needed skills in the 21st century.

Critical thinking skills are high-level thinking skills that involve cognitive and creative thinking skills and the ability to synthesize and evaluate the information obtained (Pollarolo et al., 2022; Fadhilah et al., 2022; Syahfitri et al., 2019). Critical thinking is an effort to increase awareness and intelligence and compare several problems to resolve them (Wibowo et al., 2018). If everyone can think critically, problems will become simpler and easier to solve (Wibowo et al., 2018; Zulfaneti et al., 2018).

According to PISA (2018), the average student learning outcomes in Indonesia is 396. Indonesia's ranking is still below Thailand's, with a score of 426, meaning Indonesian students are still below the average OECD country. This shows that students' thinking skills

are still very low. Students are currently only able to measure memory and understanding but not effectively answer analytical questions requiring problem-solving, an important aspect of critical thinking skills. Therefore, it is necessary to improve the learning process. As we know, learning objectives in Indonesia are currently focused on developing critical thinking skills.

Critical thinking skills can be improved by implementing a project-based learning model (PjBL) (Nawangsari et al., 2022; Sagita et al., 2021; Wibowo et al., 2018). Project Based Learning can help reflect critical thinking by analyzing problems found in daily life (Aránguiz et al., 2020). In this 21st century, educators are required to be aware of how to integrate technology into the learning process. One example is electronic modules (e-module) (Nadiyah & Faaizah, 2015). According to Nurdiyanti et al (2022), integrating technology into learning can improve students' soft skills.

The electronic module is an innovative learning media presented digitally, including text, images, and video (Herawati & Muhtadi, 2018). According to Sugihartini & Jayanta (2017), e-modules have advantages compared to printed modules. One of the advantages is their interactive use because the presentation contains images, audio, animation, and video. Besides that, e-modules can also be equipped with tests or quizzes, making it easier for educators to get student feedback. E-modules are learning media that are digital or non-print and are arranged systematically for independent learning purposes. Generally, the components of electronic modules have similarities with printed modules, but in terms of presentation, e-modules require electronic devices such as computers or Android (Wijayanti et al., 2016). In the digital era, using electronic devices in the learning process provides convenience for educators and students. Learning activities are not limited by place and time so they can be carried out anywhere and anytime. Educators and students can easily access e-modules as a learning source (Masruroh & Agustina, 2021). According to research conducted by Wulandari et al. (2021) using e-modules makes it easier for educators to communicate learning materials, collect assignments, give quizzes, and provide various other conveniences. Furthermore, using e-modules can also increase students' motivation to engage in learning as they use innovative and interactive learning media.

Using e-modules based on PjBL in the learning process can potentially improve students' critical thinking skills. It is considered crucial in the 21st-century era. In addition, technology in education allows educators and students to face the challenges of constantly advancing technological developments.

Universitas Muhammadiyah Makassar has developed an Online Learning System (SPADA) developed by LP2AI. One of the course materials from the Biology Education Study Program that has been presented in electronic media is general ecology. However, the material presented in implementing learning has not been integrated with Project Based Learning. Based on the explanation, the researcher is interested in developing e-modules that use the project-based Learning (PjBL) approach to improve students' critical thinking skills in general ecology. This research aims to develop an e-module based on project-based learning that is valid and practical.

Methods

The research and development (R&D) method was used in this study by adopting the Alessi & Trollip development model. Alessi & Trollip's model comprises planning, design, and development stages. The development model used is very suitable for developing learning multimedia (Hotimah et al., 2021). This research produces a product in the form of an electronic module that students can use in lecturing about general ecology.
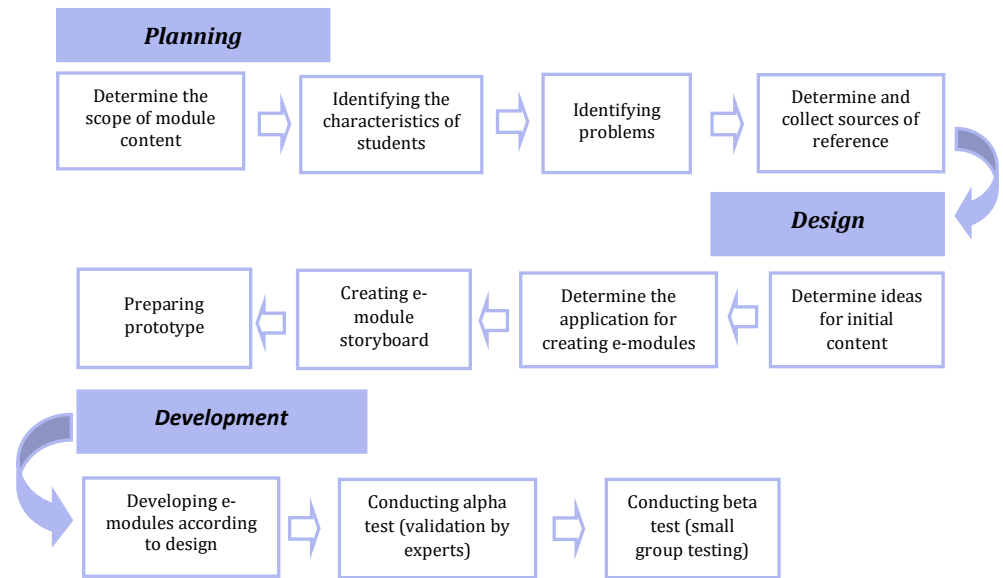
Figure 1. Alessi & Trollip Model Stages

Subject or Participant

This research was conducted at the Biology Education Program of Muhammadiyah University of Makassar. The subjects were 28 students, two content experts, and two media experts. The expert referred to in this study will assess or validate the product developed, called a validator. Students in this research are all students enrolled in general ecology courses.

Data collection and Data analysis

This study used a questionnaire as the data collection method; it was a valid and practical questionnaire. E-module validation questionnaires for content and media experts, while practicality questionnaires for student responses in small group trials. The quantitative data was obtained using a Likert scale consisting of 5 criteria and analyzed by the formula:

$$R = \frac{\Sigma \; validator \; answer}{\Sigma \; highest \; score \; of \; validato'ranswer} \; x \; 100\%$$

Table 1. E-module validity level

Category	Rating Scale	Percentage of assessment results (%)
Very valid	5	86-100
Valid	4	66-85
Valid enough	3	51-65
Invalid	2	36-50
Very invalid	1	20-35

Source: Nawawi & Wardhani (2023)

Result and Discussion

The purpose of this study is to develop teaching materials that are appropriate and can be used in the learning process. The teaching material is the development of electronic modules (e-modules) based on project-based learning. The development model used in this research is Alessi & Trollip, which consists of 3 stages of development: planning, design, and development.

Planning

This stage involves analyzing students' needs and characteristics, determining and collecting references, and determining the design and platform used in the e-module. A needs analysis was conducted by reviewing learning outcomes in the general ecology course. It also identifies characteristics to determine the abilities of students. Furthermore, the lecturer discussed with the teaching team of the general ecology course to determine the topics and project-based materials that will be developed. Through these discussions, the platform that will be used to develop the e-module is Kvisoft Flipbook Maker.

Design

At this stage, the researcher designs the product that will be developed according to project-based Learning syntax that integrates into the e-module component, analyzes concepts and tasks, and makes a storyboard. The storyboard was made to illustrate the steps in developing the e-module. In addition, researchers also compiled instruments for the validity and practicality of e-modules.

Development

This development stage consists of two stages, namely, the alpha test and the beta test. The alpha test was conducted to test the validity of e-module based on Project-based learning in general ecology courses. Validation was conducted by two content expert validators and two media expert validators. The validation of e-module content focuses on several components, such as the feasibility of teaching content, presentation, language, and PjBL learning. In contrast, media validation focuses on the feasibility of e-module graphics.

Table 2. Validation data of content expert

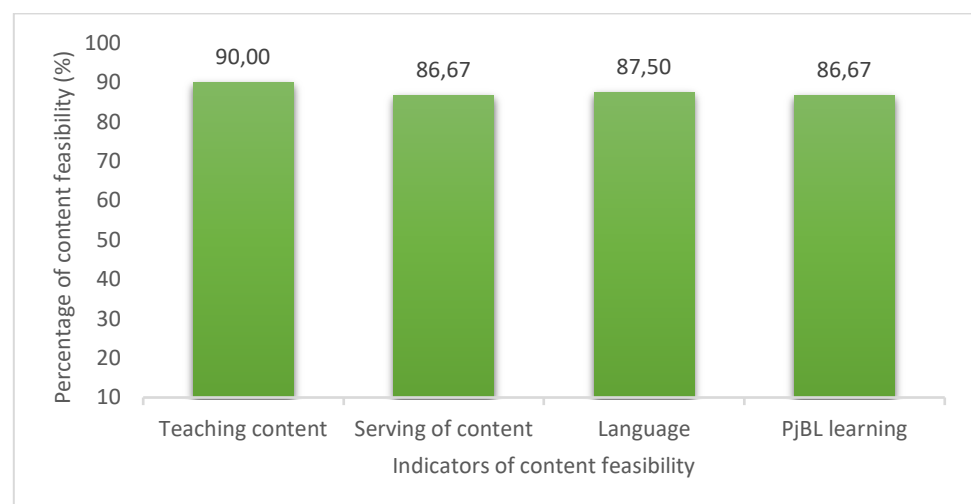| Assessment aspect	Validator 1	Validator 2	Average	Category
Teaching content	4,33	4,67	4,50	Very valid
Presentation of content	4,33	4,33	4,33	Very valid
Language	4,25	4,50	4,38	Very valid
PjBL Learning	4,33	4,33	4,33	Very valid
Total Average			4,39	Very valid

Figure 2. Percentage of feasibility of teaching content

Based on Table 2, the average assessment of the two content expert validators of e-modules that have been developed is 4.39, which indicates that the e-module developed is in a very valid category.

Overall, the average value of the validator's assessment for all aspects was 4.39, with

a percentage of 87.71%. This percentage indicates that e-module is in a very valid category. The percentage for each indicator of e-module feasibility is 90.0% for teaching content, 86.7% for content presentation, 87.5% for language, and 86.7% for PjBL learning. The average assessment of the two media expert validators of the e-module is 4.48. This result shows that the e-module is categorized as very valid.

Table 3. Media expert validation data

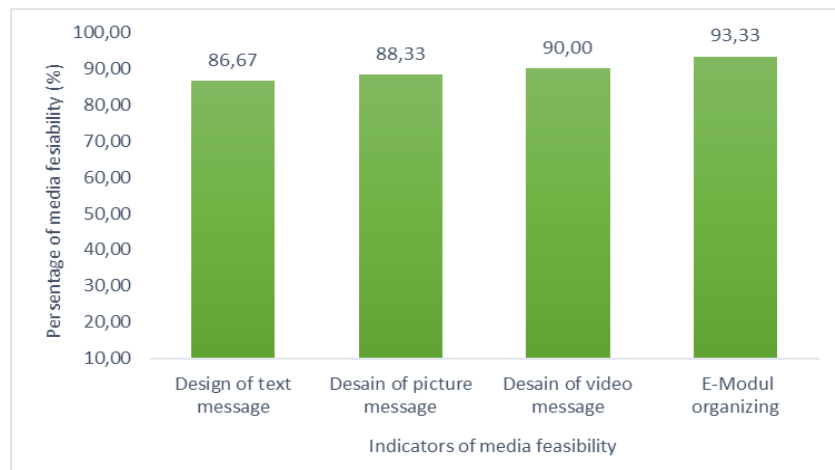| Assessment aspect	Validator 1	Validator 2	Average	Category
Text Message Design	4,17	4,50	4,33	Very valid
Image Message Design	4,50	4,33	4,42	Very valid
Video Message Design	4,67	4,33	4,50	Very valid
Organizing e-modules	4,33	5,00	4,67	Very valid
Total Average			4,48	Very valid

Figure 3. Percentage of media feasibility

The average value of media validity obtained from media expert validators is 4.48, with a percentage of 89.58%. The percentage value shows that the e-module that has been developed is very valid and feasible to use. Therefore, text message design reached a percentage of 86.67%, image message design reached a percentage of 88.33%, video message design reached a percentage of 90.00%, and e-module organization reached a percentage of 93.33%. After the e-module is declared valid, the next step is to beta-test the e-module.

A beta test is a trial test of using e-modules in small groups or students. At this stage, the e-module will be given to students and equipped with an instrument (questionnaire) to evaluate their response to the e-module.

Table 4. Student response

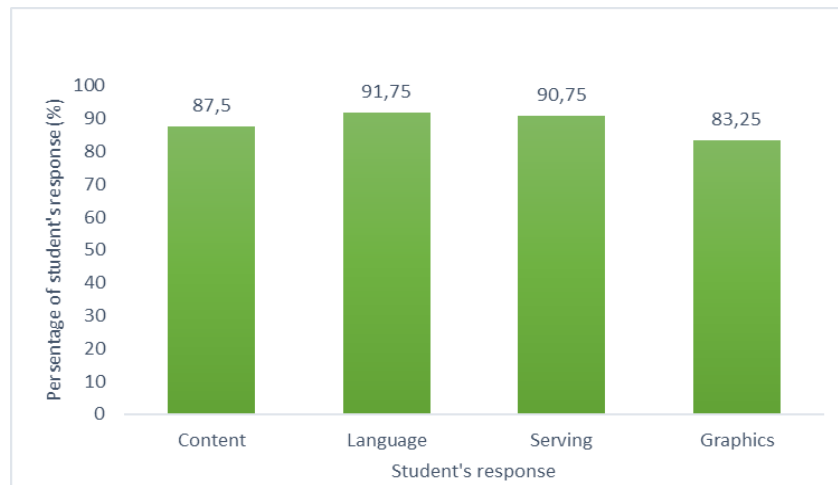| Assessment aspect	Average	Description
Content	4,50	Very good
Language	4,33	Very good
Presentation	4,38	Very good
Graphics	4,17	Very good
Total average	**4,35**	**Very good**

Figure 4. Percentage of student responses

It was found that students' responses to the e-module were very good, with an average score of 4.35. The percentage reached 86.90% (Table 4). This shows that e-modules reach the criteria of practicality and can be used by students in general ecology courses.

The module developed is a project-based learning e-module in general ecology courses. According to Sriwindari et al. (2022), An e-module is an electronic teaching material presented in an application form. The difference between e-modules and printed modules is in technology that allows them to be digitally modified, including animation media. E-modules can be made in digital form that allows multimedia technology and animation. In this case, e-modules provide advantages in terms of interactivity, flexibility, and the ability to display content in a more dynamic form.

Expert validators conducted the validation of the e-module. Based on the expert validator's assessment, the validity value of the e-module related to material content reached 87.71%. The assessment results show that the material content contained in the e-module is included in the "Very valid" category. According to Nawawi & Wardhani (2023) and Suhendri (2022), this category was obtained by expert validators based on Likert scale categorization. The value is included in the range of very valid. Therefore, it can be concluded that the material content in the e-module is feasible to use.

Furthermore, the validity of e-modules related to media based on the assessment of expert validators is 89.58%, and the percentage shows the value is in the "very valid" category. Based on the assessment results from media experts, it can be concluded that e-modules are feasible to use as learning media in the learning process. Meanwhile, the practicality value of the e-module based on the student response assessment is 86.90%, which means that it is in the "very good" category. It shows that e-modules fulfill the criteria of practicality and can be used by students in the learning process in general ecology courses.

Based on the results of the validity and practicality tests, it can be concluded that the e-modules that were developed have fulfilled the valid and practical criteria and are suitable for use in the learning process. According to Salsabillah et al. (2023), the product of developing teaching materials is considered feasible to use when it fulfills the components of validity, effectiveness, attractiveness, and applicability.

The integration of technology in using learning media with learning models can have a positive impact on student learning motivation. The statement is to the findings of (Lin et al., 2017), which stated that implementing digital learning impacts motivation and learning outcomes compared to conventional learning methods. Also, applying learning models such as PjBL is one method to improve motivation and learning outcomes. Project-based learning also practices communication and student activeness because they can complete tasks together (Desramaza et al., 2022).

According to Nursyafti et al. (2023) in her research, using digital modules based on project-based learning provides convenience in the learning aspect and module layout so that students easily understand the module's contents. In addition, the research of Wulandari et al. (2021) showed that implementing e-modules is very effective in helping students understand the concept of material so that students are more motivated to learn because of interactive digital modules in the learning process. Besides that, Santoso et al. (2023), in their research, said that e-modules integrated with PBL learning models effectively improve critical thinking skills in learning.

In the developed e-module, the learning process focuses on the lecturer and the students, who are allowed to build and develop their knowledge and skills. Integrating PjBL into e-modules is an innovation that aims to enable students to construct their knowledge and skills and practice communication skills and creativity. According to Sugiani et al. (2019), the use of e-modules in the learning process has several advantages, which include: 1) increases learning motivation because detailed instructions follow each task, 2) allows students to achieve learning outcomes according to their abilities, 3) can be accessed easily through electronic media such as computers, tablets, and other devices.

Conclusions

The e-module based on project-based learning developed in this study shows valid validity and practicality. So, the e-module is suitable for use in the learning process. The use of e-modules based on project-based learning also has the potential to improve students' critical thinking skills.

Acknowledgments

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