



DEVELOPMENT OF MOBILE-BASED E-MODULES FOR UNDERSTANDING THE CONCEPT OF ECOLOGY AND BIODIVERSITY MATERIAL IN INDONESIA

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Abstract

This research aims at mobile-based e-modules on Indonesian ecology and biodiversity material for class VII junior high school. This research is a Research and Development study using the Lee and Owens model. The results obtained by the products developed by researchers are mobile-based e-modules on Indonesian ecology and biodiversity materials. The data collection techniques used were observation, interviews and questionnaires. The result of this research is to produce mobile-based e-modules. Data on the quality of mobile-based e-modules are obtained from the validation results of media experts and material experts. From the implementation results, it was found that the difference in the average pre-test and post-test scores of seventh grade C students was quite significant. And the income gain value is in the good category. The developed media is also proven to be able to improve the understanding of science concepts in students. Thus it is concluded that mobile-based e-modules are categorized as moderate in learning effectiveness and can improve student learning outcomes.

Keywords: E-Modul; Concept Understanding; Ecology and Indonesia Biodiversity.

1. Introduction

The science learning process aims to develop students' abilities in understanding concepts, thinking critically, and conducting investigations. This process involves various activities that require students to be actively involved. The skills acquired through science learning provide a strong foundation for continuing their studies to a higher level (Junaid et al., 2021). Science learning is a compulsory subject at every level of school education, including junior high school (SMP). Science learning at the junior high school level is a crucial factor in students' academic and personal growth. In addition to providing a fundamental understanding of science, this learning also equips students with the competencies and values needed for future success (Pertwi et al., 2018). Science learning at the junior high school level aims to help students understand science concepts and develop their scientific skills. One important factor in science learning is conceptual understanding. A good understanding of science concepts allows students to connect theoretical knowledge with real-world situations and phenomena (Thiveny, 2019). The degree of up-to-date material referenced by looking at the proportion of the last 10 years and referring to the primary literature. Problems and objectives, as well as the usefulness of research written narratively in paragraphs, do not need to be given special subheadings. Similarly, operational definitions, if deemed necessary, are also written narratively

After conducting observations and interviews with teachers and students at SMP Negeri 02 Batu, it was found that the ecology and biodiversity material in the learning process was

still abstract, so that students' abilities in understanding problems, solving problems, solving problems and re-examining the solutions given by the teacher had not been successful. This is also because in solving problems, the ability to understand concepts as a prerequisite and the ability to make connections between concepts and mental readiness is required. This is shown by the statement of the seventh grade science teacher during the interview that during the learning process, students only paid attention to the teacher's explanation, however, the students' conceptual understanding ability after being given the material on ecology and biodiversity of Indonesia was still low. Without a deep understanding of basic concepts, students will have difficulty developing critical thinking and problem-solving skills (Wahyuni et al., 2020).

Comprehension is one of the levels in Bloom's taxonomy. (Anderson & Krathwohl, 2001) Understanding refers to a person's ability to grasp the meaning of given information. This goes beyond simply memorizing facts, but also involves the ability to explain, interpret, and apply that information in different contexts. This understanding can be likened to a bridge between basic knowledge and higher-order thinking skills such as analysis, evaluation, and creativity. In Bloom's taxonomy, understanding is the second level after remembering. This indicates that understanding is an important initial step in the learning process, where students not only passively receive information but also actively seek to understand it. In other words, understanding is the foundation for the development of other higher-order thinking skills.

The low level of students' conceptual understanding indicates a low quality of learning activities. The quality of learning is phenomenally influenced by several variables, such as learning approaches, learning models, and learning resources. These resources can include the internet and reading materials such as textbooks and modules. Developing learning materials, modules can be an alternative for delivering material interactively. E-modules contain several media to support the module content, such as text, video, images, animation, sound, and games that can be operated on mobile devices, which are now smart communication tools that are almost like computers (Tortorella et al., 2017). Interactive and engaging learning makes students more enthusiastic about learning and understanding concepts. (Kurniawati, 2018) By using contextual teaching materials in the form of e-modules, the learning process becomes more meaningful and tailored to the needs of both individuals and members of society. E-modules are part of the utilization of technology for further application in modern-day learning (Fajjriah et al., 2023). Developments in the world of education have now reached the point where learning models incorporate technological influences in their implementation. (Kartini & Putra, 2020).

E-modules are digital teaching materials that offer high flexibility and interactivity in the learning process. With a variety of formats, from text and images to videos, e-modules allow students to learn independently at their own pace. Interactive features such as quizzes and simulations also make the learning process more engaging and effective. Furthermore, e-modules can be accessed anytime and anywhere via digital devices, allowing students to learn more efficiently outside the classroom. E-modules are part of the utilization of technology for further application in modern-day learning (Fajjriah et al., 2023). Engaging visualizations: The use of images, animations, and videos in e-modules makes learning materials more engaging and easier to understand, especially for abstract concepts (Apriliani et al., 2022).

Based on the problem description above, it was found that the ecology and biodiversity material in the learning process is still abstract, and students' conceptual understanding is still

low. One way to facilitate student understanding of concepts is by actively involving them in learning. The use of digital teaching materials in the form of e-modules can be an alternative for delivering material interactively (Aeni & Widodo, 2022). One way to facilitate student understanding of concepts is by actively involving them in learning. When students feel involved and participate in the learning process, their motivation and interest in the subject matter increase (Aziz, 2015). Based on this background, the researcher wanted to conduct research by developing a mobile-based e-module to improve students' conceptual understanding of the material on Indonesian ecology and biodiversity.

2. Method

This research uses the Research and Development (R&D) development approach developed by (Lee & Owens, 2004) because it is in accordance with the development stages of a media product, and has a complete development procedure starting from the first stage, namely analysis (analysis), design stage (design), development stage (development), implementation stage, and the final stage, namely evaluation (evaluation). In the (Lee & Owens, 2004) model, there are several levels of development that need to be observed and done, the following is the presentation of the chart below.

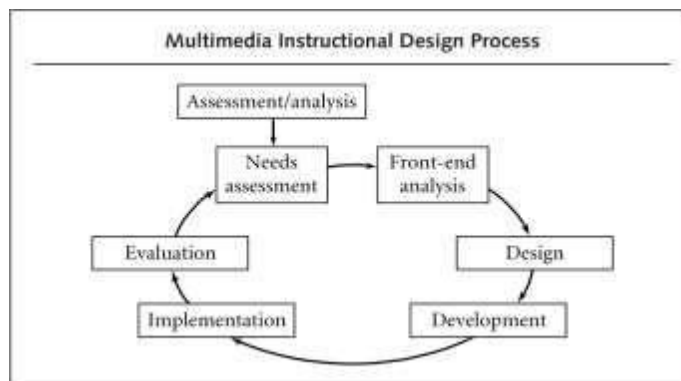


Figure 1 Lee & Owens 2004 Model of Development

The first stage is analysis, in this stage according to (Lee & Owens, 2004) there are two procedures, namely needs analysis (need assesment) and initial and final analysis (front-end analysis). Needs analysis is a procedure to determine the actual initial state and the desired state. While the initial and final analysis are analyses that bridge the current state to achieve the desired state, some analyses include audience analysis, technology analysis, situation analysis, task analysis, issue analysis, critical event analysis, objective analysis, media analysis, data analysis, and cost analysis.

The second stage is design, the design stage is the planning stage of the project to be created. Next in the design stage the researcher determines the development schedule, project team, media specifications, material structure, and configuration control. After finding several desired needs, the next step is to create a product development framework or product storyboard. Where in the science subject on the material of Indonesian ecology and biodiversity, a mobile-based electronic module is needed, the specifications are in a link format, a format that can only be operated via smartphones, laptops in the electronic module

using the principle of interactive multimedia, namely the material will be combined with videos, images, and text to support interactive learning.

The third stage is development which consists of several stages, in the first stage determining the type of product, mobile-based E-modules are developed with the Genially platform, the second stage Developing and assembling components from the media, including the process of integrating materials with the products to be produced, the third stage conducting the review and revision process of the product, including the review process on the product that has been developed is also revised if there are deficiencies from the suggestions and comments given by the validator. The product will be revised until it is declared valid or suitable for use in the learning process, the fourth stage of product presentation, the product that has been developed is tried to be implemented in learning the last stage is conditioning the session, including the process of providing product operating instructions, instructions for use, sub-sub materials, and learning activities using this mobile-based e-module.

The fourth stage of implementation begins with technical preparation, including designing an e-module implementation plan, training users and administrators, and ensuring all hardware and software are functioning properly. During implementation, the e-module is integrated into the curriculum by monitoring usage and providing technical and pedagogical support to ensure a smooth user experience. Real-time evaluations are conducted to assess the e-module's effectiveness and make adjustments if necessary. After implementation, evaluation results are used to refine the e-module, and follow-up is conducted to ensure the e-module continues to support the learning process effectively and relevantly.

The final stage is the evaluation stage. Developing instruments is necessary to obtain evaluation results. The content of the instruments varies depending on the validation data source and the trial object. Some of the instruments that will be used by researchers are subject matter expert instruments and media expert instruments. The validation stage is carried out to determine the success of a project that has been developed. In this study, the material was validated by a PGSD lecturer at Malang State University. The media was validated by an educational technology lecturer at Malang State University. The data from this study are qualitative and quantitative data. Qualitative data were obtained from suggestions and input from subject matter experts and media experts, while quantitative data were collected through questionnaires completed by subject matter experts, media experts, and students.

Furthermore, to measure the increase in students' conceptual understanding, the N-gain calculation process is used, which is analyzed using IBM SPSS 25, then the average is calculated to measure the effectiveness of learning or the increase in students' conceptual understanding.

Table 1 Criteria for Hake effectiveness

| Value of $\langle g \rangle$ (n) | Criteria |
|----------------------------------|-----------|
| $g > 0,7$ | High |
| $0,3 \leq g \leq 0,7$ | Currently |
| $0,0 < g < 0,3$ | Low |

(Hake, 1999)

The analysis results show variations in students' conceptual understanding after participating in the learning process. Students who achieved a gain score of more than 0.7

showed very significant improvement, indicating significant success of the learning strategy. Conversely, students with a gain score between 0.3 and 0.7 experienced significant improvement, but still had room for improvement. Meanwhile, students with a gain score below 0.3 require special attention because their conceptual understanding improvement is still relatively low. This indicates the need for adjustments or additional learning interventions for this group of students.

Through structured development stages, developers proactively identify and address potential issues that could hinder the effectiveness of learning media. This process ensures that the resulting learning media not only meets quality standards but also provides an optimal learning experience for students. Thus, the resulting product is ready for implementation and is expected to significantly improve students' conceptual understanding.

3. Results and Discussion

3.1 Result

The resulting product of this development is a mobile-based e-module designed to enhance students' conceptual understanding of Indonesian ecology and biodiversity. This e-module features three main components: interactive materials, videos, and interactive quizzes. The following is a preview of the developed product:



Figure 2 Material Display

Based on Figure 2, this material features interactive image explanations that allow students to interact with the material through images on their devices. The use of image media is a strategy appropriate for science learning (Utami, 2020).



Figure 3 Display of Learning Materials and Videos

Figure 3 shows a display of the learning materials and videos included in the e-module. The use of learning videos helps students improve their understanding of the material after using the mobile-based e-module. Through video learning media, students' learning motivation and understanding of concepts can be increased. (Iwantara et al., 2014).



Figure 4 Interactive Quiz Display

Figure 4 shows one of the interactive quiz displays included in the e-module. The interactive quizzes displayed are quite diverse, including true-false quizzes, multiple-choice quizzes, picture quizzes, and sorting quizzes. By providing quizzes to enhance understanding of the material studied, quizzes can help students effectively learn basic terms and concepts in a particular subject. Furthermore, providing random quizzes with questions (illustrating how the concepts become more practical) can help students understand the concepts and apply them to new contexts on subsequent tests. (Nguyen & McDaniel, 2015).

Data were obtained from the collection of validator assessments by material experts and media experts, as well as the results of improving conceptual understanding by administering pre-tests and post-tests to class VII C students of SMP Negeri 02 Batu. Validation of material expert assessments by one of the PGSD FIP UM lecturers with a focus on science and mathematics. Data obtained from the following 3 aspects:

Table 2 Results of Validation by Material Experts

| Aspect | %Rate-Rate |
|--------|------------|
|--------|------------|

| | |
|--------------------------|--------|
| Learning objectives | 83,33% |
| Presentation of Material | 100% |
| Grammar | 100% |

Table 2 shows the results of the material expert assessment. The percentage obtained is derived from the overall results of the validator's assessment to obtain a valid value. The overall validation results of the material experts obtained a percentage of 96.4%, which is included in the valid category. The validation assessment consists of three aspects: the learning objectives aspect obtained a percentage of 83.33%, while the presentation of material and grammar aspects obtained a percentage of 100%. Based on the results that have been determined, it shows that the mobile-based e-module on Indonesian ecology and biodiversity material is valid and suitable for use in the learning process.

Media validation by media experts is the stage where media experts determine the validity of an application or media through media use and questionnaire completion. Data is obtained from the following five aspects:

Table 3 Media Expert Validation Results

| Aspect | %Rate-Rate |
|------------------|------------|
| Display Design | 93,75% |
| Content/Material | 100% |
| Program Media | 83,33% |
| Accessibility | 100% |
| Product Benefits | 100% |

Based on Table 3, it shows the results of the media expert assessment. The overall results of the material expert validation obtained a percentage of 95% is included in the valid category. The validation assessment consists of 5 aspects with average income in table (). Based on the established results, it shows that the mobile-based e-module on Indonesian ecology and biodiversity is valid and suitable for use in the learning process.

Next is the learning outcome test. The learning outcome test aims to determine the effectiveness of media use in the teaching and learning process. The test was conducted by administering a pre-test and post-test to 31 students in class VII C. Results pre-test in the following table:

Table 4 Student Pre-test Results

| Indicator | Pre-test |
|--|----------|
| Frequency of students who obtained a score ≥ 70 | 19 |
| Frequency of students who obtained a score ≤ 70 | 12 |

Average value 61.29

Based on Table 4, at the stage of giving *pre-test*, 12 students were found to have scored above 70, this indicates that the students have not fully understood the material, so the next stage is to provide access to mobile-based e-modules to improve students' conceptual understanding.

Table 5 Student Post-test Results

| Indicator | Post-test |
|--|-----------|
| Frequency of students who obtained a score ≥ 70 | 1 |
| Frequency of students who obtained a score ≤ 70 | 30 |
| Average value | 86.45 |

Based on Table 5, 30 students scored above 70, indicating an increase in students' conceptual understanding of the Indonesian ecology and biodiversity material after using the developed mobile-based e-module. This is evident in the improved learning outcomes *pre-test* the *post-test*.

From the results of the *pre-test* and *post-test*, the development applied the N-Gain method. The results of the N-Gain calculation show that the learning intervention carried out was quite effective in improving student understanding, with an N-Gain score of 0.61 which is in the moderate category.

3.2 Discussion

In this study, according to Bloom's revised taxonomy, the cognitive domain is the ability to understand, namely the ability to organize and group information for clarity. At this stage, a person must be able to see patterns and relationships between concepts. This ability is crucial because it forms the foundation for achieving higher levels of thinking. Understanding means truly understanding something. Understanding material can be defined as absorbing the meaning of material that has been studied (Santoso, 2017). Understanding material is a learning outcome, students are able to explain using their own language according to what they hear and read from learning, are able to provide examples and apply them to other cases. Understanding material is also influenced by external factors such as the learning process in the classroom, effective and enjoyable learning makes it easier for students to understand the learning material presented (Nugraha, 2018). Based on the description of the definition of understanding, it can be concluded that understanding material in this study is that students can be said to understand the material if they are able to absorb the material they have learned correctly and can re-explain it using their own words correctly. Understanding material is a flexible ability so there are ways to improve it (Anwar, 2021).

The use of mobile-based e-modules in learning has become increasingly popular in recent years. Developing e-modules as a digital literacy medium in 21st-century learning provides a comprehensive and easy-to-understand framework. (Kurniawan & Kuswandi,

2021) The flexibility and accessibility offered by mobile technology allow students to learn anytime and anywhere. In line with the opinion of (Martha et al., 2018), mobile-based e-modules have proven effective in increasing student learning motivation due to the more engaging and interactive presentation of material. Research by (Panis et al., 2023) also shows that the use of e-modules can improve students' conceptual understanding, especially in abstract subjects. Meanwhile, according to (Suryani et al., 2023), mobile-based e-modules can also facilitate students' independent learning, allowing teachers to focus more on providing personalized guidance.

The result of this development is a mobile-based e-module to enhance conceptual understanding of Indonesian ecology and biodiversity. The product includes two sub-topics: the influence of the environment on organisms and the interactions between components of an ecosystem. The research subjects were 31 seventh-grade students at SMP Negeri 02 Batu. This media can be used on devices such as: smartphone so that it is flexible and easily accessible to students. (supporting sentences about device use)

The development of this mobile-based e-module aims to improve the conceptual understanding of seventh-grade students at SMP Negeri 02 Batu, particularly regarding the ecology and biodiversity of Indonesia. This digital product is designed as a website that can be accessed through smartphone. Moreover, the latest technology now equips devices with touchscreens, making these mobile devices more user-friendly (Ulfa, 2016). By integrating images, text, animation, video, and interactive quizzes, this e-module is expected to present material visually and engagingly, allowing students to more easily understand important concepts in Indonesian ecology and biodiversity.

The development process for this mobile-based e-module began with the visual design phase. Background designs, illustrations, and color palettes were created using Canva. The Genially platform was then used to integrate various multimedia elements, such as text, images, animations, and videos, into the design. An interactive quiz feature was also developed using the features available on the Genially platform. Once all design elements were well integrated, the e-module was validated by subject matter and media experts to ensure its suitability for the learning objectives. The final stage of the development process was the implementation of the e-module in the classroom to measure its effectiveness in improving students' conceptual understanding.

Developing effective learning media requires a systematic approach, as emphasized by (Lee & Owens, 2004). This research began with a needs analysis of seventh-grade students at SMP Negeri 02 Batu. Through observation and interviews, the researchers sought to deeply identify the obstacles students faced in understanding the concepts of ecology and biodiversity. Based on the results of this analysis, the researchers then designed and developed a mobile-based e-module as a solution to the identified problems. Thus, this e-module is expected to significantly improve students' conceptual understanding.

The developed product was then validated by experts. Validation is a method used to determine the feasibility and suitability of the developed teaching materials based on teaching material criteria (Haekal et al., 2022). The overall assessment by material experts obtained a percentage of 96.4%, from these results, it shows that the presentation of the material in the development of the mobile-based e-module has appropriate depth and is presented with appropriate visualization. The overall assessment by media experts obtained a percentage of

95%, from these results, it shows that the display design and content are presented attractively, creating enjoyable learning. The results of the validator by experts are included in the range of 80% - 100%, categorized as valid and suitable for use in the learning process.

Next, the implementation phase was carried out in class VII C of SMP Negeri 02 Batu with a total of 31 students. The initial stage was that students were instructed to complete a pre-test before accessing the developed product. After completing the pre-test, students were then directed to access the mobile-based e-module via the barcode provided. The final stage was that students were directed to complete a post-test to measure whether there was an increase in students' conceptual understanding after using the developed product. To measure the increase in students' conceptual understanding, the N-gain calculation was carried out according to Hake. The calculation used SBM IPSS 25 and obtained a g value of 0.61. falls within the range of $0.3 \leq g \leq 0.7$, there is an increase between the pre-test and post-test scores and the increase is included in the moderate category. It can be concluded that science learning on the Ecology and Biodiversity of Indonesia material using mobile-based e-modules is effective in learning.

Based on the overall research results, it can be concluded that the developed mobile-based e-module has proven feasible and effective in improving students' conceptual understanding of Indonesian ecology and biodiversity. Thus, the research objective of producing innovative and high-quality learning media has been achieved. The results of the trial conducted indicate that this e-module is able to make a significant contribution to improving the quality of learning in grade VII of SMP Negeri 02 Batu. Therefore, this e-module has great potential for wider application in the learning process.

4. Conclusion

Based on the results of the development of mobile-based e-modules in improving students' conceptual understanding of science on the topic of ecology and biodiversity of Indonesia in grade VII of junior high school, it is proven to be valid and feasible to use for the subject of science on the topic of ecology and biodiversity of Indonesia. This is proven by the results of the feasibility test by material experts getting a percentage of 96.4% and the feasibility test by media experts getting a percentage of 95%. To measure the increase in students' conceptual understanding after using Genially-assisted mobile-based e-modules, it was measured through pre-test and post-test. The calculation results showed that the average post-test score was significantly higher than the pre-test, with an N-gain of 0.61, which indicates an increase in students' conceptual understanding in the moderate category. In its application, students feel more enthusiastic and motivated with this mobile-based e-module because it has many advantages such as making learning more interactive and interesting. Visualization of learning images and videos contained in the e-module helps students understand the concept of the material better, increases learning motivation and enables flexible independent learning. It can be concluded that the development of mobile-based e-modules in improving students' understanding of science concepts on the material of ecology and Indonesian biodiversity in grade VII of junior high school with a value of 0.61 is categorized as moderate in learning effectiveness.

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