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DEVELOPMENT OF DIGITAL MATERIALS FOR CLASS 5 NATURAL AND SOCIAL SCIENCES LEARNING ORIENTED ON DANU KERTHI LOKA BALI

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Abstrak
Tujuan penelitian ini adalah untuk mengembangkan bahan pembelajaran digital berbasis Danu Kerthi Loka Bali guna meningkatkan prestasi belajar siswa kelas V di tingkat sekolah dasar pada pendidikan IPAS. Pengembangan dilakukan dengan mempertimbangkan kebutuhan untuk mengintegrasikan kearifan lokal Bali, khususnya konservasi air dan lingkungan, melalui media pembelajaran yang kontekstual dan menarik. Penelitian ini menggunakan metode Penelitian dan Pengembangan dengan model ADDIE, yang meliputi analisis, desain, pengembangan, implementasi, dan evaluasi. Penelitian ini dilakukan dengan partisipasi siswa kelas V, guru, dan ahli media dan bahan pembelajaran. Data dikumpulkan menggunakan validasi wawancara, kerja lapangan, dan pretest-posttest. Analisis data dilakukan menggunakan ringkasan kuantitatif, ANCOVA, dan N-Gain. Hasil penelitian menunjukkan validasi produk berada pada kategori sangat valid pada aspek media dan materi. Uji kepraktisan ke guru dan murid menunjukkan kategori sangat praktis,. Efektivitas produk dibuktikan melalui peningkatan sikap peduli lingkungan pada kelas eksperimen dengan N-Gain yang dikategorisasikan cukup efektif, lebih tinggi dibandingkan dengan kelas kontrol yang terkatagori kurang efektif, serta hasil ANCOVA menunjukkan perbedaan yang signifikan. Dengan demikian, bahan ajar digital yang dikembangkan efektif mendukung penguatan sikap peduli lingkungan siswa.

Kata Kunci: Danu Kerthi Loka Bali; IPAS; Sikap; Peduli Lingkungan; Sekolah Dasar

Abstract
The purpose of this study is to develop digital learning materials based on Danu Kerthi Loka Bali to improve the learning achievement of fifth-grade elementary school students in science education. The development was carried out by considering the need to integrate Balinese local wisdom, especially water and environmental conservation, through contextual and engaging learning media. This study used the Research and Development method with the ADDIE model, which includes analysis, design, development, implementation, and evaluation. This study was conducted with the participation of fifth-grade students, teachers, and media and learning material experts. Data were collected using interview validation, fieldwork, and pretest-posttest. Data analysis was carried out using quantitative summaries, ANCOVA, and N-Gain. The results showed that the product validation was in the very valid category in the media and material aspects. The practicality test for teachers and students showed a very practical category. The effectiveness of the product was proven by the increase in environmental awareness in the experimental class with N-Gain which was categorized as quite effective, higher than the control class which was categorized as less effective, and the ANCOVA results showed a significant difference. Thus, the developed digital teaching materials effectively support the strengthening of students' environmental awareness..

Keywords*: Danu Kerthi Loka Bali; IPAS; Attitude; Environmental Care; Elementary School*

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INTRODUCTION

Education plays a crucial role in developing generations who are not only intellectually capable but also possess noble character and concern for the environment and local culture (Akhyar et al., 2023; Hardiyanto et al., 2024). Environmental awareness is an essential character trait that needs to be instilled in children from an early age because it influences their behavior related to cleanliness, environmental conservation, and responsibility toward surrounding ecosystems (Amelia & Prasetyo, 2022).

These conditions have a significant impact on the educational process in schools. The Natural and Social Sciences (IPAS) curriculum in elementary schools seeks to enhance environmental awareness and scientific literacy (Rahmayati & Prastowo, 2023). IPAS educates students about the relationship between humans and their social and physical environments, as well as human responsibility to preserve nature. However, Indonesian students' scientific literacy achieved a score of only 383 in the 2022 PISA assessment, which is far below the OECD average of 485 (Wijaya et al., 2024). Beyond conceptual knowledge, weak scientific literacy is associated with poor critical thinking skills and indifferent attitudes toward environmental issues (Atiaturrahmaniah et al., 2022; Qondias et al., 2022).

Helping elementary school students develop sensitivity toward the environment remains challenging. According to data from the Center for Educational Assessment of the Ministry of Education, Culture, Research, and Technology (2023), only 42% of elementary school students voluntarily care about classroom cleanliness, while teachers still need to remind the remaining students. According to a 2021 LIPI study, more than 60% of elementary school children in Indonesia continue to litter both inside and outside school environments. Similar observations were also reported by UNESCO (2022), indicating that Indonesian children's ecological awareness remains low, particularly in terms of waste management, water conservation, and energy conservation. More than half of elementary school students in Bali are still unaware of the importance of protecting water resources, such as lakes, as essential components of community life (Koster & Ramantha, 2022; Tarisna et al., 2023).

Based on initial observations, students still do not understand the ecological significance of lakes and are unable to articulate the role of lakes as sources of water, regulators of ecosystem balance, and support systems for communities. Although trash bins are available, several children were found to have a tendency to litter, indicating a lack of engagement in environmentally responsible behavior. In addition, some students placed plastic containers and food leftovers under desks. Several students cleaned classrooms only when instructed by teachers, demonstrating limited involvement in environmental conservation and cleanliness. Students often participate passively in school community service projects or environmental cleanliness initiatives, showing little initiative and a tendency to wait for directions.

Another issue lies in the traditional character of science teaching and science education. According to interviews conducted by Lieutenant Colonel Wisnu with fifth-grade teachers in Cluster V, lectures and textbooks still dominate instruction, causing students to quickly lose interest, become less engaged, and lack opportunities for interactive learning. Despite the importance of introducing local knowledge from an early age to help children better understand the surrounding sociocultural realities, educators also highlighted the lack of digital teaching resources that integrate local values.

As a result of these conditions, students are unable to fully understand the relationship between humans and the environment, leading to inadequate scientific literacy and weak environmental awareness. Students often merely memorize scientific concepts without being able to relate them to real-world environmental issues. Furthermore, this situation contributes to low environmental

awareness, which affects students' daily behavior and makes them less environmentally conscious. Littering, poor classroom cleanliness, and lack of concern for natural resources such as water and lakes are indicators that children have not internalized ecological values. Because children lack understanding from an early age, this condition may exacerbate environmental degradation in the future.

The concept of *Danu Kerthi*, a teaching about the preservation and protection of lakes as sources of life within the Sad Kerthi philosophy, represents one form of Balinese local wisdom that is relevant to be integrated into science education (Prasada et al., 2024). *Danu Kerthi* emphasizes the importance of protecting lakes as sources of water, livelihoods, and ecological balance (Koster & Ramantha, 2022). Unfortunately, these noble values are still rarely found in elementary school learning materials, particularly in interactive digital formats that align with the needs of contemporary students (Paramita et al., 2025; Udayani et al., 2021).

Digital learning resources have been shown to effectively increase students' attention and understanding, according to several previous studies (Fernández-Batanero et al., 2021; Ramadhani et al., 2023; Widiyasari et al., 2024). However, most studies do not incorporate local content as a primary focus and instead concentrate mainly on media or technical issues. In fact, integrating local content into educational materials is crucial for enhancing learning relevance and developing students' environmental awareness (Arisandhi et al., 2023; Meirbekov et al., 2022; Rakhman et al., 2023).

Digital teaching resources provide students with a deeper understanding of interactions between humans and the environment through interactive, visual, and contextual presentations (Magdalena et al., 2020). To help students not only memorize information but also apply it to real-world environmental issues, previously abstract science topics can be presented in the form of images, animations, videos, and simulations (Dewi et al., 2025; Widiyasari et al., 2024).

Through the integration of local wisdom values, such as those embodied in *Danu Kerthi*, digital learning materials are expected to contribute to environmental awareness while also enhancing conceptual understanding. Digital learning resources can offer learning environments that are relevant to the lives of Balinese students by emphasizing lakes as sources of life that must be preserved. Students can understand the ecological and cultural significance of lakes through the presentation of stories, images, and interactive activities centered on *Danu Kerthi*. As a result, these values are not only learned cognitively but also internalized as attitudes and actions.

Consequently, there is a research gap in the development of digital teaching resources based on traditional knowledge, particularly those related to Balinese *Danu Kerthi* values. Therefore, this study aims to evaluate the level of validity of the developed digital teaching materials, analyze media design for the development of digital teaching materials focused on Balinese *Danu Kerthi Loka*, and investigate their usefulness in supporting the learning process. In addition, this study seeks to assess the effectiveness of developing digital teaching resources centered on Balinese *Danu Kerthi Loka* in improving fifth-grade students' understanding of environmental issues in Cluster V, Letkol Wisnu.

METHOD

This study employed a Research and Development (R&D) method to create digital teaching materials oriented toward *Danu Kerthi Loka* Bali and to assess their validity, practicality, and effectiveness in improving fifth-grade students' environmental awareness in science education. The ADDIE development model was applied, consisting of five stages: analysis, design, development, implementation, and evaluation. The analysis stage involved observations and teacher interviews to

identify curricular needs, student characteristics, learning environments, and media used. The design phase produced a plan for the water cycle material flow, interface layout, learning objectives, interactive activities, and exercises aligned with the values of *Danu Kerthi Loka* Bali. The development phase comprised the creation of the product and research instruments, while the implementation phase included expert validation and field trials. The evaluation phase involved revisions based on expert suggestions, user feedback, and attitude measurement data.

This research was conducted in Cluster V, Letnan Kolonel Wisnu, involving two validators, three fifth-grade teachers, and seven students as subjects for practicality testing, as well as effectiveness testing with 31 students in the experimental class (SD Peguyangan 12) and 31 students in the control class (SD Peguyangan 6). The instrument trial involved 31 students from SD Peguyangan 10. The study utilized a 1–4 Likert Scale questionnaire (Resi, 2021) and a pretest–posttest design to assess environmental care attitudes. Data were analyzed descriptively and inferentially. Validity was determined using the Gregory formula (Arikunto, 2019), practicality was assessed through mean scores and category conversion, and product effectiveness was analyzed through improvements in environmental care attitude scores using ANCOVA and N-Gain to determine posttest differences between experimental and control classes after controlling for initial ability (Darma, 2021). The calculation of environmental care attitude improvement was analyzed using the N-Gain formula based on Hake (1998), with categorizations of high ($g \geq 0.70$), medium ($0.30 \leq g < 0.70$), and low ($g < 0.30$).

RESULT

The design process produced the first draft of digital teaching resources that incorporate local knowledge from *Danu Kerthi Loka* Bali. The materials were developed based on a needs analysis, student profiles, curriculum demands, and the cultural values to be integrated into learning. At this stage, the learning objectives were refined to align more closely with the Science Learning Outcomes of Phase C, with a focus on developing students' understanding of the water cycle, the importance of water resource conservation, and the formation of environmentally conscious attitudes. The learning materials were presented in a flipbook format and structured progressively to illustrate various levels of environmental learning, beginning with fundamental concepts of the water cycle, its relationship with aquatic habitats, and the impact of environmental changes on water supply. The content was organized methodically so that it not only conveyed knowledge but also encouraged students to investigate, draw conclusions, and enhance their awareness of environmental conservation.

The design process also included the development of the visual and technological features of the educational materials to reflect the characteristics of elementary school-aged children. The media presentation was developed using child-friendly images, attractive yet comfortable colors, and a simple page layout to reduce complexity and ensure ease of understanding. To minimize the burden on children's reading abilities, the language was designed using short and conversational phrases. The media format was selected to use HTML5 output to ensure compatibility with laptops, projectors, and other digital devices in the classroom, while also allowing the integration of interactive elements such as navigation buttons, page transitions, and learning aids. Furthermore, the design stage encompassed more complex design activities, such as compiling learning task lists, developing specific learning objectives, creating assessment instruments to measure environmental awareness, and determining the learning methodologies to be applied. All of these components were then presented in tabular form, ensuring that the media design flow was clear and well directed. The results of the media development are presented in Figure 1.

Figure 1. Product Design Results

Based on Figure 1, the results of the development of digital teaching materials incorporating the local wisdom of *Danu Kerthi Loka* Bali are presented through systematically arranged panels in accordance with the product design. These panels begin with a cover entitled Candra Danu, featuring *Danu Kerthi* illustrations that emphasize Balinese cultural identity, followed by a narrative preface written in communicative language and a mind map that serves as a guide for navigating the material. The structure of the teaching materials includes a preface, mind map, learning materials, activities and tasks, reflection, gallery, acknowledgements, and developer profile. The materials presented cover *Danu Kerthi* values, human activities and their impacts on the environment, environmental conservation efforts, the water cycle, and water resources, all delivered visually and interactively to facilitate understanding for fifth-grade students. The activities and tasks section is designed contextually through exercises, observations, discussions, and simple projects to connect science concepts with everyday experiences, while the reflection section helps students evaluate their understanding and foster a commitment to environmentally responsible behavior. Overall, these digital teaching materials function as comprehensive, engaging learning media that integrate local culture and align with the learning needs of elementary school students.

The results of the analysis indicate students' need for engaging, visual, and contextual media; alignment with the cognitive developmental characteristics of fifth-grade students; achievement of Phase C learning objectives in Natural Sciences; and the application of *Danu Kerthi Loka* Bali values. The design process produced digital teaching resources that incorporate narrative elements, child-friendly graphics, communicative language, structured storylines, and cultural values. The development phase resulted in HTML5-based digital teaching materials with a systematic panel structure, complete and relevant content, tasks, experiments, and reflective questions.

The validity of the digital teaching resources was tested in terms of learning media, instructional content, and language. Two experts with expertise in *Danu Kerthi Loka* Bali media issues evaluated the accuracy of the media content. Based on the results of media and content validity, the digital teaching materials incorporating the local wisdom of *Danu Kerthi Loka* Bali obtained an average media validity score of 1, indicating that both experts considered all media-related indicators to be relevant and highly valid. The material aspect achieved an average score of 0.96, meaning that one expert considered one indicator in the material component to be irrelevant, while the other expert considered it relevant. Despite this difference, the overall review assessed the content component as highly valid.

The digital teaching resources incorporating the local wisdom of *Danu Kerthi Loka* Bali, which had been validated by experts, were then tested with students as end users to ensure their suitability for learner needs. Table 1 presents the results of the practicality trials conducted with teachers.

Table 1. Results of the Practicality Test by Teachers

Statistic	Teacher 1	Teacher 2	Teacher 3
Score	3,87	3,80	3,93
Average	3,87		
Category	**Very Practical**		

Based on Table 1, the digital teaching resources intended for *Danu Kerthi Loka* Bali received positive reactions from teachers. Teacher assessments yielded an average score of 3.87, placing them in the Very Practical category. Furthermore, student practicality assessments yielded an average score of 3.90, placing them in the Very Practical category. Overall, these findings indicate that the digital teaching tools are highly practical and suitable for use in science and technology learning. Teachers and students had similar scores, indicating that the tools were well-received by both educators and students. After assessing the feasibility of the resulting learning materials, an effectiveness test was conducted, which yielded the following findings.

Table 2. ANCOVA Test Results

Tests of Between-Subjects Effects

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	197089346.330[a]	2	98544673.165	160.104	0.000	0.838
Intercept	7978167.589	1	7978167.589	12.962	0.001	0.173
Pretest	132177028.703	1	132177028.703	214.746	0.000	0.776
Kelas	8076875.922	1	8076875.922	13.122	0.001	0.175
Error	38161207.517	62	615503.347			
Total	3185686025.000	65				
Corrected Total	235250553.846	64				

a. R Squared = 0.838 (Adjusted R Squared = 0.833)

Referring to Table 2, the results of the ANCOVA hypothesis test indicate that the learning model affects posttest outcomes after being adjusted for pretest scores. The findings show that the class variable, which represents differences in treatment between the experimental and control classes, has a highly significant effect on environmental care attitudes, with an F value of 13.122 and a significance value of 0.001, which is far below the 0.05 significance level. Furthermore, the pretest covariate variable demonstrates a substantial influence with an F value of 214.746 and a significance value of 0.000, indicating the relevance of initial ability in determining final outcomes. Overall, the ANCOVA model contributes significantly to the variation in the data (R Squared = 0.838), suggesting that the use of digital teaching materials oriented toward Danu Kerthi Loka Bali significantly enhances students' environmental awareness and attitudes toward water cycle material compared to traditional learning.

The N-Gain test was used to assess the level of improvement in environmental awareness in each group. The N-Gain calculation summarizes the relative efficiency of digital learning resources oriented toward *Danu Kerthi Loka* Bali in enhancing students' environmental awareness. The results of the N-Gain test are presented in Table 3.

Table 3. N-Gain Test Results

Statistic	Group	
	Experiment	Control
Mean	0.43	0,21

Table 3 shows the results of the N-Gain test for the experimental group, which had an average N-Gain value of 0.43, indicating high efficacy. Meanwhile, the control group had an average N-Gain value of 0.21, which is classified as less effective. Overall, our findings indicate that digital learning materials adapted to Danu Kerthi Loka Bali were significantly more successful in raising environmental awareness.

DISCUSSION

The development of digital teaching resources incorporating local wisdom of *Danu Kerthi Loka* Bali aims to enhance environmental awareness among fifth-grade elementary school students during science instruction on the water cycle. The product development was conducted to address learning gaps identified during the analysis phase while simultaneously strengthening contextual learning in accordance with curriculum requirements. The resulting digital teaching materials are intended to be visually appealing and functionally effective as learning tools capable of increasing students' awareness of the importance of protecting water resources and the environment. Integrating the IPAS curriculum with the principles of *Danu Kerthi Loka* Bali is expected to foster attitudes and practices of environmental conservation in everyday life.

The digital educational materials were designed using the systematic ADDIE methodology, which includes the analysis, design, and development stages. The analysis phase revealed that fifth-grade students are in the concrete operational stage, requiring media that convey concepts concretely through images, consistent sequencing, and simple language. This condition aligns with Piaget's view that concrete and visual representations help elementary school students learn concepts more effectively. The use of digital flipbook-based media is considered appropriate because it can integrate water cycle concepts with images and activities relevant to students' experiences. Bruner's theory also suggests that iconic or visual representations help children understand information more quickly before they can comprehend abstract concepts independently. The needs analysis results indicated that students' environmental awareness needs improvement, and their understanding of local cultural values, particularly *Danu Kerthi Loka* Bali, remains insufficient. Therefore, it is essential to provide learning media that not only deliver information but also instill values (Laksana, 2024; Prabawati & Utami, 2024).

The Phase C Science Curriculum requirements guide instruction so that students acquire scientific thinking skills, reasoning abilities, and awareness of the relationship between humans and their environment. Science and science education emphasize not only content knowledge but also scientific thinking through observation, reasoning, and ecologically responsible decision-making (Antari et al., 2023). Consequently, the digital teaching materials not only provide knowledge about the water cycle but also incorporate reflective aspects that help students apply these ideas to real-life situations and identify the impact of human behavior on water sustainability. The values of *Danu Kerthi Loka* Bali related to protecting, maintaining, and respecting water resources are integrated to strengthen ecological instruction and facilitate contextual learning. Scientific thinking is more easily developed when linked to situations relevant to students' lives and delivered through media adapted to the characteristics of younger generations (Rosnaeni, 2021). Integrating local cultural values into digital teaching resources helps students connect scientific concepts with their own social and cultural contexts.

The design process resulted in the first draft of digital teaching resources featuring local wisdom of *Danu Kerthi Loka* Bali. These materials were developed based on needs analysis, student profiles, curriculum demands, and the cultural values to be integrated. Learning objectives were formulated in accordance with Phase C Science Learning Outcomes, focusing on understanding the water cycle, conserving water resources, and fostering environmentally conscious mindsets. The media design

was structured in a flipbook style with gradual information presentation, beginning with basic concepts of the water cycle, its relationship with aquatic ecosystems, and the impact of environmental changes on water availability. The information was organized to encourage progressive knowledge development and higher-order thinking skills through tasks such as cause–effect analysis, drawing conclusions, and taking action. Thus, the flipbook functions both as a visual aid and as a teaching tool that enriches the learning process.

Visual aspects are crucial because elementary school students respond positively to media that are engaging and easy to understand. Child-friendly illustrations with attractive yet comfortable colors, minimal page layouts to reduce clutter, and consistent illustration styles are employed to maintain students' focus. The language used is concise and communicative, making it easy to understand while preserving meaning. The media format utilizes HTML5 output because it is compatible with laptops, projectors, and other digital classroom devices and allows interactive navigation such as page flipping and flexible access to materials. Selecting an appropriate digital format is important because it accommodates both guided and independent learning and meets the demands of twenty-first-century education.

Previous studies have confirmed the effectiveness of digital learning materials based on local wisdom, supporting the integration of media design. Digital learning resources that incorporate local culture can enhance student engagement, improve content comprehension, and foster positive attitudes toward the environment and culture (Fanani et al., 2022; Ramadhani et al., 2023; Yulisetiani, 2022). Local context makes learning more meaningful because students perceive the subject matter as relevant to their lives. This concept aligns with contextual learning, which emphasizes applying content to real-life situations. The principles of *Danu Kerthi Loka* Bali embedded in the flipbook provide a cultural framework for learning about the water cycle and promote water conservation among students.

The development phase culminated in the creation of the actual digital learning materials as envisioned. The package includes a cover, foreword, concept map, main content, exercises or tasks, small experiments, and reflection. This framework is designed to follow the flow of scientific learning, guiding students step by step through the topic. Water cycle information is presented through text, graphics, contextual examples, and critical thinking exercises. The values of *Danu Kerthi Loka* Bali are visualized through images, symbols, and narratives, emphasizing the importance of water conservation, environmental purity, and human impact on nature. Strong visual components enhance student engagement and attention during learning. Digital learning resources with attractive visual designs can increase student motivation, concentration, and comprehension by facilitating information processing (Fajjriah et al., 2023; Juniati et al., 2023; Muflikatun et al., 2021). The materials in this study align with these findings, as they are designed not only to be visually appealing but also to support students' understanding of the subject matter.

Cultural values are integrated into everyday experiences, allowing students to understand environmental themes organically. Presenting cultural values in situations close to students' lives is a vital method because these values are embedded in scenarios that students can imagine and experience, rather than being communicated only theoretically. Digital teaching tools based on local culture can enhance cultural understanding while improving learning outcomes (Akayoglu et al., 2020; Padmini et al., 2022; Wibowo et al., 2023). The reflection section in the flipbook encourages students to evaluate their actions and internalize values, leading to the development of environmentally conscious individuals (Alarcón et al., 2020). Reflective activities also support higher-order thinking skills by prompting students to examine, assess, and develop specific actions.

Before implementation, the designed product was validated for practicality and quality through expert validation. Validation is essential to determine whether the media meet acceptable content, presentation, and language criteria for elementary school students. Two specialists in learning media, science, and scientific content conducted the validation, ensuring that both technical and pedagogical aspects were evaluated. Media feasibility was assessed based on presentation quality, content relevance to learning objectives, and language clarity (Bergvall & Dyrvold, 2021; Murni & Jannah, 2022; Pitriani et al., 2021). Expert assessments in this study emphasize media and material characteristics as key components of digital learning quality.

The validation results indicate that the digital learning materials are highly valid, with an average score of 1 for the media aspect and 0.98 for the material aspect. These findings demonstrate that the visual appearance, layout, navigation, and flipbook design meet the requirements for interactive learning media for elementary school students. The alignment of the materials with IPAS Phase C Learning Outcomes is also rated very highly, incorporating relevant and contextual *Danu Kerthi Loka* Bali values. High validity indicates that the product is suitable for use in subsequent stages, namely practicality and effectiveness testing.

Feedback from experts was used to improve the product, particularly by adjusting font colors to enhance readability and including supporting materials in the form of video recordings to strengthen content context. Readability is critical, as inappropriate combinations of font and background colors can reduce reading comfort. Revisions included font color changes, identification of authors and supervisors, and the addition of supporting items. These modifications align with the ADDIE concept, which emphasizes product development based on expert feedback to maximize quality.

The validated product was then evaluated for usability to ensure that it is easy for teachers and students to use in real classroom settings. Practicality is crucial because even valid media may be ineffective if they are difficult to use. Practicality testing involved end users such as students and teachers. Effective learning media must be practical, user-friendly, and provide engaging experiences that support learning objectives (Azmi et al., 2024; Munawaroh et al., 2021; Valverde-Berrocoso et al., 2021). Practicality refers to ease of access, time efficiency, and the ability of the media to assist teachers in delivering content more clearly.

Individual trials produced a student response rate of 96%, indicating that the media are easy to use, visually engaging, with simple navigation and understandable content. Interactive visual media can increase student engagement by stimulating reading and investigation (Badaruddin et al., 2022; Suprianto, 2020). Small group trials yielded very good results, with a score of 97%, indicating that the media remain effective when used in collaborative learning. These findings are consistent with previous studies showing that digital learning materials are suitable for collaborative learning because visualization encourages discussion and active understanding (Fanani et al., 2022; Yulisetiani, 2022).

The average teacher assessment score was 3.87, indicating that the materials are highly practical. Teachers reported that the digital teaching resources are easy to use, relevant, and more effective in the learning process. The media help students better understand water cycle concepts and environmental values through images and exercises. High practicality indicates that the materials are suitable for daily instructional use and ready for effectiveness evaluation.

The effectiveness of the digital learning tools was examined to determine whether they have a significant impact on students' environmental awareness. The testing involved comparing pretest and posttest results and conducting inferential analysis using ANCOVA. Descriptive analysis

showed an increase in environmental awareness scores from 62.00 to 77.84. This improvement indicates that the digital learning tools enhance students' knowledge of water and environmental conservation. Effective learning media improve student understanding by presenting information more clearly (Juniati et al., 2023). The observed improvement suggests that the media can accommodate diverse student needs because the visuals and simple language make it easier for students to follow the learning process.

The N-Gain calculation yielded an average of 0.43, classified as moderately effective. This result indicates a positive shift following the use of the digital learning materials, although the effect could be further enhanced through habituation and long-term use. ANCOVA analysis confirms this conclusion, with an F value of 13.122 and a significance level of 0.001, indicating that the treatment made a substantial contribution to improving environmental awareness after controlling for students' initial abilities. An R-squared value of 0.838 indicates that the model explains 83.8% of the variance in environmental awareness improvement, demonstrating that the digital teaching materials have a significant impact.

The digital teaching materials meet pedagogical, aesthetic, and functional standards and effectively integrate science content with local cultural values. Media tailored to student characteristics, curriculum demands, and cultural backgrounds can facilitate effective learning experiences. The media play a role in shaping attitudes and values through contextual learning experiences, as evidenced by the statistically significant growth in environmental awareness. Digital teaching materials oriented toward *Danu Kerthi Loka* Bali are appropriate for use as innovative alternative learning media for fifth-grade science and have the potential to be expanded to cover other topics, thereby promoting broader and more sustainable environmental awareness.

CONCLUSION

The ADDIE model has successfully produced an HTML5-based digital book that is systematic, contextual, and aligned with the characteristics of elementary school students as well as the demands of Phase C Science Learning Outcomes, enabling media design to integrate water cycle concepts with environmental conservation values of *Danu Kerthi Loka* Bali. The product feasibility was also proven to be very high based on expert validation results, which confirmed that the media, content, and language aspects met the criteria of being highly valid after revisions were made in response to validator feedback, indicating that the digital teaching materials are appropriate for use in learning. The practicality of media use was reinforced by feedback from teachers and students, which fell into the very practical category, demonstrating that the media are easy to use, engaging, and able to facilitate the learning process both individually and in groups. The effectiveness of the digital learning materials was also demonstrated by an increase in students' environmental awareness attitudes, which were classified as moderately effective based on the N-Gain value and statistically significant differences after treatment, indicating that the media have a tangible impact on shaping environmental awareness attitudes. These findings indicate that digital teaching materials oriented toward *Danu Kerthi Loka* Bali have the potential to be further developed by adding various interactive features, expanding their application to other science topics and materials, and testing their effectiveness over a longer period, thereby enabling the formation of more sustainable environmental awareness attitudes.

REFERENCES

Akayoglu, S., Satar, H. M., Dikilitas, K., Cirit, N. C., & Korkmazgil, S. (2020). Digital literacy practices of Turkish pre-service EFL teachers. *Australasian Journal of Educational Technology, 36*(1), 85–97.

Akhyar, M., Deliani, N., Batubara, J., & Gusli, R. A. (2023). Studi analisis pendidikan budaya alam Minangkabau terhadap pembentukan karakter anak di sekolah dasar. Idarah Tarbawiyah: *Journal of Management in Islamic Education, 4*(2), 193–206.

Alarcón, R., Del Pilar Jiménez, E., & de Vicente-Yagüe, M. I. (2020). Development and validation of the DIGIGLO, a tool for assessing the digital competence of educators. *British Journal of Educational Technology, 51*(6), 2407–2421.

Amelia, V., & Prasetyo, D. (2022). Pengelolaan Desa Wisata Berbasis Masyarakat sebagai Penguatan Ketahanan Pangan. *Jurnal Sosial Ekonomi Dan Humaniora*, 8, 550–556.

Antari, P. L., Widiana, I. W., & Wibawa, I. M. C. (2023). Modul Elektronik Berbasis Project Based Learning Pembelajaran IPAS untuk Meningkatkan Hasil Belajar Siswa Sekolah Dasar. *Jurnal Ilmiah Pendidikan Dan Pembelajaran, 7*(2), 266–275.

Arikunto, S. (2019). *Prosedur Penelitian Pendidikan Suatu Pendekatan Praktik*. Rineka Cipta.

Arisandhi, G. A. M. M., Wibawa, I. M. C., & Yudiana, K. (2023). Flipbook: Media Pembelajaran Interaktif Untuk Meningkatkan Kognitif IPA Siswa Sekolah Dasar. *Mimbar PGSD Undiksha, 11*(1), 165–174. https://doi.org/10.23887/jjpgsd.v11i1.55034%0A%0A

Atiaturrahmaniah, A., Arnyana, I. B. P., & Suastra, I. W. (2022). Peran model science, technology, engineering, arts, and math (STEAM) dalam meningkatkan berpikir kritis dan literasi sains siswa sekolah dasar. *JPGI (Jurnal Penelitian Guru Indonesia), 7*(4), 368–375. http://dx.doi.org/10.29210/022537jpgi0005

Azmi, M. N., Mansur, H., & Utama, A. H. (2024). Potensi Pemanfaatan Virtual Reality Sebagai Media Pembelajaran Di Era Digital. *Jurnal Dimensi Pendidikan Dan Pembelajaran, 12*(1), 211–226.

Badaruddin, M. A., Abduloh, & Aminudin, R. (2022). Pengaruh Media Audio Visual Terhadap Ketepatan Teknik Shooting (Free Trhow) Permainan Bola Basket. *Jurnal Porkes, 5*(2), 369–377. https://doi.org/10.29408/porkes.v5i2.6386

Bergvall, I., & Dyrvold, A. (2021). A Model for Analysing Digital Mathematics Teaching Material from a Social Semiotic Perspective. *Designs for Learning, 13*(1), 1–7.

Darma, B. (2021). *Statistika Penelitian Menggunakan SPSS (Uji Validitas, Uji Reliabilitas, Regresi Linier Sederhana, Regresi Linier Berganda, Uji t, Uji F, R²)*. Guepedia.

Dewi, D. A. P., Arnyana, I. B. P., & Gading, I. K. (2025). Model Pembelajaran Kooperatif Tipe Jigsaw Berbantuan Media Konkret Terhadap Hasil Belajar IPAS Ditinjau dari Motivasi Berprestasi. *Journal of Education Action Research, 9*(2), 210–220.

Fajjriah, N., Atiqoh, A., & Hartono, H. (2023). Pengembangan E-Modul Ajar Informatika Untuk Meningkatkan Minat Belajar Dasar Program Keahlian SMK. JKTP: *Jurnal Kajian Teknologi Pendidikan, 6* (4), 218.

Fanani, A., Rosidah, C. T., Juniarso, T., Roys, G. A., Putri, E. S., & Vannilia, V. (2022). Bahan ajar digital berbasis multiaplikasi mata pelajaran IPAS SD. *Jurnal Pembelajaran, Bimbingan, Dan Pengelolaan Pendidikan, 2*(12), 1118–1175.

Fernández-Batanero, J. M., Román-Graván, P., Montenegro-Rueda, M., López-Meneses, E., & Fernández-Cerero, J. (2021). *Digital teaching competence in higher education: A systematic review. Education Sciences, 11*(11), 689.

Hardiyanto, L., Iriansyah, H. S., & Saryono, S. (2024). Landasan filosofis pendidikan budaya dan karakter bangsa. *Jurnal Citizenship Virtues, 4*(1), 733–741.

Juniati, G., Putrayasa, I. B., & Margunayasa, I. G. (2023). Pengembangan Bahan Ajar Digital Berorientasi Wana Kerthi Loka Bali pada Pembelajaran IPAS Kelas IV Sekolah Dasar. PENDASI *Jurnal Pendidikan Dasar Indonesia, 7*(1), 94–106. https://doi.org/10.23887/jurnal_pendas.v7i1.2018

Koster, W., & Ramantha, I. W. (2022). Ekonomi Kerthi Bali: Economic Transformation Based on Bali Nature, Human and Culture. *Journal of Positive School Psychology*, 7382–7392.

Laksana, D. N. L. (2024). Pengembangan Media Pembelajaran Literasi Dan Numerasi Berbasis Budaya Lokal Untuk Siswa SD Kelas Rendah. *JKTP: Jurnal Kajian Teknologi Pendidikan, 7* (1), 012.

Magdalena, I., Prabandani, R. O., Rini, E. S., Fitriani, M. A., & Putri, A. A. (2020). Analisis pengembangan bahan ajar. *Nusantara, 2*(2), 180–187. https://doi.org/10.36088/nusantara.v2i2.805

Meirbekov, A., Maslova, I., & Gallyamova, Z. (2022). Digital education tools for critical thinking development. *Thinking Skills and Creativity*, 44, 101023.

Muflikatun, M., Santoso, S., & Ismaya, E. A. (2021). Pengembangan bahan ajar digital berbasis microsoft sway untuk meningkatkan literasi sains siswa sekolah dasar. *PSEJ (Pancasakti Science Education Journal), 6*(2), 84–92.

Munawaroh, F. H., Janah, U. I. W., Suparno, A. D., Niswa, B., Mufidah, I., Sari, S. A., Firlintan, A. S., Apriliani, S., Fadhilah, D., & Wulandari, S. S. (2021). *Model dan media pembelajaran Bahasa Indonesia SD*. Scopindo Media Pustaka.

Murni, A. W., & Jannah, M. (2022). Pengembangan Media Pembelajaran Interaktif Berbasis Construct Two Pada Tema 2 Selalu Berhemat Energi Subtema 1 Kelas IV SD. *Jurnal Muassis Pendidikan Dasar, 1*(1), 10–17.

Padmini, N. M. W., Widiana, I. W., & Rati, N. W. (2022). Mini web linktree berbasis kearifan lokal Bali untuk meningkatkan literasi budaya siswa. *Jurnal Pendidikan Multikultural Indonesia, 5*(1), 39–49. https://doi.org/10.23887/jpmu.v5i1.49632

Paramita, N. made N. W., Lasmawan, I. W., & Kertih, I. W. (2025). Pengembangan Media Pembelajaran Interaktif Berbasis Web dengan Genially Materi Karakteristik Geografi Indonesia kelas V Sekolah Dasar. *JIIP - Jurnal Ilmiah Ilmu Pendidikan, 8*(1), 148–152. https://doi.org/10.54371/jiip.v8i1.6537

Pitriani, N. R. V., Wahyuni, I. G. A. D., & Gunawan, I. K. P. (2021). Penerapan Model Addie Dalam Pengembangan Media Pembelajaran Interaktif Menggunakan Lectora Inspire Pada Program Studi Pendidikan Agama Hindu. Cetta: *Jurnal Ilmu Pendidikan, 4*(3), 515–532. https://doi.org/10.37329/cetta.v4i3.1417

Prabawati, A. P. C., & Utami, D. D. (2024). Pengembangan Animasi Pembelajaran Berdiferensiasi Bagi Siswa Berkebutuhan Khusus Di Taman Kanak-Kanak. *JKTP: Jurnal Kajian Teknologi Pendidikan, 7*(3), 161–171.

Prasada, D. K., Nurjaya, I. N., Sulistyarini, R., & Muktiono, M. (2024). Sad Kerthi as a Legal Concept of Self-Determination for Indigenous People in Bali. *Human Rights in the Global South (HRGS), 3*(1), 25–52.

Qondias, D., Lasmawan, W., Dantes, N., & Arnyana, I. B. P. (2022). Effectiveness of Multicultural Problem-Based Learning Models in Improving Social Attitudes and Critical Thinking Skills of Elementary School Students in Thematic Instruction. *Journal of Education and E-Learning Research, 9*(2), 62–70.

Rahmayati, G. T., & Prastowo, A. (2023). Pembelajaran Ilmu Pengetahuan Alam Dan Sosial Di Kelas IV Sekolah Dasar Dalam Kurikulum Merdeka. *Elementary School Journal PGSD FIP Unimed, 13*(1), 16–25.

Rakhman, P. A., Rokmanah, S., & Fariha, S. (2023). Implementasi muatan lokal pencak silat di sd negeri lialang kota serang. EL-Muhbib *Jurnal Pemikiran Dan Penelitian Pendidikan Dasar, 7*(2), 257–267.

Ramadhani, D., Nurhasanah, A., & Fadillah, M. A. (2023). Pengembangan Bahan Ajar Berbasis Digital Menggunakan Aplikasi Heyzine Flipbooks Tentang Kesultanan Banten Abad Ke-17 Di Kelas X Smkn 2 Kota Serang. *Jurnal Inovasi Pembelajaran Di Sekolah, 4*(2), 388–402.

Rosnaeni, R. (2021). Karakteristik dan Asesmen Pembelajaran Abad 21. *Jurnal Basicedu, 5*(5), 4341–4350. https://doi.org/10.31004/basicedu.v5i5.1548

Suprianto, E. (2020). Implementasi media audio visual untuk meningkatkan kemampuan menulis teks eksplanasi. Trapsila: *Jurnal Pendidikan Dasar, 1*(02), 22–32. http://dx.doi.org/10.30742/tpd.v1i02.810

Tarisna, M. M., Suma, K., & Wibawa, I. M. C. (2023). Efektifitas e-lkpd berbasis project based learning pada muatan pembelajaran ipa di kelas v sekolah dasar. *Jurnal Ilmiah Pendidikan Profesi Guru, 6*(2), 276–287. https://doi.org/10.23887/jippg.v6i2.62088

Udayani, N. K. R. T. K., Wibawa, I. M. C., & Rati, N. W. (2021). Development of e-comic learning media on the topic of the human digestive system. *Journal of Education Technology, 5*(3), 472–481.

Valverde-Berrocoso, J., Fernández-Sánchez, M. R., Revuelta Dominguez, F. I., & Sosa-Díaz, M. J. (2021). The educational integration of digital technologies preCovid-19: Lessons for teacher education. *PloS One, 16*(8), e0256283.

Wibowo, E. W., Kanzunnudin, M., & Fathurohman, I. (2023). Efektivitas buku cerita bergambar berbasis budaya lokal untuk peningkatan ketrampilan membaca. *Jurnal Pendidikan Dasar, 11*(1), 131–137. https://doi.org/10.20961/jpd.v11i1.72264

Widiyasari, R., Astriyani, A., Ramadianti, W., & Kirana, D. A. (2024). Pengembangan Bahan Ajar Digital Matematika Berbasis Flip Pdf Corporate untuk Meningkatkan Kemandirian Belajar Mahasiswa. *Prosiding Seminar Nasional Penelitian LPPM UMJ*.

Wijaya, T. T., Hidayat, W., Hermita, N., Alim, J. A., & Talib, C. A. (2024). Exploring contributing factors to PISA 2022 mathematics achievement: Insights from Indonesian teachers. *Infinity Journal, 13*(1), 139–156.

Yulisetiani, S. (2022). *Merancang Bahan Ajar Digital Berwawasan Budaya Nusantara Untuk Pembelajaran Bahasa Indonesia Sekolah Dasar* (Vol. 1). Jejak Pustaka.