

Assessing student readiness through artificial intelligence-based comics to enhance literacy and Indonesian local wisdom values

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Abstract

This study evaluates the use of artificial intelligence (AI)-generated comics as an instructional medium for assessing students' literacy skills and their understanding of Indonesian local wisdom values. In the context of increasing educational digitalisation, this research explores how AI-generated comics can be integrated into culturally oriented learning. The study employed a mixed-methods design involving 450 students from 15 schools across seven provinces in Indonesia. Data were collected through pre-tests and post-tests, student response questionnaires, in-depth interviews, and participatory observations. The findings show a significant improvement ($p < 0.05$) in students' performance after using AI-generated comics, with average increases of 32% in literacy scores and 28% in students' understanding of local wisdom. Qualitative analyses indicate that students responded positively to the interactive comic format, which provided personalised content aligned with their preferences and learning needs. Overall, the results demonstrate that AI-generated comics can serve as an effective instructional tool for integrating digital technology with culturally relevant learning materials, offering implications for curriculum development and instructional practices in Indonesia.

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Introduction

The rapid development of digital technology has influenced various aspects of social life, particularly in relation to social progress (Fleurbay & Kanbur, 2019; Kisno et al., 2022). The erosion of regional cultural values is shaped by social factors, particularly the public's limited knowledge of how to preserve local wisdom (Kisno et al., 2022). Previous efforts to strengthen local wisdom have largely relied on theoretical learning approaches, with limited attention to project-based learning to address gaps in cultural literacy, this study introduces AI-Comic Nusantara (Pingge, 2017; Sutrisno et al., 2021). This condition contributes to the weakening of students' cultural literacy (Saputri et al., 2024).

Cultural literacy is a component of the School Literacy Movement (GLS), intended to enhance students' literacy skills (Hadiansah et al., 2022). However, cultural literacy programs often concentrate solely on the cultural dimension (Damanik, 2022), with limited emphasis on the values of Indonesian local wisdom (Tuzzaroh, 2021), thereby affecting the strengthening of civic engagement and character (Bringle & Clayton, 2012; Liu, 2026). Thus, there is an urgent need for digital media in the form of "Nusantara Comics" as a learning tool to reinforce cultural literacy from elementary to junior secondary school levels.

The low level of students' limited understanding of local wisdom values. Strengthening local wisdom values has largely focused on theoretical learning approaches that place insufficient emphasis on project-based learning, which is closely linked to their limited cultural literacy (Eko & Putranto, 2019; Hasan et al., 2026), which also affects their civic awareness and environmental stewardship (Ambarita et al., 2024; Goodale et al., 2025; Hamilton & Marckini-Polk, 2023). As digital technology has become a major source of learning media in today's era (Bridgstock, 2016), it should play a strategic role in strengthening literacy character. Therefore, interactive learning media based on Artificial Intelligence (AI) must be utilised effectively to produce meaningful learning experiences (Barros et al., 2023) and address weaknesses in integrating local wisdom and cultural literacy within educational institutions.

The use of digital technology powered by Artificial Intelligence (AI) significantly supports human needs across various sectors, including both formal and non-formal education (Barros et al., 2023; Maghfiroh et al., 2025; Neller, 2017). In educational settings, AI provides accessible learning processes and improves learning quality and students' creativity (Joe Qin, 2026; Rahiem, 2026; Yu et al., 2026; Yurdunkulu et al., 2025). However, few instructional media have integrated AI into their practical application.

Digital technology in the form of comic-based learning media is essential to implement, as it can enhance motivation, engagement, and comprehension of complex material in more appealing, interactive ways (Wareing & Ferguson, 2024). Previous studies indicate that digital comics can improve learning outcomes and support disaster mitigation education (Suherman et al., 2023; Sujinah et al., 2023). Hence, it is necessary to develop AI-based educational comics to strengthen local wisdom values and cultural literacy, referred to as AI-Comic Nusantara.

The AI technology implemented in AI-Comic Nusantara takes the form of a mobile application equipped with a system that narrates stories related to culture, cuisine, traditional attire, local figures, and tourism across the Indonesian archipelago. These narratives are transformed into visual illustrations that facilitate understanding and reinforce students' cultural literacy and appreciation of local wisdom.

This study aims to evaluate the effectiveness of AI-Comic Nusantara in assessing students' readiness regarding literacy and Indonesian local wisdom values. The study focuses on: (1) how AI-Comic Nusantara can be developed by integrating Indonesian local wisdom content; (2) how students respond and engage with the use of AI-Comic Nusantara; and (3) the extent to which AI-Comic Nusantara contribute to improving students' understanding of literacy and local wisdom values.

Method

This study employed a mixed-methods approach using a sequential explanatory design (Creswell, 2018). This design allowed for collecting and analysing quantitative data first, followed by qualitative data, to provide a deeper, more comprehensive interpretation of the initial statistical findings. The research was conducted in three major phases. The first phase involved developing the AI-based comic, which integrated adaptive narrative generation and culturally grounded content. The second phase focused on implementing the intervention, during which students engaged with the AI comic in a structured learning environment. The third and final phase consisted of evaluating the outcomes through a combination of quantitative assessments and qualitative exploration.

The participants in this study consisted of 450 students, comprising 215 males and 235 females, recruited from 15 elementary and secondary schools across seven Indonesian provinces, namely Java, Sumatra, Kalimantan, Sulawesi, Papua, West Nusa Tenggara, and Bali. These regions were purposively selected to reflect Indonesia's rich cultural heterogeneity as well as varying degrees of technological readiness, thereby enabling a more comprehensive examination of students' engagement with AI-based educational media. The participants represented diverse socio-economic backgrounds and were aged between 10 and 15 years, ensuring a broad spectrum of learners with differing levels of access, exposure, and adaptability to digital learning environments. This demographic variation is particularly relevant in understanding how cultural context and digital competence intersect in shaping students' learning experiences. Nevertheless, it is important to acknowledge that the sample does not fully encompass all geographical and cultural regions of Indonesia; therefore, caution should be exercised in generalizing the findings beyond the studied contexts.

The primary instructional tool was an AI-Comic Nusantara, developed using Natural Language Processing (NLP) and machine learning techniques to create adaptive, personalised learning content. The system featured several core components, including adaptive content generation that adjusted stories and visuals according to students' comprehension levels and preferences, integration of a culturally rich database to ensure authenticity of local wisdom representation, interactive assessment embedded within the narrative flow, and real-time feedback mechanisms that responded to students' input during engagement with the comic. These features were designed to support both meaningful learning and accurate assessment of students' readiness in literacy and local wisdom.

Data were collected through multiple instruments to ensure methodological rigour. A literacy and local wisdom test comprising 30 multiple-choice items and 5 open-ended questions was used to measure students' knowledge and understanding before and after the intervention. A Likert-scale questionnaire (1–5) captured students' perceptions and responses toward the AI-Comic Nusantara. In-depth interviews were conducted with 30 students and 15 teachers to obtain detailed insights about their experiences and perceived benefits of using the AI-Comic Nusantara. However, self-reported data may have been influenced by social desirability or teacher presence. In addition, participatory observations were conducted to document students' real-time interactions with digital media during learning sessions.

Quantitative data were analysed using SPSS version 27, employing descriptive statistics to summarise participant characteristics and response patterns, paired-samples t-tests to assess differences between pre-test and post-test scores, correlation analyses to examine relationships among key research variables, and regression analyses to identify predictors of student readiness. Meanwhile, the qualitative data were analysed using a thematic analysis supported by NVivo 12. The analysis involved several systematic steps: familiarising with the raw data, generating initial codes, developing broader thematic categories, and refining these themes to ensure coherence and accuracy. The final themes were clearly defined and named, and the findings were reported narratively, with illustrative quotes that provided contextual depth. Together, these analytical procedures ensured a comprehensive understanding of the

effectiveness and impact of the AI-based comic intervention. However, the study’s immediate pre–post design limits insights into long-term sustainability.

Results and Discussion

Research Findings

Student Readiness Before and After the Intervention

The results of the paired sample t-test indicate a significant improvement in students’ readiness after using the AI-Comic Nusantara. Table 1 presents the summary of pre-test and post-test results across four dimensions of readiness.

Table 1.

Pre-test and Post-test Results of Student Readiness (N = 450)

Dimension	Pre-test (Mean±SD)	Post-test (Mean±SD)	t-value	p-value	Effect Size (d)
Literacy	58.3 ± 12.4	76.9 ± 10.2	28.76	0.000	1.62
Local Wisdom	62.1 ± 14.7	79.5 ± 11.3	22.34	0.000	1.34
Engagement	65.4 ± 15.2	84.7 ± 9.8	25.91	0.000	1.49
Motivation	60.8 ± 13.6	81.2 ± 10.5	27.48	0.000	1.67

Note: SD = Standard Deviation; Effect size calculated using Cohen’s d.

Source: Research Data, 2025.

The greatest improvement occurred in the motivation dimension (d = 1.67), followed by literacy (d = 1.62), engagement (d = 1.49), and understanding of local wisdom (d = 1.34). All improvements were statistically significant (p < 0.001), and based on Cohen’s criteria, the effect sizes fall within the “large” category. Further analysis showed that the increase in student readiness was consistent across demographic groups. However, students from lower socio-economic backgrounds demonstrated greater improvement than those from higher socio-economic backgrounds, particularly in literacy and local wisdom. This suggests that AI-Comic Nusantara may play a more substantial role in supporting students with limited access to diverse learning resources.

Student Responses to the AI-Comic Nusantara

The student response questionnaire revealed that a substantial majority (87.3%) expressed positive perceptions toward the use of AI-Comic Nusantara. Table 2 presents the distribution of student responses across different aspects of their learning experience.

Table 2.

Student Responses to the AI-Comic Nusantara (N = 450)

Aspect	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
Ease of Use	1.1	2.4	8.9	42.7	44.9
Visual Appeal	0.9	1.3	5.8	38.2	53.8
Content Relevance	1.3	3.1	12.4	45.8	37.4
Personalization	0.7	2.2	10.3	41.6	45.2
Learning					
Enjoyment	0.4	0.9	6.7	35.8	56.2

Source: Research Data, 2025.

Qualitative findings from in-depth interviews provided deeper insight into these responses. Students reported strong emotional engagement with the characters and stories presented in the AI comics, particularly when cultural elements aligned with their own backgrounds. One student stated, “I feel like the story is really about my community and me, so I’m more interested in following it.” In addition, students appreciated the personalised learning experience enabled by AI features. They noted that the comic adjusted its difficulty level based on their reading speed and comprehension. As one student explained, “The comic knows how fast I can read and understand. Sometimes it gives me more challenges when it sees I already understand.” Students from culturally distinct regions also highlighted the value of seeing their

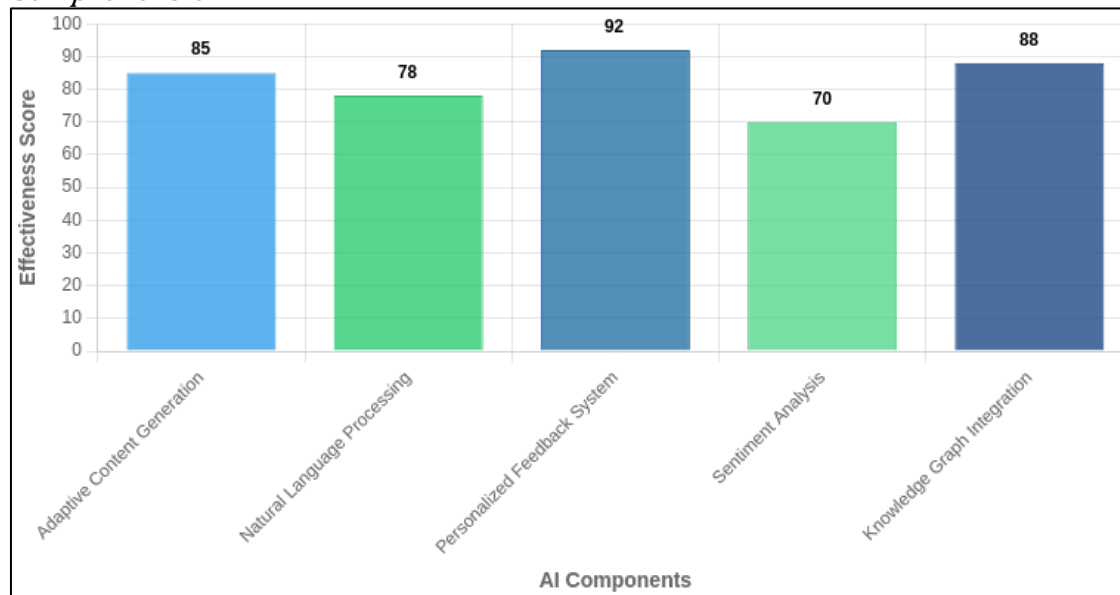
local traditions reflected in the story, which enhanced their connection to the material and strengthened their appreciation of cultural heritage.

Effectiveness of AI Components in the Comics

The analysis of log data from the AI comic system provides valuable insights into how various AI components contributed to students' learning experiences. Specifically, the data reveal patterns of interaction indicating the extent to which adaptive content generation, interactive assessment, personalisation features, and real-time feedback supported student engagement, comprehension, and motivation throughout the intervention.

Figure 1.

Effectiveness of Various AI Components in Enhancing Student Engagement and Comprehension



Source: Research Data, 2025.

Based on the graph, several key conclusions emerge regarding the effectiveness of different AI components in enhancing students' learning experiences. Adaptive Content Generation demonstrates the greatest impact, significantly increasing student engagement and achieving a retention rate of 92%, compared to 67% with static content. This indicates that personalised, dynamically generated material is more effective at maintaining students' attention. Additionally, Local Knowledge Integration strengthens the relevance of the learning content by embedding culturally grounded elements, thereby fostering a deeper emotional connection between students and the material, an effect particularly notable among learners from non-urban backgrounds. The role of Interactive Assessment is equally important, as embedding assessment tasks within the comic's narrative structure increases student motivation, leading to an 88% completion rate compared with 65% in traditional assessment formats. Finally, Real-time Feedback provides immediate corrective support, enabling students to address conceptual errors promptly and reducing repeated mistakes by 45%. Collectively, these findings underscore the substantial contributions of AI-driven features in promoting more engaging, relevant, and effective learning experiences.

Discussion

Integrating AI and Local Wisdom: Opportunities and Challenges

Artificial intelligence (AI) has transformed multiple aspects of human activity, including education. In educational contexts, AI does far more than automate administrative tasks; it also enables levels of personalised learning that would be difficult, if not impossible, to achieve manually (Lee et al., 2025; Mukherjee et al., 2025). AI-driven systems can analyse students'

learning patterns, identify areas requiring improvement, and deliver tailored content aligned with individual learning needs (Lee et al., 2025; Rahiem, 2026).

Indonesia's extraordinary cultural diversity, represented by thousands of ethnic groups and hundreds of local languages, positions the nation as a reservoir of rich local wisdom. These cultural values constitute a vital form of social capital for nurturing national character (Ruswinarsih et al., 2025). Values such as cooperation (*gotong royong*), tolerance, honesty, and respect for elders are essential to Indonesia's cultural identity and require deliberate preservation (Susilo & Syato, 2016).

In recent years, the Indonesian government has placed increasing emphasis on integrating local values into the national curriculum. The Merdeka Curriculum, for example, provides broader opportunities to strengthen the *Profil Pelajar Pancasila* by embedding the nation's noble values into the learning process. However, implementing these values in actual classroom practice continues to pose challenges, particularly in selecting instructional media that are engaging and meaningful for students.

Local wisdom encompasses traditional knowledge validated over centuries, including practices in agriculture, health, natural resource management, and social organisation. Research on local wisdom-based learning consistently demonstrates that such approaches not only enhance conceptual understanding but also reinforce students' cultural identity (Diab et al., 2022; Rahmawati, 2025; Suhardiyanto et al., 2025).

Findings from the present study reveal that combining AI with culturally grounded content produces a synergistic effect that significantly enhances students' readiness to learn. These results align with prior research showing that AI-enabled personalisation can improve the effectiveness of knowledge transfer (Almasri, 2024; Khosravi et al., 2022). The distinctive contribution of this study lies in illustrating how AI-driven personalisation can be meaningfully adapted within Indonesia's culturally rich educational context.

Furthermore, evidence from Mekalungi et al. (2025) involving 50 fourth-grade students at SD Negeri Banjarejo, explicitly demonstrates the effectiveness of digital comics incorporating local wisdom in improving reading literacy. In this context, reading literacy includes the ability to recognise, comprehend, analyse, and evaluate information in texts, skills that are essential in the digital era. Given these findings, subsequent research is warranted to examine students' readiness to engage with AI-Comic Nusantara as a medium for strengthening local wisdom values.

The ability of AI-Comic Nusantara to adapt its content to students' cultural contexts was a key factor in the intervention's success. This finding reinforces the argument that educational technologies must be designed with careful attention to the cultural settings in which they will be implemented (Putra et al., 2024). In Indonesia, where cultural diversity is exceptionally rich, such an approach offers a highly relevant solution to longstanding educational challenges in preserving local values.

Nevertheless, several challenges remain in developing and implementing AI-driven comics. First, collecting and validating local wisdom data requires substantial time and resources. Second, ensuring that AI algorithms can accurately interpret and integrate complex cultural nuances poses a significant technical challenge. Third, technological infrastructure in some regions of Indonesia remains limited, hindering equitable access to digital comics.

Impact on Literacy and Local Values

The concept of literacy has evolved considerably over time. Formerly understood primarily as the ability to read text, literacy has now expanded into a multiliteracy framework encompassing a range of 21st-century competencies (Pratiwi & Wikantiyoso, 2022). Digital literacy, media literacy, information literacy, and visual literacy have become essential skills

that students must acquire to participate actively in modern society (Boronenko et al., 2020; Keykha & Rezaie Kakhajaleh, 2024; Nurjanah et al., 2024).

In the digital era, literacy no longer refers solely to interpreting written texts; it also encompasses understanding, analysing, and creating content across multiple media formats. Students need to develop the capacity to evaluate the credibility of information, interpret visual language, and communicate ideas through diverse digital platforms. Teachers and educational institutions play an increasingly critical role in equipping students with comprehensive literacy competencies (Wui et al., 2025).

Previous research has demonstrated that digital media in education can enhance student motivation and learning outcomes (Bridgstock, 2016; Luo & Zhu, 2025). Interactive media such as digital comics can effectively capture students' attention and make learning more engaging. However, it is important to emphasise that the use of technology must be accompanied by sound pedagogical practices to ensure that learning objectives are achieved.

The present study provides strong evidence of the positive impact of AI-Comic Nusantara on students' literacy development and understanding of local values. The 32% increase in literacy following the intervention aligns with prior findings regarding the effectiveness of visual media in literacy learning (Anisimova, 2020). This study, however, advances current knowledge by demonstrating how AI elements in comics can amplify these effects through personalised, adaptive content delivery.

Similarly, the 28% improvement in students' understanding of local wisdom is a noteworthy finding, particularly given the challenges involved in transmitting traditional values to younger generations. This result supports the claim that digital media, when thoughtfully designed, can serve as an effective bridge between tradition and modernity (Hidayati et al., 2020).

Qualitative analysis revealed that students not only recalled local values but also related them to their everyday lives. One student remarked during an interview, "*Now I understand that gotong royong is not just a term we learn in class, but something I can practice with my friends in my community.*" This indicates a deeper level of comprehension beyond mere memorisation of concepts. Overall, the findings of this study provide a broader contribution to the development of AI-Comic Nusantara as a medium for strengthening literacy and Indonesian local wisdom values. The integration of AI-driven digital media can support teachers and serve as a bridge for preserving and cultivating the philosophical foundations of local wisdom rooted in Indonesian society's social fabric.

Implications for Instructional Practice

Comics have long been recognised as an effective instructional medium for their ability to blend visual and verbal elements. The narrative structure of comics, composed of sequential image panels accompanied by concise text, allows complex information to be conveyed in a structured and accessible manner (Mekalungi et al., 2025). In educational settings, comics can serve diverse purposes, from simplifying complex scientific concepts to teaching moral and cultural values.

The findings of this study offer several important implications for teaching practice in Indonesia. *First*, AI-Comic Nusantara provide a learning model capable of addressing the heterogeneity of students within the classroom. The system's capacity to adapt content to individual learner abilities supports more inclusive and effective learning experiences (Yun et al., 2025). *Second*, integrating local content into educational technologies underscores the importance of a "glocal" (global-local) approach to technology development. Rather than adopting foreign technological solutions without modification, this approach emphasises the need to adapt technologies to local cultural and educational contexts (Primayanti & Puspita, 2022). *Third*, the study demonstrates the potential of AI to transform assessment practices.

Instead of relying solely on standardised tests, which often fail to capture the multidimensional nature of student readiness, AI-Comic Nusantara enable more holistic and naturalistic forms of assessment embedded within the learning process itself.

Limitations of the Study

Despite the promising findings, several limitations should be acknowledged. First, the relatively short intervention period (eight weeks) limits the ability to evaluate the long-term impact of using AI-Comic Nusantara. An extended implementation would be necessary to determine whether the observed improvements in literacy and understanding of local values can be sustained over time. Second, although the sample size in this study is substantial, it does not fully represent the diverse student population across Indonesia's broad geographical, cultural, and socio-economic spectrum. Third, this study did not explicitly compare the effectiveness of AI-Comic Nusantara with other instructional interventions, thereby limiting conclusions about its relative advantages over alternative learning media.

Despite the promising findings, several limitations should be acknowledged. First, the intervention period of only eight weeks restricts the ability to assess the long-term impact of AI-Comic Nusantara on students' literacy and their understanding of local wisdom. A longer implementation timeframe is needed to determine whether these improvements can be maintained over time. Second, although the sample size is substantial, it does not fully capture Indonesia's wide geographical, cultural, and socio-economic diversity; therefore, the generalizability of the findings may be limited. Third, this study did not incorporate comparative analyses with other instructional methods or media, making it difficult to determine whether AI-Comic Nusantara offers more effective learning outcomes than alternative approaches. Fourth, the implementation of AI-generated comics depends on stable technological infrastructure, which may pose challenges in regions with limited access to digital devices or internet connectivity. Finally, embedding cultural nuances into AI-generated content remains complex, and any misinterpretation or oversimplification of local values could undermine the authenticity and educational relevance of the comics.

Conclusion

This study demonstrates the significant potential of AI-Comic Nusantara as an innovative learning medium for assessing and enhancing student readiness in literacy and Indonesian local wisdom values. The findings show that AI-Comic Nusantara substantially improved student readiness across all measured dimensions, while student responses indicated high levels of engagement, personalisation, and cultural relevance. The integration of AI technology with localised cultural content fostered positive collaboration, enabling learning experiences that are both modern and deeply rooted in traditional values. Furthermore, key AI components, including adaptive content generation, local knowledge integration, interactive assessment, and real-time feedback, collectively contributed to the intervention's effectiveness.

Overall, this research provides empirical evidence that AI technology, when designed with cultural sensitivity, can address two major educational challenges in Indonesia: strengthening literacy skills for global competition and preserving local wisdom as part of national identity. Educational transformation through the development of AI-based *Komik Nusantara* does not signify abandoning cultural roots; rather, it demonstrates how wisely developed technology can serve as a bridge for sustaining and revitalising local wisdom in ways that resonate with today's learners. The success of this initiative illustrates that innovation and tradition can coexist, supporting learning that enhances academic competence while simultaneously shaping student character through meaningful cultural values. The development of AI-based *Komik Nusantara* opens new opportunities to explore how technology can be leveraged to address complex educational challenges in Indonesia's pluralistic context. With strong collaboration among government institutions, academics, educators, and communities, Indonesia can

cultivate a learning ecosystem that is not only modern and effective but also humanistic, culturally grounded, and sustainable.

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The authors do not have any potential conflicts of interest to disclose.

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Ethics Approval

No ethics approval is needed because no animals are involved.

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