



Development of a Balinese Local Wisdom–Based Digital Flipbook to Enhance Elementary Students’ Science Learning Outcomes

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Abstract: This study aims to develop a Balinese local wisdom-based digital flipbook for ecosystem learning and to examine its validity, practicality, and effectiveness in improving fifth-grade elementary students’ science learning achievement. The study employed a Research and Development (R&D) approach using the ADDIE model, which consists of the Analysis, Design, Development, Implementation, and Evaluation stages. The participants included expert validators, fifth-grade elementary school teachers, students involved in the practicality assessment, and 60 fifth-grade students who participated in the effectiveness testing. The research instruments comprised expert validation sheets, teacher and student practicality questionnaires, and a validated science learning achievement test administered before and after the intervention. Quantitative data were analyzed using descriptive statistics and inferential statistical analyses, including the Shapiro–Wilk normality test, homogeneity test, paired-samples *t*-test, and effect size analysis. The results indicated that the digital flipbook demonstrated excellent validity, with media and content validity scores of 96.00% and 95.99%, respectively. The media also showed excellent practicality, with teacher and student practicality scores of 98.91% and 98.98%, respectively. Furthermore, the effectiveness test revealed a statistically significant improvement in students’ science learning achievement following the implementation of the digital flipbook ($p < 0.05$), with a large effect size. These findings indicate that the Balinese local wisdom-based digital flipbook is valid, practical, and effective for supporting elementary science learning. By integrating the principles of Tri Hita Karana and the cultural traditions of Tumpek Wariga and Tumpek Uye into ecosystem learning, the digital flipbook also contributes to strengthening students’ digital science literacy while fostering the preservation of Balinese cultural values.

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Introduction

Education plays an important role in individual development and life. In the last decade, the world of education has undergone a significant transformation due to the digital revolution (Andriani et al., 2024; Ranting & Wibawa, 2022). However, behind this acceleration, various complex challenges have emerged. Studies reveal that 68% of teachers experience difficulties in developing interactive digital teaching materials, while 72% of students complain about the monotony of learning based on static text (Suciartini et al., 2025).

Local wisdom is an element of local culture that describes how humans utilize their cognitive abilities to act and behave in response to objects and events occurring within a specific spatial context. By integrating local wisdom into the curriculum, learning becomes



more meaningful and is able to foster students' character, enabling them to remain grounded in the noble values of their culture even amidst the currents of globalization (Parwati et al., 2018; Septiyani & Ramadan, 2025).

The integration of digital technology into locally-based cultural materials is a strategic solution to maintain the relevance of Balinese values in the eyes of the current generation (Edwin & Franky, 2026; Sumerta & Sujana, 2022). Digital flipbooks have emerged as an innovative solution to the aforementioned challenges (A'yun et al., 2024; Ramadhani et al., 2023). Based on recent neuroscience research, presenting material through digital flipbooks has been proven to activate three crucial areas in the brain: the fusiform gyrus (visual recognition), Broca's area (language processing), and the prefrontal cortex (problem-solving) (Criesthyanie et al., 2021).

Although innovations in digital learning media are beginning to develop, the development of digital flipbooks that specifically integrate local wisdom is still relatively limited (Ginting et al., 2024; Yulis et al., 2024). Existing flipbooks mostly only present academic material without a cultural context, have not yet accommodated local values such as *Tri Hita Karana*, the harmony between humans and the environment, and cultural practices relevant to science, and have not fully utilized the potential of visuals, local narratives, and students' experiences within the context of real life.

The concept of "*Tri Hita Karana*" which emphasizes harmony between humans and God, with others, and with the natural environment, serves as an important foundation for fostering ecological awareness in students, and local values can be used as strategic instruments in instilling environmental concern from an early age" (Dewi et al., 2025; Kertih, 2023). The *Tumpek Uye* tradition reflects the implementation of the *Tri Hita Karana* concept in the life of Balinese society, as does *Tumpek Wariga*, which is rich in environmental conservation values. "*Tumpek Uye*" is a celebration to honor animals as part of God's creation that play an important role in the balance of the ecosystem. The *Tumpek Uye* ceremony contains Hindu ethical values in the form of respect for animals and teaches humans to maintain a balanced life with other creatures; this tradition is highly relevant to be integrated into learning (Mujiburrahman et al., 2024).

Tumpek Uye and *Tumpek Wariga* are not merely religious rituals in Balinese Hindu society, but also represent forms of ethnopedagogy and ethnosience that can be connected to elementary science learning. From an ethnopedagogical perspective, these traditions transmit cultural values, moral responsibility, and respect for living beings and the natural environment through meaningful local practices. From an ethnosience perspective, *Tumpek Uye* reflects human awareness of the role of animals in maintaining ecological balance, while *Tumpek Wariga* emphasizes the importance of plants and environmental conservation in sustaining life. These values are closely related to the concept of ecosystems taught in fifth-grade science, particularly the interaction between biotic components, such as animals, plants, and humans, and abiotic components, such as soil, water, sunlight, and air. Therefore, integrating *Tumpek Uye* and *Tumpek Wariga* into digital flipbook media enables students to understand ecosystem concepts through cultural examples that are familiar, contextual, and relevant to their daily lives.

The researchers conducted a preliminary study in seven public elementary schools within the Komiayang Sujana Cluster in January-February 2025 using classroom observation, interviews, and surveys. The results showed that 78% of science learning activities still used the lecture method and only 12% of schools had a collection of digital teaching materials. Interviews with 7 fifth-grade teachers revealed difficulties in finding concrete examples to



explain food chains relevant to the Balinese environment. A survey of 140 students showed that 68% found the Ecosystem material difficult to understand, 89% wanted video/animation media, and 76% were interested in learning about the subak ecosystem. However, the results of several study also revealed several weaknesses of the media, including limitations in the visual aspects that did not optimally depict the real environment and a lack of interactive elements such as quizzes, simulations, and videos that could stimulate students to develop critical and active thinking skills. Furthermore, the presentation of the local context used was still general in nature and had not yet deeply featured unique and original cultural values and local wisdom (Aryani et al., 2023; Kamelia et al., 2022; Wiweka et al., 2021). This study aims to develop a digital flipbook learning media based on Balinese local wisdom on ecosystem materials and to determine its level of validity, practicality, and effectiveness in improving the science learning achievement of fifth-grade elementary school students

This research contributes to the development of contextual science learning by integrating digital technology and Balinese local wisdom into ecosystem learning for elementary school students. Theoretically, this study enriches the discourse on ethnopedagogy and ethnoscience-based learning media by showing how local cultural practices, such as *Tri Hita Karana*, *Tumpek Uye*, and *Tumpek Wariga*, can be transformed into meaningful science learning resources. Practically, the developed digital flipbook provides teachers with an alternative interactive learning medium that connects abstract ecosystem concepts with students' real-life cultural environment. In addition, this research contributes to the preservation of Balinese local wisdom by introducing cultural values through digital science literacy, so that students are not only able to improve their science learning achievement but also develop awareness of ecological harmony and cultural identity from an early age.

Research Method

This research applies the Research and Development (R&D) method utilizing the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) (Sumiati, 2022). Validation in this study was carried out in an integrated manner by three experts who have competence in the field of Science Education as well as Learning Media (Fatirul & Walujo, 2022). The practicality test subjects involved 5 fifth-grade elementary school teachers from schools in the Kompyang Sujana Cluster. Each teacher guided 5 students from their respective classes, so a total of 25 students were involved in the trial. The subjects for the product implementation effectiveness trial involved two fifth-grade elementary school classes from schools in the Kompyang Sujana Cluster, with a total of 60 students.

The data collection instruments used in this study consisted of expert validation sheets, practicality questionnaires, and a learning achievement test. The expert validation sheets were used to assess the validity of the digital flipbook media in terms of media design and science learning material. The practicality questionnaires were administered to teachers and students to determine the ease of use, attractiveness, accessibility, and usefulness of the developed media in the learning process. Meanwhile, the effectiveness of the digital flipbook media was measured using a science learning achievement test, not a questionnaire. The achievement test was administered in the form of a pretest and posttest to measure students' cognitive achievement before and after using the digital flipbook media. The test items were developed based on the fifth-grade ecosystem learning indicators and were validated prior to their administration to ensure their content validity, item appropriateness, and suitability with the learning objectives. The data obtained from the achievement test were analyzed using



inferential statistical analysis, including the normality test, homogeneity test, paired sample t-test, and effect size calculation.

Results and Discussion

Analyze

The initial stage in the development process of the Balinese local wisdom-based digital flipbook media on ecosystem material for fifth-grade elementary school students. At this stage, a series of processes are carried out, starting from needs analysis, initial product design, to media development in accordance with the ADDIE development model. The Analysis phase serves as the foundation for development, involving three main activities: needs analysis, curriculum analysis, and a literature study on Balinese local wisdom. The results of this study produced an integration map between scientific ecosystem concepts and Balinese local wisdom, so that learning can be presented contextually and meaningfully for students.

Design

The design process of the digital learning media in this study began with the selection of an application program that could be used to realize the creation of the digital learning media. Based on the results of a review of relevant sources or literature, Flip PDF Corporate Edition 2.4.10.3 was chosen because this application program can display each page of the digital learning media like a printed book that can be flipped.

The next stage was to design the composition of each page of the digital learning media using a storyboard based on each component of the digital learning media. The opening section of this digital learning media consists of a cover, preface, table of contents, learning objectives, and a concept map. The content section of this digital learning media consists of seven learning activities, complete with learning materials, formative assessments, and daily assessments.

Development

The development stage in this research is to realize the digital learning media that has been designed according to the storyboard. The display of the results of creating each component in the digital learning media will be described as follows.



Figure 1. Front Cover and Back Cover Display

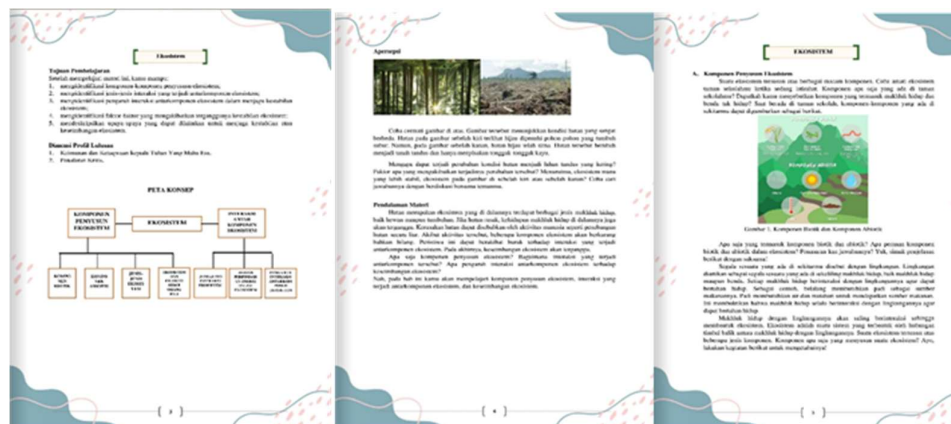


Figure 2. Material Description Display

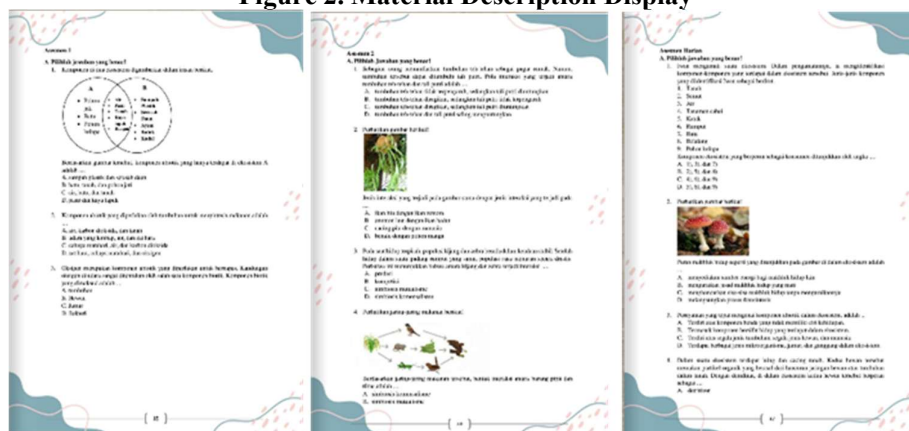


Figure 3. Formative Assessment and Daily Assessment

Implementation

The implementation was carried out with 25 fifth-grade elementary school students, involving 5 classroom teachers as practitioners. At this stage, the digital flipbook media was used in the science learning process on ecosystem material according to the designed learning flow. Teachers utilized the digital flipbook as the primary medium for delivering the material, while students actively used the media to read the material, observe illustrations and contextual images based on Balinese local wisdom, and work on the exercises and evaluations available within the media. During the implementation process, students showed high enthusiasm and engagement in following the lessons. The integration of Balinese local wisdom elements, such as the concepts of *Tri Hita Karana*, *Tumpek Wariga*, *Tumpek Uye*, and examples of local ecosystems in the Balinese environment, helped students connect ecosystem concepts with real-life experiences. This had an impact on increasing students' understanding of the material and encouraged active participation in discussions and learning activities.

Evaluation

The evaluation stage in this study aims to assess the effectiveness, practicality, and final quality of the developed digital flipbook media based on Balinese local wisdom. The evaluation begins with an analysis of the students' pretest and posttest results using inferential statistical tests to determine the improvement in learning achievement after using the media.

**Table 1. Results of the Learning Media Expert Assessment**

	Percentage	Criteria
Mean	96%	Very Valid

Based on the results of the media validity test conducted by three media experts, the validity percentage of the digital flipbook based on Balinese local wisdom was 96%, falling under the very valid criteria.

Table 2. Results of the Science Learning Material Expert Assessment

	Percentage	Criteria
Mean	95,99%	Very Valid

Based on the recapitulated results of the material validity assessment, the validity percentage of the digital flipbook material based on Balinese local wisdom was 95.99%, placing it within the very valid criteria.

Table 3. Results of the Media Practicality Assessment by Practitioners (Teachers)

	Percentage	Criteria
Mean	98,91%	Very Practical

Table 4. Results of the Media Practicality Assessment by Practitioners (Teachers)

	Percentage	Criteria
Mean	98,98%	Very Practical

Based on the results of the learning media practicality test conducted by practitioners (teachers) and students, the digital flipbook media based on Balinese local wisdom demonstrated a very high level of practicality. The practitioners' assessment results achieved an average percentage of 98.91% with very practical criteria, while the results of the practicality test by students achieved an average percentage of 98.98% with very practical criteria.

Table 5. Normality Test**Tests of Normality**

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PRE	.157	60	.001	.961	60	.055
POST	.153	60	.001	.963	60	.063

a) Lilliefors Significance Correction

PRE variable: The Sig. value is 0.055. Since $0.055 > 0.05$, it can be concluded that the data for the PRE variable is normally distributed. POST variable: The Sig. value is 0.063. Since $0.063 > 0.05$, it can be concluded that the data for the POST variable is also normally distributed.

Table 6. Homogeneity Test
Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Prestasi Belajar	Based on Mean	.011	1	118	.916
	Based on Median	.007	1	118	.936
	Based on Median and with adjusted df	.007	1	117.78	.936
	Based on trimmed mean	.007	1	118	.934

Since the Sig. value is $0.916 > 0.05$, it can be concluded that the Learning Achievement data groups have equal variances, or are Homogeneous.



Table 7. t-test

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	PRETEST - POSTTEST	-14.917	.645	.083	-15.083	-14.750	-179.000	59	<.001

Conclusion of the Paired Sample T-Test: Since the Sig. (2-tailed) value is < 0.05 , H_0 is rejected and H_a is accepted. This means there is a very significant difference between the Pretest and Posttest results for Learning Achievement.

Table 8. Effect Size

Paired Samples Effect Sizes

		Standardizer ^a		Point Estimate	95% Confidence Interval	
					Lower	Upper
Pair 1	PRETEST - POSTTEST	Cohen's d	.645	-23.109	-27.270	-18.939
		Hedges' correction	.650	-22.962	-27.096	-18.818

a. The denominator used in estimating the effect sizes.

Cohen's d uses the sample standard deviation of the mean difference.

Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

The data show ideal results: homogeneous variances, a very significant difference ($p < 0.001$), and a very large effect size. It can be concluded that the learning method tested is highly effective in improving learning achievement.

Discussion

The digital flipbook media based on Balinese local wisdom developed in this research has proven to be feasible, practical, and effective for use in science learning for fifth-grade elementary school. The evaluation was conducted by administering an initial test (pretest) before using the media and a final test (posttest) after learning using the digital flipbook media. The results of the data analysis showed a significant increase in students' science learning achievement after using the media. The effect size calculation results indicated that the digital flipbook media had a strong impact on improving student learning achievement. These findings indicate that the media is not only statistically effective but also practically meaningful in supporting science learning.

This finding reinforces that the success of a learning innovation, whether in the form of a model or media, is determined not only by its novelty but also by its ability to facilitate students' active and reflective thinking processes. The digital flipbook media based on Balinese local wisdom developed in this research provides a contextual, systematic, and visual-interactive learning experience, thereby being able to support the process of knowledge construction more meaningfully.

The effectiveness of the Balinese local wisdom-based digital flipbook can also be explained through contemporary cognitive educational psychology theories, particularly Cognitive Load Theory proposed by Sweller and Multimedia Learning Theory developed by Mayer. According to Cognitive Load Theory, effective learning media should help students process information without imposing excessive extraneous cognitive load (Mayer, 2021; Sweller, 1988). In this study, the use of digital visualization, contextual illustrations, and familiar cultural examples helped students understand ecosystem concepts more easily because abstract ideas such as biotic and abiotic interactions were presented through local contexts that were already close to their daily lives. The integration of *Tri Hita Karana*, *Tumpek Uye*, *Tumpek Wariga*, animals, plants, water, soil, sunlight, and the surrounding environment enabled students to connect new scientific information with their existing knowledge schemas. Therefore, the digital flipbook did not merely present science content



visually, but also organized information in a culturally meaningful way that reduced unnecessary cognitive processing and supported meaningful understanding.

Furthermore, the findings are consistent with Multimedia Learning Theory, which emphasizes that students learn more effectively when verbal information is combined with relevant visual representations. The digital flipbook provided text, images, illustrations, contextual examples, and evaluation activities that supported students in processing ecosystem material through both verbal and visual channels. This combination allowed students to build stronger mental representations of the relationships among living organisms, non-living components, and environmental balance. In this context, Balinese local wisdom functioned as a cognitive bridge between students' cultural experiences and scientific concepts. Thus, the improvement in students' science learning achievement after using the digital flipbook can be understood as the result of media design that supports cognitive processing, reduces extraneous load, and facilitates meaningful multimedia learning.

This finding confirms that digital flipbook media can serve as a flexible, accessible, and practical learning resource for elementary science learning. The interactive and visual features of the flipbook help teachers present science material more systematically, while also enabling students to learn through contextual illustrations, local examples, and independent exploration. This supports previous findings that digital flipbook media is easy to use, adaptable to different learning styles, and practical to implement in elementary school science learning (A'yun et al., 2024; Andriani et al., 2024; Suciartini et al., 2025; Usman et al., 2024). In addition, the effectiveness of the developed media is strengthened by the learning flow that guides students to observe, understand, and reflect on ecosystem concepts through contextual activities. This is consistent with previous studies showing that guided and inquiry-oriented learning experiences are more effective than conventional learning in improving elementary students' science learning achievement and scientific literacy (Arisandhi et al., 2023; Kusumaningtyas & Sunarso, 2024).

Practically, in order for the digital flipbook media based on Balinese local wisdom to be used optimally in learning, readiness of supporting facilities and infrastructure is required, such as the availability of digital devices (laptops, tablets, or smartphones), adequate access to electricity and internet networks, as well as the teacher's basic ability to operate digital media. The digital flipbook media based on Balinese local wisdom has implications for supporting contextual and student-centered learning. The integration of local culture makes the ecosystem material closer to students' daily experiences, thereby being able to increase interest, engagement, and learning achievement. This media can also be utilized as an independent learning resource or as a supporting medium for face-to-face learning and technology-based learning.

Conclusion

This study successfully developed a digital flipbook media on ecosystem topics by deeply embedding Balinese local wisdom frameworks, such as *Tri Hita Karana*, *Tumpek Wariga*, and *Tumpek Uye*. Developed systematically through the ADDIE model, the digital media was proven to be highly valid based on media expert validation of 96% and material expert validation of 95.99%, as well as exceptionally practical for elementary school teachers and students, with practicality scores of 98.91% and 98.98%, respectively. The effectiveness test also showed that the use of the digital flipbook significantly improved fifth-grade students' science learning achievement, as reflected in the increase between pretest and posttest scores and the strong effect size. By translating abstract ecological concepts into



localized, context-rich narratives, this media effectively bridges modern primary science education with the preservation of Balinese cultural values. Therefore, the developed digital flipbook can be considered a feasible, practical, and effective learning medium that supports contextual science learning while strengthening students' ecological awareness and cultural identity.

The effectiveness test results showed that the use of the digital flipbook media based on Balinese local wisdom was able to significantly improve the science learning achievement of fifth-grade elementary school students. The improvement in learning outcomes was evident from the difference between pretest and posttest scores after using the media. The developed digital flipbook media was declared effective in improving students' science learning achievement.

Recommendation

For teachers, this digital flipbook media based on Balinese local wisdom can be used as an alternative science learning medium to increase student engagement and learning achievement, particularly on ecosystem material. Teachers are expected to be able to utilize this media optimally and integrate it with active, student-centered learning strategies.

For students, the digital flipbook media based on Balinese local wisdom is expected to be utilized independently or together with teachers to deepen their understanding of ecosystem concepts. Students are advised to use this media actively, read the material thoroughly, observe the illustrations and contextual examples presented, and work on the exercises and evaluations available so that their understanding and achievement in science learning can improve optimally.

For schools, the results of this research are expected to serve as a consideration in the development and utilization of digital learning media that integrate local wisdom as an effort to support contextual and meaningful learning in elementary schools. For future researchers, it is recommended to develop similar media for other science materials or for different subjects by expanding the integration of Balinese local wisdom or the local wisdom of other regions. Furthermore, subsequent research could be conducted on a larger scale or with a longer duration of media usage to obtain more comprehensive results.

For learning media developers, it is recommended to carry out further development by adding more diverse interactive features, such as simulations, educational games, or integration with online learning platforms, in order to enhance the quality and appeal of the digital flipbook media.

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