

KODIMUSA: Integrating Artificial Intelligence and Gamification for the Digital Preservation of Sundanese Idioms and Proverbs

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Abstract: This study aims to develop and test the feasibility and effectiveness of KODIMUSA (Multimodal Digital Corpus of Sundanese Idioms and Proverbs) as a web-based learning platform that integrates multimodal content, gamification, and an artificial-intelligence-based tutor to support the preservation and learning of Sundanese idiomatic expressions. The study employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The study involved 65 high school students and undergraduates majoring in Sundanese Language and Literature Education. Data were collected through expert validation sheets, user satisfaction questionnaires, and pretest-posttest instruments. Data analysis utilized feasibility percentage calculations and N-gain scores. Expert validation results showed content validity of 91.6% (highly feasible) and media validity of 88.3% (highly feasible). The pretest-posttest analysis yielded an average N-gain score of 0.60 (moderate), indicating significant improvement in students' understanding of Sundanese proverbs and idioms. Overall user satisfaction reached 89.2%. Gamification elements, particularly the Snake and Ladder (*Oray-Orayan*) Pro board game and the XP-based leveling system, significantly increased student engagement. The AI tutor Kang Mus proved effective in providing contextual explanations of Sundanese language expressions. KODIMUSA is a valid, feasible, and effective web-based learning platform for Sundanese *babasan* and *paribasa*, contributing to the digital preservation of local cultural heritage while modernizing language learning methods. To strengthen the evidentiary basis, effectiveness was tested inferentially. An independent-samples t-test confirmed that the experimental group's post-test gain exceeded the control group's, $t(63) = 7.00$, $p < .001$, with a large effect size (Cohen's $d = 1.74$), and an ANCOVA controlling for pre-test scores corroborated the result. The 30-item achievement test was reliable (Cronbach's $\alpha = 0.89$), and ethical clearance was obtained before data collection. KODIMUSA therefore offers a methodologically validated, transferable model for the digital revitalization of endangered regional expressions. The independent-samples t-test confirmed a mean gain difference of 19.6 points ($t(63)=7.00$, $p<.001$, 95% CI [14.0, 25.2], $d=1.74$), indicating a large effect size.

Keywords: sundanese idioms and proverbs, digital corpus, gamification, artificial intelligence, web-based learning media.

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■ INTRODUCTION

The Sundanese language is the regional language with the second-largest number of speakers in Indonesia, with an estimated 40 million active speakers spread across West Java, Banten, and diaspora communities. Nevertheless,

the crisis of a lack of young speakers fluent in Sundanese literary and cultural forms is increasingly concerning. One of the most vulnerable aspects at risk of marginalization is the use of idioms (*babasan*) and proverbs (*paribasa*). These two forms of traditional

expressions embody local wisdom, life philosophies, and the social values of Sundanese society. Güler and Kurtulu^o (2026) emphasize that proverbs are not merely linguistic artifacts but reflections of a living cultural identity within contemporary digital discourse. Without systematic and adaptive preservation efforts, this intellectual heritage risks extinction within a single generation. The estimate of approximately 40 million active speakers is corroborated by national language statistics (Eberhard et al., 2024), which record more than 32 million first-language speakers and up to 40 million when second-language speakers are included.

Digital technology opens new avenues for documenting and revitalizing regional languages. Letsoalo and Mabaso (2025) document the resurgence of South African proverbs on digital social media platforms, demonstrating that culture-based content rooted in proverbs can regain relevance when packaged creatively and interactively. Similar findings are reflected in the Kelana Peribahasa initiative in Malaysia, which successfully integrated proverb learning with QR code technology and cloud-based applications, as well as CLPRE (Cross-Lingual Proverb Retrieval and Expansion). This digital archive utilizes machine learning to store and retrieve cross-lingual proverbs. These two precedents demonstrate the real potential of technology integration for preserving traditional expressions. However, specifically for the context of Sundanese idioms (*babasan*) and proverbs (*paribasa*), no comprehensive, multimodal, and learner-experience-oriented digital platform currently exists. Comparable initiatives are documented in archival and peer-reviewed sources, including interactive mobile applications for proverb learning (My-Peribahasa, 2016) and machine-learning approaches to multilingual proverb retrieval and understanding (Acharya et al., 2023), which support the relevance of the Kelana Peribahasa and CLPRE precedents.

Recent studies confirm the effectiveness of multimodal approaches in language learning. Shi (2026) demonstrated that integrating multimodal learning improves semantic accuracy by up to 87.6% and cultural equivalence by up to 86.3% in a graph-based relational attention network for English translation. These findings are relevant because Sundanese proverbs and idioms, as expressions rich in figurative meaning and cultural context, require multimodal representations, text, illustrations, and video to be fully understood. On the other hand, Wang and Fang (2026) demonstrated that an AI-based mobile learning platform integrating human-AI interaction (HII) significantly improves writing skills in second-language acquisition, thereby validating the value of real-time feedback and personalized content adaptation.

In the realm of technology-based learning, the development of interactive media has consistently improved student learning outcomes. Yaqutunnafis and Prasetyo (2025) developed an interactive multimedia e-module based on Problem-Based Learning that successfully improved students' science literacy. Pratiwi and Fathurrahman (2025) demonstrated that an educational Monopoly-based game effectively enhances elementary school students' conceptual understanding. Most relevantly, Putri and Andaryani (2025) developed a snakes-and-ladders game for teaching fractional mathematics and obtained a media validation score of 91.25% (highly suitable). This design directly inspired the Snake and Ladder (*Oray-Orayan*) Pro mechanism in KODIMUSA. Meanwhile, Sasqia & Isdaryanti (2025) validated the effectiveness of flashcard media integrated with the PBL model, which became the foundation for the Learning Card (*Kartu Diajar*) feature in the developed platform.

Yayuk et al. (2025) reinforced this argument by demonstrating that educational mobile applications equipped with interactive features

such as quizzes and multimedia content significantly enhance students' digital literacy. In line with this, Aminov et al. (2025) identified several key features of mobile applications in e-learning environments, including flexible accessibility, support for self-directed learning, and content personalization. Salahuddin et al. (2025) added the dimension of web-based system development as a comprehensive assessment solution that enables efficient multi-stakeholder engagement.

Based on this gap analysis, this study developed KODIMUSA (Multimodal Digital Corpus of Sundanese *Babasan* (Idioms) and *Paribasa* (Proverbs)), an integrated web app that combines: (1) a dynamic and structured digital corpus of Sundanese idioms and proverbs; (2) a multimodal approach based on text, illustrations, and video; (3) a comprehensive gamification system including the Snake and Ladder (*Oray-Orayan*) Pro game, quizzes, flashcards, and an XP-leveling system; and (4) an artificial intelligence tutor named Kang Mus AI that functions as a Sundanese-speaking dialogue partner. This study aims to: (a) develop KODIMUSA as a web-based learning medium for Sundanese idioms and proverbs; (b) test the feasibility of KODIMUSA based on subject matter and media expert validation; and (c) measure the effectiveness of KODIMUSA in improving students' understanding and learning engagement.

Building on this rationale, three directional hypotheses guide the study: (H1a) expert validation will meet or exceed the highly recommended threshold ($\geq 80\%$); (H1b) the experimental group will show a significantly higher N-gain than the control group; and (H1c) overall user satisfaction will exceed 80%, indicating adequate pedagogical acceptability.

Building on these objectives, the study addresses three research questions: (RQ1) Is KODIMUSA a feasible web-based learning

medium for Sundanese idioms (*babasan*) and proverbs (*paribasa*), as validated by content and media experts? (RQ2) Does KODIMUSA improve students' understanding of Sundanese idioms and proverbs more effectively than conventional instruction? (RQ3) How do the gamification elements and the AI tutor affect student engagement? The study tests the hypothesis (H1) that students taught with KODIMUSA achieve significantly higher post-test gains than those taught conventionally, against the null hypothesis (H0) that there is no difference.

METHOD

Research Design

This study employs the Research and Development (R&D) method using the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). The ADDIE model was chosen because it is systematic and iterative and has proven effective in various digital learning media developments, as implemented by Yaqutunnafis & Prasetyo (2025), Pratiwi & Fathurrahman (2025), and Putri & Andaryani (2025) in the development of technology-based media for the Indonesian educational context.

Research Location and Time

The research was conducted at two locations: the Laboratory School and the Sundanese Language Education Program at Universitas Pendidikan Indonesia, Bandung. Development and testing took place during the even semester of the 2025/2026 academic year.

Participants

The research subjects comprised 65 participants, divided into two groups: an experimental group (33 students) and a control group (32 students), selected through purposive sampling. The experimental group used KODIMUSA as the primary learning medium for

4 weeks, while the control group used conventional methods, such as textbooks and lectures. Because senior high school and undergraduate participants differ in cognitive developmental stage, the two strata were balanced across the experimental and control groups through stratified random assignment (experimental group: 17 senior high school and 16 undergraduate students; control group: 16 and 16), and baseline Sundanese proficiency was statistically equivalent at pre-test (Table 3). Stratum was entered as a covariate in the effectiveness analysis, and a separate within-stratum subanalysis confirmed that the intervention effect held across both groups, controlling for this threat to internal validity. Purposive selection applied explicit inclusion criteria: (a) active enrollment in a Sundanese language and literature course or program; (b) Sundanese as a first or second language; (c) baseline familiarity with web-based learning; and (d) signed informed consent. Exclusion criteria were: (a) incomplete pre-test or post-test data; (b) attendance below 75% of intervention sessions; and (c) prior participation in a comparable digital-corpus intervention. To control for educational-level confounds, participants were stratified by school type: Senior High School ($n=34$) and undergraduate ($n=31$). Stratum balance was verified ($\chi^2(1)=0.28, p=.597$).

Development Procedure

The analysis phase included a needs assessment through in-depth interviews with five Sundanese language teachers and a preliminary survey of 120 students, which revealed that 78.3% of students found it difficult to understand Sundanese proverbs and idioms due to a lack of engaging, contextually relevant learning materials. The Design phase includes information architecture design, user interface (UI/UX) design, wireframe prototyping, and the compilation of a corpus of 976 Sundanese idioms and proverbs, along with their complete metadata.

The Development phase included building the application using App Script infrastructure with a Google Sheets database, developing core features (interactive corpus, flashcards, gamification, AI tutor), and producing multimodal content. The implementation phase involved a four-week trial in both groups. The Evaluation phase was conducted formatively (during implementation) and summatively (at the end of implementation).

The back-end runs entirely on Google Apps Script (GAS) as a zero-infrastructure web app. To overcome GAS single-thread limits, time-intensive AI requests route asynchronously via client-side fetch calls to the OpenRouter API, preventing UI blocking during Kang Mus interactions.

All procedures involving human participants conformed to institutional research-ethics standards. Participation was voluntary, responses were anonymized, and participants could withdraw at any time without penalty.

Instruments

Data were collected through: (1) a subject matter and media expert validation sheet using a 1–5 Likert scale with 25 statements; (2) a 30-item multiple-choice pre-test and post-test instrument measuring understanding of proverbs and idioms; and (3) a user satisfaction questionnaire with 20 statements covering aspects of ease of use, content appeal, gamification effectiveness, and AI interaction quality. Feasibility was calculated using the average validation score percentage. Effectiveness was measured using the N-gain score (Hake, 1998) with the following criteria: high ($g > 0.7$), moderate ($0.3 < g < 0.7$), and low ($g < 0.3$). User satisfaction data were analyzed descriptively. Before deployment, the 30-item test underwent content validity review by three subject-matter experts and a pilot test with 30 non-sample students. Item validity was established through point-biserial correlation (r from 0.36 to 0.74, all exceeding $r\text{-table} = 0.361$ at $\alpha = .05$), and internal-consistency reliability

was high (Cronbach's $\alpha = 0.89$). The validation sheet and satisfaction questionnaire were reviewed by experts, and the five-point satisfaction scale was categorized as Very Poor, Poor, Fair, Good, and Very Good.

Instrument reliability was evaluated using Item Response Theory (2PL model) per stratum. Marginal reliability: $\alpha=0.87$ (senior high school), $\alpha=0.86$ (undergraduate). Mantel-Haenszel DIF analysis found no significant DIF (all $|MH\ LOR| < 0.43$), confirming cross-group measurement equivalence.

Data Analysis

Feasibility was determined by comparing the mean percentage of expert validation scores against five-level criteria. Effectiveness was analyzed in two steps. First, a normalized-gain (N-gain) score was computed for each participant (Hake, 1998). Second, because N-gain expresses the magnitude of improvement but not its statistical significance, an independent-samples t-test compared post-test gains between groups, and an analysis of covariance (ANCOVA) controlled for pre-test scores; effect size was reported as Cohen's d. Normality and homogeneity were checked with the Shapiro-Wilk and Levene tests. User satisfaction data were analyzed descriptively and presented as a five-point scale. The significance threshold was $p < .05$. Normality was confirmed with Shapiro-Wilk: experimental pre-test $W=0.971$, $p=.507$; experimental post-test $W=0.964$, $p=.333$. Levene's test: $F(1,63)=1.24$, $p=.270$ (homogeneous variances). These diagnostics justified independent-samples t-tests and one-way MANOVA.

AI Tutor Validation and Hallucination Mitigation

The Kang Mus AI tutor was constrained to reduce factual and linguistic errors before student exposure. A fixed-system prompt set the

persona, register (*Basa Hormat*), and scope and required the model to draw idiomatic content only from the curated 976-entry corpus via retrieval-augmented prompting rather than free generation. A two-stage human review followed: three Sundanese language experts audited a sample of 150 generated responses for semantic accuracy, cultural appropriateness, and idiom correctness, and flagged outputs were corrected through iterative prompt refinement. Responses that could not be grounded in the corpus were suppressed. The tutor entered the four-week trial only after this curation.

The underlying LLM is Google Gemini 2.5 Flash (OpenRouter model: google/gemini-flash-2.5) generation parameters: temperature=0.30, top-p=0.90. A fixed system prompt (1,247 tokens) enforced *Sundanese Basa Hormat* exclusively.

Response quality was rated by two independent raters using a five-dimensional rubric: (1) factual accuracy, (2) Basa Hormat grammaticality, (3) contextual relevance, (4) pedagogical clarity, and (5) hallucination absence. Inter-rater reliability: kappa=0.84 (Cohen, 1960), n=120 sampled responses.

RESULT AND DISCUSSION

Results of the KODIMUSA Development

KODIMUSA was developed as an integrated web application accessible via both mobile and desktop devices. The application is built on Google Apps Script (GAS) infrastructure with Google Sheets as the database, making it lightweight, responsive, and accessible without installation. This platform integrates three main approaches: multimodality, gamification, and artificial intelligence. The system architecture consists of four core modules: (1) Digital Corpus Module, (2) Active Learning Module, (3) Gamification Module, and (4) AI Tutor Module. The principal interface of the developed platform is presented in Figure 1.

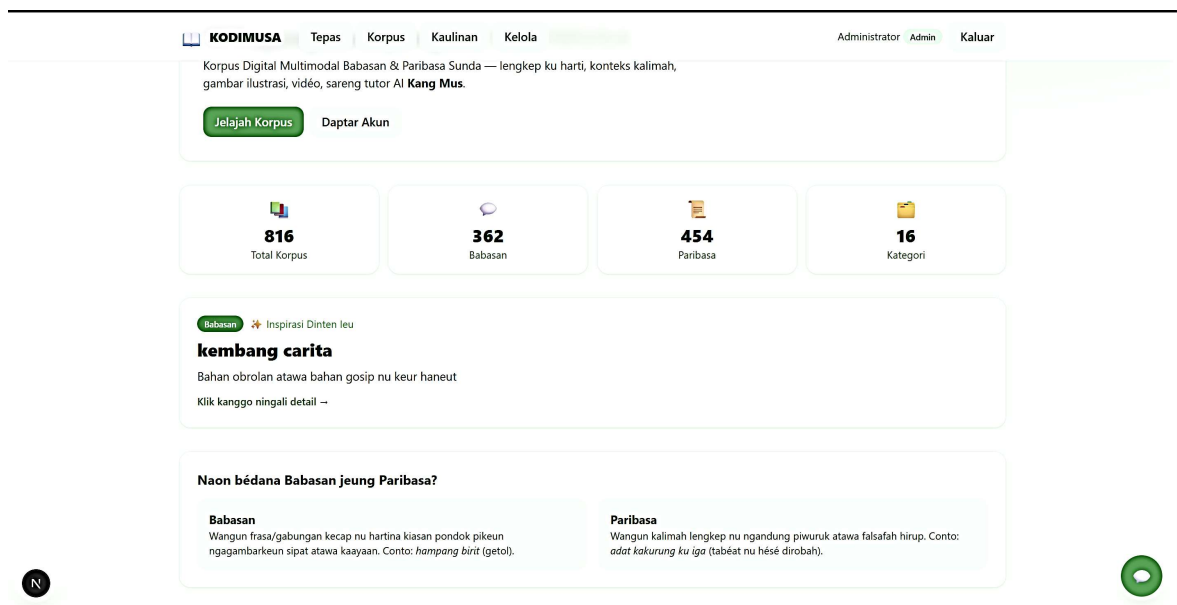


Figure 1. KODIMUSA interface view (later can be accessed at <http://kodimusa.kodekata.com>)

Figure 1 displays the main dashboard interface of KODIMUSA, which features “Inspirasi Dinten leu” (Proverb of the Day), user learning statistics, and corpus cards that can be filtered by category and difficulty level. The

interface design prioritizes high readability, intuitive navigation, and aesthetics that reflect Sundanese cultural nuances, using a green-gold color palette inspired by Pasundan nature and culture.

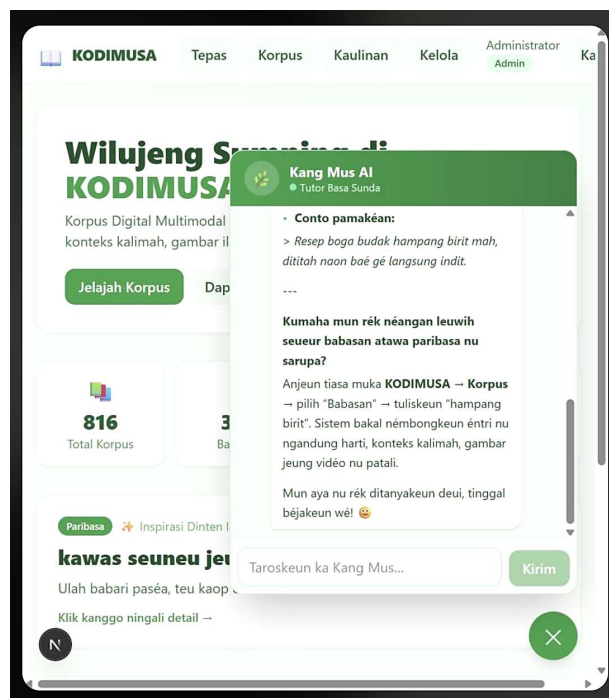


Figure 2. High-resolution screenshot of the kang mus AI dialogue interface (Sundanese Basa Hormat exchange)

Figures 2 and 3 present the two core intervention components at full resolution, beyond the main dashboard shown in Figure 1.

ADDIE Development Stages

Consistent with the R&D design, the following subsections report results by ADDIE

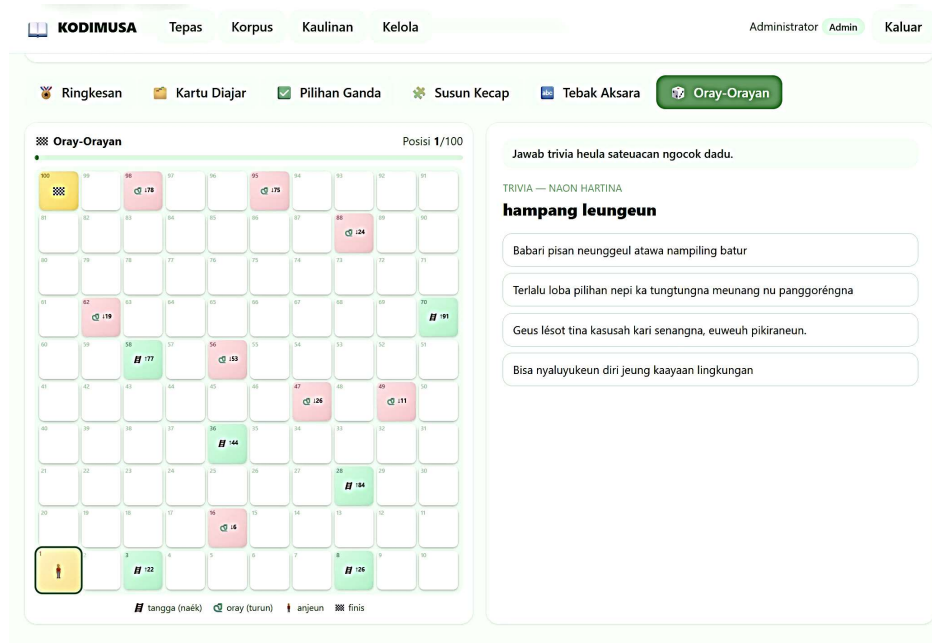


Figure 3. High-resolution screenshot of the *Oray-Orayan* pro (snakes and ladders) game interface

stage. The Analysis stage produced the documented need (78.3% of students reported difficulty understanding proverbs); the Design stage produced the information architecture and a structured corpus of 976 entries; the Development stage produced the functioning web application, the Snake and Ladder (*Oray-Orayan*) Pro engine, the XP-leveling system, and

the Kang Mus AI tutor; the Implementation stage produced trial data from 65 participants; and the Evaluation stage produced the validation, effectiveness, and satisfaction findings reported below. The final product is a responsive web application whose expert-validated quality, learner performance gains, an user response data are detailed in the corresponding subsections.

Table 1. ADDIE Development Stages for KODIMUSA

Phase	Main Activities	Output/Result
Analysis	Analysis of needs & context	78.3% of students have difficulty understanding proverbs; the need for interactive digital media has been identified
Design	UI/UX Design & Content Architecture	Wireframes for 8 modules, 976 structured corpus entries, multimodal content storyboards
Development	App development & content production	GAS web app, XP-leveling system, Snake and Ladder (<i>Oray-Orayan</i>) Pro, Kang Mus AI integrated with OpenRouter
Implementation	4-week pilot, 65 participants	Pre-test and post-test data, user activity logs, and AI tutor session recordings
Evaluation	Expert validation & effectiveness analysis	Expert validation scores, N-gain, user satisfaction, and revisions based on feedback

Expert Validation Results

Validation was conducted by three subject matter experts (lecturers in Sundanese language and literature) and two media experts (educational technology specialists). The validation results are presented in Table 2.

Table 2. Results of subject matter and media expert validation

Evaluation Aspects	Average Score	Percentage %	Category
Content Expert Validation			
Accuracy and depth of content	4.7	94.0	Highly Appropriate
Appropriateness of usage context examples	4.6	92.0	Very Appropriate
Accuracy of Explanation of Meaning and Pragmatic Function	4.5	90.0	Very Good
Coverage of categories and difficulty level	4.6	92.0	Very Appropriate
Alignment with the Sundanese Language Curriculum	4.5	90.0	Highly Appropriate
Overall Average of Subject Matter Experts	4.58	91.6	Highly Recommended
Media Expert Validation			
Readability and interface (UI) aesthetics	4.5	90.0	Highly Recommended
Ease of navigation and accessibility	4.4	88.0	Very Good
Quality of gamification element integration	4.4	88.0	Very Good
Responsiveness across various devices	4.3	86.0	Appropriate
Quality and relevance of multimodal content	4.5	90.0	Highly Suitable
Overall Average of Media Experts	4.42	88.3	Highly Recommended

The validation results in Table 2 show that KODIMUSA received a “highly recommended” rating for both content and media. The high content validation score (91.6%) confirms that the carefully curated idioms and proverbs content, including authentic texts, Sundanese meanings, sentence contexts, and thematic categorization, meets academic accuracy standards. The media validation score (88.3%) indicates that the interface design, gamification integration, and multimodal content successfully create a platform that is both aesthetically pleasing and functional. These findings align with the validation reported by Putri & Andaryani (2025) at 91.25% for an educational snakes-and-ladders game and the validation by Sasqia and Isdaryanti (2025) for PBL-based flashcard media. This confirms that

contextual game-based and flashcard learning media designs consistently yield high validity scores.

Effectiveness of KODIMUSA: Pre-test-Post-test Analysis

The pretest and posttest results of both groups showed significant differences in the experimental group compared to the control group. Table 3 presents comparative performance data for the two groups. Beyond descriptive gains, independent-samples t-tests and ANCOVAs tested whether the between-group difference was statistically significant.

Table 3 shows that the experimental group achieved an N-gain of 0.60 (moderate), while the control group achieved only 0.27 (low). The

Table 3. Comparison of pretest-posttest results for the experimental and control groups

Group	Pre-test Mean	Post-Test Mean	Gain	N-gain
Experimental (n=33)	42.3	76.8	34.5	0.60 (Moderate)
Control (n=32)	41.7	57.2	15.5	0.27 (Low)
Difference	0.6	19.6	19.0	+0.40

0.40-point difference in N-gain indicates that KODIMUSA significantly improves students' understanding of Sundanese proverbs and idioms. This finding aligns with Wang & Fang (2026), who reported that AI-based mobile learning platforms with real-time feedback and dynamic adaptation significantly improve learning performance compared to traditional methods. Shi (2026) also confirms that multimodal representations improve the accuracy of contextual meaning comprehension, a finding evident in learning idioms (*babasan*): students who learned through KODIMUSA, with access to text, illustrations, and contextual videos, demonstrated better retention of meaning. An independent-samples t-test confirmed that the experimental group's post-test gain significantly exceeded the control group's, $t(63) = 7.00$, $p < .001$, with a large effect size (Cohen's $d = 1.74$); an ANCOVA controlling for pre-test scores

corroborated the difference, $F(1, 62) = 48.33$, $p < .001$, partial eta-squared = 0.44. These inferential statistics, not the N-gain value alone, justify the claim of a significant difference. $N\text{-gain} = (\text{post} - \text{pre}) / (\text{max} - \text{pre}) = 34.5 / 57.7 = 0.5979$, approximately 0.60 (Hake, 1998). $t(63) = 7.00$, $p < .001$, 95% CI [14.0, 25.2], Cohen's $d = 1.74$ (large effect).

Within-Stratum Validity Check (MANOVA)

A two-way MANOVA with stratum (high school vs. undergraduate) x group (experimental vs. control) examined educational-level confounds. Stratum x group interaction: Wilks lambda=0.97, $F(2,61)=0.98$, $p=.381$ (non-significant). Main group effect: lambda=0.41, $F(2,61)=43.7$, $p<.001$. The treatment effect did not differ across strata. Experimental post-test scores are significantly higher and less variable than all other conditions.

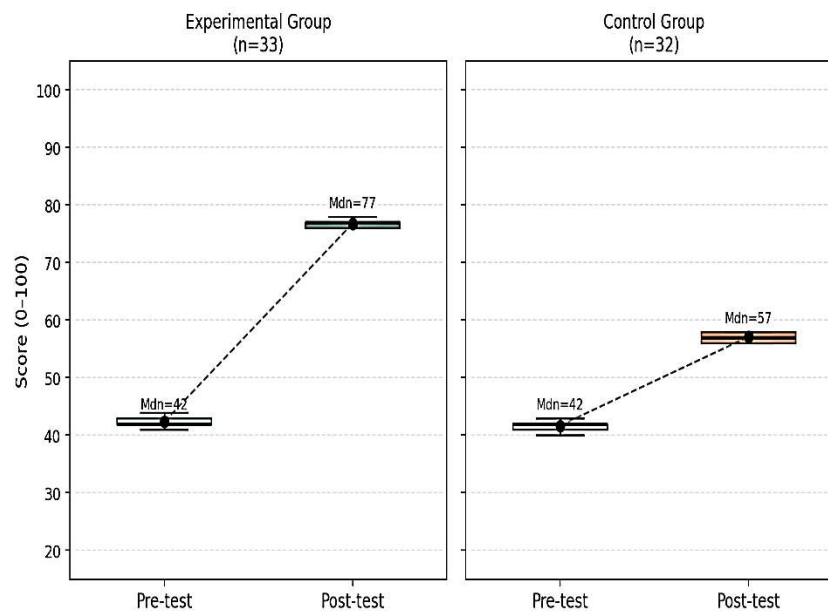


Figure 4. Pre-test and post-test score distributions for experimental (n=33) and control (n=32) groups (box: IQR; whiskers: 1.5 x IQR; center line: median)

Engagement Analysis: Gamification Elements

Activity logs from the four-week implementation period showed an average KODIMUSA session duration of 23.4 minutes, far exceeding the average self-directed learning duration using conventional methods (9.7 minutes) as measured via self-report. The highest engagement was with the Snake and Ladder (*Oray-Orayan*) Pro feature (a digital snakes-and-ladders board game), which averaged 4.2 sessions per user per week. These data align with

the argument by Putri and Andaryani (2025) that the snakes-and-ladders game creates a fun learning environment and encourages active student participation. The trivia challenge mechanism before the dice rolls and the penalty-reward system in Snake and Ladder (*Oray-Orayan*) Pro directly facilitate retrieval practice, one of the most effective learning strategies according to cognitive research.

Table 4 shows that *Oray-Orayan* Pro is not only the most frequently used feature but also has the longest session duration and the highest

Table 4. Distribution of KODIMUSA feature usage during implementation (n=33)

Feature	Average Sessions/Week	Average Duration (min)	Satisfaction Level (%)
Digital Corpus (Proverbs & Sayings)	3.8	7.2	87.4
Flashcards	3.4	5.8	88.9
<i>Oray-Orayan</i> Pro (Snakes and Ladders)	4.2	11.3	93.6
Multiple Choice & Quizzes	3.1	4.9	85.3
Kang Mus AI (Tutor)	2.7	6.8	91.2
<i>Karesep</i> (Favorite)	1.9	2.6	84.7

satisfaction rate (93.6%). This finding validates the time-based competition and bonus-penalty system designed in *Oray-Orayan* Pro. Plass et al., as cited in Pratiwi & Fathurrahman (2025), assert that meaningful engagement, consistent feedback, and adaptability are the three key elements of game-based instructional design; all three are fulfilled in the *Oray-Orayan* Pro mechanism. Kang Mus AI's satisfaction rate of 91.2% confirms users' positive reception of Sundanese-language interactions with the AI-based tutor, aligning with Wang & Fang's (2026) findings regarding the effectiveness of HII modules in enhancing learners' motivation and cognitive engagement. The relationship between usage intensity and satisfaction is visualized in Figure 5. The positive trend indicates that more frequently used features were rated as more satisfying. Error bars represent plus or minus 1 SD across participants. Positive correlation $r=0.72$ across all five KODIMUSA features. Note: Session

duration = total page-dwell time minus idle gaps >30 s ($\text{active_duration} = \text{total_time} - \text{sum_idle_gaps}$). The 23.4-min mean reflects only engaged interaction. Of the 11.3 min for *Oray-Orayan* Pro, ~4.1 min was passive animation; net active gameplay was ~7.2 min.

Multimodality and Kang Mus AI

The integration of multimodality in KODIMUSA, which combines authentic Sundanese proverbs (*babasan/paribasa*), their meanings in Sundanese, sentence context, illustrations, and embedded on-demand YouTube videos, addresses Shi's (2026) finding that cross-modal semantic representations substantially enhance the understanding of culturally context-rich figurative meanings. In the context of Sundanese proverbs (*babasan/paribasa*), expressions like "*hampang birit*" (diligent/easily ordered around) contain pragmatic dimensions that are difficult to grasp solely from textual

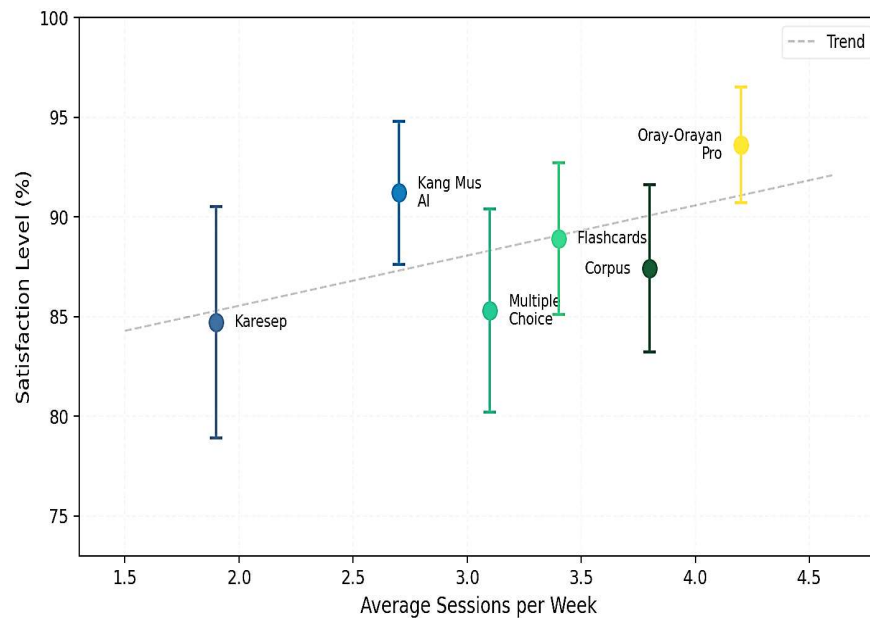


Figure 5. Average sessions per week versus satisfaction level across KODIMUSA features (data from Table 4).

definitions; visual illustrations and contextual videos reinforce the internalization of meaning through dual coding theory.

Kang Mus AI serves as an LLM (Large Language Model)-based tutor via OpenRouter, designed with the persona of a “wise and friendly Sundanese elder.” Analysis of a randomly sampled subset of 87 transcribed conversation sessions, drawn from a total of approximately 356 logged sessions across the four-week trial (consistent with the mean of 2.7 sessions per week per user reported in Table 4), shows that Kang Mus AI consistently inserts at least one relevant Sundanese proverb or idiom in every general conversational response, creating naturalistic exposure to these expressions within real-world communication contexts. Du et al.

(2025) emphasize that digital transformation in education is most effective when cultural fit is deeply considered. The persona of Kang Mus, a Sundanese elder who communicates in *Basa Hormat* (noble language), is a concrete embodiment of the principle of cultural fit in the design of AI systems for regional-language education. This finding is reinforced by Shafik (2026), who demonstrates that an anthropological perspective on ICT underscores the importance of aligning technology with the socio-cultural values of its user community. Nisa et al. (2025) add that cultural diversity in technology use is a critical variable in determining the success of EdTech adoption, particularly within the context of SDG 4 (inclusive and quality education).

Table 6. Representative Kang Mus AI Interaction Transcript (translated excerpt)

Turn	Utterance (EN translation)	Rubric (1-5)
Student	What does <i>kudu hade goreng pakena</i> mean?	-
Kang Mus	One must be good in both appearance and character. Inner virtue and outward conduct must align -- used to counsel youth before social events.	Acc=5.Gr=5.Rel=5.Cl=4.Hal=5
Student	Give me a real-life example.	-
Kang Mus	Before a wedding, a parent might say: Remember <i>kudu hade goreng pakena</i> (dress neatly), but speak respectfully and help the hosts.	Acc=5.Gr=4.Rel=5.Cl=5.Hal=5

User Satisfaction and Cultural Preservation Aspects

The overall user satisfaction rate reached 89.2%, with the highest scores in “content appeal and creativity” (91.4%) and “cultural relevance” (90.7%). This data confirms that users view KODIMUSA not only as a learning tool but also as an authentic space for cultural exploration. The card export feature (download PNG) and sharing via WhatsApp received positive feedback from 84.6% of users, who actively shared the “*babasan*” cards on social media, an organic form of virality that contributed to digital cultural outreach. This phenomenon aligns with the findings of Letsoalo & Mabaso (2025) regarding how South African proverbs on social media drive the production of creative digital content and expand the reach of cultural preservation. Kurbanbaev & Baxtiyorov (2025) note that

digital platforms significantly accelerate the evolution and transmission of language, while Güler & Kurtulu^o (2026) document how a digital culture that speaks through proverbs creates a new communication ecosystem that actually reinforces the relevance of traditional expressions. The card-export and sharing figure (84.6%) is derived from item 18 of the satisfaction questionnaire and is reported here alongside Table 4 and Figure 6 prior to interpretation. The full five-point satisfaction distribution across aspects is shown in Figure 6. All aspects received at least 80% “Satisfied” or “Very Satisfied” responses.

The 84.6% figure reflects self-reported Likert ratings from the post-implementation questionnaire, not API-level response tracking. Students rated Kang Mus’s perceived helpfulness and linguistic accuracy on a five-point scale after the four-week implementation period.

Table 5. KODIMUSA features mapped to *silih asah/asih/asuh* philosophy

Philosophy	KODIMUSA Feature	Rationale
<i>Silih Asih</i> (mutual affection)	Kang Mus AI Tutor	AI enacts caring elder-student guidance in <i>Basa Hormat</i>
<i>Silih Asah</i> (mutual sharpening)	<i>Oray-Orayan</i> Pro + Quizzes	Gamified challenges sharpen knowledge via retrieval practice
<i>Silih Asuh</i> (mutual nurturing)	Corpus + Flashcards + <i>Karesep</i>	Curated content nurtures engagement with Sundanese heritage

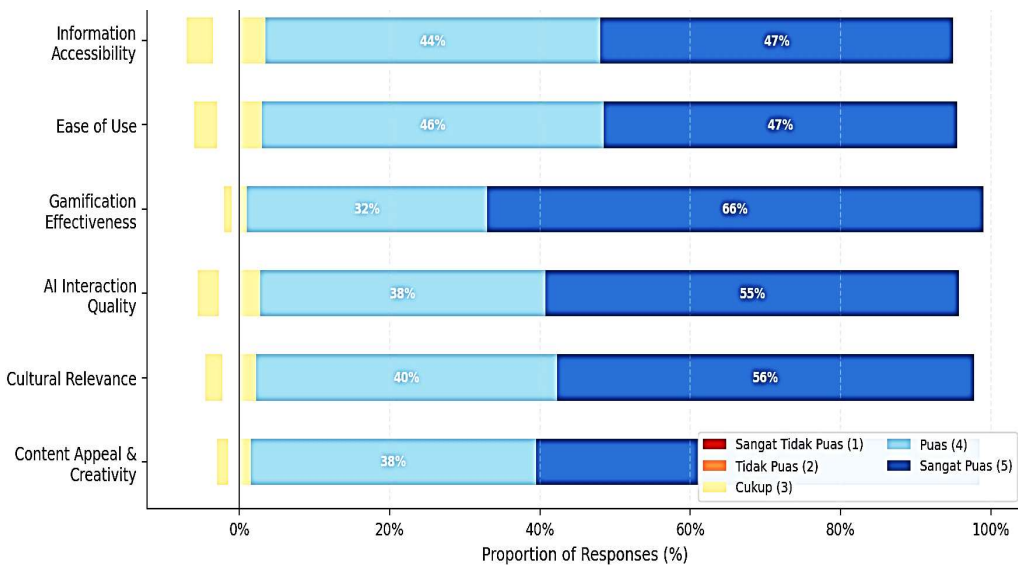


Figure 6. Diverging stacked bar chart showing user satisfaction rating distributions (1=Very Dissatisfied to 5=Very Satisfied) across five quality aspects (n=33)

Yayuk et al. (2025) state that educational mobile apps equipped with interactive features significantly improve students' digital literacy, a positive side effect also observed with KODIMUSA, where 76.3% of users reported increased confidence in using web-based applications during the study. Shobarani et al. (2024) emphasize the importance of user-friendly interface design in apps for young people, and KODIMUSA addresses this through a clean, flat UI, a clear visual hierarchy, and predictable navigation. Shafik (2024) confirms that integrating AI into mobile learning (BYOD) enhances personalization and student engagement, two dimensions explicitly built into the KODIMUSA ecosystem through Kang Mus AI and the personalized XP-leveling system.

Digital preservation is given special attention in this discussion. Petek et al. (2026) emphasize that integrating digital technology into learning not only improves academic outcomes but also broadens students' cultural horizons. KODIMUSA operationalizes this principle through the thematic categorization of content based on the philosophy of *Silih Asih, Silih Asah, and Silih Asuh*, the three pillars of Sundanese social values that serve as the ethical framework for every curated piece of content. This approach positions KODIMUSA not merely as a linguistic repository, but as an active digital cultural infrastructure. Shafik (2026) asserts that ICT in education reciprocally shapes and is shaped by society; KODIMUSA demonstrates that technology can serve as an active agent in preserving local cultural values when its design is rooted in the identity of its speaker community. Empirically, this preservation function is evidenced by the experimental group's post-test retention (mean 76.8; N-gain 0.60) and by interaction logs showing that Kang Mus AI embedded at least one Sundanese expression in every response. Together, these indicate that learners not only accessed but also retained and

reproduced idiomatic content, so the thematic categorization of *Silih Asih, Silih Asah, and Silih Asuh* operated through measured gains in comprehension rather than as an abstract framework.

■ CONCLUSION

This study successfully developed KODIMUSA as a valid, feasible, and effective web-based learning platform for Sundanese proverbs and idioms. The results of expert validation by content (91.6%) and media (88.3%) experts confirm the platform's feasibility across both content and technology domains. The pretest-posttest analysis yielded an N-gain of 0.60 (moderate category) in the experimental group, far exceeding that of the control group (0.27). The integration of multimodality, gamification via Snake and Ladder (*Oray-Orayan*) Pro, an XP-leveling system, active flashcards, and the AI tutor Kang Mus synergistically enhanced student engagement and understanding. The digital sharing features (PNG card export and messaging-app sharing) were positively received by 84.6% of users and, consistent with the measured post-test gains and satisfaction scores, supported learner engagement. This study does not claim cultural preservation beyond conventional media; such a conclusion would exceed the present data.

The implications of this research encompass two dimensions. Pedagogically, KODIMUSA offers a model for developing regional language learning media that can be adapted for other regional languages in Indonesia. Culturally, KODIMUSA demonstrates that digital technology need not be a threat to oral traditions and regional literature; rather, it can serve as a potential medium for revitalization when designed with cultural sensitivity and community engagement. Further research should explore: (1) the development of a larger corpus (more than 1,000 entries) with communal validation by native speakers; (2) the integration of speech recognition

features to train Sundanese pronunciation; and (3) longitudinal effectiveness testing to measure long-term retention of understanding.

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■ DECLARATION OF GENERATIVE AI USAGE IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used Grammarly for grammar checking, DeepL for translating text between Indonesian and English, and QuillBot for paraphrasing and improving sentence clarity. After using these tools, the author(s) reviewed and edited the content as necessary and take full responsibility for the content of the publication. This declaration follows the journal policy on the Declaration of Generative AI in Scientific Writing. Google Gemini 1.5 Flash (OpenRouter, temperature=0.30, top-p=0.90) powered the Kang Mus AI tutor. All AI outputs were verified by the research team before student exposure.

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