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Banana Diversity E-module for Contextual Learning in High School Education

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ABSTRACT

This research aims to develop an e-module with banana diversity in Serang City, Banten, as its content to be used as an alternative learning resource for high school students. The research method used is the research and development (R&D) method. Data on various banana types in Serang were systematically collected and identified through surveys conducted across both traditional and modern markets. The resulting e-module underwent rigorous validation diversity and education technology experts, achieving high feasibility scores of 96.67% and 88.55%, both values classified as a very decent category. Subsequently, a limited trial was conducted with 32 tenth-grade science students at SMAN 8 Serang, where the e-module was used to teach the biodiversity topic. Student responses analysis yielded a score of 82.1%, which falls in the appropriate category. Overall, this study successfully provided a contextual learning medium that utilizes local biodiversity as relevant content, proving the e-module's utility in high school biology classes. Moreover, the e-module is particularly suitable for showcasing local biodiversity, thereby enriching students' understanding of Indonesian biodiversity as a whole. E-module can change the way students learn about biodiversity to be more relevant, interactive, and based on local potential.

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Introduction

Biodiversity represents the richness of life on earth, encompassing organisms ranging from microorganisms to higher plants and animals. It plays a pivotal role in national development, serving as a vital biological resource, a genetic reservoir for breeding programs, and a fundamental element in food security systems. Indonesia, recognized as one of the world's mega-biodiversity centers, provides a unique opportunity for the exploration and utilization of its diverse genetic resources [1]. With its archipelagic geography, Indonesia harbors an exceptional variety of flora, fauna, and microorganisms that support ecological balance and socio-economic development.

Bananas (*Musa* spp.) are one of the most significant commodities within Indonesia's biodiversity. According to the Food and Agriculture Organization (FAO), Indonesia ranks among the world's leading banana producers, alongside India, China, and Brazil. Several cultivars are widely cultivated, including Cavendish, Barangan, Ambon, Raja Sereh, Mas, and Muli for fresh consumption, and Kepok, Tanduk, and Raja Nangka for cooking [2]. In the community, banana plants are used as an ethnobotanical with economic value as a basic ingredient for making traditional foods, cultural practices, and agriculture, such as making compost [3]–[4]. In Banten Province, particularly in Serang and Pandeglang, banana cultivation contributes substantially to local agricultural output [5]–[6]. However, challenges such as Fusarium wilt disease threaten the sustainability and productivity of these crops [7].

Previous studies have highlighted the diversity of bananas in Pandeglang and assessed threats to their cultivation [8]–[9]. Banana plantations in Serang are across Cilowong and Dalung, as well as horticultural agricultural areas in Curug District and Taktakan District [10]. Bananas have diverse potential, making them attractive as a learning medium in schools. This is in line with research [11] that students utilize bananas in the Yogyakarta City germplasm garden to make banana yogurt while studying biotechnology material. In addition, banana peel waste can be used as a contextual experiment-based learning medium in the manufacture of environmentally friendly biobatteries [12]. Based on the results of a needs analysis in the form of a questionnaire conducted with biology teachers and students in Serang City, the learning media frequently used in schools are Student Worksheets (SW) and textbooks in printed form. The use of these learning media is not optimal, this is because printed learning media tends to be thick and contain a lot of writing. Therefore, interesting and varied learning media are needed to keep up with the times. Electronic media is one of the learning media that is in line with technological advances. Various types of electronic media have been developed to be used to attract students' attention and make it easier to deliver biology materials, including the development of websites about biodiversity, the development of Augmented Reality (AR) for three-dimensional visualization of plant structures, and the development of socio-scientific e-

modules on issues in the circulatory system to improve literacy and reasoning skills [13]–[15]. Nevertheless, limited research has explored integrating this rich local banana diversity into educational resources, particularly in Serang, where traditional and modern markets provide rich sources of genetic variation. Considering the increasing emphasis on contextual learning in contemporary education, this gap presents a clear opportunity to utilize banana diversity as a medium for teaching biodiversity. The novelty of this study lies in the development of a contextual e-module that incorporates local banana diversity as a learning resource for high school learning resource. Unlike conventional printed textbooks, which are often bulky and less engaging, e-modules offer interactive, flexible, and student-centered approaches that align with 21st-century education demands. Therefore, the objective of this research was twofold:

- to survey and document the diversity of banana cultivars in Serang, and
- to develop and validate a contextual e-module based on this diversity as an alternative learning resource for high school students.

This study not only contributes to the conservation and documentation of local biodiversity but also provides an innovative model for integrating local potential directly into science education.

Material and Methods

The research methodology consists of two main parts: first, a survey to document the diversity of banana varieties in Serang, and second, using the collected diversity data to develop an e-module to be used as a contextual learning source for high school students. The survey was carried out in traditional and modern markets in Serang, Banten. Banana varieties are identified based on their fruit morphological characteristics and information obtained from sellers [16].

The banana diversity e-module was developed following the research and development (R&D) method with Sugiyono's research and development design. The research stages include identifying potential problems, data collection, product design, design validation, design revision, product testing, product revision, usage trials, product revisions, and mass production [17]. However, the research was only conducted up to the limited product trial stage, so the next stage is needed, namely, determining the effectiveness of the electronic module learning media. This design was chosen because each step is systematic and oriented towards practical products in accordance with the development of educational media.

The e-module was sent to three experts in IT and learning media, bananas, and teaching for validation [18]. The final e-module was then pilot-tested on 32 students in 10th grade at SMAN 8 Serang. The selection of the school used a purposive sampling technique, because the school is located close to the traditional banana market center, and the 10th-grade students are studying biodiversity material.

A. Data Collection Technique

The data collection techniques used in this study included questionnaires, interviews, observations, literature reviews, and documentation.

1. Questionnaires were used to identify obstacles in the biology learning process and media that meet the needs of teachers and students. Questionnaires were used to test the feasibility of the e-module development research and were administered to material and media experts. In addition, questionnaires were also used to assess student responses regarding the quality of the e-module. Participants responded to a four-point Likert scale: strongly disagree, disagree, agree, and strongly agree [19]. Data collected from the questionnaire were analyzed descriptively.
2. Interviews were conducted with banana traders in traditional and modern markets.
3. Observations were conducted to confirm the accuracy of various statements obtained during the interviews and to enrich the data and information related to banana diversity in Serang City.
4. Literature reviews were used to identify banana data obtained from informants.
5. Documentation was used to record data on bananas in Serang City and student responses during the e-module response test.

B. Data Processing Techniques

The data obtained in this study were processed through several systematic stages. First, the collected data were analyzed descriptively to provide a general overview of the research findings. Second, the feasibility scores of the developed e-module provided by experts were processed by converting them into percentage values for each assessment aspect. This step aimed to determine the level of feasibility of the media based on expert evaluations. Third, the average score for each assessment criterion was calculated using the data obtained from both media experts and student response tests. Afterward, the resulting average scores were converted into percentage values to facilitate the interpretation of the expert assessments and student responses. The interpretation criteria for the expert feasibility test were then determined according to the eligibility score categories presented in Table 1. Meanwhile, the scoring criteria used to measure student responses to the developed e-module followed the Likert scale categories from 1 (Strongly Disagree) to 4 (Strongly Agree).

Table 1. Criteria for Interpretation of Eligibility Scores

Percentage of achievement (%)	Interpretation
81% - 100 %	Very Decent
61% - 80%	Decent
41% - 60 %	Quite Decent
21% - 40 %	Less Decent
0% - 20 %	Not Decent

Results and Discussions

A total of traditional and modern markets in Serang were surveyed. The traditional markets included Kalodran Market, Tamansari Market, Lama Market, Rau Market, Karangantu Market, and Royal Market, while modern markets were Hypermart, Transmart, Lottemart, and Robinson. Generally, the types of bananas found in the traditional markets were similar, with only slight variations (Table 2). Notably, the traditional markets featured greater banana diversity compared to the modern ones. The bananas sold in traditional markets typically originate from the areas surrounding Serang and Lampung. In 2020, the Serang Badan Pusat Statistik (BPS) recorded that banana production in Serang reached 1,692.7 tons. This number represents the highest output compared to other types of fruit in Serang. The community manages a vast agricultural area of approximately 47.5 thousand hectares [5]. Local bananas from plantations and agriculture in Serang and its surroundings are primarily used for local consumption and market supply. Varieties such as Ketan, Nangka, and Tanduk are the most popular banana varieties from Kabupaten Serang and are sold both locally in the surrounding area and in nearby districts like Pandeglang [6].

Cavendish bananas have advantages for banana farmers due to the high market demand for Cavendish bananas for consumption from the lower middle class to the upper middle class [20]. Cavendish bananas are widely exported because the fruit is small, has clean yellow skin, is easy to eat, has a soft texture, and has excellent nutrition [21].

Table 2. Traditional and modern supermarkets, banana varieties, and GPS location

No.	Market Name	∑ varieties	Banana Varieties	GPS Location
1.	Kalodran	9	Tanduk, Muli, Kepok Saba, Raja Tanglun, Lebu, Kepok, Ambon, Ketan, Nangka.	6°7’22”106°13’8”S
2.	Tamansari	12	Kepok, Muli, Raja Tanglun, Merah, Ketan, Mas, Raja Sereh banana, Ambon, Tanduk, Masak Ijo, Susu, Nangka.	6°6’52”106°9’32”N
3.	Pasar Lama	8	Tanduk, Ambon, Raja Sereh, Ketan, Muli, Raja Bulu, Nangka, Lebu.	6°6’37”106°9’17”N
4.	Rau	7	Ambon, Muli, Kepok, Raja Sereh, Ketan, Nangka, Tanduk.	6°6’30”106°10’10”S
5.	Karangantu	7	Muli, Raja Bulu, Lebu, Nangka, Ambon, Ketan, Kepok.	6°2’13”106°9’45”N
6.	Royal	4	Tanduk, Kepok, Muli, Ketan.	6°6’50”106°9’29”N
7.	Hypermart	1	Cavendish	6°7’6”106°10’58”W
8.	Transmart	1	Cavendish	6°7’17”106°10’20”N
9.	Lottemart	1	Cavendish	6°6’37”106°8’36”SW
10.	Robinson	1	Cavendish	6°7’0”106°9’12”SW

A total of 16 types of bananas were identified across all survey locations (Fig. 1). Variations observed among bananas within one type are an example of gene diversity [22]. Species-level diversity refers to the variation that occurs at the individual level due to the

influence of the diverse genes that form an individual's genotype [23]. The various types of bananas identified within the same family in the Serang Market are highly relevant and can be effectively used as learning content for biodiversity at the species level.



Fig. 1. Sixteen banana varieties in the Serang: (a) Pisang Nangka, (b) P. Saba, (c) Raja Nangka, (d) Muli, (e) Tanduk, (f) Ambon, (g) Kepok, (h) Lebu, (i) Ketan, (j) Masak Ijo, (k) Udang, (l) Mas, (m) Cavendish, (n) Raja Sereh, (o) Raja Bulu, (p) Susu.

Table 4. Diversity of bananas sold in traditional and modern supermarkets

No.	Local Name (Serang)	Popular Name	Scientific name/genome
1.	Nangka	Nangka	*Musa* AAB 'Nangka'
2.	Kepok Saba	Kepok	*Musa* ABB 'Kepok Besar'
3.	Raja Tanglun	Raja Nangka	*Musa* AAB 'Nangka'
4.	Muli	Mas Muli	*Musa* AA 'Muli'
5.	Tanduk	Tanduk	*Musa* AAB 'Tanduk'
6.	Ambon	Ambon	*Musa* AAA 'Ambon'
7.	Apu	Lebu	*Musa* ABB 'Siem'
8.	Uli	Ketan	*Musa* AA 'Uli'
9.	Kepok	Kepok	*Musa* ABB 'Kepok'
10.	Masak Ijo	NA	NA
11.	Udang	Merah	*Musa* AAA 'Merah'
12.	Mas	Mas	*Musa* AA 'Mas'
13.	Susu	Madu	*Musa* AA 'Madu'
14.	Raja Bulu	Raja	*Musa* AAB 'Raja Bulu'
15.	Raja Sereh	Raja Sereh	*Musa* AAB 'Raja Sereh'
16.	Sunpride	Cavendish	*Musa* AAA 'Cavendish'

The most numerous type of bananas identified were the Raja Bananas, specifically Raja Bulu, Raja Sereh, and Raja Nangka (Fig. 2). These three cultivars share the same AAB genome

composition, meaning they possess two sets of chromosomes originating from *Musa acuminata* and one from *Musa balbisiana* [16]. Despite their shared genetic background, the three types of Raja Banana exhibit distinct differences in their morphology and taste.

The Raja Bulu banana has a straight fruit morphology, with a blunt tip, measuring approximately 12 cm in length. It is seedless, with bright yellow skin when ripe and light-yellow flesh. Raja Sereh fruit is straight at the distal end with a rounded tip, measuring $13.5 ± 0.87$ cm long. It is also seedless, featuring dark orange-yellow skin and cream or light yellow-orange flesh when ripe. Finally, the Raja Nangka banana is straight at the distal end with a pointed tip, measuring $18.3 ± 0.8$ cm long. It is seedless, and both its skin and flesh are light yellow when ripe [16]. In general, ripe plantains have a sweet taste with a strong aroma [24].



Fig. 2. Gene level diversity: Raja Bulu (a), Raja Sereh (b), Raja Nangka (c)

An e-module based on contextual learning with banana diversity as its content could serve as an alternative learning resource for high school students. The e-module was systematically developed using six procedures: Possibilities, data collection, product design, design validation, design revision, and product testing.

The first procedure involved identifying the potential and the problem. Students frequently use electronic media, such as smartphones, to find information during biology lessons. However, it was found that not all teachers use innovative teaching materials, including e-modules. Consequently, students often become bored and passive, which results in difficulty understanding biological material, especially biodiversity material, because this material has many concepts and is very complex. A needs analysis was conducted in three schools: SMAN 5 Serang, SMAN 6 Serang, and SMAN 8 Serang. Data shows that biodiversity material is complex according to 41% of students; 32% consider it moderate, and the remaining 27% consider it easy. Students cited several reasons why biodiversity material is complex: the printed teaching materials used (59%), less innovative learning resources (32%), and too much learning material (9%). Too much learning material creates difficulties that affect students' understanding of the learning material. Students have difficulty with terms from the meaning of class-order-family-genus-species. Students need help remembering and memorizing the scientific names and Latin language of living things [25]. One way to help students make it easier to understand biodiversity material is to use appropriate learning

resources.

The second procedure was data collection. This involved a literature study to collect and examine references related to the learning resources being developed. Data collection is carried out to support the development of e-modules. The data collection stage includes curriculum analysis and macro and microstructure. Curriculum analysis is carried out after conducting a needs analysis. This step ensures that the learning media created can help students achieve the specified competencies [26]. The e-module emerged as the most preferred learning resource among students, chosen by 52% of respondents. E-modules are valued as teaching materials because they facilitate independent learning and use communicative, two-way language, which simplifies the learning process. E-modules are teaching materials arranged systematically so that they can present the material coherently [27]. The e-module also contains material and practice questions that make it easier for students to learn the subject matter. E-modules can display text, images, animations, and videos via the Android system, which students currently use. This is in line with research [28] that in multimedia design principles, material should be presented with appropriate images and videos. Using e-modules allows students to learn by reading texts and seeing animations, and even get simulations in the form of processes that resemble actual events to increase students' understanding. Developing e-modules based on contextual learning can help students understand biodiversity material because it is closely related to students' daily (real) lives. Teaching materials are one of the important components that support learning activities to achieve learning goals, and are meaningful if they are linked to real-life contexts and utilize local potential in the surrounding environment [29].

The third procedure focused on product design. The developed E-module contains the results of banana diversity exploration in the Serang market, which is adapted to the curriculum and implemented through context-based learning. This is in line with research [30] that in developing e-modules, they must be adapted to the curriculum, and material must be collected from various sources to be combined into one relevant concept. The e-module's structure is comprehensive, including a cover, table of contents, introduction, instructions for use, essential competencies, and indicators of competency achievement, lesson 1 (concept of biodiversity), summary, practice questions, self-assessment, lesson 2 (efforts to preserve biodiversity and banana diversity in Serang market), practical activities, glossary, bibliography, and conclusion. The e-module was created using the Flip PDF Professional application, which is accessible to both teachers and students via smartphones or laptops. In the e-module, there are practice questions whose results can be seen by students, and the teacher checks their scores. Apart from that, some videos can be played directly on the available display. The video is connected to the YouTube application. This e-module is

contextually based and contains contextual components, namely constructivism, discovery, questioning, learning communities, modeling, reflection, and concrete assessment, presented systematically, accompanied by images and facts. The e-module also contains activities and practical work, as well as self-assessment, so students can measure their understanding of biodiversity material. This module can be used as an additional reference for students studying biology, particularly biodiversity material.

The fourth and fifth procedures, product validation and revision, involved assessing the contextual e-module using specific validation instruments. Validation was conducted by two specialized groups: material experts and media experts. The material expert validation was performed by a researcher specializing in tetraploidy-induced bananas and crosses between cultivated, wild, and tetraploid bananas resulting from tetraploidy induction to obtain Fusarium wilt-resistant bananas. This validation used a specific e-module validation questionnaire. The media experts validationwas carried out by lecturers at the Department of Biology Education, Faculty of Teacher Training and Education, Universitas Sultan Ageng Tirtayasa.

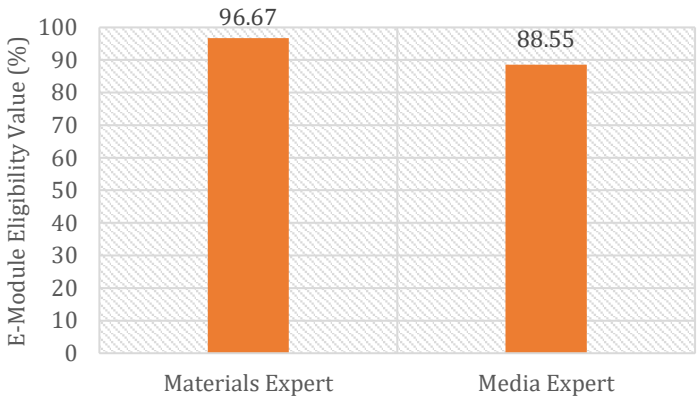


Fig. 3. Expert validation results

The banana diversity E-Module validation value in Serang for material experts was 96.67%, and the media expert's assessment was 88.55%, both of which were included in the very feasible category (Fig. 3). The material expert's assessment was higher than the media expert's because, based on their assessment, the e-module accommodated the appropriateness of the curriculum material, and its content supported students in achieving learning objectives. Furthermore, the e-module employed a contextual approach aligned with the material and students' experiences. The media expert's assessment still had unmet assessment indicators, including the flexibility component. This can have an impact on students' visual experience and reading conditions.

A. Material Expert Validation Results

Material validation assessed four components: curriculum, material suitability, language, and contextual approach. The overall assessment from the material experts received an

average score of 96.67%, including in the very appropriate category. The curriculum component achieved a perfect score of 100%, categorized as very appropriate; the material feasibility component scored 86.67%, also deemed very appropriate; the language component received a score of 100%, falling into the very appropriate category, and the contextual approach component scored 100%, included in the very feasible category (Fig. 4).

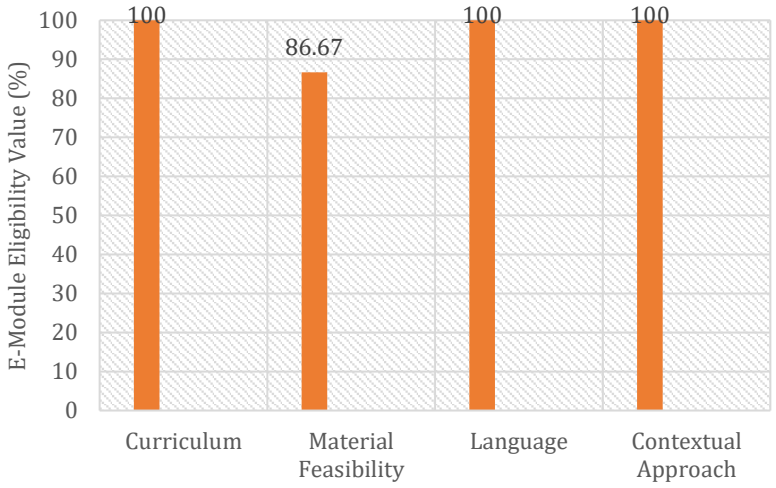


Fig. 4. Material expert component values

B. Media Expert Validation Results

Media validation consists of four assessment components that further substantiate the e-module's quality: display quality, writing quality, flexibility, evaluation, and content representation. See Fig. 5.

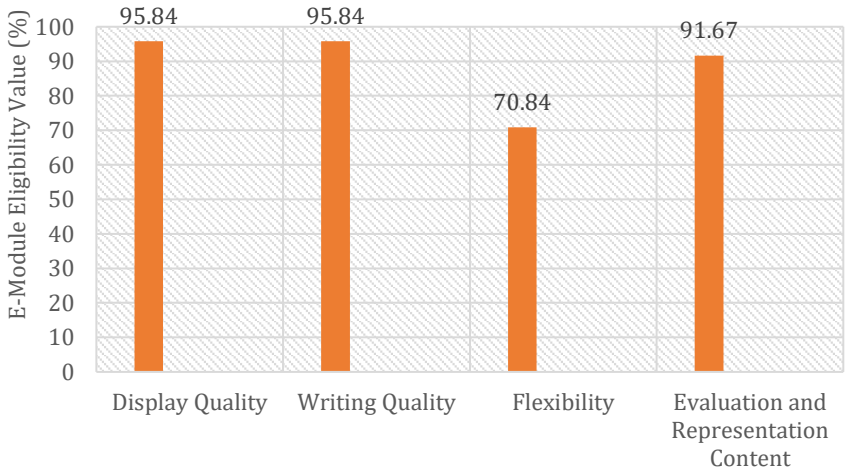


Fig. 5. Media expert component values

An overall average score obtained from media experts was 88.55%, categorized as very decent. The display quality component is included in the very decent category with a score of 95.84%; the writing quality component is included in the very decent category with a score of 95.84%; the content evaluation and representation component is included in the very feasible category with a score of 91.67%; and the flexibility component is included in the decent

category with a score of 70.84%. This flexibility value is only included in the decent category due to the inconsistency in the layout of the e-module instructions and their systematics, as well as the e-module display lacking animation (Fig. 5). This is in line with research [31] that the instructions for using biology learning modules should be improved to be clearer to make it easier for students to understand the operational steps for using the module.

In the appropriateness component of the material, the expert confirmed that the material presented had a depth of material that was appropriate for grade 10 students, increased students' insight, and the order of the material was appropriate. However, the material expert found an error in the definition, and there was an inappropriate image, both of which were subsequently corrected. The material experts suggest using appropriate local and popular names in the table of banana names in Serang and improving the use of scientific names. The local names referred to in the table are commonly used by the local people of Serang. In contrast, according to the KBBI, famous names are words known by many people in everyday life that are easy to understand and familiar.

As a follow-up to improvements according to comments or suggestions from material experts, the scientific names in the table of banana names were changed to cultivars, referring to Simmonds & Shepherd (1955). This nomenclature system used to classify banana cultivars is a two-part Latin name (the first part indicates the genus, and the second indicates the species). This system eliminates all taxonomic difficulties and inconsistencies based on *Musa paradisiaca* and *Musa sapientum*. This system also contributed to the continued use of the Latin binomial to refer to edible bananas.

On the media suitability component, media experts assessed overall that the navigation was appropriate, making it easier for users to use this e-module. Destination selection based on the menu was appropriate and functions well. Navigation is the most essential thing that must be tested for the accuracy of the buttons to go to each page on the e-module [32]. The navigation buttons on the e-module have been developed appropriately, so the e-module product is very suitable for use in the learning process. However, the experts offered several design critiques. In the display quality component, the expert assessed that using variations in bold and italic letters was inappropriate. This is because the researchers in developing the e-module were not precise in choosing the font type; the previous font type, namely Kristen ITC, was changed to Comic Sans MS. The title and subtitles in the e-module use the Christian ITC typeface, while the definitions and others use Comic Sans MS. This type of font is easy to read and attractive, thus increasing students' interest in reading. In the flexibility component, experts assess that the e-modules are arranged less systematically; this is related to layout consistency. The previous user instructions section is located after the revised introduction; the instructions for use are placed before the introduction.

The sixth procedure was product testing; after the product was deemed valid and passed through a revision stage from media and material experts, it was submitted for testing to students on a limited basis. This research was conducted at SMAN 8 Serang, grade 10 Science. The trial was carried out on a small group consisting of 32 students by providing an e-module in the form of a link, after which students were asked to provide an assessment in the form of a questionnaire to assess the appearance, language, and usefulness aspects of the context-based e-module learning media. The results of limited trials obtained an average value of 82.1% with very feasible criteria. This outcome confirms that the developed E-module is a highly suitable learning resource for the biodiversity material for high school students in grade 10 SMA/MA.

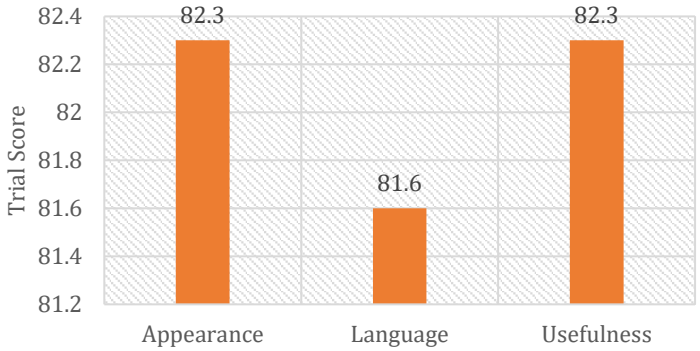


Fig. 6. Value of product trial results

Based on Fig. 6, the results of limited trials on E-module learning media showed that the percentage value for the appearance and usability aspects was 82.3%, including in the very feasible category, and the percentage for the language aspect was 81.6%, thus getting an average score of 82.1% in the very feasible category.

In terms of appearance, there were eight indicators of achievement in the e-module created, including the design of the e-module makes me interested in reading, the cover can describe the contents of the e-module, the form of writing on the cover is easy to read, the color used on the cover matches the contrast, The content design on the e-module made me interested in reading and videos on the e-module. By the biodiversity material, the images in the e-module are presented clearly, and the font size is proportional. Despite the high score, the suggestions found in the product review regarding the appearance aspect include things like the color on the cover being too flashy. One of the good media is in terms of color appearance; using good colors that are not flashy will help the aesthetic value and provide comfort for those who read it. This is in accordance with research [33] that the display on the biomagz should be colored to make it more attractive, but there is no need to use too many colors.

In the language aspect, there were four indicators of achievement in the e-module created, including that the sentences used in the e-module are not stiff, the sentences used in the e-module do not contain double meanings, the sentences in the e-module are easy to understand, and the sentences used in the e-module comply with EYD (Enhanced Spelling). The suggestions in the product trial for the language aspect are that it should use more straightforward language and not contain double sentences to make it easy for students to understand. A good language for learning is Indonesian, which is used by applying Indonesian language rules or conventions with high language variations; usually, high language variations are found in something official, such as textbooks [34].

In terms of usefulness, there were eight indicators of achievement in the e-module created, including I understand the material or information contained in the e-module, I understand the images presented, the e-module adds to my insight or knowledge, I understand the flow of the e-module, the e-module makes me feel carried away by everyday life situations, the e-module gives me the latest information, the e-module makes it easier for me to understand biodiversity material, " and " the e-module keeps me from getting bored. According to the results of product trials, students said that the e-module increased their insight and knowledge regarding biodiversity material, especially about bananas in the area where they live, namely Serang. Learning media in e-modules have never been used in the learning process at SMAN 8 Serang schools. The learning process requires media as a communicator and a communication medium in the learning process. Lecturers must develop their potential to improve the quality of professionalism and develop teaching materials, models, and learning media in the 21st century, so that students understand current skill needs, such as scientific communication [35]. E-modules are arranged based on core competencies, essential competencies, and competency achievement indicators. They are equipped with practice questions and a bibliography glossary that students can use to make learning more enjoyable. The e-module design is made systematic, and the design is attractive, interactive in the form of visuals, text, images, animations, and videos to increase students' motivation and interest in learning [36].

Conclusion

Based on the research findings, it was identified that there were 16 types of banana diversity in Serang, which are sold across six traditional markets and four modern markets. These findings were implemented in preparing E-modules in biology lessons, especially grade 10 biodiversity material, as an alternative learning resource for high school students. The e-module was developed using the R and D method, consisting of potential and problem procedures, data collection, product design, design validation, design revision, and product testing. The results of the e-module development were tested for feasibility by media and material experts. Design revisions were executed based on suggestions from the two experts

to enhance the media's quality. In conclusion, the development of an e-module based on contextual learning with Serang banana diversity content on biodiversity material for grade 10 students is very suitable to be used as an alternative learning resource and to increase students' knowledge about banana diversity in Indonesia, particularly within the Serang region. This e-module can be enriched with pedagogical innovations, conservation, and technological applications, such as the integration of artificial intelligence and machine learning, so that biology learning is more interactive and contextual in understanding local biodiversity.

Conflict of Interest

The authors declare no conflict of interest.

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