



Validity of the development of a digital handout on bryophyte diversity based on problem-based learning (PBL) in Tahura Sultan Adam Mandiangin

Siti Maryati *, Aulia Ajizah, Amalia Rezeki

Department of Biology Education, Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Banjarmasin City, South Kalimantan, Indonesia, 70123

*Corresponding Author Email: 2010119220028@mhs.ulm.ac.id | Received date: 03/05/2025; Accepted date: 16/05/2025

Abstract

The development of digital handouts based on Problem-Based Learning (PBL) is important to improve the quality of contextual, interactive learning, and in accordance with the demands of 21st century skills. Biodiversity such as moss (Bryophyta) can be a direct source of learning in learning Cryptogamae courses that can be packaged as teaching materials in the form of digital moss handouts based on PBL. The development of digital handouts can increase the attractiveness of students and overcome obstacles in learning moss material that is difficult for students. This research and development aim to describe the validity of the developed digital handouts. The teaching material development model used is the ADDIE model which is limited to the development stage. The subjects in the study consisted of material validation tests and media experts. The developed digital handout product obtained a percentage of 91.50% in the material validation test with very valid criteria, 70.40% in the media validation test with valid criteria. Based on these results, the digital handout is suitable for use as a support for the Cryptogamae course on moss material. In addition, this study shows that the PBL model packaged in digital handouts can increase student engagement and understanding of complex materials and can be used as a reference for other digital teaching materials.

Keyword: ADDIE; validity; moss; bryophyta; digital handout

Abstrak. Pengembangan handout digital berbasis Problem-Based Learning (PBL) penting untuk meningkatkan kualitas pembelajaran yang kontekstual, interaktif, dan sesuai dengan tuntutan keterampilan abad ke-21. Keragaman hayati seperti lumut (Bryophyta) dapat menjadi sumber belajar langsung dalam pembelajaran mata kuliah Cryptogamae yang dapat dikemas sebagai bahan ajar berupa handout digital lumut berbasis PBL. Pengembangan handout digital dapat meningkatkan daya tarik peserta didik dan mengatasi kendala dalam mempelajari materi lumut yang sulit bagi peserta didik. Penelitian dan pengembangan ini bertujuan untuk mendeskripsikan validitas terhadap handout digital yang dikembangkan. Model pengembangan bahan ajar yang digunakan adalah model ADDIE yang dibatasi sampai tahap pengembangan (development). Subyek dalam penelitian terdiri dari uji validasi materi dan media. Produk handout digital yang dikembangkan memperoleh persentase 91,50% pada uji validasi materi dengan sangat valid, 70,40% pada uji validasi media dengan kriteria valid. Berdasarkan hasil tersebut, maka handout digital layak digunakan sebagai penunjang mata kuliah Cryptogamae pada materi lumut. Selain itu, penelitian ini menunjukkan bahwa model PBL yang dikemas dalam handout digital dapat meningkatkan keterlibatan dan pemahaman peserta didik terhadap materi yang kompleks dan dapat menjadi acuan sebagai bahan ajar digital lainnya.

INTRODUCTION

Education today is part of the 21st century, which is characterized by the development of digital information. 21st-century skills are related to the ability to apply technology by utilizing creative and critical thinking in the era of literacy (Annida et al., 2022). The 6C skills are also known as 21st-century skills, which include critical thinking, collaboration, communication, creativity, culture, and connectivity (Rahayu et al., 2023). According to Wahidah et al. (2022), textbooks are often rarely used in learning because they contain few pictures and more text, making them less interesting to read. Utami et al. (2022) mention that in the digital era 4.0, information can be easily obtained online and accessed via smartphones.

According to Yulianti et al. (2021), handouts are one alternative that educators can use to convey material concisely and in an easy-to-understand manner. Handout teaching materials are given to students to facilitate their understanding of the learning process. In addition, handouts can be designed and packaged in such a way that they are attractive and enjoyable for students. This is in line with Turrohmah and Hakim (2022), who state that handouts are practical teaching materials because they contain summaries of important material for students, so that they can immediately recognize the important parts of the material.

Based on the results of the needs analysis, moss material is difficult to understand because the material or educational media discussed is insufficient or scarce, and it is difficult to distinguish between moss leaves, moss hearts, and moss horns. Participants also mentioned that there is a lack of learning resources about moss, because visually appealing teaching materials are still scarce. Education participants want additional teaching materials that are interesting and have colorful pictures, and want to use digital teaching materials in moss learning. The analysis results indicate the need to develop teaching materials as visual support in studying Cryptogamae.

The study by Sirumahombar and Mailani (2023) developed a PBL model used to deliver application-based digital teaching materials, specifically focusing on topics related to speed, which resulted in an improvement in the learning experience of students. The results of the study show that the effectiveness of digital teaching materials reaches 98.5%, which is classified as "very effective." The validation results by media experts include "Very Good," so that digital teaching materials are suitable for use in the learning process in the classroom. Ajizah et al. (2024) state that problem-based learning teaches students to acquire new knowledge by starting the learning process through problems that need to be solved.

The development of digital teaching materials that has been carried out includes research by Munawarah et al. (2023) on the development of digital teaching materials with the context of "Bacterial Colony Diversity in the Rhizosphere of Oil Palm Trees in Swamp Environments," which was rated "Very Good" for use as teaching materials. Based on the above discussion, it is necessary to develop teaching materials in the form of digital teaching materials to produce reliable and quality-assured learning resources. This study aims to examine the validity of digital teaching materials on the diversity of moss (Bryophyta) based on PBL in the Sultan Adam Mandiangin Forest Park Area.

In the context of education, the development of teaching materials is an important aspect to support the achievement of student competencies in a systematic and efficient manner. Teaching materials are considered an effective form of learning material because they present information in a concise, interesting, and easy-to-understand manner for students. Problems arise with material on moss, which is difficult for students to understand due to the limited availability of interesting visual media and the lack of teaching materials that clearly distinguish between different types of moss. Therefore, it is necessary to develop teaching materials in the form of digital handouts based on PBL to facilitate a more contextual and interactive understanding of the material. This study aims to test the validity of digital handouts on the diversity of moss in the Sultan Adam Mandiangin Forest Park area based on PBL.

RESEARCH METHODS

The research and development (R&D) method in this study used the ADDIE model. The purpose of this stage was to produce material that was in line with the input provided by the validators. This stage was validated by subject matter and media experts. The research was conducted in the biology education study program at FKIP ULM. The research was carried out over a period of six months. The previous product trial

was first validated by experts to validate the handout teaching materials. Feedback from the validation process will be used to refine the development of this handout. Data analysis used Formula 1 from Akbar (2017). The known validation test results, criteria for average score validation interpreted as in Table 1.

$$Va = \frac{TSe}{TSh} \times 100\% \dots \dots \dots \text{Formula 1}$$

Description:

Va = Expert Validation

Tse = Total score empirical (results validation from validator)

TSh = Total score maximum expected

Table 1 Criteria Evaluation Validation

No	Percentage of assessment score	Information
1	$85.00\% < \bar{x} < 100\%$	Very valid
2	$70.00\% < \bar{x} < 85.00\%$	Valid
3	$50.00\% < \bar{x} < 70.00\%$	Less valid
4	$00.00\% < \bar{x} < 50.00\%$	Invalid

(Source: Akbar, 2017)

RESULTS AND DISCUSSION

The diversity of mosses in the Sultan Adam Mandiangin Forest Park area as many as 12 species among others *Calymperes brachythecium*, *brachythecium rutabulum*, *Acroporium secundum*, *Leucobryum glaucum*, *Octoblepharum albidum*, *Bryum argenteum* Hedw., *Ectropothecium falciform*, *Barbula consanguinea*, *Lejeunea flava*, *Thysananthus anguiformis*, *Lejeunea trinitensis*, and *Marchantia polymorpha* L.

Analysis which is obtained from the results of moss diversity allows determination step beginning for develop handout that meets need participant educate in a way more effective with consider characteristics, capabilities, and performance participant educate. Analysis need give important insights known that student own preference to teaching materials that include picture relevant moss. Stage design m designing A teaching materials that can reach the goals that have been set about development digital diversity handout moss based PBL in Sultan Adam Mandiangin Forest Park, the next is the validation test stage. The results of the validation test regarding the developed handouts can be seen in Table 2.

Table 2 Recapitulation of Material Validation Test Results

No	Rated aspect	Indicator	Score		Average Score
			V1	V2	
1.	Content eligibility				
	a. Compliance description material with CPMK and objectives learning	Completeness material	4	4	4
	b. Accuracy material	Accuracy concepts and definitions	4	4	4
		Accuracy images, illustrations and videos	4	3	3.5
2.	Eligibility presentation				
	a. Supporters' presentation	Question	4	3	3.5
	b. Presentation learning	The collapse presentation material	4	4	4
3.	Eligibility linguistics				
	a. Straightforward	Accuracy structure sentence	4	3	3.5
		Standards and consistency use term	4	3	3.5
	b. Compliance with Indonesian Language rules accuracy	Grammatical correctness	3	3	3
		Accuracy spelling	3	3	3

No	Rated aspect	Indicator	Score		Average Score
			V1	V2	
4.	Completeness presentation	Introduction	4	4	4
		Contents section	4	4	4
		Closing section	4	4	4
Total score			46	42	44
Validation score results			3.83	3.50	3.66
Average validation score			3.66		
Average percentage			91.50%		
Conclusion			Very valid		

Table 3 Recapitulation of Media Validation Test Results

No	Rated aspect	Score
1.	Eligibility screen design view	
	Composition color of writing against color background behind can read with clear	4
	Text and images arranged in a way proportional with appropriate	3
	Layout each part digital handout already appropriate	3
	Relatedness between illustration graphic, visual, and verbal accordingly	3
	Developed digital handouts own attractive design (colors, images/illustrations, letters)	4
2.	Eligibility graphics	
	Use size letter easy read with clear	4
	Use type letter easy read with clear	4
	Use illustration selected image clear (no blurry)	3
	Proportion images and illustrations realistic	3
	Video running with smooth (not stuck) and can see with clear (no blurry)	4
	The video narration is clear and understandable. Understood	3
	Use the colors on the digital handouts are already right and wrong excessive	4
3.	Eligibility consistency	
	Use of words, terms and sentences consistent throughout material digital handout	3
	Shapes and letters used in a way consistent	4
	Layout display (lay out) consistent	3
4.	Eligibility convenience use	
	Digital handouts which are developed served in a way coherent in accordance order parts digital handout	4
	Digital handouts which are developed easy operated, good using a cellphone or pc/laptop	4
	Digital handouts which are developed can used in various place, time and circumstances	3
	Digital handouts which are developed own instruction clear usage	4
	Digital handouts which are developed own buttons navigation that works with well	4
5.	Eligibility benefits	
	Use digital handout capable increase attention participant educate to material learning	3
	Use digital handout capable make it easier educator in the learning process teach	4
	The use of digital handouts is able to make it easier participant educate study in a way independent	3
Total score		81
Validation score results		3.52
Average validation score		3.52
Average percentage		70.40%
Conclusion		Valid

According to Putra et al. (2023), to obtain a quality product and achieve the desired results, several validation processes are carried out. Validation tests identify product deficiencies based on input from validators. Based on Table 3, the results of the material validation test show an average score of 3.66 with a score percentage of 91.50%. Based on the validation test criteria according to Akbar (2017), this score is considered highly valid. To measure the quality of digital handouts, a validation process involving subject matter experts was carried out. This validation covers four main areas of assessment: content suitability,

presentation suitability, language used, and overall layout (Awlia & Febrianti, 2023). Based on the material validity results, the developed digital handout has the highest score in terms of completeness of presentation, as it presents a complete introduction, content, and conclusion.

Rahima et al. (2022) stated that in the presentation of the product, the conceptual content was presented in a coherent and consistent manner, so that the developed product was in accordance with the concept presentation aspect and could be utilized. Salsabilla et al. (2023) stated that the main objective of expert validation was to provide information and evaluate the meaningfulness of the material delivery in accordance with the variables assessed. Adjie et al. (2022) assessed the teaching materials as good, containing all the necessary material, plus explanations of the main topics and interesting pictures to clarify the main topics.

Expert validation of the material is very valid in digital handouts, meaning they are effective for use in the learning process (Fujianti et al., 2024). Based on the validation test results by subject matter experts on content, the developed digital handouts are in line with the learning objectives and meet the conceptual accuracy of the material, and are equipped with attractive images.

Based on Table 3, the media validation test results show an average score of 3.52 with a score percentage of 70.40%. Based on the validation test criteria according to Akbar (2017), this score is considered valid. The developed digital handout has an attractive design and is equipped with links and barcodes. This is because there are many colorful images and animations. This is in accordance with Rahmi et al. (2020), who describe practical, attractive, and colorful teaching materials as characteristics that are liked by students.

The aspects assessed by media experts include evaluating various aspects when assessing a product, such as usability, functionality, text quality, image/video quality, color quality, design quality, suitability, and language use (Putri et al., 2021). The media expert validation process is intended to assess the quality of digital handouts in terms of presentation and graphics (Awlia & Febrianti, 2023). According to Damayanti et al. (2022), the appropriate use of colors, images, and text can facilitate reading and attract students' attention to learning. One effort to improve student learning is to develop educational materials that contain real images, which will help students learn concepts and facts and enjoy the process.

Research on digital handouts based on PBL on Bryophyta material developed with a local context at the Sultan Adam Mandiangin Forest Park has a very high level of material validity and good media validity. These results are in line with the research by Munawarah et al. (2023), which tested readability to determine whether the developed handouts were easy to read and could be used as a learning resource.

This study reinforces the finding that digitally designed teaching materials that are visually appealing, conceptual, and contextual can improve students' understanding of abstract material. The innovation of using the PBL model in digital handouts not only addresses the challenges of 21st-century learning but also provides a real solution to students' difficulties in understanding the diversity of mosses more critically and meaningfully.

The above explanation is also reinforced by literature that mentions that the use of digital handouts also has benefits for increasing students' interest in learning and their understanding of the learning process because the material in the handouts is a summary or key points of the material being taught, thus helping students to focus on relevant and important parts (Ananda et al., 2024). These digital handouts are also made as interesting as possible so that students do not get bored reading them by writing in a communicative language, accompanied by pictures, animations, and illustrations (Ayuningrum & Mulyono, 2022).

This digital handout certainly has several advantages and disadvantages. The advantages of this digital handout teaching material are that it is easy to use and can be taken anywhere, so it can be used for independent learning. It also comes with practical guidelines and tool parameter specifications that can help students in their Cryptogamae practical activities. Digital handouts are useful in environmental sustainability practices because they reduce paper use and are environmentally friendly, as they can be accessed anytime and anywhere. However, the disadvantages of this digital handout teaching material are its limitations, namely that it requires internet access, the process of creating it is quite long, and it requires sufficient storage space on mobile phones.

CONCLUSION

The validity results of the Digital Handout on Bryophyta Diversity Based on PBL at Sultan Adam Mandiangin Forest Park show that the material validation test results indicate an average score of 3.66 with a percentage of 91.50% and a highly valid criterion. The media validation test results obtained a score of 3.52 with a percentage of 70.40% and a valid criterion. This study contributes scientifically to the development of digital teaching materials based on PBL, especially for Bryophyta material, which is abstract and difficult for students to understand. This study supports the strengthening of science literacy and critical thinking in 21st-century learning, while enriching references for the development of PBL based teaching materials in the Cryptogamae course. The development of Digital Handouts on Moss Diversity based on PBL at the Sultan Adam Mandiangin Forest Park has not been fully implemented up to the evaluation stage, so that further research can be continued up to the implementation stage.

REFERENCES

- Adjie, G. S., Ajizah, A., & Amintarti, S. (2022). *Pteridophyta* di sekitar danau Sari Embun Kabupaten Tanah Laut dan pengembangan buku saku. *JUPEIS: Jurnal Pendidikan dan Ilmu Sosial*, 1(2), 230-240. <https://doi.org/10.55784/jupeis.Vol1.Iss3.192>
- Ajizah, A., Nahadi, N., Pasani, C. F., & Nurdin, E. S. (2024). *Research Trend of Integration of Problem Based Learning in Laboratory Activities: A Bibliometric Analysis*. *Jurnal Penelitian Pendidikan IPA*, 10(6), 262-268. <https://doi.org/10.29303/jppipa.v10i6.6784>
- Akbar, S. (2017). *Instrumen perangkat pembelajaran*. Bandung: PT Remaja Rosdakarya.
- Ananda, P. N., Nerita, S., & Kasmari, R. (2024). Pengembangan e-handout berbasis mindmap pada materi sistem koordinasi kelas XI SMA/MA. *Jurnal Pendidikan Tambusai*, 8(1), 8263–8272. <https://www.iptam.org/index.php/iptam/article/view/13623>
- Annida, S. F., Putra, A. P., & Zaini, M. (2022). Pengaruh penggunaan E-LKPD berbasis *liveworksheets* terhadap hasil belajar dan keterampilan berpikir kritis peserta didik pada konsep pembelahan sel. *QUANTUM: Jurnal Inovasi Pendidikan Sains*, 13(2), 155-167. <https://dx.doi.org/10.20527/quantum.v13i2.12111>
- Awlia, Z. & Febrianti, N. (2023). Penyusunan *e-handout* pengayaan materi bioproses sel sebagai bahan ajar biologi siswa SMA kelas XI IPA. *Bioilmi: Jurnal Pendidikan*, 9(2), 23-34. <https://doi.org/10.19109/bioilmi.v9i2.13999>
- Ayuningrum, E. D., & Mulyono, W. D. (2022). pengembangan media pembelajaran menggunakan e-handout pada mata pelajaran dasar-dasar konstruksi bangunan dan teknik pengukuran tanah. *Jurnal Kajian Pendidikan Teknik Bangunan*, 8(1), 1-10. <https://doi.org/10.26740/jkptb.v8i1.48931>
- Damayanti, F. R., Amintarti, S., & Rezeki, A. (2022). Pengembangan *e-booklet* jenis-jenis jamur makroskopis di taman buah lokal kawasan mangrove rambai center sebagai bahan ajar biologi di SMA. *JUPEIS: Jurnal Pendidikan dan Ilmu Sosial*, 1(3), 157-172. <https://doi.org/10.55784/jupeis.Vol1.Iss3.163>
- Fujianti, A., Noorhidayati, N., & Ajizah, A. (2024). Validity of e-handout diversity bacterial colonies in Rhizosphere citrus nobilisat karang bunga Agrotourism Barito Kuala. *Jurnal Praktisi Pendidikan*, 2(1), 22-28. <https://doi.org/10.58362/hafecspost.v3i1.58>
- Munawarah, M., Ajizah, A., & Amintarti, S. (2021). Pengembangan *handout* keragaman koloni bakteri pada rizosfer pohon kelapa sawit di lingkungan lahan basah. *BIOSFER, J.Bio. & Pend.Bio*, 8(2), 96-105. <https://doi.org/10.23969/biosfer.v8i2.10837>
- Putra, A. P., Kaspul, K., & Utami, N. H. (2023). Pengembangan handout digital berorientasi keterampilan proses sains pada materi biologi pada kelas X. In *Prosiding Seminar Nasional Lingkungan Lahan Basah* (Vol. 8, No. 2, pp. 193-197). <https://snlib.ulm.ac.id/prosiding/index.php/snlib-lit/article/view/927>
- Putri, N. K., Yuberti, Y., & Hasanah, U. (2021). Pengembangan media pembelajaran berbasis web google sites materi hukum newton pada gerak benda. *Physics and Science Education Journal (PSEJ)*, 1(3), 133-143. <https://doi.org/10.30631/psej.v1i3.1033>
- Rahayu, T., Budhihartati, B., Hamsina, H., & Bahri, A. (2023). Model pembelajaran A2ipar sebagai solusi untuk melatih dan meningkatkan keterampilan berpikir kreatif peserta didik. In *Prosiding Seminar*

Nasional Biologi FMIPA UNM (pp. 575-583). <https://journal.unm.ac.id/index.php/semnasbio/article/view/1027>

- Rahima, R., Kaspul, K., & Putra, P, A. (2022). Validitas dan keterbacaan peserta didik kelas X SMA terhadap pengembangan modul elektronik berbasis Flip HTML5 konsep protista. *Jurnal Pendidikan Universitas Garut*, 16(1), 560-580. <https://doi.org/10.52434/jp.v16i1.1828>
- Rahmi, F., Noorhidayati, N., & Riefani, M. K. (2020). The validity of the human circulatory system concepts handout at class XI IPA SMAN 6 Banjarmasin. *BIO-INOVED: Jurnal Biologi Inovasi Pendidikan*, 2(1), 14-19. <http://dx.doi.org/10.20527/bino.v2i1.7885>
- Salsabilla, N. L., Mahrudin, M., & Rezeki, A. (2023). Validitas booklet keanekaragaman jenis semak di kawasan mangrove Desa Pagatan Besar. *JUPEIS: Jurnal Pendidikan dan Ilmu Sosial*, 2(2), 1-8. <https://doi.org/10.57218/jupeis.Vol2.Iss2.561>
- Sirumahombar, A. R. P. & Mailani, E. (2023). Pengembangan bahan ajar e-handout berbasis aplikasi melalui model problem based learning pada materi kecepatan di kelas V. *INNOVATIVE: Journal of Social Science Research*, 3(2), 4074-4085. <https://j-innovative.org/index.php/Innovative/article/view/801>
- Turrohmah, L. & Hakim, N. (2022). Pengembangan handout elektronik menggunakan flip pdf professional pada materi kingdom plantae siswa kelas X SMA/MA. *Jurnal Biotek*, 10(1), 52-65. <https://doi.org/10.24252/jb.v10i1.28458>
- Utami, R. P., Noorhidayati, N., & Ajizah, A. (2022). Pengembangan bahan ajar sub konsep struktur dan fungsi jaringan pada tumbuhan di SMA/MA berbentuk e-booklet. *JUPEIS: Jurnal Pendidikan dan Ilmu Sosial*, 1(3), 241-252. <https://doi.org/10.55784/jupeis.Vol1.Iss3.193>
- Wahidah, S., Amintarti, S., & Rezeki, A. (2022). Pengembangan e-booklet lumut kerak (lichen) di taman buah lokal kawasan mangrove rambai center sebagai materi penunjang mata kuliah cryptogamae. *JUPEIS: Jurnal Pendidikan dan Ilmu Sosial*, 1(3), 109-118. <https://doi.org/10.55784/jupeis.Vol1.Iss3.148>
- Yulianti, R., Hardiansyah, H., Mahrudin, M., & Rezeki, A. (2021). The validity handout about proboscis monkey (*Nasalis larvatus*) on Curiak Island as an enrichment material for the concept of biodiversity in high school. *BIO-INOVED: Jurnal Biologi-Inovasi Pendidikan*, 3(1), 39-43. <http://dx.doi.org/10.20527/bino.v3i1.9753>