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Developing Discovery-Based Flip E-Module to Support Undergraduate Students Collaboration

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Abstract

The implementation of discovery learning in plant systematics course requires learning media that can be used by undergraduate students. The learning media must have a user-friendly design and accessibility so that it can be used in the field. This study aims to develop a flip e-module as learning media in the discovery learning to enhance undergraduate students' collaboration. This research is a Research and Development with 4D model with four stages: define, design, develop, and disseminate. The feasibility decision is based on various tests carried out including expert validation tests, readability tests, and classroom application tests by implementing flip e-module in discovery learning model. The results of expert validation and practicality tests indicate that the flip e-module is valid and no revision required. The results of the implementation test indicate that there is an increase in the quality of student collaboration with mean score from 75 to 84. The role of e-modules in discovery-based learning is to facilitate groups' collaboration in carrying out the discovery activity stage. Further research in quasi-experimental design is needed to observe the effectiveness of e-modules.

Keywords: 21st Century Skill; Collaboration; Discovery learning; Flip e-module

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INTRODUCTION

21st century skills encompass a wide range of competencies, including learning and innovation skills, such as critical thinking, problem solving, creativity, communication, and collaboration (Griffin et al., 2012; Thornhill-Miller et al., 2023). 21st-century learning skill set at a larger scale lead students to have good collaboration skills among them to complete the work (Evans, 2020). Collaboration skills is essential for statistical practice for students (Vance & Smith, 2019) and an important educational method that involve teams of learners to work together to solve problems, complete a task, or create a product (Laal, et al., 2012; Riaz & Din, 2023). So there is a great importance to highlight the true role of collaboration in learning process.

Learning process in plant systematic course at biology undergraduate program, Universitas 17 Agustus 1945 Banyuwangi, Indonesia, has implemented discovery-based learning. Discovery learning is one of the learning models that focus on students to build their competency through activity. Discovery learning models can improve students' collaboration (Azis et al., 2013) because discovery learning makes learners actively explore and construct knowledge together (Saab et al., 2010). However, observation results in biology learning about plant systematic in waterfall site, shown that collaboration between students has not been fully

developed. Students are lack of responsibility in groups with score 69 out of 100 (as seen in Figure 3). On the other hand, there is no learning media that can be used as a guide for students in applying the syntax of discovery learning in groups. In fact, materials should be provided with varying degrees of guidance (Alfieri, et al., 2011). So, students need a learning media that are effectively accessed via smartphones, easy to use in the field, and can be used as a guidance to collaborate in discovery learning set.

In the 21st century, the rapid advancement of multimedia, information, mobile technologies, and virtual reality has profoundly influenced all facets of human life, including the field of education (Allen & Velden, 2012). These emerging technologies also transforming the dynamics of teaching and learning across some critical dimensions (Pavlik, 2015; Raja, 2018). As a result, innovative digital learning media are revolutionizing the educational landscape, facilitating a significant shift from traditional to more engaging, interactive, and flexible approaches (Palková, 2015; Lin, et al., 2017; Scott, et al., 2017; Basak, et al. 2018). So, the potential of educational technology to enhance learning outcomes in higher education is undeniable (Akintayo, et al., 2024).

The global COVID-19 pandemic served as a catalyst for the accelerated adoption of educational technology, highlighting its capacity to supplement or even replace conventional printed learning materials (Sudarmo, et al., 2021; Mulenga & Marbán, 2020). Numerous studies have demonstrated that the integration of Information and Communication Technology (ICT) into educational practices can significantly improve student performance and learning outcomes (Valverde-Berrocoso, et al., 2022). Among the diverse array of digital tools available, flipbooks have emerged as a particularly popular choice due to their user-friendly design and accessibility.

Flipbook learning media not only create a more dynamic and interactive classroom environment but also foster better student comprehension of the material (Amanullah, 2020). Research has consistently shown that the use of flipbooks can lead to higher student achievement compared to traditional methods or the absence of learning media (Fonda & Sumargiyani, 2018; Roemintoyo & Budiarto, 2021; Sriyanti, et al., 2021). When combined with ICT-based learning media, discovery learning has been shown to yield significant improvements in both learning outcomes and collaboration skills (Sumianingrum, et al., 2017; Rahmayani, et al., 2019).

This study aims to develop a flip e-module as learning media in the discovery learning to enhance undergraduate students' collaboration skills. Both discovery learning methods and ICT-based learning media have been empirically linked to enhanced student achievement and the development of collaboration skills (Ananta, et al., 2023; Qian & Clark, 2016; Rusmalinda & Syaifudin, 2022; Sari, et al., 2024). This research specifically focuses on creating a good quality flip e-module that can have synergy with the discovery learning method to foster collaboration skills in plant systematic course.

METHOD

Research Type

This research is a Research and Development with 4D model. The 4D model consists of four stages: define, design, develop, and disseminate (Thiagarajan, et al., 1974) (see figure 1). Define stage consists of front-end analysis, subject analysis, task analysis, concept analysis, and define the development purpose. In the define stage, analysis was conducted on the learning achievement of the plant systematics course, students collaboration skills, and learning facilities at the Universitas 17 Agustus 1945 Banyuwangi. The overall results of the analysis became the basis for mapping the urgency of the need for teaching media and determining development objectives for the upcoming stage.

The Design stage is conducted to produce a flipbook maker-based e-module that can be accessed in students' smartphones. In line with its function as a learning technology to support students' collaboration in discovery learning, the flipbook maker-based e-module is designed to be able to visualize the morphological characteristics and habitat of ferns (Pteridophyta) as the basis for classification. The contents of the E-module are also equipped with instruction steps that can guide students in discovery learning. The content of the e-module uses plants photos obtained contextually from the Kalibendo waterfall and the Telunjuk Raung waterfall in Banyuwangi regency, Indonesia. After the prototype of the flipbook-based e-module has been created, a technical trial was carried out on the Sidebooks app. to ensure that the e-module can be operated on a smartphone with at least Android version 5.0.

The Develop stage is the prototype testing stage of the e-module application based on the flipbook maker that has been created. The first test is a validation test by one material expert, one media expert, and one learning expert. The test by the expert validator aims to determine the quality of the e-module that has been created in terms of design and function as a learning media. The second test is a practicality test by undergraduate students.

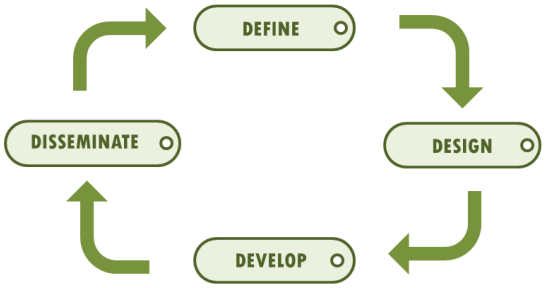

Figure 1. 4D Stages

Participants

The research subjects are one material expert, one media expert, one learning expert, four undergraduate students, and twenty four biology undergraduate students. The material expert is a biology lecture with magister degree in the biology study program. The media expert is a lecture with magister degree in educational technology study program. The learning expert is a lecture with magister degree in biology education study program. Validation by experts is important to get constructive feedback and improvements.

The subjects of practicality test are students who have taken the Plant Systematics course and is working on a final assignment on research and development. Validation by four undergraduate students is needed to find out the user response about the practicality of e-module prototype. After that, the e-module is applied in a real learning in the plant systematics course and attended by twenty-four biology undergraduate students. This twenty-four undergraduate biology students consist of 4 male and 20 female students, and familiar with the use of smartphone as learning media.

Instruments

The research data includes 3 types of feasibility: e-module validity data, e-module practicality data, and e-module implementation data. The e-module validity data were obtained from material expert, media expert, learning expert using questionnaire. The questionnaire contains closed-ended scaled statements, and a blank suggestions column for improving the e-module. The questionnaire was validated through previous research by Muhimmatin & Jannah (2021) to provide accurate and precise measurement results in accordance with the research objectives.

Validation data was collected by providing questionnaires along with e-module prototypes to expert. E-module practicality data were obtained from final year undergraduate students through a questionnaire. The questionnaire contains closed-ended scaled statements,

as well as a column for responses. The e-module implementation data were obtained during the implementation of the e-module in discovery-based learning.

Data Analysis

The data analysis technique used in this study is quantitative descriptive analysis. The data analysis technique in this study used a Likert scale to determine the level of validity of the e-module from the expert validator. Furthermore, data from Likert scale was processed using a percentage formula, as written below.

$$P = \frac{F}{N}\ x\ 100\%$$

Description: P : Practicality percentage
F : Score acquisition
N : Minimum score

The results of the analysis in percentage form are used to determine the qualifications of the e-module, and whether revisions need to be made. The qualifications are shown in Table 1. This decision becomes foundation for the next stage.

Table 1. Qualification Criteria and Decision

Validation result (%)	Qualification	Decision
81 – 100	Very good	Valid, no revision required
61 – 80	Good	Valid, no revision required
41 – 60	Moderate	Invalid, revision required
21 – 40	Bad	Invalid, revision required
0 – 20	Very bad	Invalid, revision required

The practicality of the e-module is measured by questionnaire with Likert scale. The Likert scale is a modified alternative answers, which is 1 means strongly disagree, 2 is disagree, 3 is neutral, 4 is agree, and 5 is strongly agree. Analysis of practicality using the percentage formula. Based on the practicality percentage, e-module categories are determined according to the criteria in Table 2.

Table 2. Criteria for Interpreting the Practicality Score

Practicality (%)*	Category
81 – 100	Very practical
61 – 80	Practical
41 – 60	Moderate
21 – 40	Less practical
0 – 20	Not practical

(*Siahaan, et.al. 2022)

The effectiveness of e-modules in discovery-based learning focuses on the assessment of student collaboration which includes three aspects: respect for each other, compromise, and responsibility. The assessment of student collaboration uses a rubric adopted from Greenstein (2012) which has a scale of 1 to 4. Then, the scale was processed using a percentage formula and compared with the quality of student collaboration before using the e-module.

RESULTS AND DISCUSSION

Student collaboration in plant systematics course needs to be improved, so students own one of the important skills in the 21st century. Based on the discovery learning in plant systematics courses in previous years, e-modules as a learning media are needed to support

students discovery process. The e-module must be easily accessible when students work in the field, and contain a flow of activities that in line with the syntax of discovery learning. The creation of e-modules is carried out in the following stages.

Define phase

This e-module development began with the stage of defining the urgency of the e-module to support learning in plant systematics courses. The define stage consists of five steps: front-end analysis, subject analysis, task analysis, concept analysis, and determining development goals. Analysis was carried out on Learning Outcomes (CPL) in plant systematics courses, learning facilities, and collaboration skills of biology education students at the Universitas 17 Agustus 1945 Banyuwangi.

Analysis of students' initial collaboration abilities was carried out by observation and sample interview. The observations results on students' collaboration abilities are that students have not been able to collaborate optimally in work groups. This is because there are students who rely on their colleagues to complete group assignments, and do not have the desire to work together.

Design phase

The e-module is designed to be operated on smartphones via flipbook application. E-module designed vertically to fit a smartphone screen, easy to turn the pages with a swipe movement, and contains various images and diagrams. In accordance with its function as a learning media to support students' collaboration ability, the e-module is designed with columns and instructions for discovery activity steps.

The e-module content uses photos of Pteridophyta from Kalibendo waterfall and Telunjung Raung waterfall, Banyuwangi regency, Indonesia. The Pteridophyta whose photos were taken are common Pteridophyta that found in Banyuwangi, making it easier for students to recognize and learn the characteristics of Pteridophyta. This image of Pteridophyta taken from a waterfall aims to support students' contextual knowledge. The research from Nainggolan & Purwaningsih (2024) show that student' collaboration skills using discovery learning with a contextual approach increase collaboration skills in good category.

The e-module prototype was initially created in a paid flipbook application, but due to limited access and concerns that it would make it difficult for students to use, the e-module was finally created in open access media. Figure 2 below is an example of the e-module display.

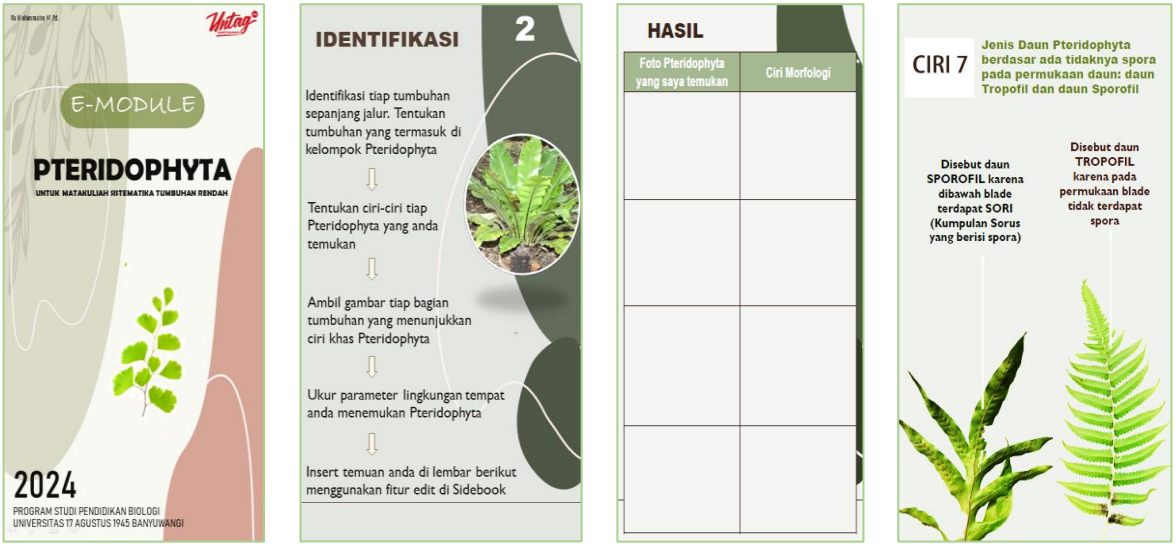

Figure 2 Example of E-module Layout

After e-module prototype was created, technical trials were carried out to ensure the e-module could be operated on a smartphone of at least Android version 5.0 using the Sidebooks

application. The Sidebooks application was chosen because it is available on Playstore and Appstore for free. Apart from that, the Sidebooks application has an editing feature so that e-modules can be crossed out, edited, images inserted, and can even open links so that they are easy for students to use. The results of technical testing show that the e-module can be opened with the Sidebooks application, and is suitable for testing in the next development stage.

Develop phase

The Develop stage is the testing stage for the flipbook e-module that has been created. The first test is a validation test by material experts, media experts, learning experts using questionnaires. The material expert validator is a botany lecturer. Media expert validators are lecturers that graduated from Educational Technology program, teach learning media courses, and have experience in developing learning media. The learning expert validator is a lecturer and has experience in research on undergraduate biology learning.

Validation by three experts use questionnaire on GoogleForm. Validators access the e-module using the Sidebooks application, and then provide an assessment of the quality of the e-module according to their respective expertise. Table 3 below is the result of validation by media experts.

Table 3. Media Expert Validation Results

Validator	Mean Score	Percentage	Decision
Media Expert	4.92	98.33%	Valid

The media expert validation results showed mean of 4.92 on a scale of 5, with a percentage of 98.33%. That validation show that the e-module developed is valid in terms of suitability as a learning medium, and does not need to be revised. The media expert validator also provided additional input regarding the design of the e-module, especially about the arrow indicating the Pteridophyta section to make it larger, as well as writing scientific names that needed to be bolded. Based on this input, revisions were made, the pointing arrow was enlarged. This revision was carried out so that the e-module developed truly complies with media development principles. However, there was no revision to thicken the scientific name of Pteridophyta because the scientific names of plants have been regulated in KITT (International Code of Plant Nomenclature).

The validation from material expert also resulted in the decision that the e-module was valid with an average assessment of 4.62 on a scale of 5 with a percentage of 92.31%. Material expert's recommendation is about the language used in the e-module being less semi-formal. This caused the possibility that students were less able to grasp the meaning of the explanation in the e-module. Based on this recommendation, the sentences of the e-module were revised, although not all of them because they considered the readability aspect. The results of the validation test of the material expert seen in Table 4.

Table 4. Material Expert Validation Results

Validator	Mean Score	Percentage	Decision
Subject Expert	4.61	92.31%	Valid

The validation by the learning expert produced data in Table 5. The learning expert validation resulted in the decision that the e-module was valid in 85%. The plus point of the e-module is the pictures taken from waterfalls in Banyuwangi so that students relate to the plants presented in the e-module. The part that needs to be added to the e-module is instructions for use. The purpose of adding instructions is so that students can use the e-module effectively. Based on expert input, basic instructions for using the e-module were added in the e-module.

Table 5. Learning Expert Validation Results

Validator	Mean Score	Percentage	Decision
Learning Expert	4.25	85%	Valid

The next test is a practicality test by students. The practicality test was carried out by four undergraduate students, by accessing the e-module via Sidebooks, then conducting an test on GoogleForm. Practicality test consists of 10 statements: e-modules display; students' reading interest; font type and size; image clarity; layout; use of terms; language; user interface; e-module with sidebooks application; use of e-modules in learning. Table 6 below is the results of the readability test by students.

Table 6. Practicality Result

Subjects	Mean Score	Percentage	Decision
Students	4.67	93.33%	Very practical

The practicality test results in table 6 show that the average rating is 4,67 and the percentage is 93,33%. This table shows that the e-module is “very practical” based on student assessments, so the e-module can be used as a learning media in plant systematics courses. The highest score is about appearance of the e-module, clarity of images and fonts, as well as the use of e-modules in learning. Meanwhile, the lowest score was in the assessment of language use in the e-module. These results are in line with the results of the practicality test from Erniwati, et al. (2022) which showed that the use of professional flip pdf-assisted e-modules can attract students' attention.

Respondents stated that the arrows on each fern image need to be thickened, the color of the arrows needs to be changed, the scientific name of the plant needs to be emphasized, and the instruction sentences in the discovery learning activities need to be changed to make them easier for students to understand. Based on these responses, the e-module was revised.

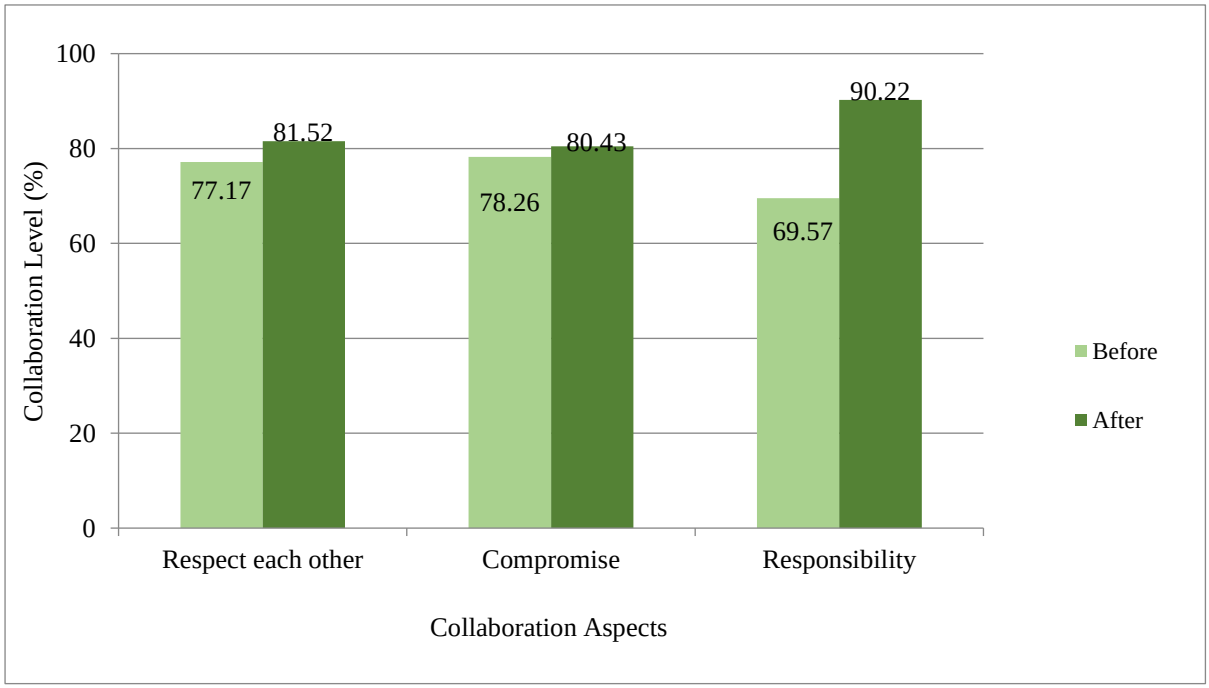

Figure 3 Student Collaboration Abilities

The implementation of e-modules in plant systematics courses was carried out by applying the discovery learning model. The stages of discovery learning are: stimulation,

problem identification, data collection, data processing, verification, and generalization (Dikdasmen, 2020). The discovery learning stage was carried out in two meetings. The first meeting was held in Kalibendo waterfall area to learn about pteridophyta in real life to do the stimulation, problem identification, and data collection. The second meeting is classroom learning to do the data processing, verification, and generalization.

E-modules are used as learning media in discovery learning. The e-module has several group work instructions, which allow students to work together and collaborate. Assessment of the quality of student collaboration with their group colleagues is carried out through observations during the implementation of discovery learning. Collaboration assessment includes three aspects: respect for each other, compromise, and responsibility. The assessment results are in Figure 3.

The results of the student collaboration assessment show that there is an increase in the quality of student collaboration, both in the aspects of respect each other, compromise, and aspects of responsibility. The initial score of student responsibility is the lowest aspect at 69,57%. Then after implementing discovery learning using flip e-module media, the student responsibility score increase statistically up to 90,22%. Student's responsibility has the most visible increase compared to two other aspects. This result in line with the research from Mundelsee & Jurkowski (2021) that peer collaboration boosted students' confidence sufficiently to participate in the class, especially to raise their hand.

The Increasing student activities in discovery learning is caused by several factors; one of them is because discovery model requires students to be active in finding concepts and have discussion activities, so students can express opinions, responding to statements and asking questions (Istiana et al., 2015). The discovery learning model provides the opportunity for students to work together with their groups in identifying a problem (Pramudiyanti et al., 2020). This 'work together' can also called collaboration.

Implication of Study

Collaboration is a learning process in groups to discuss differences views and knowledge (Greenstein, 2012) and working together to achieve one goal in the process of solving a problem (Hughes & Jones, 2011). This can be seen from the behavior of students who are starting to actively play a role in the group and identifying pteridophyta in field. The guidance in e-module help students find the special characteristics of the Pteridophyta. Students carry out their task, and follow up on the group assignment until it is completed. This result is in line with a research from Ekaputra (2023) that the discovery learning model in inorganic chemistry course is effective in improving students' communication and collaboration skills.

The role of e-modules in discovery-based learning is to facilitate groups in carrying out the discovery activity stage. This finding is in line with the research result from Budi et al. (2024) that the application of discovery learning assisted by student worksheets has facilitated students to contribute to each other and collaborate to make the learning process more meaningful, so that it can improve students' collaboration skills. E-modules that can be accessed using smartphones make it easier for students to understand the basic concepts of pteridophyta and fill in the findings with the group. According to students in practicality test, e-modules can be accessed and filled without an internet connection so they can use the e-modules in any field, including in the waterfall area.

The creation of this flip e-module as a learning media in discovery learning is a part of students' habituation with technology in learning. Knowledge of technology, pedagogy, and content are the three main components of TPACK (Technological Pedagogical Content Knowledge) (Hanik et al., 2022). TPACK approach can provide new challenges for students (Nuraini et al., 2023). A research by Kumar & Bervell (2019) shown that habit was the most important factor in determining actual usage of Google Classroom rather than Behavioural

Intention. So, habituation to technology plays an important role in familiarizing prospective undergraduate students with technology in learning.

CONCLUSION

This development research produces a flip e-module that valid and suitable as learning media to support students' collaboration skills in plant systematics courses. The feasibility decision is based on various tests. The validation from media expert validation showed that the e-module was valid with percentage at 98.33%. The validation from material expert also resulted in the decision that the e-module was valid with percentage at 92.31%. The learning expert validation resulted in the decision that the e-module was valid in 85%. The e-module revision was conducted based on input from media experts, material experts, and learning experts.

The results of the implementation test indicate that there is an increase in the quality of student collaboration from 75 to 84 at 100 scale. The role of e-modules in discovery-based learning is to facilitate groups' collaboration in carrying out the discovery activity stage. This e-module has been implemented in learning in one biology class. To find out more about the effectiveness of e-module in discovery-based learning to improve student collaboration, a quasi-experimental implementation is needed.

RECOMMENDATION

This research has gone through four stages of development in 4D model, but the effectiveness test of the e-module can be continued by further research in quasi-experimental design. This e-module contains about plants in the Banyuwangi area, so there is a possibility that it can be used for discovery learning in biology lessons in high schools.

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