RESEARCH ARTICLE

Plant diversity in Montel Muria Kudus Waterfall area for college student e-module development

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Abstract: Many college students have difficulty in understanding the diversity and morphology of plants at the species level. The research aims to analyze the potential of species-level plant diversity in Montel Muria Kudus Waterfall, develop e-modules integrating local potential, and preserve the local potential of Montel Muria Kudus Waterfall. The research and development study design with the 4D model was implemented in this study to produce the e-module. E-module was tested on 30 Tadris Biology college students who assigned with random sampling technique. Data were collected with expert validations and trial. In Montel Muria Kudus Waterfall, various plant species groups were found, including ferns, epiphytes, shrubs, herbs, and trees. Instructional media expert validation obtained score of 95% which in the "very valid" category. Moreover, material experts scored of 91.66%, means in the "very valid" category. Practical feasibility analysis obtained score of 95.83%, represents the "very practical" category. The results of the college students' N-Gain value of 56.7338, represents the category of "moderately effective" in improving science literacy. This research findings show that the e-module produced can potentially be widely implemented in biology instruction for improving college students' science literacy skill as well as preserving local potential.

Keywords: e-module; inquiry; local potential; plant diversity; science literacy

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Introduction

Plant diversity, especially at the species level, is important to study. Plant morphology studies the structure and organization of the plant body consisting of roots, stems, leaves, and flowers (Rutishauser, 2020; Woudenberg et al., 2022). Based on the need assessment conducted by researchers to Tadris Biology college students at one of the universities in Indonesia stated that the material of plant diversity at the species level and plant morphology is difficult to understand. Supported by research that has been conducted by Sari (2017) obtained the results that there was a misconception of plant morphological structures in 43% biology education college students. In addition, research conducted by Sari (2023) The results showed that college students had misconceptions about species-level biodiversity. It is important to conduct research on species-level plant diversity and plant morphology because if left unchecked it will create misconceptions in the material. Factors causing the difficulty of this material are the absence of local potential empowerment discussing species-level plant diversity in terms of plant morphology directly that can support improving science literacy skills, teaching materials that are less supportive of improving science literacy skills, and the learning model used is monotonous.

Montel Muria Waterfall, Kudus, Central Java Province is one of the local potentials that become a tourist attraction. In addition to being a tourist attraction that is visited by many tourists, one interesting thing about the area is that it has biological potential that is rich in species-level plant diversity that has morphological characteristics, where various plant species are found. The potential of species-level plant diversity in terms of plant morphology in the Montel Muria Kudus Waterfall should be able to support improving science literacy skills, but based on the observations of researchers, it shows that so far the learning of college students around Kudus has not empowered the potential of species-level plant

diversity in terms of plant morphology in the Montel Muria Kudus Waterfall area. Empowering the potential of species-level plant diversity in terms of plant morphology can basically be used to support the improvement of college student science literacy. Based on the need assessment conducted by researchers, the results of lecturers at one of the universities in Indonesia stated that the potential of plant diversity in Montel Muria Kudus Waterfall can improve college students' scientific literacy, but there is a problem that there is not enough time to use this local potential as teaching material for biology learning, especially in diversity material in terms of plant morphology.

Science literacy is the ability that must be possessed by college students to explain, describe, and predict phenomena that occur in nature and find solutions to problems with various learning activities that must be owned to be applied to their lives (Norambuena-Meléndez et al., 2023; Walker, 2020). The scientific competence measured in science literacy in this study is first, identifying scientific issues (problems) with the following indicators: College students identify valid scientific opinions about the material studied (Istyadji & Sauqina, 2023; Sugiarti et al., 2021). Second, explaining scientific phenomena with the following indicators: Conduct effective literature searches on the material studied, understand the elements of research design on the material studied, solve problems on the material studied, college students can understand and interpret the results of the investigation (Popova & Jones, 2021). Third, using scientific evidence with the following indicators: Make inferences, predictions, and conclusions based on the results of the investigation (Adnan et al., 2021). In the 21st century, science literacy skills must be possessed by college students to carry out all activities, and college students are expected to have high science literacy (Glaze, 2018).

However, in reality, not all college students have high science literacy. Based on the results of the need assessment conducted by researchers on Tadris Biology college students at one of the universities in Indonesia, the results of college students need to improve science literacy. Supported by research conducted by Wibowo (2019), Biology Education college students at one of the universities in Indonesia obtained science literacy in the low category. the factors causing low science literacy are due to teaching materials that are less supportive for improving science literacy and the learning model used is monotonous. From these factors it is important to make alternative development of teaching materials with learning models that are not monotonous to improve science literacy (Fikri & Rahmaniyyah, 2023).

Teaching material is a material that is one of the important factors in the effectiveness of learning at the Higher Education level which contains material, both from the cognitive (knowledge), psychomotor (skills), and affective (attitudes) aspects that college students must achieve according to certain learning outcomes (Castro & Tumibay, 2021). Teaching materials have a function as a source of information, a means of learning, and a means of practicing to master the learning program from lectures (Puspitarini, 2019). Teaching materials are an important part that provides information needed by lecturers and college students (Dakhi et al., 2020). It is important to create innovative interactive teaching materials to make it easier for college students to master concepts and improve science literacy (Sari et al., 2022).

In this study, the type of teaching material developed is in the form of an e-module. E-modules are called electronic digital teaching materials because they can be accessed using computers and smartphones so that they can be accessed whenever needed (Song et al., 2021). In addition, e-modules are also one of the interactive teaching materials that contain text, audio, and video to make learning active (Liu & Amelia, 2024; Thirraja et al., 2023). The advantages of e-modules are more practical, cheaper production costs, long e-module durability, and not weathered by time. Based on the need assessment conducted by researchers on Tadris Biology college students at one of the universities in Indonesia, there is still a need for interactive teaching materials innovation, because the teaching materials used still tend to be papers, power points, and rarely integrate teaching materials. Based on the need assessment conducted by researchers on Tadris Biology college students at one of the universities in Indonesia, it is stated that there is still a need for innovative interactive teaching materials, because the teaching materials used still tend to be papers, power points, and rarely integrate teaching materials with local potential around to improve science literacy by selecting the right model in learning.

The inquiry model is a model that provides broad opportunities for college students to investigate problems and phenomena of interest to them (Bogar, 2019; Herranen & Aksela, 2019; Khalaf & Zin, 2018; Orozco et al., 2023). The inquiry model relates to science literacy. In the context of species-level plant diversity, the inquiry model can help college students to improve science literacy by understanding plant morphology by directly observing and measuring by investigating the physical characteristics of the structure of leaves, roots, flowers, and stems. Thus, college students can understand how plant morphology is different. Supported by several previous studies, the application of the inquiry model can improve students' scientific literacy skills (Hastuti et al., 2019; Wen et al., 2020).

Several previous studies have developed modules to improve college students' scientific literacy. Some of the modules developed have utilized an ethnoscience approach (Pitri & Diliarosta, 2023; Syaifullah & Diliarosta, 2023). Other studies have also developed modules that are not only aimed at improving scientific literacy, but also problem-solving skills (Annisa, 2022). In addition, there are also modules in previous studies that have also been developed into interactive modules (Irwansyah et al., 2017). However, of the various modules, not too many modules utilize the diversity of plants in the surrounding area, especially in the Kudus area.

Based on the need assessment and literature review conducted by the researcher, the solution carried out by the researcher is to develop an e-module inquiry model on species-level plant diversity in terms of plant morphology in Montel Muria Kudus Waterfall to improve college student science literacy, as a solution to solving the problem of not knowing the potential of species-level plant diversity in Montel Muria Kudus Waterfall, college students' science literacy is low, teaching materials do not support the improvement of science literacy skills, the learning model seems monotonous, the material of species-level plant diversity in terms of plant morphology is difficult to understand, and there is not enough time to use local potential directly as teaching material on plant diversity material in terms of plant morphology. The uniqueness of this research is to integrate the local potential of Montel Muria Kudus Waterfall. The novelty of this research is to create an e-module that designs college students to directly investigate the physical characteristics of the structure of leaves, roots, flowers, and stems. Because the purpose of the research is to analyze the potential of species-level plant diversity in Montel Muria Kudus Waterfall, develop e-modules integrating local potential, and preserve the local potential of Montel Muria Kudus Waterfall.

Method

Research and Development (R&D) research type. This research uses the 4D model, namely define, design, develop, and disseminate (Thiagarajan et al., 1974). The stages of the 4D model carried out by researchers is presented in Table 1.

Table 1. 4D research stages

Stages	Description	Analysis	Instrument
Define	Determine development requirements or needs analysis	a. Front end analysis	a. Interviews and need assessment questionnaires about the problems that occur in the learning process.
		b. College student analysis	b. Interviews and need assessment questionnaires about college student characteristics during the learning process.
		c. Curriculum analysis	c. Study program curriculum, ecology course RPS, Pancasila profile, graduate learning outcomes, and learning objectives.
		d. Concept analysis	d. Study program curriculum, ecology course RPS, teaching materials, and learning resources.
		e. Formulation of objectives	e. Indicators of plant diversity sub-materials.
Design	Make a design	Analyzing the initial design	Draft e-module product development grids, draft validation sheet instruments, draft product practicality instruments, draft college student science literacy instruments.
Develop	Make products and test the feasibility of product development results	a. Product development	a. Draft I e-module product
		b. Media and material expert validation and revision	b. Draft II e-module product
		c. Test run	c. Draft III e-module product
Disseminate	Distribute teaching materials	Providing teaching materials to universities and drafting articles	E-modules and articles

In Table 1, at the Define stage, researchers first conducted a front-end analysis through the distribution of interviews to lecturers and the provision of college student need assessment questionnaires about core problems during the learning process. Second, researchers conducted college student analysis through the distribution of interviews to lecturers and the provision of college student need assessment questionnaires about college student characteristics during the learning process to obtain a representation of college student characteristics, especially at the level of background, skills, cognitive development, background experience, science literacy in each individual, and others. Third, researchers conducted a curriculum analysis through analyzing the independent curriculum used by the study

program, analyzing the RPS of the ecology course on the sub-chapter of plant diversity material, Pancasila profile, graduate learning outcomes, learning objectives. Fourth, researchers analyzed concepts according to the independent curriculum, analyzed learning resource materials and identified learning resources by looking at the RPS of the ecology course in the sub-chapter of plant diversity material that supports the development of e-modules. Fifth, researchers formulate learning objectives through the elaboration of basic competencies more specifically in indicators according to the results of needs analysis, initial material, and observation of learning implementation.

The next stage is design, which is the product planning stage. Researchers designed, draft e-module product grids, draft validation sheet instruments, draft product practicality, and draft college student science literacy instruments. After that, the develop stage was continued, in which at this stage the product development of draft I e-module and validation by media and material experts to test the validity and produce the validity of draft II e-module products. The validity and validity of the product is determined based on the validation score and assessment of lecturers and college students with a Likert scale of 4 (strongly agree), 3 (agree), 2 (disagree), 1 (strongly disagree).

After the items are scored by the expert, the percentage is then sought using the validity formula presented in Formula 1. The formula is based on Sugiyono (2016). Based on the validity value that has been obtained, valid criteria are determined as stipulated in Table 2.

$$\text{Percentage Formula} = \frac{\Sigma\ Item\ Score\ given\ by\ the\ validator}{\Sigma\ Maximum\ score}\ x\ 100\% \quad (1)$$

Table 2. Validity categories

Score	Categoy
81%-100%	Very valid
61%-80%	Valid
41%-60%	Moderately valid
21%-40%	Less valid
0%-20%	Not valid

From the results of the validation of material and media experts, if there are suggestions for improvement, revisions are made and produce draft III which is ready for testing to the experimental class of Tadris Biology college students at one of the universities in Indonesia, the research subjects were 30 college students who had received plant diversity material, collecting research data with random sampling techniques in ecology subjects. After obtaining the data, the data processing was analyzed using Sugiyono (2016) practicality percentage formula presented in Formula 2 and categorized based on Table 3.

$$\text{Practicality Score Formula} = \frac{Item\ score\ obtained)}{\Sigma\ Maximum\ score}\ \text{x}\ 100\% \quad (2)$$

Table 3. Category of practicality

Score	Categoy
81%-100%	Very practical
61%-80%	Practical
41%-60%	Practical enough
21%-40%	Less practical
0%-20%	Not practical

To find out the effectiveness of e-modules in improving college students' sanist literacy, it can be calculated using the N-Gain formula and the criteria that presented in Formula 3 and Table 4. Both formula (3) and Table 4 are based on Wahab et al. (2021).

$$\text{N-Gain} = \frac{posttest\ score - pretest\ score}{Ideal\ score - pretest\ score} \quad (3)$$

Table 4. N-Gain value

Score	Categoy
<40	Not effective
40-55	Less effective
56-75	Moderately effective
>76	Effective

Besides being analyzed using N-Gain, it continued to measure the level of scientific literacy with the Formula 4 (based on Chasanah et al. (2022)) and Table 5 (based on Novitasari (2018)).

$$\text{Science Literacy Formula} = \frac{Earned\ score}{\Sigma\ Maximum\ score} \times 100 \quad (4)$$

Table 5. Science literacy criteria

Interval	Categories
85-100	Very good
70-84	Good
55-69	Good enough
50-54	Deficient
0-49	Very poor

After the development product is said to be valid, practical, and effective in use, the product then continues the disseminate stage by distributing the e-module products that have been developed to universities and publicized to journals.

Results and Discussion

Based on the research conducted, the results in Montel Muria Kudus Waterfall found biological potential rich in species-level plant diversity in terms of morphological characteristics, where a variety of plant species were found, both in the form of ferns, epiphytes, shrubs, herbs, shrubs, and trees. Species-level plant diversity data are presented in Table 6.

Table 6. Species-level plant diversity data from morphological aspects in Montel Muria Waterfall Kudus

Category	Plant Name	Morphology			
		Roots	Stem	Leaves	Flower
Fern	*Adiantum raddianum* (suplir spike)	Fibrous roots	Round	Round wavy	-
	Asplenium nidus (nest spike)	Rhizoma root	Round	Oblong and obovate	-
	Thelypteri palustris (swamp fern)	Fibrous roots	Round	Elongated	-
	Pteris vittata (Chinese brake fern)	Fibrous roots	Round	Elongated	-
Epiphyte	*Hoya diversifolia* (Hoya flower)	Fibrous roots	Round	Egg-shaped	Star
	Piper betle (betel nut)	Taproot	Round	Heart	-
	Aglaomorpha corons (basket fern)	Rhizome root	Round	Aisle	-
	Medinilla speciose (parijotho)	Fibrous roots	Round	Oval	Round
Bushe	*Ageratum conyzoides* L. (bandotan)	Fibrous roots	Round	Egg-shaped	Flat panicle
	Synedrella nodiflora L. (Jotang kuda)	Taproot	Round	Oval	Flat panicle
	Eclipta alba L. (urang aring)	Fibrous roots	Round	Ovoid	Discs
	Acalypha indica (cat galak)	Fibrous roots	Round	Heart	Grain
	Euphorbia hirta (Petikan kebo)	Taproot	Round	Ovate	Umbrella
	Clidemia hirta (senduduk bulu/herendong),	Taproot	Round	Elongated ovoid	Fan
	Mimosa pudica (putri malu)	Taproot	Round	Oval	Cob
	Cyanthillium cinereum (sky mustard)	Fibrous roots	Round	Ovate	Cob
	Tridax procumbens (gletang)	Taproot	Round	Ovate	disk
Herb	*Colocasia esculenta* L. (taro)	Fibrous roots	Round	Shield	Cob
	Alpinia galangal (galangal)	Fibrous roots	Round	Lanceolate	Bell

Category	Plant Name	Morphology			
		Roots	Stem	Leaves	Flower
	Clematis albicoma Wherry	Fibrous roots	Round	Sword	Fan
	Oxalis barrelieri L. (ground celicina)	Taproot	Round	Inverted heart	Trumpet
	Aglaonema crispum (sri rejeki)	Fibrous roots	Round	Elongated like a dagger	Oval round
	Ocimum sanctum L (basil)	Taproot	Round	Oval	Cob
	Impatiens balsamina (water girlfriend)	Taproot	Round	Lanceolate	Inverted trumpet
	Philodendron tenue	Fibrous roots	Round	Shield	Cob
	Camaecostus cuspidatus (cuspidatus plant)	Fibrous roots	Round	Oval	Round
	Musa paradisiaca (banana)	Fibrous roots	Round	Elongated	Cobs
Shrub	*Bauhinia purpurea* (Tayuman)	Taproot	Cylindrical	Shield	Butterfly
	Syzygium aqueum (water guava)	Taproot	Round	Ovoid	Funnel
	Ficus septica (awar-awar)	Fibrous roots	Round	Aisle	Syconium
	Coffea sp. (muria coffee)	Taproot	Round	Aisle	Anthela
	Citrus sinensis (grapefruit)	Taproot	Round	Oval	Circular oval
	Annona muricata L (soursop)	Taproot	Round	Elongated	cup
	Muntingia calabura L (kersen)	Taproot	Round	Lanceolate	Cup
	Codiaeum variegatum (golden rain croton)	Fibrous roots	Round	Lanceolate	-
Tree		Taproot	Round	Ovoid	Fan
	Moringa oleifera L (moringa tree)	Taproot	Round	Oval	Saucer
	L. parasiticum (langsat tree)	Taproot	Round	Oval	Panicle
	Paraserioanthes falcataria L. Nielsen (sengon tree)	Taproot	Round	Ovoid	Stump
	P. Speciosa (petai tree)	Taproot	Round	Ellipse	Compound umbrella
	Tectona grandis Linn. f. (teak tree)	Taproot	Round	Oval	Compound umbrella
	Mangifera indica (manga tree)	Fibrous roots	Round	Lanceolate	-
	Bambusa vulgaris Schrad (bambo tree)	Taproot	Round	Oval	Grain
	Artocarpus heteruphyllus (jackfruit tree)	Taproot	Round	Lanceolate	Umbrella
	Monoon longifolium (glodokan tiang)	Fibrous roots	Round	Elongated	Cob

Based on the results in Table 6, plant species with the most morphological characteristics found are tree and herb as many as 10 plants. Bushe as many as 9 plants, and the least found is fern and epiphyte as many as 4 plants. This is the uniqueness of Montel Muria Kudus Waterfall, which is usually found in many waterfalls with fern species. However, in Montel Muria Kudus Waterfall, tree and herb are the most commonly found, this is because Montel Muria Kudus Waterfall is located at the foot of Mount Muria Kudus. So that the most plant species found are tree and herb. Furthermore, 4D model procedure was

conducted.

At the define stage the researcher obtained the results, first, front end analysis: College students have difficulty learning species-level plant diversity material in terms of plant morphology, low college student science literacy, and unknown potential species-level plant diversity in Montel Muria Kudus Waterfall. Second, college student analysis: College students often chat during learning, teaching materials that are often used ppt and papers that do not support science literacy. Third, curriculum analysis: SLOs of species-level plant diversity and plant morphology based on the independent curriculum. Fourth, concept analysis: Plant diversity material sub-species of ferns, epiphytes, shrubs, herbs, shrubs, and trees with root, leaf, stem, and flower morphology explained. Fifth, formulation of objectives: increase knowledge of species-level plant diversity and its morphology in the surrounding environment, improve science literacy by investigating species-level plant diversity in the surrounding environment.

At the design stage, the results of the design of the draft inquiry model e-module grids, draft validation sheet instruments, draft product practicality instruments, and draft college student science literacy instruments.

At the develop stage, the results of making the first draft of the e-module product are presented in Figure 1. E-module form the results of making draft I e-module products whose opening part of the cover consists of the e-module title, topic or learning material, author, table of contents, glossary and introduction consisting of: Purpose, brief description of the material, rationalization and relevance, motivation, instructions for using e-modules. The content section consists of learning activities, material descriptions, summaries, exercise tasks, self-assessment. And the closing section consists of answer keys and scoring guidelines, bibliography, and consultation.

Figure 1. Sample part of the module that has been developed: (a) E-module cover image, (b) Image of e-module table of contents, (c) Image of e-module objectives, (d) Brief descriptive image of the e-module, (e) Image of rationalization and relevance of e-modules, and (f) Motivational images of e-modules

After the product is developed, it is continued with validation, on media expert validation with indicators: The use of media design variations is not excessive and interactive, the determination of the media colors used, the use of text, images in the media is proportional, the appearance of images and tasks in the media is in accordance with the content of the media, there are fun tasks, the layout and layout of the media display is consistent, the creativity of the media design, the media display is attractive, the media is easy to use, and the media makes it easier for college students to learn independently and actively (Jalil, 2021). In material experts with indicators: Actualization of material, quality of material content, depth of material, coverage of material, suitability of language, provision of learning editorials, accuracy of language, conciseness of material, clarity of objectives, relevance between aspects of learning (Jalil, 2021). The results of media and material expert validation are presented in Table 7.

Table 7. Media and Material Expert Validation Results

Validator	Percentage Result	Category
Media expert	95%	Very Valid
Material expert	91,66%	Very valid

Based on the results in Table 7, the value of the validation of media and material experts shows the category “Very valid”. Based on Sugiyono's category of products that get 81%-100% the product is said to be very valid. So, this teaching material is said to be very valid. From the results of validation based on there are suggestions for improvement. Table 8 and Table 9 present the suggestions from validator and revise results.

Table 8. Revision based on media validator suggestion

Suggestion	Revised version
	
The objectives in the learning section were deleted because they were already there at the beginning of the introduction section.	Revised objectives in the learning section removed.

Table 9. Revision based on material validator suggestion

Suggestion	Revised Version
	
The writing of the material on the betel classification not in white pointers.	Revision of material writing on betel classification not in white pointer.

Suggestion	Revised Version
	
The writing of material on moringa classification not in white pointers.	Revision of material writing on moringa classification not in white pointer.

After revising the draft II e-module, continued to test the draft III e-module to college students and lecturers. The results of the practicality assessment by lecturers with indicators: Presentation techniques, clarity of cpl and learning objectives, presentation of the front page of the e-module inquiry model, supporting material exposure, learning exposure, completeness of presentation, ease and consistency of navigation. no errors occur in the software, the quality of program use is good, the instructions for use are clear, the effectiveness of the use of e-module inquiry teaching materials, readability, compliance with Indonesian language rules, use of inquiry terms, and increasing science literacy. The practicality results is presented in Table 10.

Table 10. Practicality results

Validator	Percentage Result	Category
Lecturer	95.83%	Very practical

The results in Table 10. The practicality assessment from the lecturer shows the category “Very practical”, based on Sugiyono's category of products that get 81%-100% the product is said to be very practical. So, this teaching material is said to be very practical.

To see the science literacy of college students, N-Gain is calculated, the N-Gain value is seen in the Table 11. In the Table 11, the results of the pretest and posttest college students get an N-Gain value of 56.7338 in the moderately effective category. Because according to Wahab (2021) the percentage of N-Gain values of 56-75 is in the moderately effective category. So, this e-module is quite effective in improving science literacy.

Table 11. Average N-gain value

Pre test	Post test	Post-Pre	Ideal Score (100-Pre)	N-Gain Score	N-Gain Score (%)
55.3	81.4	26.1	44.7	0.567338	56.7338

Apart from being analyzed using the N-Gain value, there is an increase in college student science literacy from several indicators presented in the form of Figure 2. Figure 2 shows the results that after the e-module treatment the science literacy indicators have increased. X shows the results of the science literacy improvement score. Y shows the science literacy indicators achieved. The first indicator of college students can identify valid scientific opinions about species-level plant diversity in terms of morphology by 40% to 86%. The second indicator college students can conduct an effective literature search on species-level plant diversity in terms of morphology by 44% to 84%. The third indicator of college students understanding the elements of research design on species-level plant diversity in terms of morphology by 34% to 88%. The fourth indicator of college students can solve problems from the findings of plant morphological investigations directly by 45% to 80%. The fifth indicator college students can understand and interpret the results of direct plant morphology investigations by 33% to 83%. The sixth indicator college students can make inferences, predictions, and conclusions based on the results of direct investigation of plant morphology by 41% to 78%.

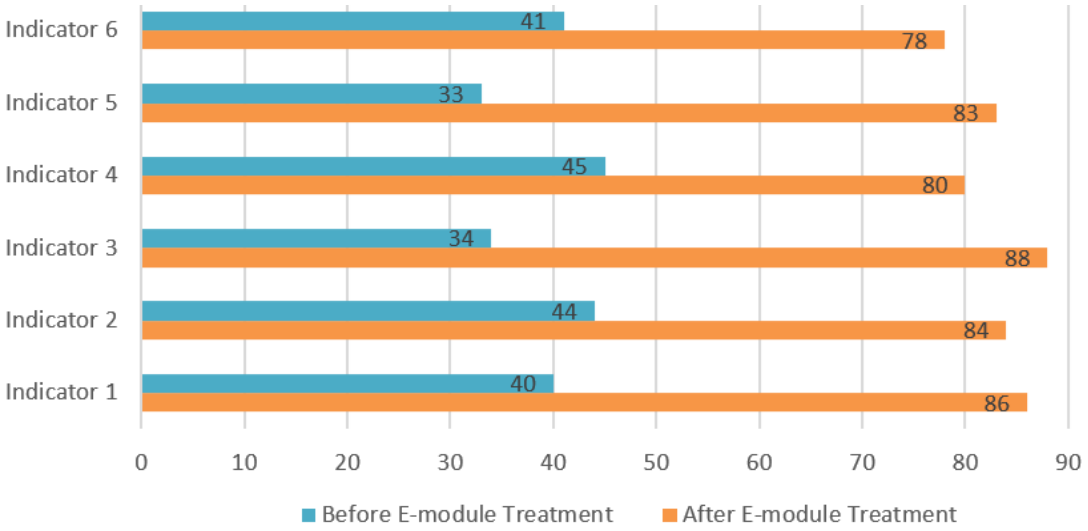

Figure 2. Results of college student science literacy improvement

Based on Figure 2. shows that after the application of e-modules there is an increase in the average ability of science literacy of 83.16% in the “Good” category, from these average results it can be said that e-modules can improve science literacy.

After that, the dissemination stage was conducted. The disseminate stage disseminates the development of e-modules by making articles published in journals related to the development of e-modules inquiry models on species-level plant diversity at Montel Muria Kudus Waterfall to improve college student science literacy.

The findings of this study are in line with several previous studies that also examined the influence of e-modules. In previous studies, modules that apply the socio-scientific issues approach are useful in improving college students' scientific literacy. Learning with these modules can encourage college students to engage with real-world problems, thereby improving their competence (Nadir et al., 2022). Other studies also report that the interactivity of modules can not only improve college students' knowledge aspects, but also their attitudes towards science (Holisoh et al., 2023). Furthermore, the incorporation of local wisdom or local context in e-modules also accommodates more relevant, interesting learning, and empowers scientific literacy (E. N. Sari et al., 2023).

The effectiveness of e-modules is also supported by other studies that report the impact of modules in reducing misconceptions. By linking learning content to the surrounding conditions, the existence of such modules can improve college students' literacy skills (Seprianto & Hasibuan, 2021). In line with that, modules packaged based on the Science, Technology, Engineering, and Mathematics (STEM) framework are also effective in encouraging a deeper understanding of scientific principles (Fayez & Saleh, 2023; Hutomo et al., 2022).

Moreover, as a consideration for further studies, the development of e-modules that implement certain learning models is also reported to be able to improve college students' scientific literacy more optimally. Several learning models that support the usefulness of modules in achieving college student literacy, for example problem-based learning and inquiry-based learning (Herlina & Abidin, 2024; Rahmawati et al., 2021). These learning models can encourage college students to actively participate and carry out inquiry activities. In addition, the integration of augmented reality technology in the developed modules is also recommended for further research. Modules that involve this technology will be able to enhance the learning experience by providing immersive and engaging educational environments (Emilya & Mufit, 2023).

Conclusion

The results of the investigation carried out by the researcher obtained the results in Montel Muria Kudus Waterfall found biological potential rich in species-level plant diversity in terms of morphological characteristics, where a variety of plant species were found, both in the form of ferns, epiphytes, shrubs, herbs, shrubs, and trees. The most commonly found plant species are tree and herb. This is the uniqueness of Montel Muria Kudus Waterfall, which is usually found in waterfalls with many species of ferns. However, in Montel Muria Kudus Waterfall, tree and herb are the most common, this is because Montel Muria Kudus Waterfall is located at the foot of Mount Muria Kudus. So that the most plant species

found are tree and herb.

The development of e-modules carried out by researchers obtained the results of media expert validation getting a score of 95% in the "Very valid" category. The material expert scored 91.66% in the "Very valid" category. In the practicality test, the lecturer received a score of 95.83% in the "Very practical" category. In the college student science literacy test, the score was 73.28% in the "Very practical" category. The results of college student pretest and posttest get an N-Gain value of 56.7738 in the moderately effective category and indicators of college student science literacy increase after the application of the e-module, namely an increase in the average ability of science literacy of 83.16% in the category "Good Then this e-module is effective in improving science literacy. From the assessment of experts, lecturers, college students, Sugiyono's percentage formula, and N-Gain value analysis, it was found that the development of e-module teaching materials for the inquiry model on species-level plant diversity in terms of plant morphology in Montel Muria Waterfall is valid, practical, effective in increasing college student science literacy, and preserving the local potential of Montel Muria Waterfall.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

V. Zuslia: composing the first draft in preparation, methodology and analyzed data, **A.W. Subiantoro:** review paper, editing and approval of the final version of the manuscript.

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