



Development and Feasibility of a Problem-Based Learning E-Module Integrating Local Plantation Potential for Ecosystem Learning

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Abstract:

Background. Integrating digital learning resources, Problem-Based Learning (PBL), and local potential can provide contextual learning experiences while supporting student-centered learning in biology education.

Aims. This study aimed to develop and determine the feasibility of a PBL-based e-module integrated with local potential for teaching the Ecosystem topic to Grade 10 high school students.

Methods. The study employed research and development using the ADDIE model, comprising analysis, design, development, implementation, and evaluation. The e-module incorporated local plantation agroecosystems, including oil palm, rubber, cassava, and sugarcane, from Tulang Bawang, Tulang Bawang Barat, and Mesuji Regencies. Material, media, and language experts evaluated product feasibility, while teacher responses and a small-group trial with 20 Grade 10 students at SMAN 1 Way Kenanga assessed usability. Data were collected using validation and response questionnaires and analyzed descriptively using percentages.

Result. The results showed that the e-module achieved feasibility scores of 84.44% for material, 89.00% for media, and 90.77% for language, all categorized as highly feasible. Teacher and student responses reached 85% and 83%, respectively, both categorized as very good. These findings indicate that the developed PBL-based e-module integrating local plantation potential is highly feasible and well received as a contextual digital learning resource for teaching ecosystems.

Conclusion. The e-module offers a locally relevant approach that connects ecosystem concepts with authentic environmental problems in students' surrounding areas. Further research involving larger samples and experimental designs is needed to determine its effectiveness in improving students' critical thinking, science process skills, and learning outcomes.

Keywords: ecosystem, e-module, local potential, problem-based learning, contextual learning



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INTRODUCTION

After completing their education at a given educational level, students are expected to possess comprehensive competencies known as the dimensions of the graduate profile. The graduate profile has eight dimensions: faith and devotion to God Almighty, citizenship, critical reasoning, creativity, collaboration, independence, health, and communication. To achieve these graduate profile dimensions, educational units need to develop curricula that are contextual and relevant to their respective educational settings. A contextual curriculum reflects diversification aligned with the educational unit's characteristics and local context, including sociocultural and environmental aspects. An educational unit is considered to have successfully developed a curriculum in accordance with curriculum development principles when it meets criteria such as positioning students as active learners, implementing learning based on real-life contexts, emphasizing fundamental learning, ensuring accountability, and involving stakeholders (Keputusan Kepala Badan Standar Kurikulum, 2025).

To align learning with the educational unit's curriculum development, teachers need to provide contextual and student-centered learning resources. Through contextual and student-centered learning resources, students can achieve the dimensions of the graduate profile. Teachers can design contextual learning by utilizing local potential. Local potential refers to regional resources and assets that students can use for independent learning (Destiara et al., in Destiara, 2020, p. 73). Local potential encompasses the resources possessed by a particular region, which may include natural resources, human resources, culture, geographical characteristics, and historical aspects (Mumpuni, in (Anisa, 2017: 2). Learning integrated with local potential can foster students' interest, develop a sense of social responsibility, and increase their engagement in learning (Aryanto et al., in Nurjanah et al., 2024: 48). Problem-Based Learning (PBL) is a student-centered learning model that introduces real-world problems at the beginning of the learning process (Putri et al., 2025). Problem-based learning can develop critical thinking skills. In addition, PBL can develop students' ability to solve problems in real-world situations and gather information, thereby motivating them to explore, describe, and identify various solutions (Widiasworo, in Hardiantiningsih et al., 2023). Thus, learning through the PBL model integrated with local potential can position students as active learners, foster their interest in learning, and provide a contextual learning experience.

Teaching materials can facilitate the learning process. A module is one type of teaching material. Modules are systematically developed and include planned learning experiences and specific learning objectives for students to achieve. Developing modules ensures that learning materials are not presented solely in verbal form, addresses limitations related to time, space, and students' ability to comprehend information, encourages students to learn, and promotes independent reflection and evaluation (Gunawan, 2022). The main components of a module include learning objectives, learning instructions, activity materials, student activity worksheets, answer keys for the student activity worksheets, and evaluations accompanied by answer keys (Vembrianto, in Kosasih, 2021: 28–30).

Technological developments in the 21st century have transformed conventional learning into digital-based learning. Learning must adapt to meet 21st-century challenges, including 6C skills: *critical thinking, creativity, culture, collaboration, communication, and connectivity* (Srirahmawati et al., 2023).

Learning content selection is one instructional strategy that can be influenced by changing times. One form of learning content that has emerged in response to 21st-century developments is the *e-module*. E-modules are attractively designed and can be accessed electronically through internet-connected devices, allowing students to study without time and space limitations (Kurniawan & Kuswandi, 2021). Printed modules can be adapted and developed into digital formats, such as e-modules (Sugihartini & Jayanta, 2017). The interactive nature, ease of navigation, inclusion of images, videos, audio, and animations, and formative tests that enable immediate feedback are among the advantages of e-modules (Suarsana & Mahayukti, in Sugihartini & Jayanta, 2017).

Several development studies on PBL-based e-modules integrated with local potential have been conducted. The e-module developed by Rosidi et al. (2023) demonstrated good validity and practicality by incorporating PBL and local wisdom. An ethnoscience-based e-module using PBL as an integrated learning model was developed by Hasan et al. (2025). The product demonstrated very high feasibility and practicality and effectively improved students' problem-solving and critical thinking skills. Farhani et al. (2025) developed a science e-module based on the local potential of the Kahyangan Plantation in Jember, which showed very high validity and feasibility for improving process skills in science learning.

Previous research on developing PBL-based e-modules integrated with local potential has shown that such products are feasible, practical, and effective in improving various student competencies, including critical thinking skills, science process skills, and

problem-solving skills. However, previous studies on developing PBL-based e-modules have not integrated the local potential of Tulang Bawang, Tulang Bawang Barat, and Mesuji Regencies, particularly plantation agroecosystems involving oil palm, rubber, cassava, and sugarcane. In addition, previous studies have not addressed the Ecosystem topic for Grade 10 high school students. Grade 10 students of SMAN 1 Way Kenanga, Tulang Bawang Barat, have also not previously been involved as research subjects in related studies. Therefore, a PBL-based e-module is needed that integrates plantation areas as local potential in Tulang Bawang, Tulang Bawang Barat, and Mesuji Regencies to teach the Ecosystem topic in Grade 10. SMAN 1 Way Kenanga is located in Tulang Bawang Barat Regency, which directly borders the other two regencies. These three regions share similar local potential, particularly in the plantation sector.

The student needs analysis at SMAN 1 Way Kenanga showed that learning still relied heavily on conventional teaching materials, namely printed materials, at 73%. The teaching materials used were not yet digital-based and were available in limited quantities. Conventional teaching methods, namely lectures and discussions, were also relatively common, at 65%. Students' interest in Biology learning remained low, at 40%, and they perceived Biology as difficult to understand. Students' understanding of local potential in their area, such as oil palm, rubber, cassava, and sugarcane plantations, was relatively high, at 68%. According to the students, learning would be more engaging if they used local potential as learning material. Students' readiness to use digital teaching materials, such as e-modules, was relatively high (76%). The students responded positively to the development of a PBL-based e-module integrated with local potential. Students' need for a PBL-based e-module integrated with local potential was high, at 83%.

The needs analysis among Biology teachers at SMAN 1 Way Kenanga showed that teaching materials used in the learning process were limited and mostly available in printed form. During instruction, teachers predominantly used lectures and discussions. The Grade 10 Biology teachers at SMAN 1 Way Kenanga were already familiar with the PBL learning model and had implemented it in their classrooms. However, teachers encountered several challenges in implementing PBL, including limited instructional time and uneven student participation. Some teachers had not yet integrated local potential into their teaching, although they understood the local potential associated with oil palm, rubber, cassava, and sugarcane plantations. The teachers were also ready to use digital teaching materials such as

e-modules. Therefore, developing teaching materials in the form of a PBL-based e-module integrated with local potential is needed.

Developing a PBL-based e-module integrated with local potential is expected to address limited instructional time when implementing innovative learning models such as PBL, as e-modules can be accessed without time or space restrictions. Students' learning interest, an important foundation for student-centered learning, is expected to increase once digital teaching materials in the form of e-modules are available for use in the learning process.

METHODS

This study used the ADDIE model as the development model. The ADDIE model consists of five development stages: analysis, design, development, implementation, and evaluation (Sugiyono, in Sholeha, 2019: 14). The product developed in this research was a PBL-based e-module integrated with local potential for teaching the Ecosystem topic to Grade 10 high school students. This study was conducted at SMAN 1 Way Kenanga, Tulang Bawang Barat. The research was carried out during the second semester of the 2025/2026 academic year. The small-group trial involved 20 Grade 10 students from Class X.2. Figure 1 presents the development process based on the ADDIE model.

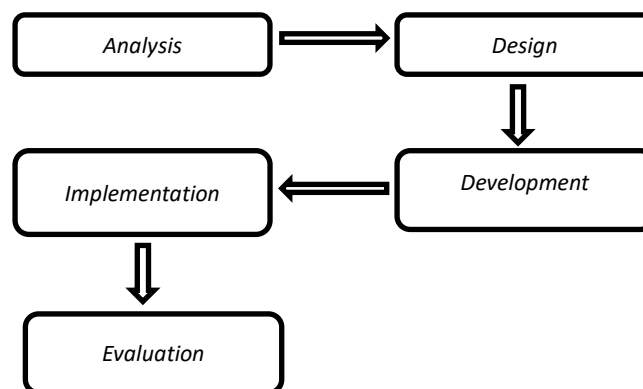


Figure 1. ADDIE Model Development Process

Questionnaires were used as data collection instruments to assess product feasibility and respondents' responses to the developed product. The product feasibility validation questionnaires consisted of a material expert validation questionnaire, a media expert validation questionnaire, and a language expert validation questionnaire. The material experts assessed indicators including content quality, accuracy of the materials and

questions, currency of the materials and questions, and integration with the PBL syntax. The media experts assessed indicators including media presentation, media attractiveness, and ease of use. The language experts assessed indicators including clarity, communicativeness, developmental appropriateness, the use of Indonesian language conventions, and the use of terminology, symbols, and images.

The researchers also distributed questionnaires to assess respondents' responses to the product, including teacher and student response questionnaires. Teachers assessed materials, presentation and language, and graphical design. Students assessed learning media, materials, and benefits.

Both qualitative and quantitative data were used in this study. Experts' comments and suggestions on the quality of the developed product were considered qualitative data. Revisions were made when necessary based on the suggestions or comments provided by the validators. Quantitative data were obtained from expert validation questionnaires and teacher and student response questionnaires. Descriptive quantitative analysis was used as the data analysis technique. Data analysis was performed using *Microsoft Excel* 2016. The analysis of respondents' responses to the product used a formula modified from Rahmat et al. (2021), as follows:

$$P = \frac{\sum \text{Jumlah Skor dari Responden}}{\text{Jumlah Skor Maksimal}} \times$$

Description:

P = Percentage of respondents' responses

The percentage of respondents' responses was subsequently converted into respondent response criteria using the criteria presented in Table 1.

Table 1. Criteria for Respondents' Responses

Percentage (%)	Categori
P > 81%	Very good
61% < P ≤ 80%	Good
41% < P ≤ 60%	Fairly good
20% < P ≤ 40%	Poor
P ≤ 20%	Very poor

(Modificated from Arikunto in Rahmat dkk., 2021: 14)

RESULTS

The PBL-based e-module integrated with local potential for teaching the Ecosystem topic was the product developed in this research. The teaching material was developed using

the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation.

In the analysis stage, an analysis of the syllabus and teaching module were analyzed, along with an analysis of the needs of teachers and students. The syllabus and teaching module were analyzed to identify the learning outcomes specified in the school's implemented curriculum. SMAN 1 Way Kenanga implements the Merdeka Curriculum. The Ecosystem topic is included in Phase E, corresponding to Grade 10 of senior high school. The learning outcome for this topic requires students to demonstrate analytical skills. Students can develop analytical skills when trained to think critically. The problem-based learning (PBL) model can be implemented to develop students' critical thinking skills.

Based on the student needs analysis conducted by distributing a needs analysis questionnaire to 55 students, the results showed that 64.55% of students were not interested in Biology as a subject, while 17.25% were very uninterested in Biology. Low interest in learning Biology may affect students' understanding of the subject matter. A total of 36.40% of students agreed, and 5.5% strongly agreed that classroom learning still relied on lectures and discussions. Furthermore, 52.7% of students agreed, and 15.45% strongly agreed that classroom learning still used printed teaching materials. Therefore, there is a need to develop innovative teaching materials that can attract students' interest in learning Biology through a model that facilitates the development of higher-order thinking skills, such as critical thinking. Accordingly, a PBL-based e-module integrated with local potential is needed to teach the Ecosystem topic.

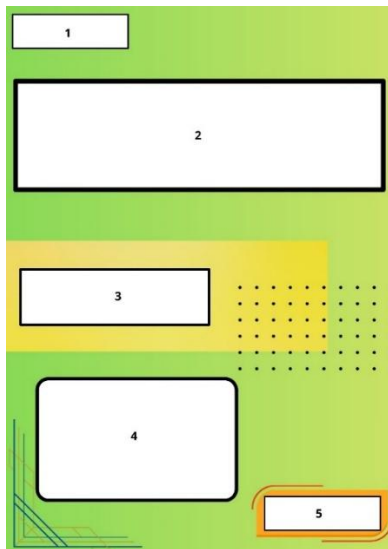
Based on the needs analysis questionnaire administered to three teachers, all teachers had previously used the PBL model but encountered challenges related to limited instructional time and uneven student participation. Integrating local potential into learning can create a contextual learning environment and is therefore expected to increase students' interest in learning Biology. Local potential that can be utilized in learning includes cassava, sugarcane, oil palm, and rubber plantations. A total of 45.5% of students reported understanding these forms of local potential, while 10.9% reported understanding them very well. In addition, 71.85% of students were ready to use digital teaching materials, indicating the feasibility of developing an e-module.

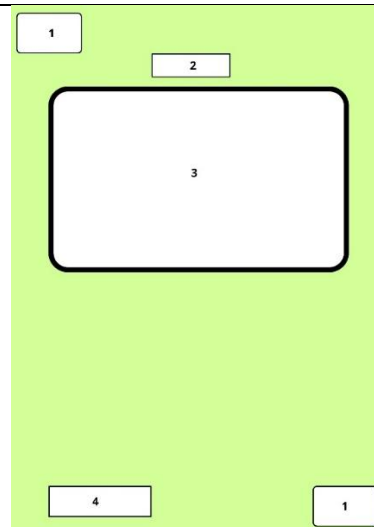
The *design* stage produced a draft e-module consisting of several components, including a cover page, preface, table of contents, list of figures, concept map, instructions for using the e-module, e-module features, learning activities, references, glossary, and

author profile. The e-module contains three learning activities; therefore, the learning objectives, based on the learning outcomes, were divided into three learning activities. After organizing the material structure and preparing the *storyboard*, the e-module was developed using Canva. This e-module design represents the initial stage of product development. The design stage also included preparing the e-module validation instruments. Table 2 presents the *storyboard* developed during the *design* stage.

The product was developed during the *development* stage. The *storyboard* served as a reference for product development. Canva and Heyzine were the main platforms used to develop this product. Other platforms, such as Google Forms, Google Drive, Wayground, and Liveworksheets, were also utilized to make the learning process more interactive.

Table 2. Storyboard of the PBL-Based E-Module Integrated with Local Potential

No	Appearance and Description
1	Cover Page  Description: The cover page uses Open Sans and Canva Sans fonts and consists of the following elements: 1. Logo, researcher's institutional identity, and year of product development. Use Open Sans at size 17. 2. Image relevant to the local potential, featuring an oil palm plantation. 3. Title, using the Canva Sans font at a size of 43. 4. Author's name, using the Open Sans font at a size of 18. 5. User's grade-level identification, using the Open Sans font at a size of 19.
2	Problem Orientation



Description:

The problem orientation section contains:

1. Images relevant to the local potential, with a cassava plant positioned in the upper left corner and an oil palm plant positioned in the lower right corner.
2. Title. This section uses the Open Sans font at a size of 14.
3. Images illustrating ecosystem-related problems, such as grasshopper population outbreaks in cassava plantations, deforestation, land fires in sugarcane plantations, and shortages of chemical fertilizers. Students are asked to formulate problem statements based on the problems presented and then present them in groups in front of the class. Use Open Sans as the font, size 12.

Footer: page number, topic, and grade level. Open Sans is used as the font, with a font size of 12.

Experts validated several aspects of the developed e-module, including content, media, and language. Table 3 presents the results of the expert validation of the e-module.

Table 3. Expert Validation Results of the E-Module

No	Validation	Persentage	Criteria
1	Material expert	84,44%	Very worthy
2	Media expert	89%	Very worthy
3	Language expert	90,77%	Very worthy

The material expert recommended that the *e*-module use up-to-date reference sources and improve the resolution of the images included in the *e*-module. The media expert recommended modifying the coloring to make it more visually appealing, revising the font used in the table of contents, and rearranging the discussion question items in Student Worksheet 2 (LKPD 2). The language expert recommended using appropriate imperative forms, such as changing the word “*baca*” to “*bacalah*,” and improving the sharpness of several images in the *e*-module. Figure 2 presents the development results based on the storyboard prepared during the design stage.

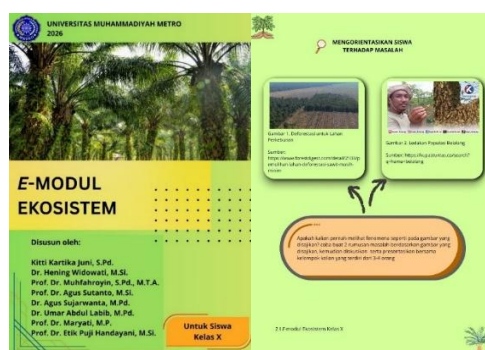


Figure 2. Developed E-Module

At the implementation stage, the researchers conducted a small-group trial involving Grade 10 students from Class X.2 at SMAN 1 Way Kenanga, as well as a Biology teacher response assessment. In the small-group trial, the researchers assessed three aspects of the e-module. Table 4 presents the results of the small-group trial.

Table 4. Small-Group Trial/Student Response Results

No	Aspect	Percentage	Criteria
1	Learning Media	83,00%	Very good
2	Material	85,50%	Very good
3	Benefits	80,50%	Good

The teacher response assessment was conducted based on three aspects. Table 5 presents the results of the teacher response assessment.

Table 5. Teacher Response Assessment Results

No	Aspect	Percentage	Criteria
1	Material	87%	Very good
2	Presentation and language	84%	Very good
3	Graphic Design	83%	Very good

Table 6 presents the results of the teacher and student response assessments.

Table 6. Respondent Response Assessment Results

No	Responden	Percentage	Criteria
1	Teacher	85%	Very good
2	Student	83%	Very good

In this development research, evaluation was conducted at each stage to ensure the developed product was feasible and of good quality.

DISCUSSION

The material expert, media expert, and language expert validated the developed product, namely a PBL-based *e*-module integrated with local potential for teaching the Ecosystem topic, as having a very high level of feasibility. The teachers and students provided very positive responses to the *e*-module.

Expert validation results indicated that the *e*-module was highly feasible in terms of material aspects. All assessed material aspects met the criteria for very high feasibility, including content quality, accuracy of topic and question content, currency of materials and questions, and integration with the PBL syntax. The *e*-module presents the Ecosystem topic clearly and in an easy-to-understand manner, in accordance with the learning indicators. The *e*-module also includes scientific phenomena related to ecosystems, such as a grasshopper population outbreak in a community plantation area in Mesuji. The *e*-module clearly explains the concepts and definitions of ecosystems; uses terminology appropriately and supports it with an included glossary; and presents images relevant to the Ecosystem topic. However, several images in the *e*-module needed improved sharpness and resolution. The authors revised the relevant images, resulting in clearer, sharper visuals. The inclusion of YouTube videos helps visualize abstract concepts in a relevant manner. The materials, ranging from food chains and ecological pyramids to biogeochemical cycles, are organized systematically and avoid misconceptions. The evaluation questions are presented in essay format and include sufficiently higher-order thinking skills (HOTS). The materials align with the latest curriculum standards, as shown by the inclusion of the 2025 learning outcomes based on the Decree of the Head of BSKAP No. 046/H/KR/2025. Videos and images in the learning materials further support content delivery. In addition, the product includes formative assessments with immediate automated feedback (Suarsana & Mahayukti, in Sugihartini & Jayanta, 2017).

The *e*-module incorporates the PBL syntax throughout. This is evident in the problem orientation section, which contains clippings and news reports on relevant local environmental problems, such as the grasshopper population outbreak in Mesuji and the burning of plantation land in sugarcane plantations in Tulang Bawang. The *e*-module also contains Student Worksheets (LKPD) that guide students in identifying specific biotic and

abiotic components based on the local problems presented. The e-module's activity feature provides instructions that encourage students to explore information using external sources and the internet. The LKPD includes discussion problems with strategic questions concerning solutions and ecosystem sustainability from the students' perspectives. The activity feature also provides clear instructions for students to engage in discussions and present their analysis results. The e-module also includes an interactive reflection sheet using the Liveworksheets platform in each learning activity.

Alveolita et al. (2023) reported an increase in learning outcomes through students' learning motivation using the PBL (Problem-Based Learning) learning model in learning Science Chapter 8 Class 4 at SD Negeri 2 Babakanmulya. In this study, the success indicator is the percentage of classical completeness, calculated as the percentage of students in one class who achieve a score of ≥ 75 . Tombokan and Managi (2023) identified barriers to implementing both solution options. They are: role change of teachers from knowledge resource to facilitator, lack of experience for teachers, good resource availability, support from stakeholders, technology support, and a careful teaching plan. However, each barrier can still be addressed with the right solution. While teachers can overcome these barriers during the learning process, they should also consider critical factors when solving math class problems.

The media expert assessed the feasibility of the developed product as very high. The developed product met the media assessment criteria, including media visualization, media attractiveness, and ease of use. The developed e-module presents the Ecosystem materials and questions completely and clearly in each learning activity. The combination of fonts used is not excessive, allowing students to maintain their concentration while learning with the e-module. The selection of font types and sizes in the developed product was appropriate; however, the table of contents still used all capital letters and needed improvement. Therefore, the table of contents capitalization needed to be adjusted. The background colors were appropriate for the Ecosystem topic, but adjustments were needed to make the e-module more visually appealing and to provide sufficient contrast between the images and text colors, thereby enhancing the overall attractiveness of the media. The e-module is practical and easy to use because it provides clear instructions and includes interactive features, such as quizzes using the Wayground and Google Forms platforms, as well as interactive Student Worksheets (LKPD) using the Liveworksheets platform.

The language expert assessed the developed product's language feasibility as very high, including straightforwardness, communicativeness, developmental appropriateness, compliance with Indonesian language conventions, and the use of terminology, symbols, and images. The terminology is consistent with the Kamus Besar Bahasa Indonesia (KBBI), and the sentences are straightforward and simple, taking into account the developmental level of senior high school students so the content is easy to understand. Some sentences required revision, such as replacing the word “baca” with “bacalah” as the appropriate imperative form in the evaluation questions in each learning activity. The use of icons throughout the *e-module* is consistent, including the icons used for the various *e-module* features distributed across the three learning activities. Each feature in the *e-module* is accompanied by a specific icon.

The teacher response assessment results indicated a very good response to the developed *e-module*. The teacher response to the material aspect was very good. The teacher assessed the alignment between the learning objectives and the materials, activities, and evaluations included in the product. The teacher's response to the presentation and language aspects was also very good. The teacher considered the *e-module* to provide complete information, as evidenced by the inclusion of materials, activities, and evaluations, along with clear instructions for using the product. Compliance with Indonesian language conventions was an important consideration in the teacher response assessment, including how easily the product could be understood. The teacher used ecosystem-related terms and concepts accurately and consistently. The sentences in the *e-module* were structured effectively and clearly and did not create ambiguous interpretations. The teacher's response to the *e-module*'s graphic design was very good. The multimedia components, such as videos and images, presented Ecosystem-related materials and supported achievement of the learning objectives. The images were clear and appropriate for the developmental level of senior high school students.

The students' responses to the developed *e-module* were very good. Regarding the learning media aspect, students assessed the *e-module* as easy to use and appropriate to their abilities, supported by clear instructions. The *e-module* contains buttons, menus, and icons that are easy to understand in each learning activity. The visual appearance and presentation of the materials were also considered attractive. The *e-module* presents comprehensive Ecosystem materials, including ecosystem components, interactions among ecosystem components, energy flow, ecosystem productivity, ecological pyramids, and biogeochemical

cycles. Students found the language and wording in the *e-module* easy to understand. They also felt that the *e-module* helped them understand the Ecosystem materials.

The students provided very good responses regarding the benefits of the *e-module*. This indicates that the *e-module* can increase students' interest in learning the Ecosystem topic and facilitate independent learning. The *e-module* can foster students' interest in learning and motivation. The *e-module* was developed to address limited instructional time, increase students' learning motivation, and help students conduct independent reflection and evaluation (Gunawan, 2022). Students can engage in independent learning through the *systematically organized e-module* (Ningrum et al., 2025).

Based on the expert validation and teacher and student response assessments, the developed *e-module* was found to be highly feasible and received very good responses. These findings support the research conducted by Rosidi et al. (2023), which showed that a PBL-based *e-module* incorporating local wisdom in Sesaot Village demonstrated high validity, practicality, and effectiveness in facilitating students' critical thinking and problem-solving skills. The researchers in the present study used different local potential than in the previous study, and the subjects and methods also differed. These differences may have contributed to slight variations in the development results. The product developed in the present study was considered highly feasible and received very good responses, whereas the product developed in the previous study was considered feasible and practical. Qomalasri et al. (2023) projected that, in order to implement the Problem-Based Learning model in classroom action research, attention should be paid to each step and the number of references used in learning should be increased.

Febriyani et al. (2025) found a significant difference between the learning outcomes of students who used the Problem-Based Learning Model and Audio-Visual Media and those of students who did not use the *Problem-Based Learning* and Audio-Visual Media Learning Model in class XI Academic MAN 2 Banyumas. The Problem-Based Learning model can improve student learning outcomes with the assistance of audio-visual learning media because, with the model and media, students become more interested in participating in learning. The Problem-Based Learning model also enables students in Class IV at SDN 1 Cigadung to think critically (Utami et al., 2023).

Based on the development of the PBL-based *e-module* integrated with local potential, Biology teachers are encouraged to use the local potential of their respective regions as learning resources and implement the PBL model not only in face-to-face instruction but

also through PBL-based *e*-modules. Implementing a PBL-based *e*-module integrated with local potential can foster students' learning motivation and encourage them to engage in independent learning. Thus, limitations in instructional time can be addressed once students' ability to learn independently, without being constrained by space and time, is established.

CONCLUSION

This study successfully developed a Problem-Based Learning (PBL)-based *e*-module integrating local plantation potential for teaching the Ecosystem topic to Grade 10 high school students using the ADDIE development model. The *e*-module contextualizes ecosystem concepts through locally relevant plantation agroecosystems, including oil palm, rubber, cassava, and sugarcane, while incorporating PBL activities that encourage students to identify, analyze, and propose solutions to authentic environmental problems.

Validation results showed that the developed *e*-module was highly feasible, with scores of 84.44% for material, 89.00% for media, and 90.77% for language. Furthermore, teachers (85%) and students (83%) gave the *e*-module very good responses, indicating positive acceptance of its content, presentation, learning media, and benefits. These findings indicate that integrating PBL with local plantation potential provides a feasible and contextually relevant approach to developing digital learning resources for ecosystem education. The *e*-module is therefore suitable for further classroom implementation and evaluation. However, because the present study was limited to a small-group trial, its effectiveness in improving learning outcomes cannot yet be established. Further studies involving larger samples and experimental designs are recommended to evaluate its effects on students' critical thinking, science process skills, and other learning outcomes.

Suggestions

The researchers conducted only a small-group trial due to the limited research period. Therefore, further research involving a larger group of participants is needed. Future studies should also examine the effectiveness of using this *e*-module in improving students' competencies, such as critical thinking and science process skills, while covering a broader range of learning materials rather than being limited to the Ecosystem topic.

BIBLIOGRAPHY

Alvionita, A., Nurkholis, N., & Rinto, R. (2023). Increased Student Motivation and Learning Outcomes Using the Grade 4 Problem-Based Learning Model. *Jurnal Edusci*, 1(2), 55–66. <https://doi.org/10.62885/edusci.v1i2.102>

- Anisa, A. (2017). Meningkatkan Keterampilan Berpikir Kritis Peserta Didik melalui Pembelajaran IPA Berbasis Potensi Lokal di Jepara. *Jurnal Inovasi Pendidikan IPA*, 3(1), 1–11. <https://doi.org/https://doi.org/10.21831/jipi.v3i1.8607>
- Destiara, M. (2020). Efektivitas Bahan Ajar Berbasis Potensi Lokal pada Materi Pisces Terhadap Hasil Belajar. *Bioeduca: Journal of Biology Education*, 2(2), 73–38. <https://journal.walisongo.ac.id/index.php/BIOEDUCA/article/view/6074/2885>
- Farhani, U. Z., Nuha, U., & Rusdianto. (2025). Pengembangan E-Modul IPA Berbasis Potensi Lokal Perkebunan Kahyangan, Jember, untuk Meningkatkan Keterampilan Proses Sains Siswa SMP. *Edumedia: Jurnal Keguruan Dan Ilmu Pendidikan*, 9, 80–90. <https://doi.org/https://doi.org/10.51826/edumedia.v9i2.1581>
- Febriyani, F., Anisah, A., & Rusdiyana, R. (2025). The The Influence of Problem Based Learning Models and Audio Visual Learning Media on Economic Learning Outcomes. *Jurnal Edusci*, 3(1), 31–43. <https://doi.org/10.62885/edusci.v3i1.859>
- Gunawan, R. (2022). *Modul Pelatihan Pengembangan Bahan Ajar/ Modul Pembelajaran* (1st ed.). Feniks Muda Sejahtera. [https://books.google.co.id/books?hl=id&lr=&id=F2JIEAAQBAJ&oi=fnd&pg=PP1&dq=Gunawan,+Rudy.+\(2022\).+Modul+Pelatihan+Pengembangan+Bahan+Ajar/Mo+dul+Pembelajaran.+Jawa+Barat+:+CV.+Feniks+Muda+Sejahtera.&ots=k52RjmbN9e&sig=HEAWo4xZYJVKFBU7DF7jYt7a9B8&redir_esc](https://books.google.co.id/books?hl=id&lr=&id=F2JIEAAQBAJ&oi=fnd&pg=PP1&dq=Gunawan,+Rudy.+(2022).+Modul+Pelatihan+Pengembangan+Bahan+Ajar/Mo+dul+Pembelajaran.+Jawa+Barat+:+CV.+Feniks+Muda+Sejahtera.&ots=k52RjmbN9e&sig=HEAWo4xZYJVKFBU7DF7jYt7a9B8&redir_esc)
- Hardiantiningsih, Istiningsih, S., & Hasnawati. (2023). Pengaruh Model Pembelajaran Problem Based Learning terhadap Kemampuan Berpikir Kritis Siswa. *CENDEKIA : Jurnal Pendidikan Terintegrasi*, 1(1), 1–12. <https://doi.org/10.63982/77hts140>
- Hasan, Y., Susilawati, & Andayani, Y. (2025). Pengembangan E- Modul Berbasis Etnosains Alat Transportasi Cidomo. *Jurnal Pendidikan, Sains, Geologi, Dan Geofisika*, 6(2). <https://jpfis.unram.ac.id/index.php/GeoScienceEdu/article/view/994>
- Keputusan Kepala Badan Standar Kurikulum, dan A. P. K. P. D. dan M. N. 046/H/KR/2025. (2025). *Capaian Pembelajaran pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar dan Jenjang Pendidikan Menengah*.
- Kosasih, E. (2021). *Pengembangan Bahan Ajar* (1st ed.). Bumi Aksara. [https://books.google.co.id/books?hl=id&lr=&id=UZ9OEAAAQBAJ&oi=fnd&pg=P1&dq=Kosasih,+E.+\(2021\).+Pengembangan+Bahan+Ajar.+Jakarta+:+PT.+Bumi+Aksara.&ots=Wq6ETmS0bu&sig=cXabY2kyWPDv8GhznNs-VGfbBlE&redir_esc=y#v=onepage&q=Kosasih%2C E. \(2021\). Pengembangan B](https://books.google.co.id/books?hl=id&lr=&id=UZ9OEAAAQBAJ&oi=fnd&pg=P1&dq=Kosasih,+E.+(2021).+Pengembangan+Bahan+Ajar.+Jakarta+:+PT.+Bumi+Aksara.&ots=Wq6ETmS0bu&sig=cXabY2kyWPDv8GhznNs-VGfbBlE&redir_esc=y#v=onepage&q=Kosasih%2C E. (2021). Pengembangan B)
- Kurniawan, C., & Kuswandi, D. (2021). *Pengembangan E-modul sebagai Media Literasi Digital pada Pembelajaran Abad 21* (1st ed.). Academia Publication. https://books.google.co.id/books?hl=id&lr=&id=RfgvEAAAQBAJ&oi=fnd&pg=PA1&dq=Kurniawan+%26+Kuswandi,+2021&ots=5IgOzHuWbQ&sig=Pz5Mve0YnGFJO18oGc0pY41GIb0&redir_esc=y#v=onepage&q=Kurniawan %26 Kuswandi%2C 2021&f=false
- Ningrum, W. D. A., Achyani, & Widowati, H. (2025). Pengembangan e-modul PjBL QR Code untuk Meningkatkan Berfikir Kreatif Peserta Didik. *Bioloa*, 6(2), 157–164. <https://scholar.ummetro.ac.id/index.php/bioloa/article/view/6257/3706>
- Nur Aida Utami, I., Nurkholis, N., & Rinto, R. (2023). Improving Learning Outcomes Using

- the Problem-Based Learning Model in Grade IV Elementary School Science Learning. *Jurnal Edusci*, 1(2), 78–87. <https://doi.org/10.62885/edusci.v1i2.104>
- Nurjanah, R., Purnamasari, S., & Rahmanisar, A. (2024). Analisis Implementasi Potensi Lokal dalam Pembelajaran Ilmu Pengetahuan Alam. *Jurnal Pendidikan MIPA*, 14(1), 48–56. <https://ejournal.tsb.ac.id/index.php/jpm/article/view/1476/756>
- Nur Qomalasari, E., Nurkholis, N., & Rinto, R. (2023). Application Model Problem Based Learning To Improve Learning Outcomes Class II Elementary School. *Jurnal Edusci*, 1(2), 67–77. <https://doi.org/10.62885/edusci.v1i2.103>
- Putri, N. A., Yuni, A. H., & Suyuti. (2025). Efektivitas Model Problem Based Learning dalam Meningkatkan Kemampuan Berpikir Kritis Siswa. *KAMPUS AKADEMIK PUBLISHER*, 3(1), 80592–80602. <https://doi.org/10.61722/jipm.v3i4.1142>
- Rahmat, A., Isa, A. H., Ismaniar, M. P., & Arbarini, M. (2021). *Model Mitigasi Learning Loss Era Covid 19: Studi pada Pendidikan Nonformal Dampak Pendidikan Jarak Jauh* (1st ed.). Samudra Biru. [https://books.google.co.id/books?hl=id&lr=&id=FsxLEAAQBAJ&oi=fnd&pg=PP1&dq=Rahmat,+A.,+Isa,+A.+H.,+Ismaniar,+M.+P.,+%26+Arbarini,+M.+\(2021\).+Model+Mitigasi+Learning+Loss+Era+Covid+19:+Studi+pada+Pendidikan+Nonformal+Dampak+Pendidikan+Jarak+Jauh.+Samudra+Biru.&ots=6i2sv0wmaM&sig=gSiFN Cos2zBsxyjKv3pY010H4G8&redir_esc=y#v=onepage&q&f=false](https://books.google.co.id/books?hl=id&lr=&id=FsxLEAAQBAJ&oi=fnd&pg=PP1&dq=Rahmat,+A.,+Isa,+A.+H.,+Ismaniar,+M.+P.,+%26+Arbarini,+M.+(2021).+Model+Mitigasi+Learning+Loss+Era+Covid+19:+Studi+pada+Pendidikan+Nonformal+Dampak+Pendidikan+Jarak+Jauh.+Samudra+Biru.&ots=6i2sv0wmaM&sig=gSiFN Cos2zBsxyjKv3pY010H4G8&redir_esc=y#v=onepage&q&f=false)
- Rosidi, A., Rohman, F., Novianti, V., Hariadi, I., Studi, P., Pendidikan, P., Matematika, F., Alam, P., Malang, U. N., Nomor, J. S., Timur, J., Narmada, S. M. A. N., Nomor, J. S., Barat, L., & Tenggara, N. (2023). Pengembangan E-module Keanekaragaman Makhluk Hidup serta Pengaruhnya Terhadap Keterampilan Berpikir Kritis, Pemecahan Masalah, dan Sikap Lingkungan. *Bioscientist: Jurnal Ilmiah Biologi*, 11(2), 1662–1677. <https://ejournal.undikma.ac.id/index.php/bioscientist/article/view/9414/5250>
- Sholeha, S. (2019). *Pengembangan Media Pembelajaran Physics Ludo Berbasis Literasi Sains Pada Materi Hukum Newton*. UIN Raden Intan Lampung.
- Srirahmawati, A., Deviana, T., & Wardani, S. K. (2023). Peningkatan Keterampilan Abad 21 (6C) Siswa Kelas IV Sekolah Dasar Melalui Project Based Learning pada Kurikulum Merdeka. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 08(01), 5283–5294. [https://eprints.umm.ac.id/id/eprint/6307/2/Srirahmawati Deviana Wardani - Peningkatan Keterampilan Abad 21 \(6C\) Siswa.pdf](https://eprints.umm.ac.id/id/eprint/6307/2/Srirahmawati%20Deviana%20Wardani%20-%20Peningkatan%20Keterampilan%20Abad%2021%20(6C)%20Siswa.pdf)
- Sugihartini, N., & Jayanta, N. L. (2017). Pengembangan E-Modul Mata Kuliah Strategi Pembelajaran. *Jurnal Pendidikan Teknologi Dan Kejuruan*, 14(2), 221–230. <https://doi.org/10.23887/jptk-undiksha.v14i2.11830>
- Tombokan, S., & Mandagi, M. O. (2025). Reveals Learning Problem Posing Mathematics In Primary School. *Jurnal Edusci*, 2(6), 307–319. <https://doi.org/10.62885/edusci.v2i6.931>