Enhancing Students' Science Literacy through *Megedong-Gedongan*: A Balinese Local Culture-based Flipbook

Ni Putu Sri Ratna Dewi[1,*] & I Made Citra Wibawa[1]

[1]Universitas Pendidikan Ganesha, Singaraja, Bali, Indonesia

*Correspondence: Universitas Pendidikan Ganesha, Jalan Udayana No.11 Singaraja, Bali 81116, Indonesia

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Abstract

This study investigates the effectiveness of the Balinese *megedong-gedongan* local culture-based flipbook in enhancing science literacy among students. This research aims to increase scientific literacy through flipbooks based on Balinese culture, especially *megedong-gedongan*. Mastery of scientific literacy opens the door to various job opportunities in science, technology, and innovation. In the digital and knowledge-based era, the demand for human resources with a strong understanding of science and technology continues to increase. Employing a quasi-experimental design with pre-test and post-test control groups, the study involved 47 Biology and Marine Affairs students at the Ganesha University of Education, Indonesia. The study used a valid and reliable scientific literacy test as an instrument. The results reveal that the Bali *megedong-gedongan* flipbook effectively improved science literacy. This is evidenced by a significant increase in student science test scores after using the flipbook. The data analysis results show that using *megedong-gedongan* Balinese culture-based flipbooks can significantly increase student scientific literacy. In addition, students more easily relate learning material to their daily lives, which impacts increasing scientific literacy. This research suggests that integrating local culture into science teaching materials can effectively increase scientific literacy among students.

Keywords: science literacy, *megedong-gedongan*, local culture, flipbook

1. Introduction

In recent years, the educational landscape has increasingly recognized the importance of science literacy as a cornerstone of informed citizenship and professional competence. Science literacy entails not only the understanding of basic scientific concepts but also the ability to apply these concepts to real-world problems, think critically, and engage in scientific discourse. However, achieving high levels of science literacy remains challenging, particularly in diverse cultural settings where traditional science education methods may not fully resonate with students' lived experiences and cultural backgrounds.

Balinese culture, rich in traditions and unique practices, offers a compelling case for exploring how local cultural elements can be integrated into science education to enhance learning outcomes. One such tradition is the *megedong-gedongan* ceremony, which celebrates pregnancy and the anticipation of new life (Damayanti, 2020; Wismayani & Dewi, 2022). This ceremony is imbued with cultural knowledge and practices related to health, biology, and nature. For instance, the ritual includes various traditional health practices and beliefs about the human body and its environmental connection. These elements provide a fertile ground for linking scientific concepts with cultural narratives, making science education more engaging and relevant to students in Bali.

The significance of this research lies in addressing the disconnect often observed between students' cultural contexts and the science curriculum. Traditional science education in many parts of the world, including Indonesia, tends to follow a one-size-fits-all model that may overlook the cultural diversity of the student population (Hanifha et al., 2023). This can lead to a lack of engagement and lower academic achievement among students who do not see their cultural identities reflected in the educational content. By integrating Balinese *megedong-gedongan* cultural elements into a science literacy flipbook, this research aims to bridge this gap, making science education more inclusive and effective.

Culturally responsive education is a pedagogical approach that recognises and utilises students' cultural backgrounds

as assets in the learning process (Gay, 2018; Mujahidin et al., 2023). This approach is based on the premise that learning is more meaningful and effective when students connect new information to their existing cultural knowledge and experiences. Research has shown that culturally responsive teaching strategies can improve student engagement, understanding, and achievement by making learning more relevant and relatable (Hastuti et al., 2020). In the context of science education, this means developing instructional materials that reflect the students' cultural practices and knowledge systems. The *megedong-gedongan* ceremony offers a unique opportunity to develop culturally responsive educational materials. This traditional Balinese ritual encompasses a wealth of cultural and scientific knowledge, including human biology, reproductive health, and ecological awareness (Ningrat, 2022). By embedding these elements into a science literacy flipbook, educators can create a resource that teaches scientific concepts and honours and leverages Balinese students' cultural heritage (Sanjayanti et al., 2022).

Despite the acknowledged importance of science literacy in fostering informed citizenship and professional competence, many students struggle to engage with and understand scientific concepts due to a lack of cultural relevance in traditional science education. Research indicates that culturally responsive education, which integrates students' cultural backgrounds into the learning process, can significantly enhance engagement and comprehension (Hanifha et al., 2023). However, existing solutions often fail to adequately bridge the gap between students' cultural contexts and the science curriculum. In Bali, the rich cultural tradition of the *megedong-gedongan* ceremony, which encompasses knowledge related to health, biology, and ecology, presents a unique opportunity to create more relevant and engaging science educational materials. Yet, despite the potential benefits, there is a paucity of research on leveraging such cultural practices to improve science literacy (Anas & Hasibuan, 2023; Andriani et al., 2023). This gap suggests that current educational strategies may not fully utilize cultural resources to enhance learning outcomes. Therefore, this research aims to develop and evaluate a flipbook based on the *megedong-gedongan* ceremony to assess its impact on science literacy among Balinese students. This study seeks a more practical approach to improving science literacy by addressing the cultural disconnect in science education, which remains a critical and unresolved issue.

The logic underpinning this research is grounded in the theory of culturally responsive education, which posits that students learn more effectively when their cultural backgrounds are acknowledged and integrated into the curriculum (Ladson-Billings, 1995; Gay, 2018). Traditional science education often fails to connect with the diverse cultural contexts of students, leading to disengagement and suboptimal learning outcomes. By contrast, culturally responsive teaching strategies leverage students' existing cultural knowledge as a bridge to new learning. In Balinese education, the *megedong-gedongan* ceremony offers a culturally rich and scientifically relevant context that can be used to teach various scientific concepts (Javani et al., 2019). This traditional ritual, deeply embedded in the local culture, includes elements of human biology, health practices, and ecological awareness, which can be seamlessly integrated into science lessons. By creating a flipbook based on this ceremony, the research aims to make science education more relatable and engaging for Balinese students, thereby enhancing their science literacy (Wiradnyana et al., 2022; Restiani & Margunayasa, 2023).

Moreover, this approach addresses the persistent issue of cultural disconnect in education. Despite numerous efforts to make education more inclusive, many strategies fail to fully integrate local cultural contexts into the learning process (Benu, 2019). Existing educational materials often overlook the rich cultural heritage of students, leading to a sense of alienation and disinterest in the subject matter. The proposed flipbook not only aims to improve understanding of scientific concepts (Anggrasari et al., 2021; Agustini et al., 2022; Darmawan et al., 2024) but also to foster a sense of cultural pride and identity among students (Anas & Hasibuan, 2023). By validating and incorporating their cultural practices into the curriculum, students will likely feel more connected to the material, enhancing engagement and retention. The research thus seeks to fill a critical gap in current educational practices by demonstrating the effectiveness of a culturally responsive educational tool in improving science literacy, offering a model that can be adapted and applied in other cultural contexts.

The potential benefits of this approach are manifold. First, it can enhance students' understanding of scientific concepts by presenting them in a familiar cultural context. Students who relate scientific ideas to their cultural practices and beliefs are more likely to grasp and retain these concepts (Nenotek & Benu, 2022; Andriani et al., 2023). Second, it can increase student engagement and motivation by making learning more enjoyable and relevant. Cultural narratives and traditional practices can be powerful tools for storytelling and contextualization, making science lessons more exciting and impactful (Putri et al., 2020). Third, it can foster a sense of cultural pride and identity among students, reinforcing the value of their cultural heritage in a modern educational setting (Verawati & Wahyudi, 2024).

This research has significant implications for educational policy and curriculum development, emphasizing the need to integrate local culture into educational materials, especially in multicultural and multilingual contexts like Indonesia. It suggests that policymakers and educators can use this approach to create more inclusive science curricula that reflect students' diverse cultural backgrounds, aligning with global educational goals prioritizing equity, inclusion, and the value of cultural diversity in learning. The study also contributes to science education and culturally responsive pedagogy by providing a case study on integrating the Balinese *megedong-gedongan* ceremony into a science literacy tool. This focus allows for a deeper examination of how traditional knowledge and scientific concepts can be combined to enhance learning (Purnawati, 2024). Additionally, the development of a flipbook as an innovative educational tool demonstrates the potential of integrating visual, textual, and interactive elements to engage students (Irfan et al., 2019; Nuha et al., 2021). This research fills existing gaps by addressing the cultural disconnect in science education through a concrete and contextually relevant tool. It sets the stage for further studies on integrating local cultural practices into educational materials.

2. Literature Review

Research on science literacy has extensively documented its importance for fostering critical thinking, problem-solving skills, and informed decision-making. Numerous studies have highlighted students' challenges in engaging with science education, mainly when presented in ways that do not connect with their cultural backgrounds. For example, studies have shown that culturally responsive education can significantly enhance students' academic performance and engagement by making learning more relevant to their experiences (Indrawati et al., 2023; Febrian et al., 2024). There has been a growing interest in incorporating local cultural elements into educational materials in Indonesia. Research by Hastuti et al (2020) explored local cultural narratives in primary education, finding that students showed improved comprehension and retention of material. However, these studies have primarily focused on primary education and have not specifically addressed the integration of local culture into science literacy materials. According to Sanjayanti et al (2022), the science learning model incorporating Balinese local wisdom positively impacts scientific literacy and character. As a result, this learning is suggested as a remedy that can be applied as a creative learning model.

The study on using flipbook teaching material showed its feasibility in learning (Roemintoyo & Budiarto, 2021). In conclusion, the studies flipbook developed can be used by students in an independent study (Dharmayanti et al., 2021; Hardiansyah & Mulyadi, 2022; Darmawan et al., 2024). The studies also demonstrated the efficacy of flipbooks as a tool for raising learning standards (Irfan et al., 2019; Rini et al., 2021; Rahmawati et al., 2022; Dewi et al., 2022; Marwan & Yuliantri, 2023). It is introducing references, evolving into a substitute medium for implementing successful teaching strategies, and revolutionizing the educational process—particularly in elementary schools.

Despite the positive outcomes associated with culturally responsive education, significant gaps remain in its application to science literacy, particularly at the middle school level. Most existing research has concentrated on broad cultural inclusivity without delving deeply into specific cultural practices and their direct application to scientific concepts. Additionally, while previous studies have emphasized the importance of cultural relevance, they have often lacked detailed evaluations of specific educational tools designed to integrate cultural elements into science curricula (Hanifha et al., 2023). This research aims to fill these gaps by focusing on the Balinese *megedong-gedongan* ceremony and developing a targeted educational tool—a flipbook—that directly incorporates this cultural practice to enhance science literacy among middle school students.

The theoretical foundation of this research is grounded in culturally responsive pedagogy (CRP), which is based on the principle that recognizing and valuing students' cultural backgrounds can enhance their academic success (Samuels, 2018). Culturally responsive pedagogy, as articulated by scholars like Ladson-Billings (1995) and Gay (2018) emphasizes the need for educational materials and teaching strategies that reflect and respect the diverse cultural identities of students. This approach is supported by constructivist learning theories, which argue that learners construct new knowledge more effectively when connected to their prior experiences and cultural contexts. By incorporating the *megedong-gedongan* ceremony into a science literacy flipbook, this research leverages these theoretical principles to create a more engaging and effective learning tool.

3. Research Method

This research employed a quasi-experimental design with pre-test and post-test control groups. The experimental group utilized a Balinese megedong-gedongan culture-based flipbook as a teaching resource, while the control group

relied on standard science materials. This setup enabled a comparison of the flipbook's effectiveness in improving science literacy. Additionally, a quasi-experimental design with pre-test and post-test control groups was conducted at Ganesha University of Education with 47 Biology and Marine Affairs students. A variety of data collection methods were used. Classroom observations captured students' interactions with the flipbook, pre-and post-tests evaluated their science literacy before and after the intervention, and semi-structured interviews explored their perspectives on the learning experience.

The materials for the study included a *megedong-gedongan* flipbook and a science literacy test. The flipbook integrated Balinese cultural elements, particularly the *megedong-gedongan* tradition, with scientific concepts such as human biology, reproduction, and the life cycle, establishing connections between cultural practices and science. The standardized test assessed students' science literacy before and after the intervention, featuring multiple-choice and open-ended questions that evaluated their understanding of scientific concepts, inquiry skills, and the application of science knowledge in real-life contexts.

The experimental and control groups completed the science literacy test before the intervention. During the intervention, the experimental group engaged with the *megedong-gedongan* flipbook in their science lessons over four weeks, with lessons designed to blend cultural and scientific content. The control group, in contrast, received traditional science instruction using standard textbooks and materials. After four weeks, both groups retook the science literacy test to assess any changes in their understanding. Additionally, a focus group discussion with a subset of students from the experimental group was conducted to gather qualitative insights into their views on the flipbook and its cultural significance.

Pre- and post-test scores were analyzed using Analysis of Covariance (ANCOVA) to identify statistically significant differences in science literacy between the experimental and control groups, adjusting for pre-test scores. Thematic analysis of focus group responses was conducted to uncover common themes related to the cultural relevance of the flipbook and its effect on student engagement and comprehension.

Table 1. Scientific Literacy Test Grid

Variable	Indicator	Description	amount	No. Question
Science literacy	Identify scientific problems/questions	Recognize problems/questions that can be investigated scientifically	3	1,2,3
		Identify keywords to obtain scientific information.		
		Recognize the key features of scientific research.		
	Explain phenomena scientifically	Apply science knowledge in a given situation	3	4,5,6
		Describe or interpret phenomena scientifically and predict change.		
		Identify appropriate descriptions, explanations, and predictions.		
	Using scientific evidence	Interpret scientific evidence	4	7,8,9,10
		Identify assumptions, evidence, and reasons behind conclusions.		
		Reflecting on the social implications of the development of science and technology		

4. Result and Discussion

The descriptive analysis results show a difference in the mean score of scientific literacy between the control group and the experimental group. The descriptive data are presented in the table below.

Table 2. Results of Descriptive Analysis of Student Scientific Literacy

Variable	**class experiment**		**class control**	
	Mean score	**Standard Deviation**	**Mean score**	**Standard Deviation**
Science literacy	72,77	12,61	51,67	12,75

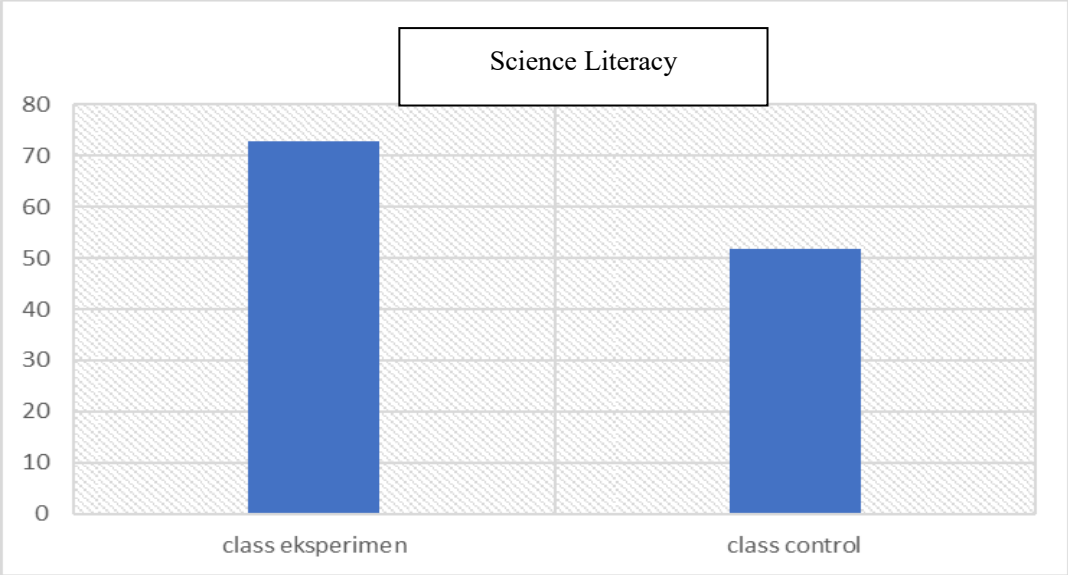


Figure 1. The Mean of Score Experiment and Control Class

Based on the table and figure above, it is known that the mean value of scientific literacy of students who are taught with Bali *megedong-gedongan* local culture-based flipbooks is higher than that of students who do not use *megedong-gedongan* local culture-based flipbooks. The statistical analysis of the hypothesis yielded a t-count significance value of 0.006 for the equal variances assumed two-tailed test. Since this significance value is less than the conventional threshold of 0.05 (0.006 < 0.05), the null hypothesis (H0) is rejected, and the alternative hypothesis (H1) is accepted. This indicates that there is a statistically significant difference between the compared groups.

Rejecting H0 implies that the observed differences are unlikely to have occurred by chance alone, suggesting that the treatment or intervention under study has a significant effect. In the context of educational research, a specific teaching method, such as using local culture-based flipbooks, significantly improves students' understanding of science concepts compared to traditional methods. The acceptance of H1 provides evidence supporting the effectiveness of the intervention. For instance, if the hypothesis was that using *megedong-gedongan* local culture-based flipbooks enhances scientific literacy among students, the statistical results indicate that this teaching approach has a significant positive impact. This finding reinforces that integrating cultural elements into educational materials can enhance student engagement and learning outcomes. Moreover, the low p-value of 0.006 underscores the robustness of the results, reducing the likelihood that the findings are due to random variation. This strengthens the case for adopting innovative, culturally relevant educational strategies in science education. By validating the effectiveness of these methods through rigorous statistical analysis, educators and policymakers can be more confident in implementing such approaches to improve student learning experiences and outcomes.

There is a difference in scientific literacy between students who are taught with Bali *megedong-gedongan* local culture-based flipbooks and students who are not taught with *megedong-gedongan* local culture-based flipbooks. The results of the data analysis also showed that the group that was taught with *megedong-gedongan* local culture-based flipbook had an average scientific literacy score of 72.77. In contrast, the students not taught with *megedong-gedongan* local culture-based flipbooks had an average score of 51.67. In conclusion, the statistical analysis confirms that the intervention being studied has a significant effect, supporting the hypothesis that culturally integrated educational tools can enhance students' scientific literacy. This evidence can guide future educational practices and research, promoting the incorporating of local culture into teaching methods to achieve better educational results.

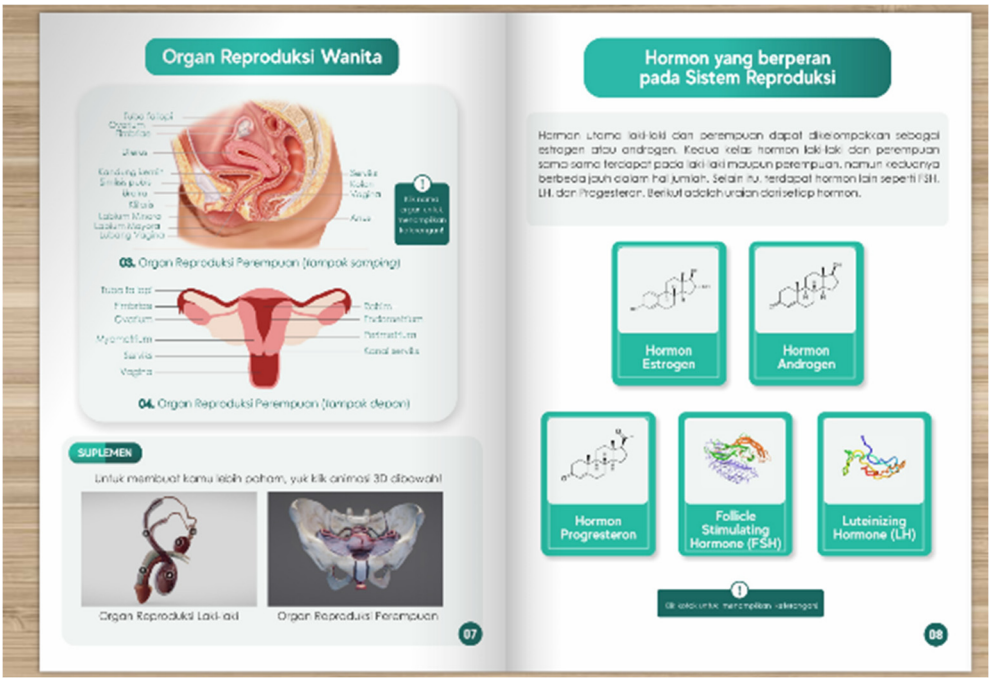
Based on the findings, scientific literacy can be defined as the ability to read, understand, and interpret scientific information, which is crucial in today's world. It enables individuals to grasp scientific concepts, analyze data, and make informed decisions grounded in scientific evidence. Integrating local cultural elements into science education, such as using *megedong-gedongan* local culture-based flipbooks, offers a promising strategy for enhancing scientific literacy among students. This traditional ceremony provides a rich cultural context that can be effectively utilized in educational materials to make science more relatable and engaging for students. By incorporating this local practice into flipbooks used in science literacy learning, educators can create a bridge between students' everyday experiences

and scientific concepts (Ladson-Billings, 1995). This method helps demystify abstract scientific ideas by linking them to familiar cultural narratives, making learning more meaningful and memorable.

The use of culturally relevant flipbooks not only increases students' engagement but also fosters a deeper appreciation of both science and their cultural heritage. When students encounter scientific concepts within the framework of their local traditions, they are more likely to develop an interest in science and recognize its relevance to their lives (Gay, 2018). This approach also supports the development of critical thinking skills as students analyze the intersection of cultural practices and scientific principles. Moreover, integrating local culture into science education promotes inclusivity and respect for diversity. It acknowledges the value of students' cultural backgrounds and encourages them to see themselves as active participants in the learning process (Ladson-Billings, 1995). This can enhance their self-esteem and motivation, leading to better educational outcomes. Integrating local cultural practices, such as a traditional ceremony for a baby in the womb, into educational contexts can significantly enhance teaching and learning experiences (Javani et al., 2019). This approach provides students with a tangible and meaningful context, allowing them to delve into the intricate connections between cultural rituals and underlying philosophies or meanings. Furthermore, it facilitates the exploration of scientific concepts related to reproductive health in a more relatable and engaging manner. Abstract scientific concepts can be challenging for students to grasp when presented in isolation. However, by embedding these ideas within familiar cultural practices, students can more easily comprehend and retain the information.

Using culturally relevant materials, such as flipbooks that depict local customs, can significantly increase student engagement and motivation (Hastuti et al., 2020). This method makes learning more enjoyable and fosters a deeper understanding of scientific principles. When students see the relevance of science in their everyday lives, they are more likely to develop an interest in the subject and appreciate its practical applications. Additionally, this approach helps bridge the gap between traditional knowledge and modern scientific theories, promoting a more holistic view of education. In addition, incorporating cultural elements into science education also encourages critical thinking and analysis. Students are prompted to compare and contrast the cultural and scientific perspectives, leading to a richer and more nuanced understanding of both (Hastuti et al., 2020; Febrian et al., 2024). This integrative approach can inspire students to value their cultural heritage while recognizing the importance of scientific inquiry. Blending local culture with scientific education creates a more inclusive and effective learning environment, fostering a sense of belonging and relevance for all students.

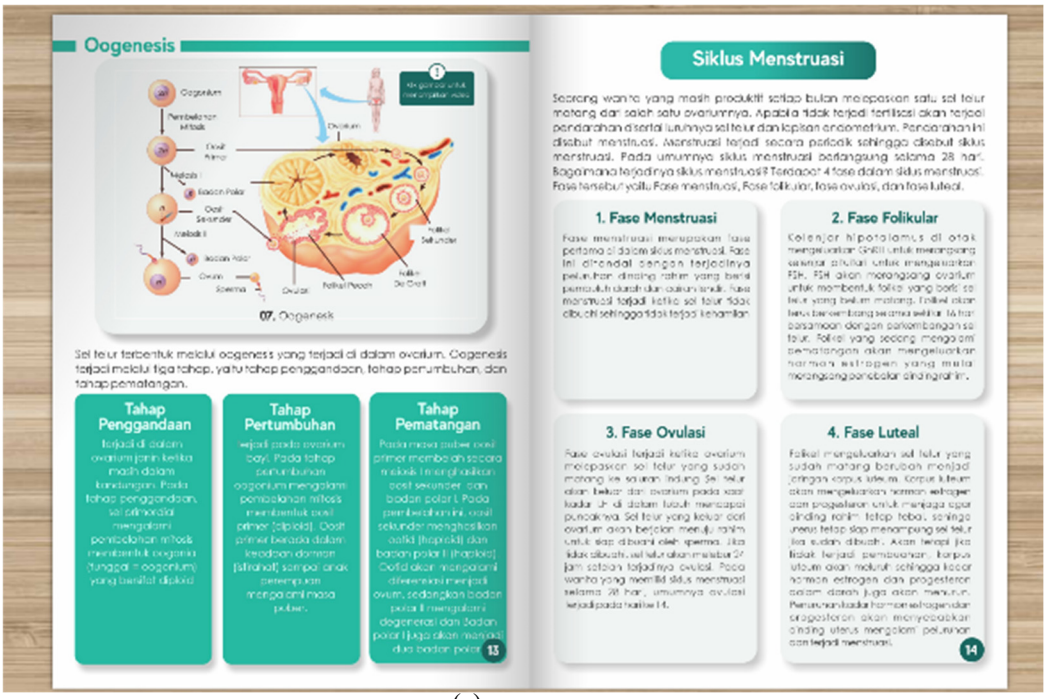
(a)



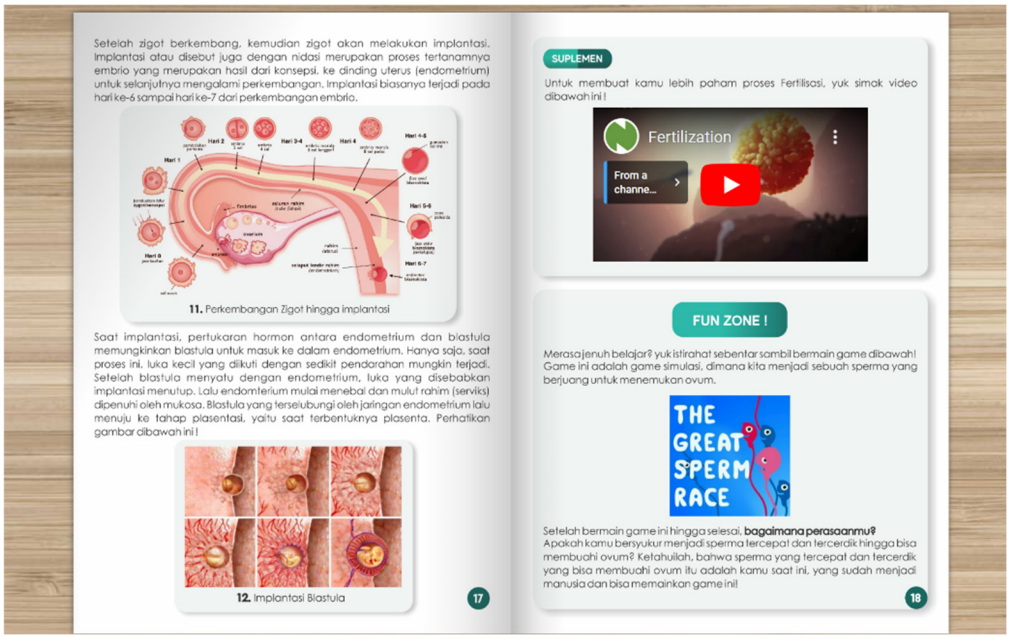
(b)

Figure 2 a-b. The Ceremony for the Baby in the Womb Provides a Natural Context for Learning

Linking activities between the local cultural context or the *megedong-gedongan* ceremony with the concepts of organs and functions of the human reproductive system trains students to identify scientific problems or questions, then describe a phenomenon/event scientifically and use scientific evidence appropriately.



(a)



(b)

Figure 3a-b. Display Pictures and Exciting Learning Activities

The *megedong-gedongan* local culture-based flipbook offers an interesting visual illustration of science concepts. Using pictures and illustrations in flipbooks helps students visualize complex ideas more easily. This makes science concepts more memorable and understandable to students. Through a combination of text and pictures, flipbooks also help students develop skills in reading and interpreting scientific information. This result is in line with the previous studies (Irfan et al., 2019; Rini et al., 2021; Rahmawati et al., 2022; Dewi et al., 2022; Marwan & Yuliantri, 2023) Flipbooks are also designed to activate students by allowing them to interact directly with video playback and take quizzes to determine their understanding after learning to use the flipbook. This increases student motivation to learn. The various components of this flipbook consist of sentences/concept descriptions accompanied by pictures that help students understand the material. It is also equipped with audio and video to accommodate the needs of various learning styles.

In the learning process using *megedong-gedongan* local culture-based flipbooks, students actively collect and analyze data related to the reproductive system. This hands-on approach promotes critical thinking and enhances scientific literacy. By directly involving students in exploring scientific concepts through culturally relevant materials, they become more invested in their learning and better able to understand and retain complex information (Gay, 2018; Septantiningtyas & Subaida, 2023).

The flipbook's integration of local culture makes the scientific content more relatable and enriches students' understanding by connecting it to their everyday experiences. This contextual learning aids in demystifying abstract concepts, making them more accessible and easier to grasp (Ladson-Billings, 1995). For instance, understanding the reproductive system through the lens of a culturally significant ceremony can provide a concrete framework that students can relate to, thereby deepening their comprehension. Moreover, using these flipbooks provides ample opportunities for students to develop communication skills. When students are tasked with explaining the science concepts illustrated in the flipbooks to their classmates or during group presentations, they practice organizing their thoughts and conveying information clearly and effectively. This practice is crucial for scientific literacy, as it helps students learn how to articulate their understanding and engage in scientific discourse.

Students learn to collaborate and exchange ideas through group discussions and presentations, enhancing their communication abilities. These activities foster a collaborative learning environment where students can critique and build on each other's ideas, promoting a deeper understanding of the subject matter (Supartini et al., 2024). Additionally, explaining scientific concepts to peers reinforces students' understanding. Teaching others is a powerful learning tool, as it requires the teacher to fully grasp the material (Kana et al., 2023). By explaining the concepts to their peers, students consolidate their knowledge and hone their ability to communicate complex ideas succinctly and accurately. In short, using *megedong-gedongan* local culture-based flipbooks in teaching the

reproductive system enhances students' scientific literacy and develops their critical thinking and communication skills. This holistic approach to learning ensures that students absorb information and learn how to apply, analyze, and communicate it effectively, preparing them for future academic and professional endeavours.

5. Conclusion

This research demonstrates that using flipbooks based on local *megedong-gedongan* culture can significantly improve students' understanding of science concepts. By connecting science to students' daily lives, the flipbooks make learning more relevant and engaging. This cultural integration helps students identify scientific problems, describe phenomena, and use evidence effectively. The interactive nature of the flipbooks, combined with opportunities for student communication, further contributes to their scientific literacy. By making science more culturally relevant, this research suggests that we can enhance students' academic success and lifelong learning. The findings of this study have implications for culturally responsive education worldwide, highlighting the importance of cultural context in creating effective and meaningful learning experiences. This research, of course, has limitations and needs to fully address all aspects that have not been previously discussed related to the integration of local culture into scientific literacy. However, it is intended to be a valuable resource and aid learning and teaching. In addition, it is expected to be able to develop the design of other teaching materials with a more diverse cultural approach and communication strategy.

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