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KEBAYA: Digital Comics on Indonesian Cultural Diversity to Enhance High-Order Thinking Skills in Elementary School

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Abstract

In the era of globalisation and digital transformation, elementary education faces challenges in preserving local cultural values within technology-based learning environments. Digital learning media often emphasise globalised content, limiting culturally grounded learning experiences. Meanwhile, Higher-Order Thinking Skills (HOTS) have become a core objective of 21st-century education, yet empirically validated media integrating Indonesian cultural diversity with HOTS development remain scarce. This study aims to develop and evaluate KEBAYA (Digital Comics on Indonesian Cultural Diversity), a culture-based digital comic designed to enhance students' HOTS through interactive narratives. Using a research and development approach with the ADDIE model, the study involved needs analysis, product design aligned with curriculum and cultural values, development using the Canva application, expert validation, and field trials with elementary students. Effectiveness was assessed through HOTS-oriented tests and response questionnaires. The results show that KEBAYA is valid, practical, and effective in improving students' HOTS, particularly analysis, evaluation, and creative thinking, offering a scalable model for culturally responsive digital learning. This study contributes to culturally responsive digital pedagogy and provides a scalable learning medium for elementary education.

INTRODUCTION

Background of the Study

Indonesia is widely recognised as a country with exceptional cultural diversity, encompassing hundreds of ethnic groups, regional languages, traditions, and forms of local wisdom (Cahyaningtyas et al., 2022; Ismiyanti et al., 2023). This diversity represents a fundamental national asset that shapes Indonesia's identity and social cohesion. In the context of elementary education, cultural understanding plays a strategic role in fostering tolerance, respect for differences, collaborative skills, and global awareness among students (Perez et al., 2025). Cultural learning, therefore, serves as a foundation for cultural literacy, enabling learners to participate meaningfully in multicultural societies. However, the dominance of globalised digital content in children's daily lives has

increasingly marginalised local cultural narratives, raising concerns about students' diminishing engagement with indigenous culture.

At the same time, the development of Higher-Order Thinking Skills (HOTS) has become a core objective of 21st-century education. Recent Programme for International Student Assessment (PISA) results indicate that Indonesian students continue to demonstrate relatively low performance in tasks that require analysis, evaluation, and reasoning, compared to international benchmarks. National studies similarly reveal that elementary students tend to rely on memorisation-based learning and show limited analytical engagement in classroom activities. These findings suggest that current instructional practices have not sufficiently supported the development of HOTS, particularly in learning contexts that require critical interpretation and problem-solving.

From a theoretical perspective, culturally relevant education is grounded in constructivist learning theory, which emphasises that learners actively construct knowledge through meaningful interactions with their social and cultural environments (Shaafi et al., 2025). Vygotsky further highlighted the central role of artistic tools and social interaction in cognitive development, suggesting that learning is most effective when situated within authentic cultural contexts (Abrori et al., 2025). Consequently, cultural diversity learning should be designed contextually and experientially to promote deeper cognitive processing rather than surface-level knowledge acquisition. In line with these perspectives, HOTS—defined in Bloom's Revised Taxonomy as analysis, evaluation, and creation—must be cultivated from the elementary level to enable students to critically interpret cultural differences and generate creative responses to social issues (Yanti & Ismiyanti, 2025). Nevertheless, cultural learning in elementary schools remains predominantly informative and teacher-centred, offering limited opportunities for higher-order cognitive engagement.

Advances in digital technology provide new opportunities to address these challenges through innovative learning media. Among various digital formats, digital comics offer distinct pedagogical advantages. Paivio's Dual Coding Theory posits that information is processed through verbal and visual systems; integrating text and images can enhance comprehension and retention while reducing cognitive load (Ismiyanti & Permatasari, 2021). Similarly, Mayer's Cognitive Theory of Multimedia Learning suggests that well-designed multimedia materials support learning by managing intrinsic and extraneous cognitive load through principles such as coherence, contiguity, and segmenting (Kwangmuang et al., 2021; Suprapto et al., 2024). Digital comics inherently align with these principles by presenting segmented narratives that allow learners to control the pace of information processing, thereby freeing cognitive resources for higher-order thinking.

Compared to videos or game-based applications, which may overwhelm learners with continuous information or prioritise procedural engagement, digital comics emphasise narrative coherence and reflective interpretation. This makes them particularly suitable for culture-based learning, where understanding values, meanings, and social contexts is essential. Moreover, digital comics align well with the visual preferences of Generation Z and Alpha learners, increasing engagement and motivation (Malysheva et al., 2022). Despite these theoretical and empirical advantages, existing studies rarely develop and empirically validate digital comic-based learning media that explicitly integrate Indonesian cultural diversity with HOTS development at the elementary level. Most cultural learning media remain descriptive and do not systematically embed higher-order thinking activities. This gap highlights the need for a culture-based digital comic grounded in multimedia learning theory and designed to simultaneously strengthen cultural literacy and HOTS.

Problem of the Study

The development of Higher-Order Thinking Skills (HOTS) has become an urgent priority in 21st-century education, particularly at the elementary level, where foundational cognitive habits are formed. International assessments and national evaluations consistently indicate that students' analytical, evaluative, and creative thinking abilities remain underdeveloped. The triangulated needs analysis conducted in this study confirms this condition, revealing that only 32% of elementary students demonstrate proficiency at the C4–C6 levels of Bloom's Taxonomy. This finding underscores

a critical gap between current instructional practices and the cognitive competencies required for future learning, problem-solving, and active citizenship (Figure 1).

Alongside cognitive demands, cultural literacy represents a fundamental component of contemporary curricula, especially in culturally diverse contexts such as Indonesia. Cultural understanding is essential for fostering tolerance, social cohesion, and global awareness from an early age. However, curriculum audits conducted in this study indicate that 60% of instructional components lack meaningful integration of Indonesian cultural contexts. As a result, only 35% of existing learning materials successfully connect abstract academic content with students' socio-cultural realities. This disconnect suggests that cultural diversity, rather than being leveraged as a pedagogical asset, remains largely underutilised in elementary classrooms. The results of the needs analysis from the national survey, classroom observations, and curriculum audits can be illustrated through the chart in Figure 1 below.

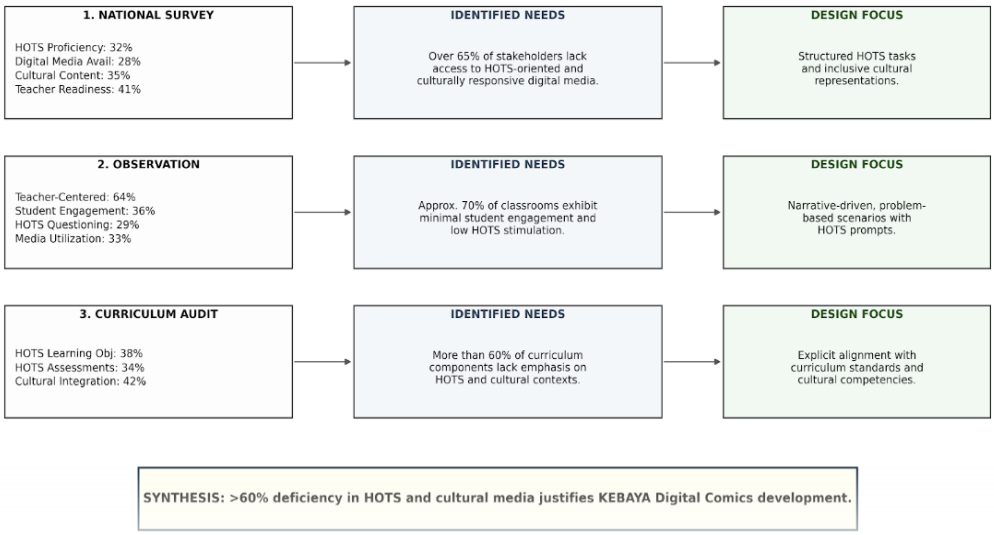

Figure 1. Need Analysis (Casiano & Palacio, 2022; Darmawan & Wuryandani, 2022)

The needs analysis further identifies structural and pedagogical obstacles that exacerbate these challenges. Instructional delivery remains predominantly teacher-centred (64%), limiting opportunities for active student engagement, which currently stands at only 36%. Higher-order questioning strategies are employed in just 29% of observed learning activities, contributing to a learning environment characterised by passive information reception rather than critical inquiry. Existing digital learning media are similarly constrained, tending to prioritise content delivery over cognitive challenge. Consequently, these media are perceived as monotonous and insufficiently stimulating to promote HOTS, reinforcing patterns of rote learning rather than deep understanding.

In response to these limitations, digital comics emerge as a promising pedagogical solution. Their narrative-driven structure enables the integration of problem-based scenarios that stimulate analysis, evaluation, and creative thinking. By combining visual and textual elements, digital comics can scaffold complex ideas while maintaining student engagement. Moreover, digital comics offer a flexible platform for embedding cultural representations in authentic and meaningful ways, aligning cognitive development with cultural literacy. This dual focus addresses both motivational and cognitive dimensions of learning, making digital comics particularly suitable for elementary education.

Based on these considerations, this study aims to develop KEBAYA digital comics as an innovative learning medium that integrates HOTS development with Indonesian cultural diversity. Unlike existing digital resources, KEBAYA is explicitly designed to embed higher-order thinking tasks within culturally inclusive narratives, providing instructional scaffolding that supports both teacher readiness—currently limited to 41%—and student engagement. This distinctive integration positions KEBAYA not merely as a supplementary medium but as a strategic pedagogical intervention that aligns curriculum standards with the cognitive and affective needs of elementary students, transforming learning into an intellectually rigorous and culturally grounded experience.

Research's State of the Art

The use of digital comics as a learning medium has been widely researched, particularly in the context of literacy, science, and character education. Most research indicates that digital comics have a positive impact on students' learning motivation, conceptual understanding, and visual literacy development (Kurniaman et al., 2025; Mollah et al., 2024; Sarimanah et al., 2022). Digital comics are considered capable of strengthening students' emotional and cognitive engagement through the integration of compelling narratives and illustrations. Some studies also show that comics can foster the development of analytical skills when their narrative design includes conflict, problem-solving, and reflection.

In some international studies, digital comics have also been developed to improve critical thinking skills by representing problematic situations within the stories (Desmaryani et al., 2024; Rahayu et al., 2024). However, in Indonesia, the use of digital comics in the context of cultural learning is still very limited. Research exploring the diversity of Indonesian culture through digital comics has not been widely conducted, especially research that examines its impact on elementary school students' HOTS (Darmayanti et al., 2022; Rutta et al., 2021). The digital comics that have been developed generally still use an informative approach or focus on basic literacy, rather than on higher-order thinking skills.

Additionally, most research on digital comics does not explicitly incorporate HOTS activities into their narrative design. The available media is more focused on delivering information without providing space for students to analyse, evaluate, or create new ideas. The development of digital media in the context of multicultural learning is still rare, even though cultural learning requires creative and contextual approaches. Therefore, there is significant potential to introduce digital comic media explicitly designed to develop HOTS within the context of Indonesia's cultural diversity.

Gap Study and Objective

The findings of this study extend the literature on Higher-Order Thinking Skills (HOTS) by demonstrating that digital comics can function not merely as engagement-enhancing media, but as cognitively generative instructional systems. Previous research has widely reported the effectiveness of digital comics in improving learning motivation, basic literacy, conceptual understanding, and visual literacy, particularly in literacy, science, and character education contexts (Kurniaman et al., 2025; Mollah et al., 2024; Sarimanah et al., 2022). However, these studies predominantly conceptualise digital comics as supportive or motivational tools, with HOTS treated as an incidental outcome rather than an explicit pedagogical objective. This study advances prior work by designing KEBAYA digital comics with HOTS-oriented cognitive demands deliberately embedded within narrative and visual-symbolic structures. Unlike earlier digital comics that rely on informative or descriptive content delivery, KEBAYA requires learners to interpret contextual information, evaluate culturally grounded dilemmas, and generate creative solutions. These processes directly activate the evaluative (C5) and creative (C6) domains of Bloom's Revised Taxonomy, addressing the empirically observed cognitive stagnation reflected in the low baseline HOTS achievement (32%).

Theoretically, this research contributes to multimodal learning theory by highlighting narrative coherence and cultural contextualisation as key mechanisms that mediate higher-order cognition. Rather than positioning culture as an aesthetic backdrop, this study reconceptualises Indonesian cultural diversity as a cognitive catalyst that supports situated reasoning, value-based judgment, and reflective thinking. In addition, KEBAYA embeds instructional scaffolding within the media itself, mitigating limited teacher readiness (41%) and reducing dependence on advanced pedagogical expertise. This study provides the first empirical evidence that a culturally responsive digital comic explicitly designed around HOTS-oriented narrative structures can function as a pedagogically mediated cognitive scaffold that integrates Indonesian cultural diversity with evaluative and creative thinking in elementary education. This research has several main objectives. First, developing the KEBAYA digital comic containing Indonesian cultural diversity content with a narrative and visual approach suitable for elementary school students. Second, assessing the feasibility and quality of the digital comic through a validation process by content experts, media experts, and pedagogical

experts to ensure that the developed media is of high quality in both content and learning design. Third, analyzing the response and effectiveness of KEBAYA in improving elementary school students' HOTS abilities through empirical testing.

METHOD

Type and Design

This research was a Research and Development (R&D) study aimed at producing KEBAYA (Digital Comics on Indonesian Cultural Diversity) digital comic media as a learning tool to improve elementary school students' Higher Order Thinking Skills (HOTS). Product development was carried out using the ADDIE model, which consists of the Analysis, Design, Development, Implementation, and Evaluation stages (Herlinawati et al., 2024). The ADDIE model was chosen because it has a systematic (Figure 3), comprehensive, and relevant structure for developing digital learning-based media (Arief et al., 2022).

Analysis

This stage focuses on identifying student needs, teacher needs, curriculum analysis, cultural competency analysis, and HOTS indicator analysis. Student characteristic analysis is conducted to determine cognitive development levels, learning interests, and readiness to use digital media. Material analysis is performed to ensure that the cultural diversity content aligns with the curriculum and students' life context.

Design

At the design stage, the digital comic concept, storyboard, character design, storyline, and the systematic integration of HOTS-oriented activities (C4–C6) were developed. This stage also involved the construction of research instruments, including expert validation sheets, student and teacher response questionnaires, and HOTS-based pre-test and post-test instruments. The comic was designed by integrating culturally grounded narratives, engaging visual elements, and problem-solving tasks explicitly aligned with analytical (C4), evaluative (C5), and creative (C6) thinking processes.

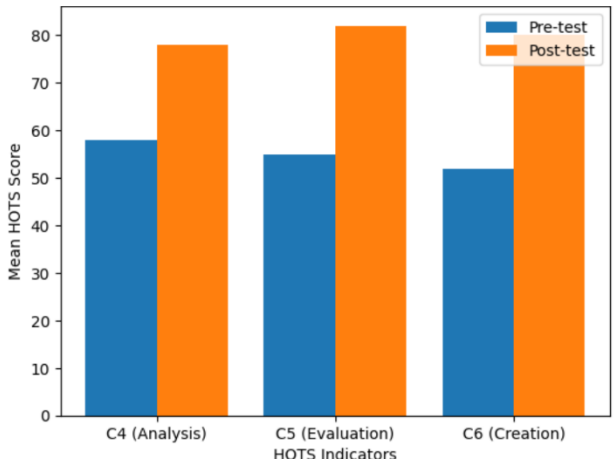

Figure 2. Comparison of Pre-test and Post-test HOTS Scores (C4-C6)

To strengthen analytical clarity and facilitate comparison across cognitive levels, a graphical representation of students' HOTS achievement was incorporated. The bar chart illustrates mean pre-test and post-test scores for each HOTS indicator (C4–C6), enabling readers to visually examine the differential impact of the digital comic on each cognitive domain. The graph demonstrates consistent score increases across all indicators, with the most pronounced gains observed in evaluative (C5) and creative (C6) skills. This visualisation supports the claim that the media does not merely enhance general learning outcomes but effectively targets higher-order cognitive processes through intentional narrative and task design (Figure 2).

Development

The development phase produces a digital comic prototype based on an application or interactive web platform. This prototype was then validated by three experts: a content expert, a media expert, and an instructional expert. Expert input is used for product revisions until it is deemed suitable.

Implementation

This stage involves implementing the KEBAYA digital comic in classroom learning. Students used comics during the learning process about Indonesia's cultural diversity. This stage includes small-scale testing to assess the clarity of navigation, readability, and appeal of the media through questionnaires completed by teachers and students. Large-scale testing is also conducted to evaluate the product's effectiveness through pre-tests and post-tests.

Evaluation

The evaluation phase comprised analyses of validity, effectiveness, and user responses. Media validity was examined through expert judgment involving content, instructional design, and visual communication aspects. Effectiveness was measured using a quasi-experimental one-group pre-test–post-test design, in which students' Higher-Order Thinking Skills (HOTS) were assessed before and after the implementation of the KEBAYA digital comic. The magnitude of learning improvement was analysed using normalized gain (N-gain) scores, while the statistical significance of HOTS improvement was examined through paired-sample t-tests. User responses were collected from students and teachers using structured questionnaires to evaluate the practicality and acceptability of the media in classroom implementation.

Figure 3. Stages of the ADDIE Development Model (Widiyastuti et al., 2021)

Data and Data Sources

The data sources in this study comprised three primary categories collected through sampling techniques aligned with each stage of the development process: expert validation data, teacher and student response data, and learning effectiveness data (Amral & Sumiharti, 2024). Expert validation data were obtained from three specialists, each representing a distinct domain of expertise. A media expert evaluated the quality of digital design, visual composition, illustration clarity, and navigation functionality. A content expert assessed the accuracy, relevance, and cultural representativeness of Indonesian cultural materials embedded in the digital comic. A learning expert examined the alignment of the media with elementary school curriculum objectives and its integration of Higher-Order Thinking Skills (HOTS) indicators (C4–C6). Teacher and student response data were collected during the limited trial phase using purposive sampling. This phase involved one fourth-grade classroom teacher and 12 students selected based on heterogeneous academic ability, prior experience with digital devices, and willingness to participate. These data provided insights into the media's attractiveness, usability, and students' learning experiences when interacting with the digital comic. Learning effectiveness data were obtained during the large-scale implementation phase through a pre-test and post-test design involving 35 fourth-grade students. Participants were selected using cluster random sampling by randomly choosing one class from the available fourth-grade population to ensure representativeness.

The research was conducted in a public elementary school located in a semi-urban area, characterised by moderate access to digital infrastructure and heterogeneous socio-cultural backgrounds. Students were exposed to diverse local cultural practices while simultaneously experiencing increasing interaction with global digital content through mobile devices and online media. This environmental context is particularly relevant, as it reflects common conditions in Indonesian elementary schools where cultural understanding and digital literacy develop simultaneously. Overall, the integration of multi-source data and contextually grounded sampling provides a robust empirical foundation for evaluating the feasibility, practicality, and effectiveness of the developed digital comic media.

Data Collection Technique

Data collection techniques were carried out using several techniques according to the ADDIE stages. In the development stage, data were collected through: (1) Expert validation sheets, used to obtain a quantitative assessment of the content, construction, and appearance of the media. (Damopolii et al., 2022). Content expert validation assesses the suitability of the Indonesian cultural diversity material with the curriculum, content accuracy, depth of concepts, and its connection to higher-order thinking skills (HOTS). Media expert validation evaluates aspects of graphic design, illustration quality, visual readability, navigation, and interactivity. Linguistic expert validation assesses language rules, sentence clarity, the suitability of the language for the cognitive development level of fourth-grade students, and text readability. (2) Student response questionnaire, to determine the level of attractiveness, ease of use, visual appeal, learning motivation, and student learning experience while using the KEBAYA digital comic. (3) Learning outcome tests in the form of pre-test and post-test are used to measure the improvement in students' higher-order thinking skills (HOTS) after using the media. The test items are designed according to HOTS indicators (C4–C6) and have been validated by content experts.

Data Analysis

Data analysis in this study was conducted quantitatively, encompassing three main components: expert validity, teacher and student responses, and the effectiveness of the learning media through N-gain calculations and t-tests (Fitria et al., 2023). These three types of analysis were used to ensure that the developed media product met the standards of feasibility, was well-received by users, and was able to significantly improve higher-order thinking skills (HOTS).

Expert Validation Analysis

Expert validation data were analysed to determine the feasibility and content validity of the developed digital comic. The validation involved three qualified experts: (1) a media expert lecturer with more than ten years of experience in digital learning media design; (2) a content expert specialising in Indonesian cultural studies and elementary social studies education; and (3) a learning expert with expertise in curriculum development and Higher-Order Thinking Skills (HOTS)–oriented instruction. Data were collected using a five-point Likert scale (1 = very inappropriate to 5 = very appropriate). This analysis aimed to evaluate the quality of media design, the accuracy and relevance of Indonesian cultural content, and the alignment of the media with learning objectives and HOTS indicators (C4–C6). The feasibility results were classified into four categories, as presented in (Table 1).

Table 1. Expert Validation Categories

Feasibility Percentage	Feasibility Level	Interpretation
85 - 100%	Very Feasible	Excellent quality; highly recommended for use.
70 - 84%	Feasible	Good quality; can be used with minor or no revisions.
55 - 69%	Less Feasible	Moderate quality; requires significant revision before use.
< 55%	Not Feasible	Poor quality; cannot be used and requires a complete redesign.

Note: The product is considered *valid for use* if it achieves a score of ≥ 70% (Tomaselli, 2022).

Analysis of Teacher and Student Responses

The responses of teachers and students were analysed using a percentage formula similar to

expert validation, which involves comparing the actual score with the maximum score. This analysis provides an overview of the acceptance level, ease of use, and user perceptions of the benefits of the developed digital media. (Table 2) The percentages were then classified as:

Table 2. Response Categories

Response Percentage	Quality Level	Interpretation
85 - 100%	Very Good	Extremely positive acceptance, highly user-friendly, and very beneficial.
70 - 84%	Good	Good quality; can be used with minor or no revisions. Positive acceptance, user-friendly, and beneficial as perceived by users.
55 - 69%	Sufficient	Moderate acceptance; some aspects may need improvement, but generally usable.
< 55%	Poor	Low acceptance; significant usability or benefit issues need to be addressed.

Note: The product is considered a *good quality response* if it achieves a score of ≥ 70% (Ruchana et al., 2025).

Effectiveness Analysis Using N-Gain

The effectiveness of the media is measured using the N-gain formula, which compares the improvement in pre-test and post-test scores. This analysis helps evaluate the improvement in students' HOTS abilities after using Indonesian cultural comic digital media (Table 3).

Table 3. N-Gain Interpretation Categories

N-Gain Value	Effectiveness Category	Interpretation
> 0.70	High	Significant and substantial improvement in students' HOTS abilities.
0.30 - 0.70	Medium	Moderate and satisfactory improvement in students' HOTS abilities.
< 0.30	Low	Minimal or non-significant improvement in students' HOTS abilities.

Note: The learning media is considered *Effective* if the N-gain value is at least in the Medium category (N-gain ≥ 0.30) (Cohn et al., 2025).

T-Test Analysis (Paired Sample t-Test)

(Table 4) To examine learning effectiveness, a paired-samples t-test was employed to determine whether a statistically significant difference existed between students' pre-test and post-test scores. Before conducting the t-test, the normality of the score differences was tested and confirmed (e.g., Shapiro–Wilk test, $p > 0.05$), indicating that the data met the assumptions for parametric analysis. The paired t-test utilised the mean difference, standard deviation of the differences, and sample size to calculate the t value. Statistical significance was determined at $\alpha = 0.05$, where $p < 0.05$ indicated a significant improvement following the intervention, while $p \geq 0.05$ indicated no significant difference. (Table 5) Overall learning effectiveness was established based on two criteria: (1) the normalised gain (N-gain) reached at least the medium category (≥ 0.30), and (2) the paired t-test demonstrated a statistically significant improvement ($p < 0.05$) between pre-test and post-test scores.

Table 4. Significance Level

Sig-value Criterion	Statistical Conclusion	Practical Interpretation
Sig < 0.05	Reject Ho	There is a significant difference between pre-test and post-test scores.
Sig ≥ 0.05	Fail to Reject Ho	There is no significant difference between pre-test and post-test scores.

Table 5. Overall Effectiveness Criterion

Condition No.	Measurement	Required Outcome
1	N-Gain Value	Must be in the Minimum Medium Category (≥ 0.30).
2	Paired t-Test	Must show a Significant Improvement (Sig< 0.05) after the intervention.

(Barreto et al., 2025)

RESULTS

Analyze

Based on the results of the preliminary study regarding learning needs analysis, it can be illustrated in the following table. The results of this needs analysis serve as a strong foundation for determining the content, flow, and form of interaction in the digital comic (Table 6).

Table 6. Results of the Needs Analysis

Analysis Aspect	Identified Need	KEBAYA Design Strategy
Student Needs	Need for engagement and digital media.	Digital Comic Format (Visual, Interactive, Accessible).
Teacher Needs	Need for practical, integrated resources.	Ready-to-Use Resource with combined cultural and HOTS content.
Curriculum & HOTS	Need for C4–C6 practice.	HOTS Integration: Problem-solving scenarios, analysis tasks embedded in the storyline.
Competency	Need for deep, authentic cultural knowledge.	Authentic Cultural Content: Accurate representation of Indonesian diversity via engaging narratives.

Design

The design phase in this study resulted in a comprehensive design for developing the KEBAYA digital comic as an Indonesian culture-based learning medium integrated with Higher-Order Thinking Skills (HOTS) abilities. In this phase, the researcher developed the comic concept, designed the storyboard and characters, created an educational storyline, integrated HOTS activities (C4–C6), and prepared research instruments to assess the product's feasibility and effectiveness.

The comic concept was developed by defining cultural scopes such as traditional clothing, regional languages, traditional houses, dance art, and typical cuisine. Comics are designed as an interactive medium that engages students in problem-solving activities so they can analyse, evaluate, and create. The main goal is to improve students' understanding of Indonesia's cultural diversity while developing higher-order thinking skills. Storyboards were created to illustrate the flow of 6 episodes, each showcasing the culture of different tribes. Each episode contains scenes, dialogue, cultural narration, and conflicts designed to stimulate critical thinking processes, such as the dilemma between traditional activities and school obligations, which leads students to analyse (C4), evaluate (C5), and create solutions (C6). The digital comic cover design representing the comic's content can be seen in Figure 4.

Figure 4. Front Cover

Character design features student characters from various regions with distinct cultural attributes such as traditional clothing, accents, and local customs. This representation aims to increase students' emotional connection and facilitate understanding of the cultural values being conveyed. The storyline is developed narratively, lightly, and relevantly to students' lives through authentic socio-cultural conflicts. Each episode concludes with a reflective question to encourage students to think critically and reassess their understanding of culture. Here is a sample character illustration from the digital comic, which can be seen in Figure 5, and an introduction to the local culture of each character in Figure 6.

Figure 5. Character Introduction

Figure 6. Introduction to Regional Culture from One of the Figures

The integration of HOTS activities is implemented through character dialogue, story conflicts, task pages, and interactive challenges. C4 activities guide students to analyse culture, C5 evaluates character actions, and C6 encourages them to create solutions or ideas for cultural preservation. Thus, comics not only present cultural information but also serve as an effective medium for developing students' higher-order thinking skills. An example of integrating HOTS in digital comics can be seen in Figure 7.

Figure 7. Integrating HOTS in Digital Comics

Development

The developed KEBAYA digital comic prototype incorporates interactive features such as animations, navigation buttons, and short quizzes designed to stimulate students' analytical, evaluative, and creative thinking skills. The content is aligned with the elementary school curriculum and presents Indonesian cultural diversity accurately and contextually to support HOTS-oriented learning. As shown in Table 7, expert validation results indicate that all assessed aspects achieved very feasible ratings, with average scores ranging from 80% to 100%. Beyond quantitative evaluation, experts provided qualitative feedback to refine the prototype. The content expert suggested minor revisions to linguistic clarity and consistency with Indonesian spelling conventions to improve readability for elementary learners. The media expert recommended small adjustments to text layout and visual balance to enhance navigation flow and user comfort. The instructional expert advised strengthening the clarity of reflective questions to better support HOTS integration within learning activities.

All suggestions were incorporated through targeted revisions, particularly in the writing systematics, as illustrated in Figures 8 and 9. Following these improvements, the KEBAYA digital comic met established standards for content quality, media design, and instructional relevance, and was deemed ready for implementation to evaluate its effectiveness in enhancing elementary students' Higher-Order Thinking Skills.

Table 7. Results of the KEBAYA Digital Comic Prototype Validation

Assessment Aspect	Content Expert (%)	Media Expert (%)	Instructional Expert (%)	Average (%)	Category
Material accuracy	90	-	-	90	Very Feasible
Curriculum alignment	95	-	85	90	Very Feasible
Relevance to cultural diversity	100	-	-	100	Very Feasible
Visual & interactive design	-	85	-	85	Very Feasible
Navigation & ease of use	-	90	-	90	Very Feasible
Aesthetics & media appeal	-	80	-	80	Very Feasible
Integration of HOTS indicators	-	-	85	85	Very Feasible
Facilitation of active learning	-	-	90	90	Very Feasible

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Figure 8. Writing systematics before revision

Figure 9. Systematics of writing after revision and adjustment to Indonesian spelling

Implementation

The Implementation phase in the ADDIE model aims to implement the KEBAYA digital comic prototype on elementary school students and assess its effectiveness on High-Order Thinking Skills (HOTS). Implementation was carried out in two stages: a limited trial with 12 students and a full-scale trial with 35 students. The limited trial aims to gather initial feedback on usability, interactivity, student interest in the media, and understanding of the Indonesian cultural diversity material. Full-scale trials were used to analyse students' improvement in HOTS through pre-tests and post-tests. Student and teacher responses were measured using a 1–100% Likert scale questionnaire. The results showed that both students and teachers gave positive to very positive responses to the KEBAYA digital comic prototype (Table 8).

Table 8. Student and Teacher Responses to the KEBAYA Digital Comic

Respondent	Number of Items	Average Score (%)	Category
Students (n=12)	10	88	Very Good
Teacher (n=1)	10	92	Very Good

Before advanced statistical analysis was performed, the Kolmogorov-Smirnov normality test was conducted on the pre-test and post-test data of 35 students. The results showed that the data were normally distributed, allowing for the application of parametric analysis (Table 9).

Table 9. Normality Test for Pre-test and Post-test (n=35)

Data	Kolmogorov-Smirnov Z	Sig.	Conclution
Pre-Test	0.098	0.200	Normal
Post-Test	0.107	0.200	Normal

To visually examine the magnitude of improvement across HOTS indicators, a bar chart was used to compare pre-test and post-test mean scores for C4, C5, and C6 (Figure X). The chart shows substantial increases in all indicators after the implementation of the KEBAYA digital comic. Among the three aspects, Analysis (C4) and Evaluation (C5) demonstrate the largest gains, indicating that the KEBAYA media has a particularly strong influence on students' analytical and evaluative thinking skills, while still effectively supporting creative thinking (C6) (Figure 10).

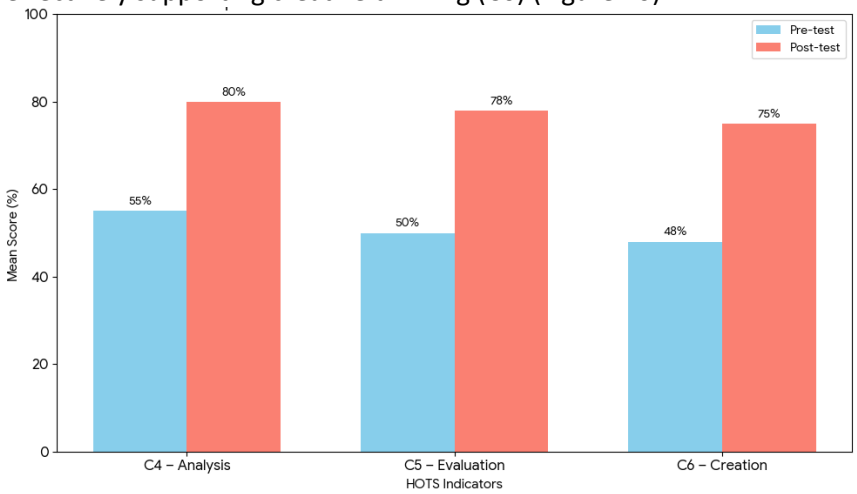

Figure 10. Systematics of writing after revision and adjustment to Indonesian spelling

The effectiveness of digital comics in improving HOTS was analysed using N-gain, which showed an increase in students' abilities from pre-test to post-test. The N-gain results indicated an improvement in the moderate to high category (Table 10).

Table 10. N-gain Calculation Results (n=35)

HOTS Indicator	Pre-test (%)	Post-test (%)	Gain	Category
Analysis (C4)	55	80	0.56	Medium
Evaluation (C5)	50	78	0.56	Medium
Creativity (C6)	48	75	0.52	Medium
Average	51	77.7	0.55	Medium

To determine the significance of the increase in HOTS, a paired t-test was conducted between the pre-test and post-test on 35 students. The results showed a statistically significant increase ($p < 0.05$) (Table 11).

Table 11. T-Test Calculation Results (n=35)

Data	N	Mean Pre-test	Mean Post-test	T	df	Sig. (2-tailed)
HOTS	35	51,00	77,71	14,23	34	0,0000

Evaluation

The evaluation of the KEBAYA digital comic development shows that this medium is highly feasible, receives very positive user responses, and is effective in improving elementary school students' High-Order Thinking Skills (HOTS). The feasibility test by content, media, and learning experts yielded a score of 80–100%, categorised as "very feasible," with aspects of content accuracy, curriculum alignment, and cultural relevance achieving the highest scores. The visual design, interactivity, navigation, and integration of HOTS indicators were also rated as excellent. User response through limited trials showed students gave it an 88% score and teachers 92%, indicating that the digital comic is easy to use, engaging, and helps with understanding Indonesian cultural diversity material. The teacher considers this medium relevant to the Merdeka Curriculum and capable of promoting higher-order thinking skills.

The effectiveness of the media was tested through a large-scale trial on 35 students. Normality tests show that the pre-test and post-test data are normally distributed. N-gain analysis shows an improvement in HOTS in the moderate category (average 0.55), with increases in the aspects of analysis, evaluation, and creativity. Paired t-tests showed a significant difference between pre-test and post-test scores ($p = 0.000$), proving that KEBAYA digital comics are effective in improving students' higher-order thinking skills. Overall, this medium is not only worthwhile and well-received but also has a significant impact on the development of critical and creative thinking literacy.

DISCUSSIONS

This study provides empirical evidence that the KEBAYA digital comic contributes meaningfully to the improvement of elementary school students' Higher-Order Thinking Skills (HOTS). The interpretation of these findings is grounded in a triangulation of expert validation results, user response data, and inferential statistical analysis, thereby reducing the likelihood that the observed learning gains are attributable to chance or subjective bias. By combining feasibility, practicality, and effectiveness measures, this study adopts a comprehensive evaluative approach commonly recommended in educational media development research (Wang & Ma, 2022). From a cognitive design perspective, the findings are consistent with Mayer's Cognitive Theory of Multimedia Learning (CTML), which posits that learning outcomes improve when instructional materials support the integration of verbal and visual information through well-structured multimedia principles (Kukreja, 2025). The high expert validation scores (80–100%) indicate that the KEBAYA digital comic adhered to key principles such as contiguity, coherence, and segmentation. These principles are critical for minimising irrelevant processing and supporting meaningful learning. Therefore, the positive student response (88%) should not be interpreted merely as affective engagement, but as an indicator of cognitive accessibility and instructional clarity (Achmad & Rusdiana, 2024).

To further strengthen the explanatory power of these results, Cognitive Load Theory (CLT) offers an important analytical lens (Maafs-Rodríguez et al., 2025; Wang & Ma, 2022). The narrative structure and visual sequencing of the KEBAYA digital comic reduced extraneous cognitive load by contextualising cultural diversity content within familiar storylines (Siba Sabon et al., 2022). This instructional efficiency allowed students to allocate more working memory resources to germane processing, such as identifying relationships, comparing perspectives, and evaluating solutions. The statistically significant improvement in HOTS scores, particularly in analysis (C4) and evaluation (C5), supports the argument that the observed gains reflect improved cognitive processing rather than surface-level memorisation.

From a sociocultural standpoint, the results are also interpretable through Vygotsky's Social Constructivist Theory, which emphasises that learning is mediated by cultural tools and social interaction (Aminudin et al., 2024). The high teacher response score (92%) suggests that the cultural representations embedded in the KEBAYA digital comic—such as characters, symbols, and local narratives—functioned as meaningful mediational artifacts. These artifacts enabled students to anchor new knowledge in culturally familiar contexts, thereby facilitating conceptual understanding. The HOTS-oriented tasks embedded in the comic can be understood as instructional scaffolding that supported learners' progression within their Zone of Proximal Development (ZPD) (Casiano & Palacio, 2022; Darmawan & Wuryandani, 2022). Importantly, the integration of cultural diversity content was operationalised not as background information, but as a cognitive driver for higher-order thinking. Students were not assessed solely on their ability to recall cultural facts; instead, they were required to analyse cultural differences (C4), evaluate alternative responses to culturally grounded conflicts presented in the narrative (C5), and generate creative solutions that promote social harmony (C6). This instructional design choice strengthens the internal validity of the study by directly aligning learning activities, assessment indicators, and HOTS outcomes.

The effectiveness results are further supported by the N-gain value of 0.55, categorised as moderate, and by the paired-sample t-test results indicating a statistically significant improvement ($p < 0.05$). While the moderate N-gain suggests that the intervention does not produce maximal gains, it remains pedagogically meaningful within an elementary school context, where HOTS development is gradual and developmentally constrained. This finding aligns with Brookhart's HOTS framework, which emphasises sustained and iterative exposure to analytical, evaluative, and creative tasks rather than immediate high-effect gains (Kurniawan et al., 2024). Several limitations must be acknowledged to ensure appropriate interpretation of the findings. First, the sample was drawn from a single elementary school, limiting external validity and generalizability. Second, the intervention relied on specific digital devices and classroom infrastructure, which may affect replicability in under-resourced settings. Third, the study focused on short-term learning outcomes; long-term retention and transfer of HOTS were not examined. These limitations suggest that the findings should be interpreted as evidence of instructional potential rather than universal effectiveness.

CONCLUSION

This study addressed the research question of whether a culturally responsive digital comic can function as an effective instructional medium for enhancing elementary school students' Higher-Order Thinking Skills (HOTS). The findings confirm that the KEBAYA digital comic supports the development of analytical, evaluative, and creative thinking by embedding Indonesian cultural diversity within a structured narrative and multimedia learning design. Rather than serving merely as an instructional supplement, the comic actively facilitates higher-order reasoning and critical literacy through contextual problem situations grounded in students' cultural experiences. The KEBAYA digital comic is a feasible and instructionally effective learning medium that supports HOTS development through cognitively efficient multimedia design and culturally grounded pedagogy. These findings directly inform the study's conclusions and implications by positioning KEBAYA as a scalable digital innovation that can support curriculum goals, teacher instructional practices, and future research on culturally responsive HOTS-oriented learning media. For classroom implementation, the KEBAYA digital comic should be integrated into broader lesson plans as a contextual learning stimulus within inquiry-based, problem-based, or project-based learning models

promoted by the Merdeka Curriculum. Teachers can use the comic to introduce learning themes, guide discussion, support analytical tasks, and scaffold reflective or creative activities aligned with lesson objectives and assessments. Future research is encouraged to examine long-term learning effects, involve more diverse school contexts, and explore teacher professional development strategies that support systematic integration of digital comics into instructional practice.

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