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Validity of e-handout diversity bacterial colonies in rhizosphere *Citrus nobilis* at Karang Bunga Agrotourism Barito Kuala

Validitas e-handout ragam koloni bakteri pada rizosfer tanaman Citrus nobilis di Agrowisata Karang Bunga Barito Kuala

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Abstract
Digital handouts, or e-handouts, are learning tools students can use to learn more efficiently and flexibly. This study aimed to assess the validity of e-handouts on bacterial diversity in the rhizosphere of *Citrus nobilis* as Microbiology enrichment material. This research uses the Research and Development (R&D) method with the ADDIE model, which is limited to the development stage. The subjects in the study consisted of validation tests by three validators, namely material experts. As many as two people are lecturers in the Microbiology and Plant Physiology Course of Biology Education FKIP ULM Banjarmasin and one media expert from a lecturer in Educational Technology FKIP ULM Banjarmasin. In the e-handout validation test, the material validator was rated as very valid with a percentage of 86.15%, and the developed media validator showed the e-handout was very valid with a percentage of 100%. It can be concluded that the e-handout of bacterial colony diversity in the rhizosphere of *Citrus nobilis* meets the category of very valid, and suggestions for further research can be carried out until the product implementation stage.

Keyword: e-handout; microbiology; bacteria

Abstrak*. Handout digital, juga dikenal sebagai e-handout, adalah alat pembelajaran yang dapat digunakan siswa untuk belajar agar lebih efisien dan fleksibel. Tujuan dari penelitian ini untuk menilai kevalidan e-handout tentang keragaman bakteri yang ada di rizosfer Citrus nobilis sebagai bahan pengayaan Mikrobiologi. Penelitian ini menggunakan metode Penelitian dan Pengembangan (R&D) dengan model ADDIE yang dibatasi sampai tahap pengembangan (development). Subjek pada penelitian terdiri dari uji validasi oleh 3 orang validator, yakni ahli materi sebanyak 2 orang yang merupakan dosen Pengampu Mata Kuliah Mikrobiologi dan Fisiologi Tumbuhan Pendidikan Biologi FKIP ULM Banjarmasin dan 1 ahli media dari dosen Teknologi Pendidikan FKIP ULM Banjarmasin. Pada uji validasi e-handout oleh validator materi dinilai sangat valid dengan persentase sebesar 86,15%, dan validator media yang dikembangkan menunjukkan e-handout sangat valid dengan persentase 100%. Dapat disimpulkan bahwa e-handout keragaman koloni bakteri pada rizosfer Citrus nobilis memenuhi kategori sangat valid dan saran untuk penelitian selanjutnya bisa dilakukan sampai tahap implementasi produk. Kata kunci: e-handout; mikrobiologi; bakteri*

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INTRODUCTION

Technological developments are now increasingly penetrating various fields of life, including education. An educator must certainly be able to master the current technological developments so as not to be left behind by the times. Education in the 21st century is intended to be increasingly improved and easily accessible to all groups. One of the efforts is the creation of the "Industrial Revolution 4.0", which focuses on digitalization (Aspi & Syahrani, 2022). In today's generation, changes continue to develop along with technological developments, so it is necessary to have media that can help heavy learners become light, fast, clear, and can be done simultaneously. Therefore, an educator must be able to shift the mindset and conventional teaching methods to learning with the 4.0 system, namely the digitalization system (Yusuf et al., 2023). The development of the era in human life is visible. It can be felt by some humans who are open to always learning or updating about the development of information technology that can facilitate human work (Aspi & Syahrani, 2022).

One of the means used to support learning is learning media, such as the internet, which is a learning resource. Of course, this changes the learning process from conventionally using books or blackboards that tend to be less interactive to digital using the internet. Using the internet as a learning resource has a positive impact on students because they can get information from anywhere, but this also has a negative effect on students; they can get information that is less valid or even wrong, which can create misconceptions.

The results of research by Yolviansyah et al. (2022) showed that students who experience misconceptions mostly get from less valid sources, such as websites in the form of blogs. This is because students can accept anything they read. Research by Luzyawati & Hamidah (2023) states that students lack learning resources, especially during online learning, making them not free to borrow books at the library and only have learning resources from LKS and the internet. So, the lack of conceptual knowledge of material and conceptual expertise can result in students' concluding a concept that is different from scientific concepts and leads to misconceptions. In addition, many students experience misconceptions due to learning sources, such as the internet or books that have been read with language that is difficult for students to understand, which can lead to misconceptions. In addition, due to the abundance of sources of knowledge that are not sorted out and studied in depth, students can exclude material according to their understanding (Rabiudin, 2023). Therefore, it is necessary to develop easy-to-understand and valid learning media to prevent these problems.

One of the learning resources that can be used is electronic handouts or e-handouts. According to Fitriana et al. (2022), electronic handouts are learning resources based on electronic technology containing a summary of material equipped with images, which can be accessed anywhere so that it is possible to use them independently. In addition, e-handouts can simplify the learning process by presenting questions, materials and guidelines for practicum that are useful for offline and online learning (Rusminah et al., 2022). This situation shows the need to develop a digital handout-based learning media to produce learning resources that can be trusted and have guaranteed quality. This study aims to assess the validity of e-handouts on bacterial diversity in the rhizosphere of *Citrus nobilis* as an enrichment material for Microbiology.

RESEARCH METHODS

This study used the ADDIE model for research and development (R&D), which consists of five stages: analysis, design, development, implementation and evaluation. This development stage aims to create a learning product that matches the validator's input. This process includes material and media expert validation. This method uses a questionnaire given to experts. For validation by material experts, it has 13 questions consisting of content and linguistic aspects, while for validation by media experts, it has 20 questions composed of graphics, appearance, and navigation.

The research was conducted for four months, from September to December 2023, at Biology Education FKIP ULM Banjarmasin. The validator subjects comprised two lecturers of Biology Education FKIP ULM as material validators and one lecturer of Educational Technology FKIP ULM as a media validator. The data analysis used the Formula 1 from Akbar (2017). The results of the suitability of the known validation value are then matched as in Table 1.

$$\text{Validity} = \frac{TSe}{TSh} x100\% \text{.....Formula 1}$$

Table 1 Validation Criteria

No.	Achievement Criteria	Validity Level
1.	80,00% ≤ - ≤ 100,00%	Very valid, very effective, very complete, can be used without improvement
2.	60,00% ≤ - < 80,00%	Moderately valid, moderately effective, moderately complete, usable but needs minor improvements
3.	40,00% ≤ - < 60,00%	Less valid, less effective, or less complete, needs major improvement, recommended not to be used
4.	20,00% ≤ - < 40,00%	Invalid, ineffective, incomplete, unusable
5.	00,00% ≤ - < 20,00%	Very invalid, very ineffective, very incomplete, not usable

(Source: Akbar, 2017)

RESULTS AND DISCUSSION

Validation of teaching materials is a procedure that aims to assess whether or not the product made to be implemented in the learning process is seen from the material presented (Nuria, 2022). Media validation aims to determine the feasibility of a product in terms of media presentation, including graphics, display, and navigation (Septiani et al., 2020). Tables 2 and 3 show the results of validating the e-handout media of bacterial colony diversity that has been developed. Digital handouts or e-handouts are effectively used for the learning process because the results of validation by material and media experts are very valid. However, there are minor revisions from the validator, namely by adding photos of observations on the cover and abbreviating the instructions for use on the e-handout to make it more attractive. On the front page of the digital handout, you can see a picture of the bacterial colonies grown, and on the back page, you can see the sampling area for this research. The table of contents also shows the discussions in the digital handout. The following digital handout display can be seen in Figures 1 and 2.

Table 2 Results of Validation by Material Experts

No.	Aspects assessed	Score		
		V1	V2	Average
1.	Content			
	a. Appropriateness of Course Learning Outcomes (CPMK)	5	5	5
	b. Suitability of material with Sub-CPMK	5	5	5
	c. Correctness of material concepts and facts	4	4	4
	d. The material is following the outcomes and is presented in a coherent, detailed, and clear manner	4	4	4
	e. The material is clarified with pictures	4	5	4,5
	f. Materials motivate students to think critically	4	4	4
	g. Evaluation following CPMK	4	4	4
	h. ICT-based material delivered	4	5	4,5
	i. The material presented uses relevant references	4	4	4
2.	Linguistics			
	a. Conformity of sentence usage with the General Guidelines for Indonesian Spelling (PUEBI)	4	4	4
	b. Accuracy in the use of terms/symbols/emblems	4	5	4,5
	c. Accuracy of scientific or foreign names	4	5	4,5
	d. Language use is easy to understand	4	4	4
Total Score		**54**	**58**	**56**
Material Validation Score Results		**4,15**	**4,46**	**4,31**
Average Material Validation Score			**4,31**	
Average Percentage			**86,15%**	
Conclusion			**Very Valid**	

Table 3 Results of Validation by Media Experts

No	Aspects assessed	Score
1.	Graphics	
	a. The cover design of the e-handout features an attractive contrast between colors and fonts	5
	b. E-handouts are easy to access	5
	c. The shape, size, and type of writing used are appropriate and easy to read	5
	d. Clarity of image display (color display, contrast, and image placement)	5
	e. The attractiveness of the color and layout of the e-handout	5
	f. E-handouts are organized systematically, including Introduction, Content, and Closing	5
	g. Suitability of e-handouts with the objectives to be achieved	5
	h. Completeness of information presentation in the e-handout	5
	i. Suitability of the picture with the discussion	5
	j. Use of language following the General Guidelines for Indonesian Spelling (PUEBI)	5
	k. E-Handout is communicative	5
2.	Display	
	a. Overall Pattern	5
	b. Arrangement	5
	c. Verbal Elements	5
	d. Appeal	5
3.	Navigation	
	a. Navigation consistency	5
	b. Effectiveness of navigation	5
	c. Navigation function	5
	d. Ease of use of e-handout operation	5
	e. Button consistency	5
Total Score		**100**
Media Validation Score Results		**5**
Percentage		**100%**
Conclusion		**Very Valid**

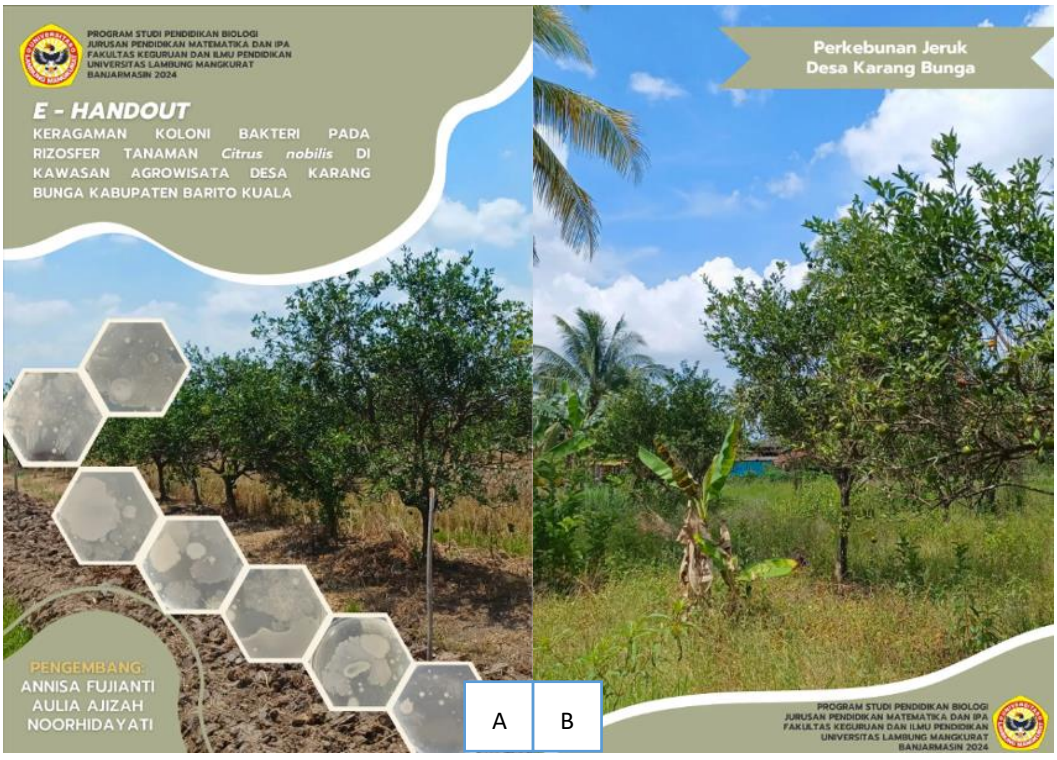


Figure 1
Front (A) and back (b) cover of e-handout bacterial colony diversity in the rhizosphere of *Citrus nobilis*



Figure 2
Preface (A) and table of contents (b) of e-handout bacterial colony diversity in the rhizosphere of *Citrus nobilis*

This research is supported by previous research, such as the research of Izzatinnisa' et al. (2020), which shows Microbiology handouts have a very valid validation score, with a score from material validators of 99.53% and a validation score from learning media validators of 98.14%, and a percentage of microbiology student practicality test 89.89%, with very valid practicality criteria. Research by Jauharati et al. (2022) on HTML5 flip-based handouts showed validity results of 93.09% and readability of 88.87%. Putra & Utami (2023) on digital handouts show a validity of 89.92%, Ajizah & Rahma (2017), related to developing Eubacteria material handouts, showed that the overall handout validity results were very high at 82.28%, including the content at 81.25%, presentation at 80%, and language aspects at 85.58%. For the readability aspect, students stated that the handout was very easy to read at 83%. Penelitian Azizah & Dewiyeti (2017) research on the development of soil bacteria handouts has a handout feasibility assessment by material experts 83.33%, media experts 83.33%, biology teachers 80.26%, and students 82.00%. Research by Munawarah et al. (2023) on bacterial colony diversity handouts showed that the suitability test obtained an average score of 87.4%, the feasibility test obtained an average score of 81%, and the student readability test obtained an average score of 89%.

Based on the research above, the same goal is to develop learning tools or media in handouts to facilitate students in learning independently and guided. The results of the study are also very valid. The study's results are also related to this study, namely developing handout-based learning media, and the validation results are very valid. The development of this digital handout is certainly not only to make it easier for students to learn independently, but it can also be used as a teaching and learning media in the classroom both offline and online, providing reliable learning resources that are contextual, and saving time when learning in class because there are features that can speed up the use of this digital handout.

The novelty of this research from previous research on the diversity of bacterial colonies in this rhizosphere is that the handout product developed is a digital handout that can be accessed anytime and anywhere through various devices such as computers or smartphones. This digital handout also has practicum guidelines and parameter tool specifications that can help students in microbiology practicum activities. Digital handouts are beneficial in environmental sustainability practices because they reduce the use of paper and are environmentally friendly. The results of this show this digital handout is feasible for learning. The development of this e-handout has several functions that are beneficial for teachers and

learners, including: 1) help reduce the need to make additional notes about the subject matter so that students can focus more on learning activities; 2) provide additional explanation and enrichment from the teacher; 3) become a reference for students; 4) facilitate the process of remembering and understanding the main subject matter; 5) allow students to remember and understand the subject matter.

The explanation above is also reinforced by the literature, which says that handouts benefit from increasing students' understanding. Besides that, they also help students not to take notes and complete the delivery by the teacher (Suryadi *et al*., 2020). This digital handout is also made as interesting as possible so that students do not get bored reading it by writing using communicative language, equipped with pictures, animations and illustrations (Ayuningrum & Mulyono, 2022). Digital handouts have benefits in facilitating the delivery of learning materials, expanding learners' knowledge, and assisting other teaching materials (Prastowo, 2011). The use of digital handouts also has the benefit of increasing students' interest in learning and students' understanding of the learning process because the material in the handout is a summary or important points of the material being taught, thus helping students to focus on relevant and important parts (Ananda et al., 2024).

This digital handout or e-handout certainly has several advantages and disadvantages. The benefits of this e-handout teaching material product are its ease of use and high portability, so it is easy to carry everywhere and use for self-study. However, the weaknesses of this e-handout teaching material are its limitations in that it can only be used on Android-based smartphones, has a fairly long manufacturing process, and requires sufficient storage space on the smartphone.

CONCLUSION

Several conclusions were obtained from the research results conducted in developing the e-handout of bacterial colony diversity in the rhizosphere of *Citrus nobilis*. The results of the media expert validity test get very valid criteria based on 20 questions with a total score of 100%, and the material expert validity test gets very valid criteria based on 13 questions with an average score of 86.15%. The development of e-handouts of bacterial colony diversity in the rhizosphere of *Citrus nobilis* plants has not been fully implemented until the evaluation stage due to the absence of Microbiology course followers in the 2023/2024 academic year therefore, for further research, it can be continued until the implementation stage and developed widely.

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