

Development of Flower Morphology E-Module Based on Tretes Waterfall Biodiversity to Improve Botanical Literacy and Communication Skills

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Submitted June 11th 2025 and Accepted August 29th 2025

Abstract

Background: Botanical literacy and communication skills are critical 21st-century competencies, yet they remain underdeveloped among Biology Education students. This study addresses this gap by developing and validating a flower morphology e-module that integrates local potential from the Raden Soerjo Natural Park. **Methodology:** Following the Lee & Owens development model, data were collected from 3 expert validators and students in one-to-one ($n=3$), small group ($n=10$), and field trials ($n=32$) using Likert scales, essay questions, and observation sheets. **Findings:** The e-module was rated "very valid" by experts (96.52% average) and "very practical" in student trials (86 - 89% average). A one-way ANCOVA test confirmed its effectiveness, showing a statistically significant and substantial increase in botanical literacy (80% average) and communication skills (78% average) in the experimental class over the control class. **Contribution:** This study contributes a validated and effective e-module that uniquely integrates local potential, offering a significant practical implication for the biology curriculum by providing educators with a resource to enhance student competencies through contextualized, self-directed learning.

Keywords: e-Module; Botanical Literacy; Communication Skills; Local Potential; Flower Morphology



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 <https://doi.org/10.36987/jpbn.v11i3.7740>

INTRODUCTION

Education in the 21st century requires students to possess skills that go beyond mere academic knowledge in the form of learning outcomes, but also encompass the 4C skills (Suaidiah *et al.*, 2024). The urgency of mastering these skills, particularly communication and science literacy, is reinforced by data at both global and national levels. Globally, reports from the World Economic Forum consistently rank communication, along with analytical and creative thinking, as one of the most vital skills required for the future job market (Di Battista *et al.*, 2023). Nationally, data from the Programme for International Student Assessment-PISA (2022), released by the OECD, reveals that the average science literacy score of Indonesian students (385) remains significantly below the OECD average (485). This low level of science literacy directly impacts students' ability to effectively understand, analyze, and communicate complex biological concepts. This situation underscores the urgent need to develop innovative learning media that can simultaneously train both of these crucial competencies.

The 4C skills critical thinking and problem solving, communication, creativity and innovation, and collaboration are some of the most important skills in current learning (Thahir, 2024). One of the 4C skills, communication skills, is particularly important to possess in order to understand and convey complex biological concepts and principles (Hamidah & Luzyawati, 2022).

Communication skills require students to be able to communicate verbally, receptively, understand meaning, clearly, strategically, and presentatively (Greenstein, 2012). Qadariah (2023) adds that good communication skills are very important for achieving a comprehensive understanding of concepts; without good communication skills, misconceptions can arise in the learning process. Communication plays a significant role in teaching and learning activities, with the aim of transferring knowledge and exchanging ideas or concepts (Urwani *et al.*, 2018).

Students must ask questions clearly to facilitate understanding and responses from teachers so that knowledge can be conveyed effectively (Mayani *et al.*, 2023). If students can receive learning materials well, then communication in learning can be said to be effective. The results of the survey on students' communication skills needs were classified as low. This shows that students' communication skills still need to be developed.

Poor communication skills can affect the learning process. This occurs because students have low ability in expressing their opinions and answering questions posed by teachers during the learning process, which can affect student learning outcomes (Faisal & Jumadi, 2024). One factor causing poor communication skills among students is the use of learning models and media that are not communicative and interactive enough (Pertiwi & Hidayat, 2024).

A lack of communication skills will cause students to face difficulties participating in presentations and class discussions, as well as a lack of understanding of concepts. In addition, students also need to be trained to think botanically in order to illustrate all biological concepts (Uno, 2009). Botanical thinking supports students in developing botanical literacy. Botanical literacy is defined as the ability to

understand and use knowledge about plants conceptually and procedurally (Pongsophon & Jituafoa, 2021).

The situation in the field shows that many students are experiencing plant blindness (Uno, 2009). Hemingway et al., (2011) explain that plant blindness is caused by various interrelated factors, such as human attitudes that disregard plants in their surroundings. Uno (2009) including low interest in plants around them, as well as limited opportunities to learn and interact with botany.

The needs analysis of students who have completed the Generative Plant Development Structure course at the Biology Department of Malang State University revealed a low average botanical literacy score of 53.95 %. The lowest percentage, 48.98 %, was observed in the core idea of plant morphology, specifically the external structure and function of plants. Although previous research has demonstrated that developing e-modules based on local potential is feasible and effective for teaching biological concepts about plants, existing studies have not specifically developed an e-module that integrates the local potential from the Raden Soerjo Natural Park area to simultaneously train both botanical literacy and communication skills on the topic of flower morphology. This gap is the focus of the current study: to create an innovative learning medium that is not only contextually relevant but also explicitly designed to empower these two essential competencies concurrently. This indicates that students' botanical literacy is still not optimal and requires further development. Empowering and training students in communication skills and botanical literacy necessitates a well-structured learning process and appropriate instructional materials.

In order to develop students' botanical literacy and communication skills, it is necessary to design a good learning process using an appropriate learning model. One learning model that can develop students' botanical literacy and communication skills is the problem-based learning (PBL) model. The problem-based learning model was chosen because it has been proven effective in improving students' communication skills (Qadariah, 2023; Oktaviani, 2022).

The success of the student learning process depends, among other things, on the teaching materials used (Nuryasana & Desiningrum, 2020). Innovative teaching materials aim to make learning more effective, efficient, and in line with established competencies (Yulaika et al., 2020). One type of innovative teaching material is that which integrates local potential. Integrating learning with local potential can encourage students to improve their understanding of concepts (Wilujeng et al., 2020). As an effort to introduce and preserve local potential in the context of learning, a strategy that can be applied is to integrate these values into learning materials through teaching materials (Sari et al., 2024).

Teaching materials based on local potential can help students learn by linking the material to reality, so that students can apply what they have learned to their everyday lives (Retawidyaningrum & Triatmanto, 2022). Teaching materials based on local potential provide students with an understanding of the strengths and unique characteristics of a region, creating a more practical and meaningful learning process (Novenea et al., 2023). One form of teaching material can be an e-module.

The e-module developed utilizes digital technology and can be accessed via digital devices. The application of teaching materials using digital technology can effectively visualize content through text, images, and videos that support students'

contextual understanding (Delima, 2024). The use of e-modules in learning activities by Vadiati & Qonita, (2022) has several advantages, namely: 1) learning becomes more interactive and dynamic; 2) students can learn independently according to their own abilities and learning speeds; and 3) e-modules can overcome verbalism through the presentation of images and videos, making learning less boring.

E-modules created using local potential can broaden students' knowledge of their environment (Aprilia & Wulandari, 2022), thereby indirectly helping to develop students' botanical literacy. E-modules are systematically designed to create more engaging learning experiences and train students to express their ideas in class (Widjaja, 2019). Creating a conducive learning environment can develop students' oral communication skills, thereby making learning more effective and consistent (Naila et al., 2022).

This is in line with research conducted by Annisa (2022) that e-module teaching materials are effective for training students' communication skills. The development of e-modules based on local potential is feasible and can be used as teaching materials in learning biological concepts in plants (Sahil et al., 2023; Pratama et al., 2018). One of the crucial concepts to master is flower morphology. A deep understanding of plant morphology is essential as it forms the basis for recognizing biodiversity and developing species identification skills. However, instruction on this topic is often perceived as theoretical and unengaging, causing many students to find the concepts difficult to grasp (Gani & Arwita, 2020). Therefore, this study aims to develop, test the validity and practicality of, and analyze the effectiveness of a flower morphology e-module based on the local potential of the Raden Soerjo Natural Park. Theoretically, this research contributes to the literature on the effectiveness of local potential-based e-modules in enhancing 21st-century competencies. Practically, this study produces a tested, ready-to-use teaching material for educators to improve students' botanical literacy and communication skills in a contextual and self-directed manner.

METHOD

The type of development model used in this study is the Lee and Owens development model (Lee & Owens, 2004). The Lee and Owens development model consists of five stages, namely: 1) assessment/analysis, which consists of needs analysis and initial-final analysis, 2) design, 3) development, 4) implementation, and 5) evaluation. The Lee and Owens development model was chosen because it is specifically designed for developing electronic media. The Lee & Owens (2004) development model scheme can be seen in the figure below.

This development model was chosen based on the e-module to be developed being the digital media most suited to this development model. A preliminary analysis was conducted after the needs analysis. This stage was carried out with the aim of finding the required solutions and determining the products to be developed to address the gaps in the field.

The multimedia development stages involved adjusting the e-module design, compiling the sequence of material to be presented, and ensuring consistency with the

topic of the course, Structure and Generative Development of Plants. The development stage consisted of three activities, namely pre-production, production, and post-production & review.

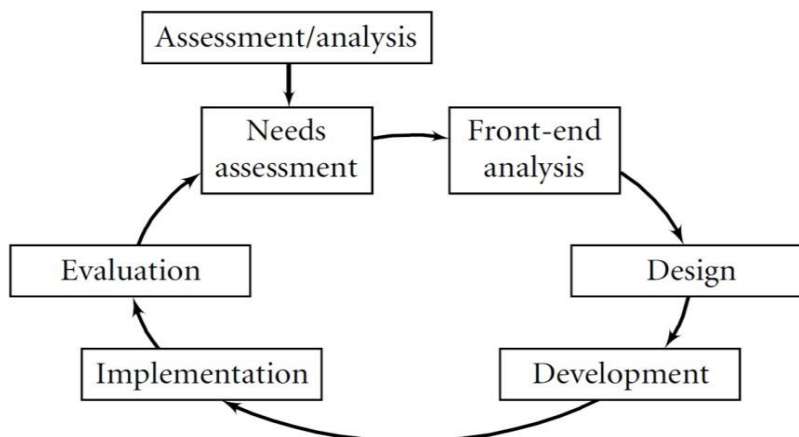


Figure 1. Development Model by [Lee & Owens \(2004\)](#)

Research data were collected through three main stages. First, the validity stage involved 3 expert validators (material, media, and an education practitioner) who assessed the e-module's feasibility using a Likert scale questionnaire. Second, the practicality stage gathered data from a total of 45 students across three trials (one-to-one $n=3$, small group $n=10$, and field $n=32$) using a response questionnaire to measure usability. Third, the effectiveness stage employed a pretest-posttest design with 32 students in experimental and control classes, using essay questions to measure botanical literacy and observation sheets to assess communication skills.

The developed e-module product will be tested by validators for improvements until it is ready for implementation. Once the e-module is declared valid, it will be tested by students by providing them with the e-module and a questionnaire to gauge their response. This is done to determine the validity and practicality of the developed e-module. Data analysis was conducted after obtaining data from validity tests, practicality tests, assessment instruments and product implementation. Data analysis was carried out quantitatively.

Product Validity Test

Product validity was measured using a Likert scale questionnaire given to validators and education practitioners, and data after conducting the trial. The validation and practicality data that has been analyzed refers to [Sulisetijono \(2018\)](#), to obtain the validity percentage with the following calculation.

$$v = \frac{TSe}{TSh} \times 100 \%$$

Explanation:

v = Product validity presentation

TSe = Total assessment score

TSh = Maximum total score

The data obtained from validation by subject matter experts, media experts, and education practitioners will then be analyzed and categorized based on the criteria in the table 1.

Tabel 1. Criteria for the Validity of Teaching Materials. Source: (Sulisetijono, 2018)

Validity Criteria	Level of Validity
$85,00 \leq X$	Very valid
$70,00 \leq X < 85,00$	Valid
$55,00 \leq X < 70,00$	Fairly valid
$40,00 \leq X < 55,00$	Less valid
$X < 40,00$	valid

The results of this validity test will be used as material for improving the e-module. The next stage is the trial stage for students, which consists of one-to-one trials, small group trials, and field tests.

Product Practicality Test

The product practicality test is conducted after the product has been validated by the validator. The practicality test consists of expert review and trial testing. The data on student responses to the product that has been analyzed refers to Sulisetijono (2018) is then categorized based on the criteria in the table 2 below.

$$v = \frac{TSe}{TSh} \times 100 \%$$

Explanation:

v = Product practicality presentation

TSe = Total assessment score

TSh = Maximum total score

Tabel 2. Criteria for the Practicality of Teaching Materials. Source: (Sulisetijono, 2018)

Practicality Criteria	Level of Practicality
$85,00 \leq X$	Very practical
$70,00 \leq X < 85,00$	Practical
$55,00 \leq X < 70,00$	Quite practical
$40,00 \leq X < 55,00$	Not very practical
$X < 40,00$	Not practical

Product Effectiveness Test

The effectiveness of the e-module was evaluated using a pretest-posttest control group design. This study involved an experimental group that learned with the developed e-module and a control group that received conventional instruction. To determine the e-module's impact, a one-way ANCOVA was conducted at a 5 % significance level, preceded by normality and homogeneity tests. In this analysis, the dependent variables were the posttest scores for botanical literacy and communication skills, while the pretest scores for both skills served as the covariate to statistically

control for any initial differences between the groups. The normality test uses the One-Sample Shapiro-Wilk test. The homogeneity test uses Levene's Test of Equality of Error Variance.

The final stage of this research and development procedure is the evaluation stage. This stage aims to determine the quality of the product that has been developed and its effectiveness in the learning process before and after the implementation stage. Activities in this stage include determining reaction, knowledge, performance, and impact (Lee & Owens, 2004).

RESULT AND DISCUSSION

Development Stage Results

The development stage is the phase in which the previously designed e-module is implemented in practice. The purpose of this process is to realize the approved design ideas into a final product. The product is validated by three experts, namely media experts, material experts, and biology education practitioners.

Subject matter validation aims to assess the relevance and scope of content, accuracy and quality of content, improve representation of material, and provide feedback on structure and language. The results of e-module validation by subject matter experts can be seen in the table 3 below.

Table 3. Subject Matter Expert Validation

No	Aspect	Percentage (%)	Category
1	Relevance	100	Very valid
2	Accuracy and quality of content	100	Very valid
3	Appropriateness of presentation	100	Very valid
4	Appropriateness of language	100	Very valid
Average		100	Very valid

Media/teaching material validators assess the e-modules that have been developed by reviewing aspects such as content suitability, presentation and display quality, practicality of use and language, and integration of the e-modules with dependent variables. The results of the validation by media/teaching material experts can be seen in the table 4.

Table 4. Validation of Media and Teaching Materials

No.	Aspect	Percentage (%)	Category
1	Content suitability	93.33	Very valid
2	Presentation and display quality	86.67	Very valid
3	Practicality of use and Language	95	Very valid
4	Integration of e-modules with bound variables	90	Very valid
Average		91.25	Very valid

The biology education practitioner involved in the research and development of this e module is a postgraduate lecturer at Lambung Mangkurat University who

teaches Botany. The results of the biology education practitioner's validation can be seen in the table 5.

Table 5. Validation Results by Education Practitioners

No.	Aspect	Score	Percentage (%)	Category
1.	Completeness of content	4.67	93.33	Very valid
2.	Accuracy of material	4.89	97.78	Very valid
3.	Language	4.75	95	Very valid
4.	Presentation	5	100	Very valid
Average		4.82	96.52	Very valid

Results of one-to-one trials

Individual trials were conducted by three students with varying academic levels, including one student with an average GPA, one student with the highest GPA, and one student with the lowest GPA. The results of the individual trials obtained an average score of 89 %, which is presented in the table 6.

Table 6. Results of one-to-one trials

No	Student	Percentage (%)	Criteria
1	Student 1	98	Very Practical
2	Student 2	88	Very practical
3	Student 3	82	Practical
Average		89	Very practical

Small Group Trial Results

A small group trial was conducted on 10 students from different academic levels using a student response questionnaire. The results of this small group trial obtained an average score of 88 % and are presented in the table 7.

Table 7. Small Group Trial Results

No	Student	Percentage	Criteria
1	Student 1	80	Practical
2	Student 2	100	Very practical
3	Student 3	94	Very practical
4	Student 4	80	Practical
5	Student 5	81	Practical
6	Student 6	82	Practical
7	Student 7	82	Practical
8	Student 8	100	Very practical
9	Student 9	86	Very practical
10	Student 10	98	Very practical
Average		88	Very practical

Field Trial Results

Field trials were conducted on 32 students from the same academic level or grade. The results of these field trials obtained an average score of 86 %, which is presented in the table 8.

Table 8. Field Trial Results

No	Student	Percentage	No	Student	Percentage
1	Student 1	92	17	Student 17	80
2	Student 2	80	18	Student 18	93
3	Student 3	80	19	Student 19	87
4	Student 4	88	20	Student 20	95
5	Student 5	82	21	Student 21	94
6	Student 6	84	22	Student 22	82
7	Student 7	80	23	Student 23	89
8	Student 8	79	24	Student 24	83
9	Student 9	82	25	Student 25	86
10	Student 10	79	26	Student 26	90
11	Student 11	86	27	Student 27	93
12	Student 12	86	28	Student 28	83
13	Student 13	78	29	Student 29	82
14	Student 14	80	30	Student 30	86
15	Student 15	88	31	Student 31	90
16	Student 16	86	32	Student 32	98
Average					86

Implementation Phase Results

The results of the implementation of the e-module on botanical literacy and communication skills of students are as follows.

Botany Literacy

Botany literacy was measured using essay questions. The results of the botany literacy test for students in the experimental and control classes through pretest and posttest are presented in table 9.

Table 9. Percentage Increase in Botanical Literacy

No	Subordinate Idea	Control		Percentage Increase	Eksperiment		Percentage Increase
		Pretest	Posttest		Pretest	Posttest	
1	Getting to know plants in the surrounding environment	36	65	82	34	83	100
2	Grouping plants based on its main characteristics	39	62	59	40	79	98
3	Structure and function of the external structure of plants	48	64	33	40	67	68
4	Find the study site	48	74	54	52	69	33

No	Subordinate Idea	Control		Percentage Increase	Eksperiment		Percentage Increase
		Pretest	Posttest		Pretest	Posttest	
	and label unknown plants						
5	Write down the scientific name	42	59	40	47	69	47
6	Distinguishing plants based on their characteristics	41	76	85	33	66	100
7	Recording and interpreting plant data	45	64	42	48	83	73
	Average	49	66	56	42	74	80

Communication Skills

Communication skills in this study were measured using observation sheets. The results of communication skills assessment in experimental and control class students through pre-learning and post-learning are presented in the table 10.

Table 10. Percentage Increase in Communication Skills

No	Aspect	Control		Percentage Increase	Eksperiment		Percentage Increase
		Pra	Pasca		Pra	Pasca	
1	Oral communication	55	72	31	57	78	37
2	Receptive communication: listening, reading, identifying	50	74	48	57	76	33
3	Understanding the meaning or purpose of communication	43	73	70	42	75	79
4	Using strategies in communication	50	68	36	52	78	50
5	Communicate clearly for specific purposes	46	78	70	50	80	60
6	Presentation skills	52	68	31	54	80	48
	Average	49	49	72	48	52	78

DISCUSSION

Validity and Practicality Test

The results of subject matter expert validation show that the e-module has been developed in accordance with sub-CPMK (*Capaian Pembelajaran Mata Kuliah* or Course Learning Outcomes), is scientifically accurate, systematic, and equipped with visual media and HOTS (Higher-Order Thinking Skills)-based exercises, thereby increasing the effectiveness, efficiency, and meaning of learning. The inclusion of text, images, videos, and flexible access makes the e-module engaging, easy to understand, and promotes student engagement and motivation (Hidayati et al., 2017; Febriana & Kartijono, 2023; Mayer, 2024; Katona et al., 2022). This demonstrates that e-modules are not only efficient but also capable of creating a more engaging and meaningful learning experience.

The validity test results by media and teaching material experts obtained a highly valid category. Empirical evidence also shows that presenting information that

combines verbal text and visual elements can reduce cognitive load and strengthen conceptual understanding (Hansen & Reich, 2020; Arsyad et al., 2024). Well-validated e-modules can be used as effective and appropriate learning resources to support optimal learning processes (Serevina et al., 2018; Nurhikmah et al., 2021; Aulia & Hardeli, 2022). In general, e-modules meet academic standards and have the potential to enhance the quality of learning.

E-modules are designed as both a medium and teaching material used in the learning process. Therefore, validity testing by lecturers as biology education practitioners is required to ensure the suitability and relevance of the e-module content to the learning objectives. Validation by practitioners is important to assess the suitability of the product with learning objectives and student characteristics, while also ensuring its practicality in the classroom (Ningtyas & Zaini, 2023; Istiqamah et al., 2019).

The involvement of practitioners in the validation process results in e-modules that are not only academically appropriate but also effective in improving the quality of biology learning (Irmayani et al., 2022; Fadhilah & Zulyusri, 2023; Meldrawati et al., 2023). Therefore, validation by experts is crucial to ensure that the developed e-modules are not only content- and design-appropriate but also practical for use in classroom learning activities.

The next step is to conduct trials with students to evaluate the practicality of its use. This test aims to see students' responses to the feasibility and ease of operating the e-module. The practicality test stage plays an important role not only in assessing the ease of use of the product, but also as a means of obtaining feedback from users for product refinement prior to implementation. Feedback from students or end-users is a crucial foundation for revising and enhancing the quality of educational media (Hidayati et al., 2017; Ramadhani & Izzati, 2023; Fernando & Sarkity, 2023; Hapsari & Gularso, 2024). This stage ensures the product is truly suitable and effective for use in education. Based on the three tests conducted, the e-module was deemed highly practical and suitable for implementation.

Study on the Effectiveness of e-modules on Botanical Literacy Skills

Based on the results of data analysis on the first subordinate idea, namely recognizing plants in the surrounding environment, it can be seen that there was a significant increase in both the control and experimental classes. This indicates that the e-module is effective in building a contextual foundation for botanical literacy, specifically in actively identifying local plant species. Sari et al., (2022) also emphasize that the use of environment-based digital media significantly enhances basic botanical understanding by linking the material to real-world contexts.

In the second subordinate idea, classifying plants based on their main characteristics, the control class showed improvement. This indicates that the use of e-modules contributes to the development of classification and morphological description skills, which are two key components of botanical literacy. Hidayati & Mustika (2021) explain that e-module-based learning can enhance classification skills through independent grouping activities and analysis of plant characteristics. Additionally, Kartika et al., (2021) visualizing plant structures through

images, diagrams, and animations supports students' spatial and conceptual understanding of biological structures.

For the third subordinate idea, the structure and function of the external structure of plants, there was an improvement. This was because the e-module presented attractive and easily accessible images and visual diagrams. Research by [Kartika et al., \(2021\)](#) showed that interactive e-module-based learning can improve students' understanding of biological structures due to the integration of text, illustrations, and animations that support visual understanding.

Unlike the previous indicators, in the fourth subordinate idea, namely finding the study location and labeling unknown plants, the control class actually showed a higher percentage increase than the experimental class. This may be due to the control group having more hands-on experience in field activities, while the experimental group primarily interacted through e-modules. Therefore, for aspects involving field practice, a combination of e-modules and direct observation activities is necessary to achieve more optimal results.

The fifth subordinate idea, writing scientific names, showed improvement. This indicates that both groups experienced development, but again the experimental group showed better results. This reflects that the use of e-modules helps students understand scientific nomenclature writing better. This is reinforced by [Irwanto et al. \(2022\)](#), who state that e-modules can improve critical thinking skills and accuracy in writing scientific concepts.

For the sixth subordinate idea, distinguishing plants based on their characteristics has improved. This shows that the use of e-modules greatly supports students who initially had low understanding, enabling them to catch up significantly. This is consistent with the results of [Oribhabor \(2020\)](#) research, which shows that activity-based learning media contributes more to students' cognitive improvement than lecture methods.

Finally, in the seventh aspect, namely recording and interpreting plant data, the control class experienced an improvement. The e-module used in the experimental group helped students not only record data but also analyze and draw conclusions based on the graphs or tables presented. This aligns with the findings of [Widyastuti et al., \(2023\)](#), who stated that the use of interactive e-modules can enhance students' science literacy skills due to the inclusion of data visualization features and contextual analysis exercises.

Overall, the average increase in scores in the control class was 56%, while in the experimental class it was 80%. This difference indicates that the use of e-modules in biology learning, particularly in plant-related material, has a significant impact on improving students' learning outcomes. E-modules designed to be interactive, engaging, and easily accessible have proven effective in supporting self-directed learning and deepening students' understanding of scientific concepts.

Study on the Effectiveness of e-modules on Communication Skills

Based on the results of the study, it was found that the average pretest scores of the control class increased, and in the experimental class, the pretest scores also increased. This indicates that the treatment given to the experimental class had a more significant impact on improving the communication skills of the students. According

to [Susanti et al., \(2022\)](#), practice-based learning and the use of e-modules can improve students' communication skills because they provide space for critical thinking, questioning, and active discussion.

In terms of oral communication, the control class experienced an improvement. This increase shows that the learning approach used in the experimental class provided students with more opportunities to practice speaking and expressing their opinions directly. According to [Rahmawati & Pratiwi \(2021\)](#), oral communication skills are very important in biology learning because students often have to present their observations or research results.

In terms of receptive communication (listening, reading, identifying), the control class showed improvement, although the experimental class showed higher improvement. It should be noted that receptive abilities are closely related to the teaching materials used. In the experimental class, the e-module focused more on interactivity than passive text. [Yuliana et al., \(2020\)](#) stated that good reading and listening skills are necessary in biology learning to understand laboratory instructions and scientific procedures.

In terms of understanding the meaning or purpose of communication, the scores of the control and experimental classes improved. This was one of the highest improvements. Understanding the meaning of communication is crucial because students grasp the essence of the scientific messages conveyed, whether in text, speech, or biological symbols. According to [Zulfikar & Arifin \(2023\)](#), in biology education, this skill plays a significant role in understanding the relationships between complex biological concepts and principles.

In terms of using strategies in communication, the control class experienced the same improvement as the experimental class. This means that students in the experimental class were able to develop better communication strategies, such as controlling intonation, choosing the right words, and adapting to the communication context. This aligns with the findings of [Nugroho & Lestari \(2021\)](#), who noted that effective communication strategies in science education influence students' success in systematically conveying scientific ideas.

In terms of communicating clearly for specific purposes, both the control and experimental classes experienced improvement. This was the aspect with the highest improvement in the experimental class. This shows the success of learning in guiding students to convey scientific information clearly and in a structured manner, which is very important in lab reports and group discussions. According to [Maulida & Hartati \(2022\)](#), clear communication in the context of biology helps students understand scientific processes and reduces misconceptions.

Finally, in terms of presentation skills, improvements were observed in both the control and experimental classes. The greater improvement in the experimental class may have been due to structured presentation activities and regular formative assessments. In line with the findings of [Lestari et al. \(2020\)](#), the use of digital media and e-modules was very helpful in improving students' presentation skills in biology learning.

CONCLUSION

Based on the research results, This study concludes that the developed e-module is a highly valid, practical, and effective tool for improving students' botanical literacy and communication skills. The key novelty of this research lies in its successful integration of local potential from the Raden Soerjo Natural Park (Tretes Waterfall Sub-Region), which created a contextually relevant and engaging learning experience that is often missing in conventional biology instruction. The findings have significant practical and theoretical implications. Practically, this e-module provides educators with a tested, ready-to-use resource that fosters self-directed learning in line with 21st-century educational demands. More broadly, the pedagogical framework presented in this study is highly adaptable. Educators outside of this specific local context can replicate this model by substituting their own region's unique biodiversity, thereby making complex biological concepts more tangible and meaningful for their students. However, this study has limitations. The research was conducted with a specific group of university students and focused solely on the topic of flower morphology. Therefore, the generalizability of these results to different educational levels or other biological subjects warrants further investigation. Future research is recommended to explore the adaptation of this local-potential-based e-module framework in diverse settings to validate its effectiveness more broadly.

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How To Cite This Article, with APA style :

Putri, A. S., Sulisetijono, S., & Ibrohim, S. (2025). Development Of An E-Module On Flower Morphology Containing Local Potential From The Raden Soerjo Natural Park In The Tretes Waterfall Sub-Region To Train Students In Botanical Literacy And Communication Skills. *Jurnal Pembelajaran dan Biologi Nukleus*, 11(3), 1102-1220. <https://doi.org/10.36987/jpbn.v11i3.7740>

Conflict of interest : The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions : All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft of the manuscript was submitted by [**Amalia Shaleha Putri**]. All authors contributed on previous version and revisions process of the manuscript. All authors read and approved the final manuscript.