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Flipbook Augmented Reality-Local Wisdom: Digital Teaching Media to Improve Digital Literacy Skills

Apriza Fitriani[1*], Rukiah Lubis[2], Meti Herlina[3], Kasmiruddin[4], Irwandi[5]

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ABSTRACT

Purpose: Students' digital literacy skills are one of the main focuses in modern education. Technology integration in education often ignores the importance of maintaining and developing local wisdom as a moral and social foundation for society. Therefore, efforts are needed to integrate local wisdom into technology-based learning media to preserve cultural values while improving digital literacy skills. This study aims to determine the influence of augmented reality flipbooks based on local wisdom on improving digital literacy skills. **Method:** This study used a non-equivalent pre-test -post-test control group design and involved 60 students in grade X of SMAN 9 tenth graders (aged 15 to 17 years) from Bengkulu, Indonesia. This research was conducted in August 2024. Observation sheets and questionnaires were given to assess students' digital literacy skills. **Findings:** The results of independent samples T test suggested that the augmented reality flipbooks based on local wisdom had affected digital literacy skills with a p-value<0.005. These findings show that augmented reality flipbooks based on local wisdom can be used as digital learning media to improve students' digital literacy skills in the classroom. **Implication for Research and Practice:** The use augmented reality flipbooks based on local wisdom in Biology classrooms is recommended. Digital literacy skills are an essential component that needs to be mastered by students.

Introduction

The 21st century is centered on the digital economy and society. The internet and digital technology provide the main communication channels in people's daily lives. The number of internet users around the world has tripled, so the rise in digital technology has changed the

[1]Biology Education Department, Universitas Muhammadiyah Bengkulu, INDONESIA.
ORCID: https://orcid.org/0000-0002-2103-634X , Email: aprizafitriani@umb.ac.id
[2]Biology Education Department, Universitas Muhammadiyah Bengkulu, INDONESIA.
ORCID: https://orcid.org/0009-0007-3962-5015 , Email: rukiah2507@umb.ac.id
[3]Biology Education Department, Universitas Muhammadiyah Bengkulu, INDONESIA.
ORCID: https://orcid.org/0009-0002-2491-028X , Email: metyalina@umb.ac.id
[4]Biology Education Department, Universitas Muhammadiyah Bengkulu, INDONESIA.
ORCID: https://orcid.org/ 0009-0009-2292-7388 , Email: kasmiruddin@umb.ac.id
[5]Biology Education Department, Universitas Muhammadiyah Bengkulu, INDONESIA.
ORCID: https://orcid.org/0000-0002-5984-9733 , Email: irwandi@umb.ac.id
*Correspondence: aprizafitriani@umb.ac.id

way people communicate, collaborate, solve problems, and consume information. Technology has also changed the learning paradigm for learners who must learn to harness the power of digital technology to achieve study success (Wang et al., 2024). Education today needs to move from traditional teaching and learning methods based on printed materials to digital formats. In addition, by increasing the quantity of learning resources, the Internet provides a wide range of disciplines and learning opportunities. Digital literacy is a 21st-century skill that students need (Ilomäki et al., 2023).

Digital literacy is associated with information-processing, cognitive, and socio-emotional skills, all of which are important in helping learners perform tasks correctly in a digital context (Kaeophanuek et al., 2019). Digital literacy refers to the capacity to explore, retrieve, organize, combine, assess, research, and combine digital materials, gain new insights, generate multimedia representations, and interact with peers in real-life scenarios (Cohen et al., 2020). Digital literacy can have a positive effect on students' social skills (~~Mewangi et al., 2020~~), cognitive, technical, and sociological interactions (Abdelraheem & Ahmed, 2018). The incorporation of digital media in the educational environment has the potential to encourage the improvement of their cognitive processes and confidence (Marci-Boehncke & Vogel, 2018). The acquisition of digital literacy skills can facilitate the development of critical thinking skills among students, thereby enabling them to achieve a higher level of maturity and awareness in information creation (Yasdin et al., 2021).

Digital literacy skills are skills that are recognized as very important in the learning process. However, some of the results of research on these skills are in the low category. For example, the results of research in Indonesian schools show that students' digital literacy is still in the "Not Good" category (Bedenlier et al., 2022; ~~Cheng & Tsai, 2021~~). According to Pratolo and Solikhati (2020), students are only limited to "knowing" by using technological devices, but not on "implementation". This digital literacy gap correlates with low self-efficacy and involvement in learning, resulting in a decrease in student performance (Getenet et al., 2024).

However, despite technological advancements offering a wide range of opportunities, there are concerns that local wisdom, which is an integral part of cultural identity, is increasingly marginalized, especially in the case of Bengkulu's local wisdom, due to the lack of digital-based local wisdom. According to Erkisheva et al. (2014) explained that education in Kazakthan has succeeded in integrating the values of local wisdom in Mathematics, Literature, Biology and Art lessons so that it is able to motivate students in developing their skills. Therefore, efforts are needed to integrate local wisdom into technology-based learning media to preserve cultural values while improving students' digital literacy skills. One of the innovative learning media that can be used is the augmented reality flipbook.

Flipbook augmented reality allows students to have an immersive and interactive learning experience, where they can access additional information through visual elements enriched with augmented reality technology. By incorporating local wisdom into an augmented reality flipbook, students not only learn about digital literacy but also about valuable local culture and values. Some of the research results of technology-based interactive teaching materials can encourage students to learn more actively. Flipbook teaching materials with an augmented reality approach are able to increase innovation in the teaching and learning process to achieve good knowledge transfer (Alhamad et al., 2024). A similar study

has been conducted by Şimşek (2024) stating that by using *augmented reality* as a learning medium, learning will be more enjoyable and more motivated. Learning materials that contain local wisdom provide opportunities for students not only to gain knowledge, but also to apply it in a social context (Mirza et al., 2025).

Augmented reality has emerged as one of the most effective technologies in education, offering a more interactive and immersive learning experience. Tying augmented reality content to local wisdom strengthens the connection between the context of students' lives and digital representations so that the potential for learning transfer to real practice becomes greater. (~~Yulindrasari et al., 2024; (Zhang et al., 2025~~). Augmented reality is a blend of physical and digital domains achieved by layering digital data into the real world (Dargan et al., 2022). This Ha interacts with virtual content while still feeling present in the real world (Wu et al., 2022). Thus, augmented reality systems allow users to learn to visualize and act on combined phenomena that are impossible only in theoretical studies and engaging with the real world (Dargan et al., 2022). While augmented reality can help address a variety of issues in DEE, such as engagement, personalized learning, improved visualization, access to hazardous environments, and technical language-related issues (Takrouri et al., 2022), augmented reality is reported to be underutilized in DEE (~~Martin & Godwin, 2022~~). Although some augmented reality applications in DEE are promising, many only feature 3D models and miss out on opportunities to leverage the interaction between the digital and physical worlds (Ivanova et al., 2023; Monroy Reyes et al., 2016). In this study, we were particularly interested in the interaction between physical and digital assets offered by augmented reality, as we believe this can create an engaging and dynamic learning experience that cannot be imagined with other technologies and tools available. In a learning context that integrates local wisdom, the use of augmented reality in local wisdom-based flipbooks can not only engage students but also provide an opportunity to understand and appreciate their local culture.

The use of augmented reality flipbooks based on local wisdom is expected to be an innovative solution in overcoming this challenge. Students can explore content rich in digital and visual information related to local wisdom, so they not only improve their digital literacy skills but also gain a better understanding of their culture. ~~Research by Rasmitadila and et al. (2020) shows that~~ In this context, augmented reality flipbooks are interactive learning mediums that combine digital visual elements with physical text to create a more engaging and informative learning experience. With augmented reality flipbooks, students can engage deeply with content that contains elements of local wisdom, thus enriching their learning experience (~~Huang & Liu, 2020~~; ~~Papamitsiou et al., 2022~~) Nikou et al., 2022). The integration of local wisdom has been proven to strengthen the relevance of materials, cultural identity, and students' learning motivation (~~Yulindrasari et al., 2024~~; ~~(Smith et al., 2024).~~

Based on these problems, the researcher conducted a study and analysis related to the influence of the use of augmented reality flipbooks based on local wisdom to improve students' digital literacy skills. The results of this research are expected to make a significant contribution to innovative learning media that is able to integrate digital technology with local cultural values, strengthen students' cultural identity, and improve the quality of education that is adaptive to changing times and remains rooted in cultural values.

Literature Review

Flipbook Augmented Reality

Augmented Reality-based flipbooks have developed into one of the technological innovations in education that combines digital media with physical elements to create a more interactive and engaging learning experience. Augmented Reality (AR) is a technology that incorporates virtual objects into real-world displays so that users can interact with digital representations in their physical context (Li et al., 2025). The application of AR in education is increasing rapidly due to its potential to visualize abstract concepts and increase student engagement (Lin & Yu, 2023). Flipbook AR combines the concept of a traditional flipbook with AR content that is active when the page is scanned or panned, thus adding an interactive layer to print or digital materials (Baiti et al., 2024). AR flipbooks as a multimodal medium can support the development of digital literacy because students interact with text, visuals, and digital interactive elements simultaneously (Alhamad et al., 2024; Li et al., 2025).

Meta-analysis and systematic review show that AR generally has a moderately positive effect on learning outcomes (Howard & Davis, 2023; Prasetya et al., 2024). Several studies show that AR consistently increases student motivation and learning engagement at various levels of education (Na & Yun, 2024). This affective involvement is often an important mediator that explains some of the improvements in cognitive outcomes in AR interventions (Lin, 2023). Research on AR-enabled books and stories has found that multimedia features such as 3D objects, audio, and interactive animations can enrich the reading experience and support short-term story retelling and comprehension (Alhamad et al., 2024; Şimşek, 2024). Research by Cheng and Tsai (2014) shows that the use of augmented reality in learning media such as flipbooks can increase students' motivation to learn and help them in understanding difficult concepts.

Local Wisdom

Local wisdom is cultural values that are inherited from generation to generation in society and reflect the cultural identity of a region. The integration of local wisdom in learning materials aims to maintain and preserve local culture while enriching student learning. An augmented reality flipbook that incorporates local wisdom content allows students to learn about their culture through modern and interactive media. Local wisdom is a system of knowledge, values, and cultural practices that are inherited from generation to generation, and function as a guideline for people's lives in interacting with the environment and society (~~Nugroho et al., 2021~~). In the context of education, local wisdom can function as a contextual and relevant learning resource to increase student involvement and foster culture-based character (~~Hidayat et al., 2022~~). The integration of local wisdom into the curriculum helps strengthen cultural identity, foster a sense of pride in traditions, and increase cross-cultural understanding in the era of ~~globalization (Putra & Fitriani, 2023).~~

Research also shows that learning based on local wisdom is able to develop students' critical thinking skills and environmental literacy through a real context that is close to their lives (~~Wati et al., 2022~~). In addition, local wisdom plays an important role in environmental conservation because traditional practices often contain the principles of sustainability and nature conservation (~~Yuliana et al., 2021~~). The results of the latest empirical research show

that integrating local wisdom in science learning can improve student learning outcomes, especially in the aspects of attitudes and values (Rahman & Abdullah, 2023). International studies emphasize that a local wisdom-based approach not only strengthens the cognitive dimension, but also facilitates the affective and psychomotor dimensions in learning and teaching (Kamaruddin et al., 2022). Thus, local wisdom has a strategic role in shaping education that is holistic, culturally rooted, and responsive to global challenges (Nugroho et al., 2021; Putra & Fitriani, 2023). Research by Pradana et al. (2020) shows This suggests that the use of augmented reality to teach local wisdom can increase students' sense of appreciation for their culture and strengthen cultural identity. The integration of local wisdom in learning through digital media can strengthen students' attachment to their social and cultural environment (Rahmawati & Wulandari, 2021).

Digital Literacy Skills

Digital literacy skills are becoming increasingly important in the digital era, where students must be able to access, understand, and use information that is available digitally. Digital literacy includes the ability to think critically, manage device security, and protect personal safety when interacting with digital media. Digital literacy skills are also defined as the ability to search, evaluate, use, and create information through digital technology and participate effectively in the digital environment (Ilomäki et al., 2023). Digital literacy includes technical (operating devices), cognitive (assessing the quality of information), social-emotional (online ethics and behavior), and practical (using digital tools for everyday tasks) (Martin & Godwin, 2022).

The implementation of augmented reality flipbooks in education not only supports the learning of teaching materials but also encourages the improvement of students' digital literacy skills, as shown in a study by Hsiao and Chen (2021) which found that students who used augmented reality flipbooks showed significant improvements in their digital literacy skills Martín-Gutiérrez et al. (2017) emphasized that the use of augmented reality in education has great potential for developing digital literacy skills, especially in terms of understanding and using new technologies. Avinç and İnan (2022) Additionally,, research has revealed that structured interventions can improve some aspects of digital literacy, but their effects depend on the instructional design, the duration of the intervention, and the characteristics of the participants. Meta-analyses on technology-based interventions showed positive effects on literacy outcomes and reading ability when technology was combined with appropriate instruction (Okeke et al., 2022).

Relationship between Augmented Reality Flipbooks, Local Wisdom, and Digital Literacy

The combination of augmented reality flipbooks, local wisdom, and digital literacy creates a holistic and relevant learning approach for today's students. Through the integration of augmented reality technology and local content, students not only learn about new technologies but also appreciate their own culture. It also strengthens their digital literacy, which is an important skill in facing challenges in the digital age. Incorporating local wisdom content into augmented reality flipbooks has the potential to increase motivation and relevance of learning because students see the direct relationship between the material and their cultural environment (Lestari et al., 2024; Sakti et al., 2024). Operationally, the use of augmented reality flipbooks that contain local content

requires students to navigate text, 3D visual content, and digital instruction and practice digital literacy skills (Prasetya et al., 2024; Şimşek, 2024).

An experimental study on AR storybooks reported significant improvements in story comprehension and retelling in a group of pre-schoolers using augmented reality (Şimşek, 2024). Motivational meta-analysis shows a positive impact on self-confidence, and develops digital literacy through augmented reality interventions (Prasetya et al., 2024). Case studies and reports on the development of augmented reality flipbooks in the context of elementary schools report that there is a significant influence on motivation and some basic skills in the use of digital media (Baiti et al., 2024; Sari et al., 2024). Research by Wang et al. (2020) supports this by showing that learning approaches that integrate technology and local culture can increase student engagement and facilitate more meaningful and contextual learning. ~~Pérez López et al. (2021) showed~~ This proves that the use of augmented reality with local content can improve students' understanding of their cultural context as well as improve their technological skills.

Methodology

Research Design

This study is a quasi-experimental research using a pre-test-post-test non-equivalent control group design (Ssemugenyi, 2022), as seen in Table 1. The independent variable of this study is an augmented reality-based local wisdom flipbook carried out in 2 treatment classes. The first is an experimental class that uses an augmented reality-based flipbook based on local wisdom, and the second is a control class that uses the YouTube application.

Table 1

Research Design

Pretest	Treatment Class	Posttest
X_1	Experimental Classes	X_3
X_2	Control Classes	X_4

Information:

X_1: Pretest of the experimental class
X_2: Control class pretest
X_3: Posttest, the experimental class
X_4: Posttest control classes

Research Sample

The population of this study includes all tenth grade students at SMAN 9 Bengkulu City. The sample of this study was selected through the class determination process by providing a placement test to test class homogeneity. The results of the study showed that all participants were homogeneous in terms of academic ability. The class names are written on paper and drawn to choose 2 random classes that will receive different treatment. The students were divided into 2 groups: the group using augmented reality

flipbook media based on local wisdom (30 students), and conventional (30 students). The total number of study participants was 60 students aged between 15 and 17 years.

Research Instruments

The research instruments used include augmented reality flipbook media-based on local wisdom, questionnaire sheets and observations. The research instrument was validated before use. The validation process was carried out by a team of experts consisting of two university lecturers with doctoral degrees and one high school teacher. This validity test is carried out to test the validity of the content and the validity of the construct. Content validity is the level of accuracy of the content of the instrument according to the curriculum, while construct validity is related to the concept of science, local wisdom to be tested. The validation results were analyzed descriptively to check whether the instruments used in this study met one of the following criteria: $1.00 \leq X \leq 1.60$ = invalid; $1.60 < X \leq 2.20$ = less valid; $2.20 < X \leq 2.80$ = valid enough; $2.80 < X \leq 3.40$ = valid; and $3.40 < X \leq 4.00$ = very valid. The validity value indicates that all instruments and media are valid with a significance value of $0.000 < 0.05$ and reliable with a coefficient of 0.953 so that they can be used to collect data.

The research instruments used include questionnaires and observations. Observation sheets to measure students' digital literacy skills using the Likert method scale 1-4: A score of 4 for four indicators met, a score of 3 for three indicators met, a score of 2 for two indicators met, and a score of 1 for one indicator met. In addition, the questionnaire used a Likert scale of 1-5, which consisted of strongly agree, agree, hesitate, disagree and strongly disagree. Aspects of digital literacy skills are adapted from the G20 Assessment of digital literacy, (Wang et al., 2022), which consisted of literacy knowledge, critical thinking, device security, and personal security.

Data Analysis

The research data was analyzed using Independent samples T Test with SPSS for windows version 25.0. Before continuing the data analysis, normality and homogeneity tests were carried out. The normality test was performed using the Kolmogorov-Smirnov One-Sample Test, and the homogeneity test was performed using the Levene Test. After that, the Independent samples T Test was carried out to determine the influence of flipbook augmented reality based local wisdom to improve students' digital literacy skills

Results

The effectiveness of augmented reality-based local wisdom flipbooks implemented during the learning process can be seen from the variables of digital literacy skills. Before conducting independent samples, a T-test was conducted to determine the influence of augmented reality-based local wisdom flipbooks on digital literacy skills. First, all data were tested for normality and homogeneity. The results of the normality test and homogeneity test are summarized in Table 2 and Table 3.

Table 2

Normality Test Results

Tests of Normality				
		Kolmogorov-Smirnov[a]		
	Class	Statistic	df	Sig.
Digital Literacy	Experiment	,115	30	,200*
	Control	,093	30	,200*

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 3

Homogeneity Test Results

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Digital Literacy	Based on Mean	2,072	1	58	,155
	Based on Median	1,829	1	58	,181
	Based on the Median and with adjusted df	1,829	1	57,523	,182
	Based on trimmed mean	2,015	1	58	,161

The normality test results in Table 2 show that the data on digital literacy skills is in the normal category with a significance value of p>0.05, namely 0.200 and 0.200. In Table 3, it is known that the significance value of each variable is p>0.05. This means that the data of the research variables have homogeneous variants.

The effect of augmented reality-based local wisdom flipbook on digital literacy skills was analyzed using independent samples T-test—the results of the independent samples T-test are presented in Table 4.

Table 4

Independent Samples T Test Result

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Literasi Digital	Equal variances assumed	2,072	,155	2,168	58	,034	7,767	3,582	,596	14,937
	Equal variances not assumed			2,168	55,688	,034	7,767	3,582	,589	14,944

From the results of the independent samples T-test, it can be seen that the F calculation is 2.072 with p-value = 0.034. P-value < α (α=0.05). This means there is a difference between classes that use augmented reality-based local wisdom flipbooks and conventional classes

regarding students' literacy skills achievement. The average digital literacy skill score in the experimental and control classes is represented in Figure 1.

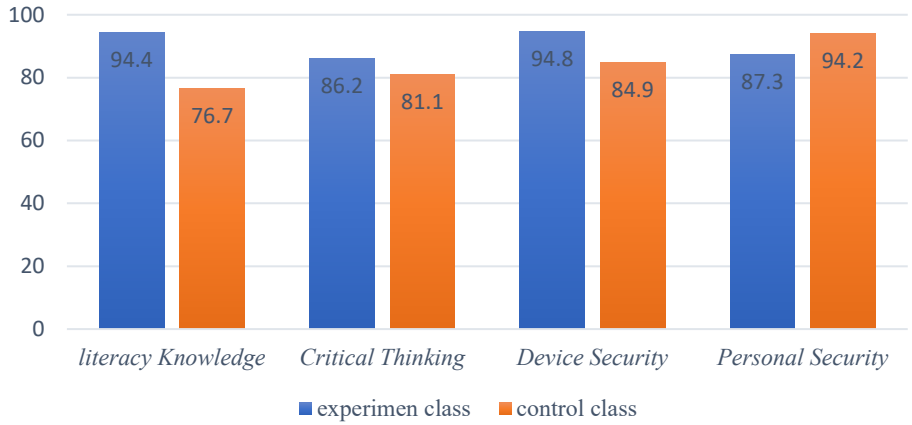

Figure 1: Average Students' Digital Literacy Skills Score in Experimental and Control Classes

Figure 1 shows that digital literacy skills in the experimental class were more effective in improving *literacy knowledge, critical thinking,* and *device security* than the control class. However, for *the personal security indicator,* the control class scored higher than the experimental class. This indicates that learning interventions focus more on literacy and device safety aspects, while personal safety aspects still need to be improved in the treatment of experimental classes.

Discussion and Conclusion

Based on the study's results, it was shown that local wisdom augmented reality-based flipbooks, along with conventional classes, influenced the achievement of students' literacy skills. This is shown from the results of the independent samples T-test with an F value of 2.072, a p-value < α (α=0.05), which is 0.034. Augmented reality-based flipbooks that integrate local wisdom into education make it easier for students to understand the material while improving digital literacy skills. Literature review confirms that a local wisdom-based approach is able to preserve culture, strengthen students' identities, and improve digital literacy through contextual experiences (Lestari et al., 2024). Digital literacy is defined not only as technical skills using devices, but also includes critical, collaborative, and ethical abilities in interacting with digital information (Ilomäki et al., 2023). In line with meta-analytical evidence that augmented reality integration has a positive impact on students' learning outcomes and cognitive processes (Chang, Hwang, & Xie, 2022).

Digital literacy skills, which include the ability to access, evaluate, and utilize information effectively, are becoming increasingly important in the rapidly evolving age of technology. The application of augmented reality flipbooks provides an interactive and engaging learning experience and strengthens students' understanding of content based on local wisdom, especially Bengkulu's local wisdom, which is often overlooked in

traditional curriculums. In the augmented reality flipbook media based on local wisdom, there are several typical flora and fauna of Bengkulu. For example, local wisdom related to *rafflesia arnoldii* flowers, where students can access and understand the features contained in the media. Research shows that the use of augmented reality in education can significantly increase student engagement, which contributes to improved digital literacy skills. The integration of augmented reality technology with local wisdom enriches the relevance and meaning of learning, as well as supports the preservation of cultural values in the digital era. This shows that augmented reality flipbooks based on local wisdom can be a pedagogical practice that is responsive to culture (Lestari et al., 2024; Sakti et al., 2024). Augmented reality flipbooks facilitate multimodal experiences (text, images, audio, and animation) that improve students' skills in reading digital content (Alhamad & Alamer, 2024).

~~Furthermore, research conducted by Setiawan and Widodo (2021) emphasizes the.~~ The importance of integrating local wisdom in education is emphasized to increase the relevance and effectiveness of learning. This has the impact that augmented reality that combines elements of local culture is able to strengthen students' identities so as to improve their skills in finding and utilizing digital information related to local wisdom. The local knowledge and digital literacy approach represent two pillars of education that, when combined, create a solid synergy to foster a holistic and culturally responsive learning environment (Nayasi & Colleagues, 2022). Recent meta-analyses show that augmented reality-based instructional design influences aspects of attention, relevance, confidence, and encourages digital literacy skills (Prasetya et al., 2024). Recent quasi-experimental studies have shown that the use of augmented reality can significantly improve digital literacy skills (Rakhimzhanova et al., 2025).

In addition, the learning experience provided by the augmented reality flipbook encourages students to engage in more independent, critical learning and practice students' digital skills such as navigation, using augmented reality applications, and problem-solving. It is in accordance with the opinion of Chetty et al. (2018) that digital literacy includes the skills necessary to navigate, evaluate, and use information effectively in the digital landscape. With the integration of digital literacy into education, students can access a wide range of digital resources, collaborate, and engage critically with diverse perspectives (Meyers et al., 2013). ~~According to Wu et al. (2020),~~ augmented reality provides a learning environment that allows students to interact directly with learning materials, which improves their ability to navigate and understand digital information. This experience is very important in developing digital literacy, because students must be able to evaluate and process data from various digital sources critically. Other studies show that using augmented reality in learning can increase student engagement and stimulate critical thinking through more interactive learning experiences ~~(Thompson & Roberts, 2021).~~

Augmented reality flipbooks based on local wisdom contribute significantly to improving digital literacy skills. Augmented reality makes learning more engaging and interactive and teaches students to think critically and reflectively in understanding and utilizing digital information. Augmented reality flipbooks based on local wisdom have increased students' literacy knowledge, especially related to local wisdom in Bengkulu. Students exposed to this technology show a significant improvement in their

understanding of the basic concepts of digital literacy. This includes the ability to understand and use a variety of digital formats, as well as skills in identifying credible sources of information. This is in line with previous research findings that show that integrating augmented reality technology in learning can strengthen students' cognitive abilities (Smith & Brown, 2020). Thus, integrating augmented reality technology in education, especially those that focus on local wisdom content, has proven effective in improving students' digital literacy skills, which will prepare them for challenges in the digital age.

Limitations, Future Directions and Implications

The results of the study showed that augmented reality-based local wisdom flipbooks affected students' digital literacy skills at $p<0.005$. These findings show that augmented reality flipbooks based on local wisdom can be used as a digital learning medium to improve students' digital literacy skills. Digital literacy skills are an important component that students need to possess. The limitations of this study are only in high school students in class X, in biodiversity materials and in digital literacy skill variables. To further investigate the potential of augmented reality flipbooks free of local wisdom, research can be conducted at different levels of education, on other groups of students, and using different variables. These findings provide a basis for policymakers to encourage the use of innovative technologies based on local wisdom in curriculum. The integration of augmented reality flipbooks can support policies to strengthen national digital literacy as well as preserve local culture through education. With the increase in digital literacy skills through augmented reality flipbooks, students are better prepared to face the challenges of the digital era, including the ability to evaluate information, think critically, and create digital content ethically.

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References

Abdelraheem, A. Y., & Ahmed, A. M. (2018). The Impact of Using Mobile Social Network Applications on Students' Social-Life. *International Journal of Instruction*, *11*(2), 1-14. https://doi.org/10.12973/iji.2018.1121a

Alhamad, K., Manches, A., & McGeown, S. (2024). Augmented Reality Books: In-Depth Insights into Children's Reading Engagement. *Frontiers in Psychology*, *15*. https://doi.org/10.3389/fpsyg.2024.1423163

~~Avinç, E., & İnan, E. (2022). A Meta-Analysis on the Effect of Digital Literacy Training Programs. *Education and Information Technologies*, 27(6), 8231-8256.~~

Baiti, N. B., Uswatun, N., & Suci, L. (2024). Development of Augmented Reality-Based Flipbook Media to Improve Children's Writing Skills. *Science Get Journal*, *1*(3), 19-29. https://doi.org/10.69855/science.v1i3.44

Bedenlier, S., Bond, M., Buntins, K., Zawacki-Richter, O., & Kerres, M. (2022). A Systematic Review on Digital Literacy in Higher Education. *Smart Learning Environments*, *9*, 1-22.

Cheng, K. H., & Tsai, C. C. (2014). The Interaction of Child–Parent Shared Reading with an Augmented Reality (Ar) Picture Book and Parents' Conceptions of Ar Learning. *British Journal of Educational Technology*, *47*(1), 203-222. https://doi.org/10.1111/bjet.12228

~~Cheng, K. H., & Tsai, C. C. (2021). Students' Trust in Online Information: A Critical Facet of Digital Literacy. *Computers & Education*, *166*.~~

Chetty, R., Friedman, J. N., & Rockoff, J. E. (2018). Digital Literacy: Navigating and Evaluating Information in a Digital World. *Educational Technology & Society*, *21*(2), 133-144.

Cohen, R., Parmentier, A., Melo, G., Sahu, G., Annamalai, A., Chi, S., Clokie, T., Farrag, A., Naik, A., Naseem, S., Sakhuja, S., Wang, J., Clausi, R., & Santin, A. (2020). Digital Literacy for Secondary School Students: Using Computer Technology to Educate About Credibility of Content Online. *Creative Education*, *11*(05), 674-692. https://doi.org/10.4236/ce.2020.115050

Dargan, S., Bansal, S., Kumar, M., Mittal, A., & Kumar, K. (2022). Augmented Reality: A Comprehensive Review. *Archives of Computational Methods in Engineering*, *30*(2), 1057-1080. https://doi.org/10.1007/s11831-022-09831-7

Erkisheva, Z., Koshanova, M., Alikhanova, B., Omarova, I., Baitenov, A., & Abishova, A. (2014). Using the Elements of Ethno Pedagogics in Teaching Maths. *Procedia - Social and Behavioral Sciences*, *143*, 591-594. https://doi.org/10.1016/j.sbspro.2014.07.442

Getenet, S., Cantle, R., Redmond, P., & Albion, P. (2024). Students' Digital Technology Attitude, Literacy and Self-Efficacy and Their Effect on Online Learning Engagement. *International Journal of Educational Technology in Higher Education*, *21*(1). https://doi.org/10.1186/s41239-023-00437-y

~~Hidayat, A., Mulyani, S., & Nurhayati, S. (2022). Integrating Local Wisdom in Curriculum to Foster Students' Cultural Identity. *Cogent Education*, *9*(1), 2065432.~~

Howard, M. C., & Davis, M. M. (2023). A Meta-Analysis of Augmented Reality Programs for Education and Training. *Virtual Reality*, *27*(4), 2871-2894. https://doi.org/10.1007/s10055-023-00844-6

Hsiao, K. L., & Chen, C. C. (2021). Exploring the Effect of Augmented Reality Learning on Students' Digital Literacy. *Educational Technology & Society*, *24*(3), 74-88.

~~Huang, Y. M., & Liu, H. L. (2020). The Impact of Augmented Reality Technology on Student Learning: A Review. *Educational technology research and development*, *68*(4), 1547-1571.~~

Ilomäki, L., Lakkala, M., Kallunki, V., Mundy, D., Romero, M., Romeu, T., & Gouseti, A. (2023). Critical Digital Literacies at School Level: A Systematic Review. *Review of Education*, *11*(3). https://doi.org/10.1002/rev3.3425

Ivanova, S., Ivanova, E., & Medarov, M. (2023). Guidelines for the Application of Artificial Intelligence in the Study of the Influence of Climate Change on Transport Infrastructure. *International Scientific Journals of Scientific Technical Union of Mechanical Engineering "Industry 4.0"*, *8*(3), 75-78.

Kaeophanuek, S., Na-Songkhla, J., & Nilsook, P. (2019). A Learning Process Model to Enhance Digital Literacy Using Critical Inquiry through Digital Storytelling (Cidst). *International Journal of Emerging Technologies in Learning (iJET)*, *14*(03), 22. https://doi.org/10.3991/ijet.v14i03.8326

~~Kamaruddin, R., Hassan, Z., & Rahim, N. (2022). Local Wisdom Approach in Education: Nurturing Holistic Competencies. *International Journal of Instruction*, *15*(3), 123-140.~~

Lestari, N., Paidi, & Suyanto, S. (2024). A Systematic Literature Review About Local Wisdom and Sustainability: Contribution and Recommendation to Science Education. *EURASIA Journal of Mathematics, Science and Technology Education*, *20*(2), em2394. https://doi.org/10.29333/ejmste/14152

Li, G., Luo, H., Chen, D., Wang, P., Yin, X., & Zhang, J. (2025). Augmented Reality in Higher Education: A Systematic Review and Meta-Analysis of the Literature from 2000 to 2023. *Education Sciences*, *15*(6), 678. https://doi.org/10.3390/educsci15060678

Lin, Y., & Yu, Z. (2023). A Meta-Analysis of the Effects of Augmented Reality Technologies in Interactive Learning Environments (2012–2022). *Computer Applications in Engineering Education*, *31*(4), 1111-1131. https://doi.org/10.1002/cae.22628

Marci-Boehncke, G., & Vogel, T. (2018, 2018/03). *Digital Literacy and Inclusion: The Impact of Theory and Practice in Teachers' Education* INTED Proceedings, http://dx.doi.org/10.21125/inted.2018.1618

Martín-Gutiérrez, J., Mora, C. E., Añorbe-Díaz, B., & González-Marrero, A. (2017). Virtual Technologies Trends in Education. *EURASIA Journal of Mathematics, Science and Technology Education*, *13*(2). https://doi.org/10.12973/eurasia.2017.00626a

~~Martin, A., & Godwin, P. (2022). Digital Literacies Revisited: A Framework for Learning in the Digital Age. *British Journal of Educational Technology*, *53*(5), 1178-1192.~~

~~Mewangi, A. B., Purnomo, A., & Ginanjar, A. (2020). The Effect of Digital Literacy on Social Skills in Social Studies Learning in Grade Ix Students of Al Azhar Islamic Junior High School 29 Semarang. *Harmony: Jurnal Pembelajaran IPS*, *5*(1), 40-46.~~

Mirza, T., Dutta, R., Tuli, N., & Mantri, A. (2025). Leveraging Augmented Reality in Education Involving New Pedagogies with Emerging Societal Relevance. *Discover Sustainability*, *6*(1). https://doi.org/10.1007/s43621-025-00877-8

Monroy Reyes, A., Vergara Villegas, O. O., Miranda Bojórquez, E., Cruz Sánchez, V. G., & Nandayapa, M. (2016). A Mobile Augmented Reality System to Support Machinery Operations in Scholar Environments. *Computer Applications in Engineering Education*, *24*(6), 967-981. https://doi.org/10.1002/cae.21772

Na, H., & Yun, S. (2024). The Effect of Augmented Reality on K-12 Students' Motivation: A Meta-Analysis. *Educational technology research and development*, *72*(6), 2989-3020. https://doi.org/10.1007/s11423-024-10385-7

~~Nayasi, S., & Colleagues. (2022). Local Wisdom and Digital Literacy: Creating Synergy for a Holistic and Culturally Responsive Learning Environment. *International Journal of Emerging Technologies in Learning*, *17*(2), 34-45.~~

~~Nugroho, Y., Santosa, S., & Widodo, A. (2021). Local Wisdom as a Source of Character Education in Indonesia. *Journal of Ethnic and Cultural Studies*, *8*(4), 45-60.~~

~~Okeke, C., Mphahlele, L., & Ngoepe, R. (2022). Technology-Supported Reading Interventions and Their Impact on Literacy: A Systematic Review and Meta-Analysis. *Journal of Computer Assisted Learning*, *38*(5), 1298-1316.~~

~~Papamitsiou, Z., Giannakos, M., & Christou, G. (2022). From Engagement to Evidence: Linking Ar Interactions to Learning Outcomes. *Computers in Human Behavior*, *136*.~~

Pérez-López, D., Contero, M., & Alcañiz, M. (2021). The Impact of Augmented Reality on Primary Education Students' Comprehension of Cultural Heritage Content. *Educational technology research and development*, *69*(3), 927-946.

Pradana, A. S., Susanto, H., & Rohman, A. (2020). The Development of Augmented Reality-Based Learning Media to Improve Student Understanding of Local Wisdom. *International Journal of Interactive Mobile Technologies*, *14*(10), 130-141.

Prasetya, F., Fortuna, A., Samala, A. D., Rawas, S., Mystakidis, S., Syahril, Waskito, Primawati, Wulansari, R. E., & Kassymova, G. K. (2024). The Impact of Augmented Reality Learning Experiences Based on the Motivational Design Model: A Meta-Analysis. *Social Sciences & Humanities Open*, *10*, 100926. https://doi.org/10.1016/j.ssaho.2024.100926

Pratolo, B. W., & Solikhati, H. A. (2020). Investigating Teachers' Attitude toward Digital Literacy in Efl Classroom. *Journal of Education and Learning (EduLearn)*, *15*(1), 97-103. https://doi.org/10.11591/edulearn.v15i1.15747

Putra, I. G. A., & Fitriani, A. (2023). Strengthening Cultural Identity through Local Wisdom-Based Learning. *Heliyon*, *9*(2), e13112.

Rahman, M., & Abdullah, R. (2023). The Effect of Integrating Local Wisdom in Science Education on Students' Attitudes and Learning Outcomes. *International Journal of Science Education*, *45*(7), 1125-1142.

Rahmawati, D., & Wulandari, I. (2021). Integration of Local Wisdom in Digital Learning: A Study in Elementary Schools in Indonesia. *Jurnal Teknologi Pendidikan*, *23*(1), 85-98.

Rakhimzhanova, L., Issabayeva, D., Kultan, J., Baimuldina, N., Issabayeva, Z., & Aituganova, Z. (2025). Using Augmented Reality to Teach Digital Literacy Course to Primary School Children with Special Educational Needs. *European Journal of Educational Research*, *14*(1), 55-71. https://doi.org/10.12973/eu-jer.14.1.55

Rasmitadila, R., & et al. (2020). The Effectiveness of Augmented Reality in Education: A Systematic Review. *International Journal of Emerging Technologies in Learning*, *15*(11), 27-45.

Sakti, S. A., Endraswara, S., & Rohman, A. (2024). Revitalizing Local Wisdom within Character Education through Ethnopedagogy Apporach: A Case Study on a Preschool in Yogyakarta. *Heliyon*, *10*(10), e31370. https://doi.org/10.1016/j.heliyon.2024.e31370

Sari, I. P., Rohmani, R., & Nisa', K. (2024). Analysis of the Effectiveness of Using Flipbook-Based E-Modules in Science Learning in Elementary Schools. *IJORER : International Journal of Recent Educational Research*, *5*(6), 1367-1382. https://doi.org/10.46245/ijorer.v5i6.615

Setiawan, H., & Widodo, S. (2021). The Role of Local Wisdom-Based Education in Enhancing Digital Literacy among Students. *Journal of Educational Technology Research*, *35*(3), 125-140.

Şimşek, E. E. (2024). The Effect of Augmented Reality Storybooks on the Story Comprehension and Retelling of Preschool Children. *Frontiers in Psychology*, *15*. https://doi.org/10.3389/fpsyg.2024.1459264

Smith, C., Makunye, M. M., & Mashapa, T. (2024). Indigenous Knowledge Systems in Science Education: A Scoping Review. *African Journal of Research in Mathematics, Science and Technology Education*, *28*(3), 249-264.

Ssemugenyi, F. (2022). Trapped at the Crossroads: Does Problem-Based Learning Make a Difference? The Moderating Role of Traditional Mode of Instruction. *Cogent Education*, *9*(1). https://doi.org/10.1080/2331186x.2022.2068398

Takrouri, K., Causton, E., & Simpson, B. (2022). Ar Technologies in Engineering Education: Applications, Potential, and Limitations. *Digital*, *2*(2), 171-190. https://doi.org/10.3390/digital2020011

Thompson, H., & Roberts, S. (2021). Augmented Reality and Critical Thinking: Fostering Analytical Skills through Digital Innovation. *Journal of Digital Education*, *29*(4), 98-110.

Wang, C., Chen, X., Yu, T., Liu, Y., & Jing, Y. (2024). Education Reform and Change Driven by Digital Technology: A Bibliometric Study from a Global Perspective. *Humanities and Social Sciences Communications*, *11*(1). https://doi.org/10.1057/s41599-024-02717-y

Wang, T., Hunter, S., West, T., Watson-Lynn, E., Socarana, B., Wulandari, D., Putri, C. M., Prasetya, Y. S., Enrico, J. H., & Tayyiba, M. (2022). *G20 Toolkit for Measuring Digital Skills and Digital Literacy: A Compilation of Reports*. https://hdl.handle.net/20.500.12870/5185

Wang, Y., Lee, C. S., & Hou, H. T. (2020). Exploring the Effects of Incorporating Augmented Reality into Elementary School Students' Science Learning. *British Journal of Educational Technology*, *51*(5), 1765-1780.

Wati, L., Susanto, H., & Dewi, N. (2022). Enhancing Students' Critical Thinking through Local Wisdom-Based Environmental Education. *Environmental Education Research*, *28*(9), 1234-1250.

Wu, C.-H., Liu, C.-H., & Huang, Y.-M. (2022). The Exploration of Continuous Learning Intention in Steam Education through Attitude, Motivation, and Cognitive Load. *International Journal of STEM Education*, *9*(1). https://doi.org/10.1186/s40594-022-00346-y

Wu, H., Lee, S., & Chang, R. (2020). Enhancing Digital Literacy through Augmented Reality: An Empirical Study in Higher Education. *Interactive Learning Environments*, *28*(7), 910-927.

Yasdin, Y., Yahya, M., Yusuf, A. Z., Musa, M. I., Sakaria, S., & Yusri, Y. (2021). The Role of New Literacy and Critical Thinking in Students' Vocational Development. *Cypriot Journal of Educational Sciences*, *16*(4), 1395-1406. https://doi.org/10.18844/cjes.v16i4.5991

Yuliana, E., Prasetyo, A., & Widiyanto, A. (2021). Local Wisdom and Sustainable Environmental Conservation Practices in Rural Communities. *Sustainability*, *13*(15), 8456.

Zhang, J., Liu, Y., & Wang, H. (2025). Ethnostem-Enhanced Learning Tools for Science Education: A Systematic Review. *Computers & Education*, *224*.