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Fostering local cultural literacy through Javanese wayang text-based learning: The development and validation of Katu Bastra Cards

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Abstract

Local cultural literacy has become an essential component of language education as schools are expected to preserve regional languages and cultural heritage while developing students' literacy skills. In Javanese language learning, wayang texts contain rich cultural values but remain difficult for students due to unfamiliar vocabulary and the limited availability of engaging instructional media. Although various vocabulary learning media have been developed, few studies have integrated local cultural literacy with Javanese wayang text-based learning through validated instructional media. This study aims to develop and validate Katu Bastra Cards as an instructional medium for fostering local cultural literacy through Javanese wayang text-based learning. This research employed a Research and Development (R&D) design using the ADDIE model, comprising the phases of Analysis, Design, Development, Implementation, and Evaluation. The study involved material experts, media experts, Javanese language teachers, and eighth-grade students at SMP Negeri 1 Kebakkramat. Data were collected through interviews, observations, questionnaires, and learning achievement tests and analyzed using descriptive statistics. The findings indicate that Katu Bastra Cards achieved a high level of validity based on expert evaluations and demonstrated practicality during classroom implementation. Furthermore, students showed improved learning outcomes and greater engagement in understanding Javanese wayang texts. By integrating visual vocabulary learning, collaborative learning activities, and authentic cultural content, the developed media effectively supported students' comprehension while fostering local cultural literacy. Therefore, Katu Bastra Cards offer a promising instructional alternative for integrating language learning with cultural preservation in secondary education.

Keywords: *Instructional media; Javanese language learning; Katu Bastra cards; local cultural literacy; wayang text-based learning*

INTRODUCTION

Local cultural literacy plays a pivotal role in modern language education by preserving indigenous heritage while fostering contextualized language learning.

However, the rapid advancement of digital technology and globalized communication channels has gradually reduced students' engagement with indigenous knowledge, regional languages, and traditional literary works. This decline creates significant challenges for educational institutions seeking to preserve local identities alongside global academic competencies. Consequently, contemporary educational policies increasingly emphasize that schools should not merely develop academic performance, but also cultivate students' cultural awareness through authentic instructional practices. Recent educational policies increasingly emphasize that schools should not merely develop academic competence but also cultivate students' cultural awareness through learning experiences that connect classroom instruction with local knowledge and traditions (Roessingh, 2020; UNESCO, 2008, 2024). Within this landscape, investigating tailored instructional media such as Katu Bastra Cards becomes academically significant, as empirical evidence remains sparse regarding how structured visual-textual media can effectively bridge the gap between abstract regional language instruction, classical literary engagement, and local cultural literacy. Articulating this academic rationale within the framework of culturally responsive pedagogy is essential to demonstrate how dedicated instructional tools can transform passive vocabulary decoding into active, culturally grounded literacy development.

In response to these challenges, local cultural literacy has emerged as an important educational objective. Cultural literacy extends beyond acquiring factual knowledge about customs or traditions; it involves learners' ability to recognize, interpret, appreciate, and apply cultural values embedded in language, literature, and everyday social practices (Hall, 2015). Contemporary perspectives conceptualize cultural literacy as a dynamic process that develops through learners' active engagement with authentic cultural experiences and culturally responsive learning environments (Aronson & Laughter, 2016; Gay, 2018; Jeong et al., 2021; Roessingh, 2020; Wesley-Nero & Donley, 2024). Within language education, integrating local cultural literacy encourages students to develop linguistic competence alongside a deeper understanding of their cultural identity, thereby making learning more meaningful and socially relevant.

Indonesia represents one of the world's most linguistically diverse countries, with more than 700 regional languages that function as repositories of local wisdom, historical memory, and cultural identity (Badan Pengembangan dan Pembinaan Bahasa, 2023). Among these languages, Javanese occupies a particularly significant position because it is spoken by millions of people and embodies philosophical values, ethical principles, and social norms that have been transmitted across generations. Consequently, Javanese language education is expected not only to develop students' communicative competence but also to preserve local cultural heritage through meaningful engagement with traditional literary texts and cultural practices (Rahadini et al., 2022; Sukowati & Subrata, 2022).

One of the most important literary materials in Javanese language education is wayang, which embodies moral values, philosophical teachings, and local wisdom that have been transmitted across generations. Consequently, learning Javanese wayang texts provides opportunities for students not only to

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improve reading comprehension but also to interpret cultural meanings, appreciate traditional wisdom, and strengthen their cultural identity through authentic literary experiences (Bayram et al., 2021; Moreno, 2021; Rahadini et al., 2022).

Literary texts such as wayang provide authentic contexts for vocabulary learning because they expose students to culturally embedded lexical items and figurative expressions. Through contextual reading, students construct vocabulary knowledge while simultaneously developing reading comprehension and cultural understanding (Bayram et al., 2021; Nugrahani et al., 2025; Olin-Scheller & Tengberg, 2017; Roessingh, 2020). Therefore, integrating wayang texts into classroom instruction aligns with the principles of culturally responsive pedagogy (Gay, 2018).

Despite the educational potential of Javanese wayang texts, their implementation in classroom learning continues to face considerable challenges. Wayang narratives are characterized by classical vocabulary, *krama* expressions, figurative language, and culturally specific lexical items that differ substantially from students' everyday language use. Consequently, many junior high school students experience difficulty interpreting textual meanings, identifying implicit cultural messages, and understanding the philosophical values embedded in wayang stories. Limited vocabulary mastery has consistently been identified as one of the primary barriers to reading comprehension, particularly when students encounter authentic literary texts containing unfamiliar lexical and cultural expressions (Nation & Hunston, 2013; Schmitt & Schmitt, 2020). Without adequate vocabulary knowledge, learners often focus merely on decoding individual words instead of constructing comprehensive textual meaning.

The preliminary study conducted at SMP Negeri 1 Kebakkramat reflects these broader educational challenges. Classroom observations revealed that Javanese language instruction remained predominantly teacher-centered, relying mainly on textbooks, PowerPoint presentations, and verbal explanations. Although *Bausastra Jawa* dictionaries were available, their limited quantity restricted students' opportunities to independently explore unfamiliar vocabulary. As a result, students frequently depended on teachers or online translation tools whenever they encountered difficult words in wayang texts. Such learning practices reduced students' active engagement in vocabulary learning and limited their opportunities to understand the cultural meanings represented within the texts. These findings indicate that existing instructional practices have not yet effectively integrated vocabulary development with local cultural literacy.

Vocabulary learning has long been recognized as a fundamental component of successful language education because vocabulary knowledge directly influences reading comprehension, critical thinking, and literacy development. Contemporary language education emphasizes that vocabulary should not be taught through isolated memorization but rather through contextualized learning experiences that enable students to construct meaning from authentic texts and communicative situations (Borkovska, 2024;

Jaikrishnan & Ismail, 2021; Pascual et al., 2022). Recent research further demonstrates that multimedia input significantly enhances vocabulary learning and long-term retention when vocabulary is presented within meaningful contextual environments (Teng, 2023). Recent studies also report that visual learning media facilitate deeper semantic processing because learners simultaneously process textual and pictorial information, thereby improving vocabulary retention, reading comprehension, and learner engagement compared with text-only instruction (Lei & Reynolds, 2022; Wu et al., 2020; Zhang & Zhang, 2024). Research further suggests that contextual vocabulary instruction supported by visual representations and collaborative learning activities significantly improves vocabulary retention, reading comprehension, and learner motivation compared with traditional teacher-centered instruction (Graham & Zhang, 2024; Schmitt & Schmitt, 2020; Y. Wang, 2024; Webb & Nation, 2017).

Consequently, instructional media capable of presenting vocabulary within meaningful cultural contexts have become increasingly important for promoting both language proficiency and cultural literacy. A recent meta-analysis also confirms that contextual exposure through meaningful reading, listening, and multimodal input substantially contributes to incidental vocabulary learning and reading comprehension, highlighting the importance of contextualized rather than isolated vocabulary instruction (Webb et al., 2023).

In response to these needs, numerous studies have explored the use of instructional media to improve vocabulary learning and literacy skills. Recent studies further demonstrate that multimedia vocabulary instruction designed using culturally responsive principles promotes vocabulary acquisition while simultaneously supporting students from diverse cultural backgrounds (Griendling et al., 2022). Recent studies have further demonstrated that multimodal input combining verbal information with meaningful visual representations significantly improves productive vocabulary learning compared with verbal-only instruction, as learners are able to construct deeper semantic connections between words and contextual meanings. Consequently, visual learning media facilitate deeper semantic processing because learners simultaneously process textual and pictorial information, thereby improving vocabulary retention, reading comprehension, and learner engagement compared with text-only instruction (Mayer, 2021; S. Wang & Lee, 2021; Zhang & Zhang, 2024). Recent systematic reviews further indicate that technology-enhanced language learning environments can improve learner engagement and vocabulary acquisition when instructional media are meaningfully integrated with pedagogical objectives (Zainuddin, 2023).

At the same time, recent educational research increasingly advocates the integration of local wisdom into language learning as a means of strengthening learners' cultural identity, contextual understanding, and meaningful engagement with instructional content. Culturally responsive pedagogy emphasizes that students learn more effectively when classroom instruction is connected to their cultural backgrounds, lived experiences, and local knowledge systems (Aronson & Laughter, 2016; Gay, 2018; Jeong et al., 2021; Wesley-Nero & Donley, 2024). Recent studies also demonstrate that culturally responsive instructional practices strengthen learner participation, cultural identity, and

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meaningful engagement across multilingual classrooms (Gube, 2024). Likewise, research on heritage language education suggests that culturally meaningful learning experiences contribute not only to language proficiency but also to the preservation of cultural identity and heritage language literacy (Bayram et al., 2021; Moreno, 2021). Consequently, local culture-based instructional media have been recommended as effective tools for bridging language learning with students' sociocultural backgrounds and fostering local cultural literacy.

Nevertheless, a critical synthesis of previous literature reveals three critical empirical gaps. First, existing vocabulary-learning media are overwhelmingly designed for major languages such as English or Indonesian, leaving regional languages like Javanese critically under-researched. Second, current instructional tools isolate vocabulary acquisition from cultural contexts, failing to explicitly embed local cultural literacy as a core learning objective. Third, while Javanese language research has addressed textbook design and general teaching strategies, empirical studies validating interactive instructional media grounded in authentic literary texts—such as wayang—remain virtually absent. Although separate research streams acknowledge the merit of digital learning media and cultural integration, they operate in isolation. Consequently, there is an urgent empirical need to synthesize contextual vocabulary acquisition, authentic Javanese wayang texts, and local cultural literacy into a unified, validated instructional medium.

To address these limitations, this study develops Katu Bastra Cards as a culturally responsive instructional medium integrating visual vocabulary learning with authentic Javanese wayang texts. The design of Katu Bastra Cards is grounded in the principles of contextual learning, multimedia learning, and culturally responsive pedagogy, which emphasize that students learn more effectively when language is presented through meaningful visual representations and authentic sociocultural contexts (Anya, 2021; Gay, 2018;). Rather than functioning merely as vocabulary cards, Katu Bastra Cards encourage learners to construct vocabulary knowledge while simultaneously interpreting the cultural meanings embedded in wayang narratives.

The novelty of this study lies in three key aspects that directly address the persistent challenge of low student engagement with classical Javanese literary texts. First, conceptually, it bridges the gap in Javanese language education where vocabulary acquisition is often detached from cultural literacy, using authentic wayang narratives as a contextual learning framework. Second, pedagogically, it addresses the lack of interactive learning tools by offering a culturally responsive medium that synergizes visual vocabulary scaffolds with text-based literary interpretation. Third, empirically, it provides rigorous validation and field-tested evidence on how Katu Bastra Cards, developed via the ADDIE model, overcome students' learning anxiety when encountering archaic krama vocabulary and complex cultural values. Collectively, these aspects distinguish the present study by transforming passive vocabulary memorization into an active, culturally grounded literacy practice.

Accordingly, this study contributes to the fields of language education, heritage language education, and culturally responsive pedagogy. Theoretically,

it expands the application of culturally responsive pedagogy in regional language learning by demonstrating how instructional media can facilitate vocabulary acquisition while strengthening students' local cultural literacy (Gay, 2018; Roessingh, 2020). Practically, it provides Javanese language teachers with an innovative instructional medium that supports vocabulary learning, reading comprehension, and cultural understanding simultaneously.

Therefore, this study aims to develop and validate Katu Bastra Cards for fostering local cultural literacy through Javanese wayang text-based learning. Specifically, the study seeks to (1) develop Katu Bastra Cards using the ADDIE instructional design model, (2) examine their validity and practicality through expert validation and classroom implementation, and (3) evaluate their effectiveness in improving students' vocabulary mastery, reading comprehension, and local cultural literacy.

METHOD

Research Design

This study employed a Research and Development (R&D) approach using the ADDIE instructional design model, which consists of five sequential phases: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). The ADDIE model was selected because it provides a systematic framework for developing, validating, and evaluating instructional media while ensuring alignment between learning objectives, instructional materials, and learner needs. During the Analysis phase, classroom observations, interviews with the Javanese language teacher, and a needs analysis were conducted to identify students' learning difficulties, particularly in understanding vocabulary found in Javanese wayang texts. The findings indicated that students experienced limited vocabulary mastery, had difficulty interpreting cultural meanings embedded in literary texts, and relied heavily on teacher explanations and online translation tools.

The Design phase involved preparing learning objectives, designing the content structure of the Katu Bastra Cards, determining vocabulary selection based on Javanese wayang texts, designing visual illustrations, and developing learning activities that integrate contextual vocabulary learning with local cultural literacy. During the Development phase, the prototype of the Katu Bastra Cards was produced and subsequently evaluated through expert validation. The validation involved experts in instructional media, Javanese language education, and learning materials. Suggestions from the validators were used to revise the product before classroom implementation.

The Implementation phase consisted of classroom trials involving eighth-grade students at SMP Negeri 1 Kebakkramat. The developed media were integrated into Javanese language instruction focusing on wayang text learning. Finally, the Evaluation phase examined the validity, practicality, and effectiveness of the developed instructional media. Product revisions were made based on expert feedback, teacher responses, student responses, and learning outcome data.

Participants

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The study was conducted at SMP Negeri 1 Kebakkramat, Central Java, Indonesia. Participants were selected using purposive sampling because they had studied Javanese language as part of the national curriculum and had previously learned wayang texts. The participants consisted of one Javanese language teacher who participated in the needs analysis and classroom implementation; three expert validators comprising one instructional media expert, one Javanese language expert, and one educational practitioner; and eighth-grade students who participated in the field implementation and effectiveness testing. The selection of participants was based on their relevance to the objectives of developing and evaluating culturally responsive instructional media for Javanese language learning.

Instruments

Multiple instruments were employed to collect both qualitative and quantitative data (Creswell & Creswell, 2023). The first instrument was a needs analysis guide, consisting of classroom observation sheets and semi-structured interview protocols used to identify instructional problems and students' learning needs. The second instrument was an expert validation questionnaire designed using a five-point Likert scale. The validation assessed four aspects of the instructional media, namely content suitability, language quality, visual design, and instructional feasibility. The third instrument was a teacher practicality questionnaire used to evaluate the ease of implementation, instructional usefulness, and classroom applicability of the Katu Bastra Cards. The fourth instrument was a student response questionnaire, which measured students' perceptions regarding the attractiveness, usability, clarity, and learning engagement provided by the instructional media. To measure learning effectiveness, a vocabulary mastery test, a reading comprehension test based on Javanese wayang texts, and a local cultural literacy assessment were administered before and after the implementation. The cultural literacy assessment evaluated students' ability to interpret cultural meanings, recognize local wisdom, and relate cultural values presented in the wayang texts to everyday life.

Procedures

The research was conducted through the five stages of the ADDIE model. First, a needs analysis was conducted through classroom observations and interviews with the Javanese language teacher to identify instructional problems and determine learning requirements. Second, learning objectives, instructional content, vocabulary selection, visual layouts, and learning activities were designed based on the results of the analysis. Third, the initial prototype of the Katu Bastra Cards was developed and validated by experts. Revisions were carried out according to the experts' recommendations until the product met the required quality standards. Fourth, the revised instructional media were implemented during Javanese language lessons involving wayang text learning. Students participated in learning activities using the developed cards to understand vocabulary and interpret cultural meanings embedded in the texts. Finally, data regarding validity, practicality, and effectiveness were collected and analyzed to determine the quality of the developed instructional media.

Data Analysis

Both qualitative and quantitative data analysis techniques were employed. Qualitative data obtained from classroom observations, interviews, and expert suggestions were analyzed using Miles, Huberman, and Saldaña's (2014) interactive model, consisting of data condensation, data display, and conclusion drawing. These findings were used primarily to revise and improve the instructional media throughout the development process. Quantitative data from expert validation, teacher responses, and student questionnaires were analyzed descriptively by calculating mean scores and percentages. The validity and practicality of the instructional media were interpreted according to predetermined feasibility criteria. To evaluate effectiveness, students' pre-test and post-test scores on vocabulary mastery, reading comprehension, and local cultural literacy were compared using a paired-samples t-test with a significance level of 0.05. Prior to hypothesis testing, normality assumptions were examined using the Shapiro-Wilk test. Additionally, the magnitude of learning improvement was calculated using the normalized gain (N-gain) to determine the effectiveness level of the developed instructional media.

RESULTS AND DISCUSSION

Needs Analysis (Analysis Phase)

The needs analysis was conducted through classroom observations and interviews with the Javanese language teacher at SMP Negeri 1 Kebakkramat. The findings revealed that Javanese language learning, particularly in wayang text instruction, remained predominantly teacher-centered. Instruction relied mainly on textbooks, PowerPoint presentations, and teacher explanations. Although printed *Bausastra Jawa* dictionaries were available, the limited number of copies prevented students from independently exploring unfamiliar vocabulary. Students experienced considerable difficulty understanding classical Javanese vocabulary, *krama* expressions, and culturally embedded lexical items found in wayang texts. Consequently, they frequently depended on teacher explanations or online translation applications rather than constructing meaning independently from textual contexts. This situation reduced opportunities for active vocabulary learning and limited students' ability to interpret the cultural values represented in wayang narratives.

Interviews with the teacher further indicated that existing instructional media primarily emphasized vocabulary memorization and reading exercises without explicitly integrating local cultural literacy. Therefore, there was a clear need for instructional media capable of supporting contextual vocabulary learning while simultaneously promoting students' understanding of local cultural values. These findings confirmed the necessity of developing culturally responsive instructional media that connect vocabulary learning with authentic Javanese literary texts.

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Table 1. Results of Needs Analysis

Aspect	Findings	Implications for Product Development
Learning process	Javanese language instruction remained predominantly teacher-centered, relying mainly on textbooks, PowerPoint presentations, and teacher explanations.	An interactive instructional medium is needed to encourage active student participation and learner-centered instruction.
Vocabulary learning	Students experienced difficulty understanding classical Javanese vocabulary, krama expressions, figurative language, and culturally embedded lexical items found in wayang texts.	The instructional media should provide contextual vocabulary support accompanied by visual representations and authentic examples.
Learning resources	Although Bausastra Jawa dictionaries were available, their limited number prevented students from independently exploring unfamiliar vocabulary.	Students require accessible learning media that facilitate independent vocabulary learning.
Student learning behavior	Students frequently relied on teachers or online translation tools when encountering unfamiliar vocabulary.	Learning activities should encourage independent meaning construction through contextual learning.
Reading comprehension	Students had difficulty interpreting the overall meaning and cultural messages contained in wayang texts.	Vocabulary learning should be integrated with reading comprehension activities based on authentic literary texts.

Local cultural literacy	Students demonstrated limited ability to interpret philosophical values and local wisdom embedded in wayang narratives.	The instructional media should explicitly integrate local cultural literacy as a learning objective.
Teacher needs	Existing instructional media mainly emphasized vocabulary memorization and reading exercises.	A culturally responsive instructional medium integrating vocabulary learning, reading comprehension, and local cultural literacy should be developed.
Learning process	Javanese language instruction remained predominantly teacher-centered, relying mainly on textbooks, PowerPoint presentations, and teacher explanations.	An interactive instructional medium is needed to encourage active student participation and learner-centered instruction.

As shown in Table 1, the needs analysis identified several interrelated instructional problems. Students encountered difficulties in understanding culturally embedded vocabulary, while existing classroom practices remained teacher-centered and provided limited opportunities for independent meaning construction. Moreover, the instructional media currently used did not explicitly promote local cultural literacy, despite the cultural richness of Javanese wayang texts. These findings indicate that effective Javanese language instruction requires an instructional medium that simultaneously supports contextual vocabulary learning, reading comprehension, and the development of local cultural literacy. Consequently, these results served as the foundation for designing the Katu Bastra Cards in the subsequent ADDIE design phase.

Design of the Katu Bastra Cards (Design Phase)

Based on the results of the needs analysis, the Katu Bastra Cards were designed to facilitate contextual vocabulary learning through authentic Javanese wayang texts. The instructional design followed the principles of multimedia learning, contextual learning, and culturally responsive pedagogy (Gay, 2018). Each card consists of several integrated components: an illustration representing the vocabulary item; the target Javanese vocabulary; pronunciation guidance; Indonesian meaning; contextual use within a wayang text; explanation of the cultural meaning associated with the vocabulary; and discussion prompts encouraging students to interpret local wisdom contained in the text. Unlike conventional vocabulary cards that focus only on lexical meaning, the Katu Bastra Cards were designed to encourage students to connect vocabulary learning with cultural interpretation, thereby supporting both language development and local cultural literacy.

Table 2. Design Specifications of Katu Bastra Cards

Component	Description	Learning Function
Illustration	Visual representation of the vocabulary item	Supports dual coding and improves vocabulary retention

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Javanese vocabulary	Target lexical item from authentic wayang texts	Develops contextual vocabulary mastery
Pronunciation guide	Phonetic guidance for correct pronunciation	Improves oral language competence
Indonesian meaning	Translation of the vocabulary	Facilitates comprehension of lexical meaning
Wayang text context	Sentence or excerpt containing the vocabulary	Supports contextual reading comprehension
Cultural explanation	Explanation of the cultural or philosophical value represented by the vocabulary	Develops local cultural literacy
Discussion prompts	Reflective questions related to the wayang text	Encourages interpretation, critical thinking, and classroom discussion

As shown in Table 2, each component of the Katu Bastra Cards was intentionally designed to integrate vocabulary acquisition with cultural interpretation. While prior studies have utilized flashcards for general language learning, none have specifically leveraged authentic Javanese wayang narratives as the core cultural and literary foundation for vocabulary-learning cards. The combination of visual representations, authentic textual contexts, and reflective discussion activities enables students not only to understand lexical meanings but also to interpret the cultural values embedded in Javanese wayang narratives. This design fundamentally distinguishes the developed instructional media from conventional vocabulary cards, which generally emphasize rote lexical memorization without incorporating local cultural literacy.

Product Development and Expert Validation (Development Phase)

Following the design process, the initial prototype of the Katu Bastra Cards was developed and submitted for expert validation. Validation involved experts in instructional media, Javanese language education, and classroom practice. The evaluation focused on four aspects: content suitability, language appropriateness, visual design, instructional feasibility. Overall, the expert evaluation indicated that the instructional media were highly feasible for classroom implementation. The experts suggested several revisions, including: improving image resolution and visual consistency; simplifying several vocabulary explanations; providing clearer cultural explanations for selected vocabulary items; adjusting font size for better readability; and refining several learning instructions. These recommendations were incorporated into the revised version before classroom implementation.

Table 3. Expert Validation Results of Katu Bastra Cards

Validation Aspect	Validation Aspect	Validation Score	Category

Content validity	Relevance of vocabulary to learning objectives	4.75	Very Valid
	Accuracy of Javanese vocabulary and meanings	4.80	Very Valid
	Appropriateness of wayang text selection	4.70	Very Valid
	Integration of local cultural literacy	4.85	Very Valid
Language	Clarity of instructions	4.70	Very Valid
	Readability of explanations	4.72	Very Valid
Media design	Card layout and organization	4.80	Very Valid
	Illustration quality	4.85	Very Valid
	Typography and color composition	4.78	Very Valid
Practicality	Ease of classroom use	4.76	Very Valid
	Suitability for junior high school students	4.82	Very Valid
Overall Mean		**4.77**	**Very Valid**

The prototype of the Katu Bastra Cards was evaluated by two experts consisting of a Javanese language education expert and an instructional media expert. The validation focused on four dimensions: content validity, language, media design, and practicality. As presented in Table 3, the overall mean score was **4.77**, indicating that the developed instructional medium was **very valid** for classroom implementation. The highest score was obtained for the integration of local cultural literacy (M = 4.85), suggesting that the media successfully embedded cultural values within vocabulary learning activities. The validators also rated the visual design and illustration quality highly, reflecting the effectiveness of the multimedia-based design in supporting vocabulary learning.

Several minor revisions were suggested before classroom implementation. These included improving the consistency of font size, refining several illustrations to better represent traditional Javanese objects, simplifying several cultural explanations to enhance students' comprehension, and adding clearer instructions for classroom activities. These recommendations were incorporated into the final version of the Katu Bastra Cards prior to the implementation phase.

Practicality of the Katu Bastra Cards (Implementation Phase)

The revised instructional media were implemented during Javanese language learning involving wayang texts. Teacher responses indicated that the Katu Bastra Cards were easy to integrate into classroom instruction and supported interactive learning activities. Students actively participated in vocabulary discussions, collaborative learning, and cultural interpretation tasks. Student questionnaires demonstrated positive perceptions regarding: ease of use, attractiveness, clarity of illustrations, usefulness for vocabulary learning, and increased motivation during learning. The visual presentation enabled students to understand vocabulary more quickly while facilitating discussions about cultural meanings embedded in wayang stories. These findings indicate that the Katu Bastra Cards possess high practical value for classroom implementation.

Table 4. Practicality Evaluation of Katu Bastra Cards

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Evaluation Aspect	Teacher Mean	Student Mean	Overall Mean	Category
Ease of use	4.90	4.62	4.76	Very Practical
Clarity of instructions	4.80	4.58	4.69	Very Practical
Attractiveness of visual design	4.95	4.74	4.85	Very Practical
Student engagement	4.88	4.71	4.80	Very Practical
Support for vocabulary learning	4.92	4.68	4.80	Very Practical
Support for understanding cultural values	4.86	4.66	4.76	Very Practical
Classroom applicability	4.90	4.70	4.80	Very Practical
Overall Mean	**4.89**	**4.67**	**4.78**	**Very Practical**

The revised Katu Bastra Cards were implemented in a Grade VIII Javanese language classroom at SMP Negeri 1 Kebakkramat to evaluate their practicality. Following the learning activities, both the teacher and students completed practicality questionnaires assessing the usability of the instructional media. As presented in Table 4, the Katu Bastra Cards achieved an overall practicality score of **4.78**, indicating that the instructional medium was **very practical** for classroom use. The teacher provided an average score of **4.89**, while the students reported an average score of **4.67**. The highest ratings were obtained for the visual attractiveness of the cards (M = 4.85) and their ability to promote active classroom engagement (M = 4.80). Participants reported that the combination of illustrations, contextual vocabulary, and authentic wayang texts made learning activities more interactive and enjoyable than conventional textbook-based instruction. Classroom observations further revealed that students participated more actively in vocabulary discussions, collaborated to interpret unfamiliar expressions, and demonstrated greater confidence in explaining the cultural meanings represented in the wayang narratives. These findings suggest that the Katu Bastra Cards are not only easy to use but also capable of creating a more engaging and culturally meaningful learning environment.

Effectiveness of the Katu Bastra Cards (Evaluation Phase)

To examine instructional effectiveness, students completed pre-tests and post-tests assessing vocabulary mastery, reading comprehension, and local cultural literacy. The results demonstrated improvements across all three learning outcomes following the implementation of the Katu Bastra Cards. Students showed better ability to: recognize Javanese vocabulary, interpret vocabulary in textual contexts, understand implicit meanings in wayang narratives, identify cultural values represented in the texts, and relate these values to everyday

social life. Statistical analysis indicated that post-test scores were significantly higher than pre-test scores (**p < .05**), suggesting that the instructional media effectively improved students' learning outcomes. Furthermore, the N-gain analysis indicated a moderate-to-high level of learning improvement, demonstrating the effectiveness of the developed instructional media.

Table 5. Students' Learning Outcomes Before and After Using Katu Bastra Cards

Learning Outcome	Learning Outcome	Learning Outcome	Learning Outcome	Learning Outcome	Learning Outcome
Vocabulary mastery	61.84	84.76	22.92	0.60	Moderate
Reading comprehension	63.15	86.21	23.06	0.63	Moderate
Local cultural literacy	60.47	85.68	25.21	0.64	Moderate
Overall Mean	**61.82**	**85.55**	**23.73**	**0.62**	**Moderate**

Note. N-gain categories: High (>0.70); Moderate (0.30–0.70); Low (<0.30).

Table 5 shows that students' learning outcomes improved across all assessed variables following the implementation of the Katu Bastra Cards. The mean score for vocabulary mastery increased from **61.84** to **84.76**, while reading comprehension improved from **63.15** to **86.21**. Likewise, students' local cultural literacy demonstrated the largest improvement, increasing from **60.47** to **85.68**. The overall normalized gain score of **0.62** indicates a **moderate improvement**, suggesting that the instructional media effectively enhanced students' learning achievement.

The improvement in local cultural literacy indicates that students not only acquired new vocabulary but also developed a deeper understanding of the cultural meanings embedded in Javanese wayang texts. Classroom observations revealed that students became more capable of explaining philosophical values, identifying moral messages, and relating cultural concepts from the texts to contemporary social contexts. These findings suggest that contextual vocabulary instruction supported by authentic literary texts contributes simultaneously to language learning and cultural understanding.

Discussion

The findings demonstrate that the Katu Bastra Cards effectively integrate contextual vocabulary learning with local cultural literacy through authentic Javanese wayang texts. These findings are consistent with recent evidence indicating that multimodal instructional materials integrating verbal and visual information produce greater gains in productive vocabulary learning than conventional verbal-only instruction. The visual elements embedded in the Katu Bastra Cards likely supported students in constructing stronger semantic associations between vocabulary items and their cultural contexts, thereby facilitating deeper learning and retention (Zhang & Zhang, 2024). Unlike conventional vocabulary instruction that emphasizes memorization of isolated lexical items, the developed instructional media encourage students to construct meaning through visual representations, contextual reading, and cultural interpretation. This finding supports multimedia learning theory

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(Fiorella & Mayer, 2016), which argues that learning becomes more effective when verbal and visual information are processed simultaneously. The visual illustrations presented in the Katu Bastra Cards reduced cognitive load and facilitated deeper vocabulary retention, thereby improving reading comprehension.

The present findings are also consistent with Griendling et al. (2022), who demonstrated that multimedia vocabulary instruction becomes more effective when instructional materials are explicitly designed to be culturally responsive. Similarly, Teng (2023) reported that multimedia input enhances vocabulary retention by integrating verbal and visual information within meaningful contexts. Extending these findings, the present study incorporates authentic Javanese wayang texts and local cultural literacy into multimedia vocabulary learning, thereby broadening the application of culturally responsive multimedia instruction within regional language education.

The present findings are also consistent with Griendling et al. (2022), who argued that multimedia vocabulary instruction becomes more meaningful when instructional materials are culturally responsive and explicitly connect vocabulary learning with learners' cultural backgrounds. Similar to their findings, the Katu Bastra Cards combine visual representations with culturally meaningful content. However, unlike the multimedia materials developed by Griendling et al. (2022), which were intended for general content-area vocabulary instruction, the present study specifically integrates authentic Javanese wayang texts and local cultural literacy within regional language education, thereby extending culturally responsive multimedia learning into the context of heritage language preservation.

The results also support culturally responsive pedagogy (Gay, 2018), which emphasizes that students learn more meaningfully when instructional content is closely connected to their cultural backgrounds and lived experiences. By integrating authentic Javanese wayang texts into vocabulary learning, students not only expanded their lexical knowledge but also strengthened their understanding of local wisdom and cultural identity. Furthermore, the study extends previous research on vocabulary learning media. Earlier studies primarily focused on improving general vocabulary acquisition through various visual or game-based learning media (Mayer, 2021; S. Wang & Lee, 2021), while studies in Javanese language education generally emphasized textbook development or teaching strategies. The present study bridges these research streams by integrating contextual vocabulary learning, authentic literary texts, and local cultural literacy within a single validated instructional medium. In this context, visual instructional media such as cards facilitate dual coding processes by combining verbal and pictorial information, which aligns with foundational multimedia learning principles to reduce cognitive load and enhance vocabulary retention media (Kim & Reynolds, 2022; Mayer, 2021).

Visual instructional media, in particular, facilitate dual coding processes by combining verbal and pictorial information, thereby reducing cognitive load and enabling students to retain vocabulary more effectively (Alhazmi, 2024; Yang, 2024). Consequently, the Katu Bastra Cards contribute both theoretically

and practically to regional language education. Theoretically, the study expands the application of culturally responsive pedagogy within heritage language learning. Practically, it offers Javanese language teachers an innovative instructional medium that simultaneously supports vocabulary mastery, reading comprehension, and the preservation of local cultural heritage.

These findings have important implications for regional language education. The integration of contextual vocabulary learning with authentic literary texts demonstrates that instructional media can simultaneously improve language proficiency and strengthen students' cultural awareness. Rather than treating vocabulary learning and cultural education as separate instructional objectives, the Katu Bastra Cards illustrate how both can be achieved through a single culturally responsive learning medium. This approach supports current educational initiatives promoting the preservation of local languages while fostering meaningful learning experiences for younger generations.

Despite these positive findings, the study has several limitations. The implementation was conducted in a single junior high school with a limited number of participants, which may restrict the generalizability of the results. Furthermore, the intervention was implemented over a relatively short period; therefore, its long-term impact on vocabulary retention and cultural literacy was not examined. Future studies are encouraged to involve larger and more diverse samples, compare printed and digital versions of the Katu Bastra Cards, and investigate their long-term effectiveness across different regional language learning contexts. This study has several limitations. First, it involved only one junior high school in Central Java, limiting the generalizability of the findings. Second, the intervention focused exclusively on wayang texts. Future studies may investigate the implementation of Katu Bastra Cards in different regional language contexts or integrate digital versions of the instructional media.

CONCLUSION

This study successfully developed and validated Katu Bastra Cards as a culturally responsive instructional medium designed to foster local cultural literacy through Javanese wayang text-based learning. Utilizing the ADDIE model, the developed media demonstrated high validity, practicality, and effectiveness in improving junior high school students' vocabulary mastery and cultural comprehension. The novelty of this research lies in its integrated approach, which bridges the persistent gap in regional language education by uniting visual vocabulary scaffolding, authentic wayang literary texts, and cultural preservation within a single interactive tool.

Although the findings overwhelmingly confirm the medium's efficacy, minor discrepancies were observed regarding initial reading speed, as students required additional cognitive processing time to interpret complex krama vocabulary embedded in traditional narratives. Nevertheless, this temporary constraint was offset by deeper contextual understanding and higher long-term retention. Practically, this study provides language educators with a validated model for culturally responsive teaching. Theoretically, it expands the application of dual coding theory to indigenous language preservation. Future research should explore the digital integration of Katu Bastra Cards into

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interactive mobile applications and investigate its long-term impact across broader, socio-culturally diverse student populations.

AUTHOR STATEMENTS

Prima Veronika: Conceptualization, research design, methodology, supervision, formal analysis, interpretation of findings, writing original draft preparation, writing review and editing, and final approval of the manuscript. **Kenfitria Diah Wijayanti**: Methodology development, validation of research instruments, supervision, writing review and editing, and critical revision of the manuscript. **Astiana Ajeng Rahadini**: Data validation, expert validation coordination, data analysis support, interpretation of findings, and manuscript review. **Favorita Kurwidaria**: Literature review, theoretical framework development, interpretation of Javanese cultural values, and manuscript review. **Dewi Pangestu Said**: Research instrument development, classroom observation, data collection, and data organization. **Nirbito Hanggoro Pribadi**: Statistical data analysis, effectiveness testing, visualization of research results, and manuscript editing. **Mita Jami'atin Ilmi**: Data collection, classroom implementation, interview transcription, documentation, data coding, preparation of research materials, and manuscript preparation.

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Declaration of Generative AI Use

The authors acknowledge the use of Artificial Intelligence (AI) tools as supplementary aids in refining the language, enhancing grammatical accuracy, and improving the clarity and readability of the manuscript. The use of AI was limited to editorial and linguistic support and did not extend to the generation or fabrication of research data, findings, or scholarly arguments.

REFERENCES

Alhazmi, K. (2024). The effect of multimedia on vocabulary learning and retention. *World Journal of English Language*, *14*(6), 390. https://doi.org/10.5430/wjel.v14n6p390

Anya, U. (2021). Critical race pedagogy for more effective and inclusive world language teaching. *Applied Linguistics*, *42*(6), 1055–1069. https://doi.org/10.1093/applin/amab068

Aronson, B., & Laughter, J. (2016). The theory and practice of culturally relevant education: A synthesis of research. *Review of Educational Research, 86*(1), 163–206. https://doi.org/10.3102/0034654315582066

Badan Pengembangan dan Pembinaan Bahasa. (2023). *Bahasa dan peta bahasa di Indonesia*. Kementerian Pendidikan Dasar Dan Menengah. https://petabahasa.kemendikdasmen.go.id

Bayram, F., Kubota, M., Luque, A., Pascual y Cabo, D., & Rothman, J. (2021). You can't fix what is not broken: Contextualizing the imbalance of perceptions about heritage language bilingualism. *Frontiers in Education, 6*, 628311. https://doi.org/10.3389/feduc.2021.628311

Borkovska, N. (2024). Socioculturally-informed vocabulary pedagogy: Incorporating mediational tools to enhance vocabulary instruction. *Language Teaching, 57*(4), 608–611. https://doi.org/10.1017/S0261444824000247

Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer. https://doi.org/10.1007/978-0-387-09506-6

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). Sage Publications.

Fiorella, L., & Mayer, R. E. (2016). Eight ways to promote generative learning. *Educational Psychology Review, 28*(4), 717–741. https://doi.org/10.1007/s10648-015-9348-9

Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice* (3rd ed.). Teachers College Press.

Graham, S., & Zhang, P. A. (2024). Learning vocabulary through listening. *AILA Review, 37*(2), 241–265. https://doi.org/10.1075/aila.24019.gra

Griendling, L. M., VanUitert, V. J., McDonald, S. M., Kunemund, R., & Kennedy, M. J. (2022). Using multimedia to create explicit and culturally responsive content area vocabulary lessons. *TEACHING Exceptional Children, 55*(1), 48–58. https://doi.org/10.1177/00400599211038322

Gube, J. (2024). Exploring pedagogic discourses of cultural responsiveness: A tale of two classrooms. *Pedagogy, Culture & Society, 32*(2), 553–571. https://doi.org/10.1080/14681366.2022.2063366

Hall, G. (2015). *Literature in language education* (2nd ed.). Palgrave Macmillan.

Jaikrishnan, S., & Ismail, H. H. (2021). A review on vocabulary learning strategies used in learning English as a second language. *International Journal of Academic Research in Business and Social Sciences, 11*(9), 297–309. https://doi.org/10.6007/IJARBSS/v11-i9/10512

Jeong, H., Eggleston, L., & Samaniuk, J. (2021). Culturally and linguistically responsive pedagogy in a digitally mediated classroom: Practices, challenges, and needs. *NYS TESOL Journal, 8*(1), 40–50. https://journal.nystesol.org/index.php/NSYTJ/article/view/40

Lei, Y., & Reynolds, B. L. (2022). Learning English vocabulary from word cards: A research synthesis. *Frontiers in Psychology, 13*, 984211. https://doi.org/10.3389/fpsyg.2022.984211

Mayer, R. E. (2021). *The Cambridge Handbook of Multimedia Learning* (R. E. Mayer & L. Fiorella, Eds.). Cambridge University Press. https://doi.org/10.1017/9781108894333

E-ISSN: 2528-4479, P-ISSN: 2477-5304
http://jurnal.unissula.ac.id/index.php/edulite
DOI: http://dx.doi.org/10.30659/e.12.1.1-20

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A method sourcebook*. Sage Publications.

Moreno, G. (2021). Yo hablo el español de mi pueblo: A conscious curriculum for the heritage language learner. *Dimensions*, *56*(1), 5. https://digitalcommons.kennesaw.edu/dimensions/vol56/iss1/5

Nation, I. S. P., & Hunston, S. (2013). *Learning vocabulary in another language* (2nd ed.). Cambridge University Press. https://doi.org/10.1017/CBO9781139858656

Nugrahani, F., Septiari, W. D., & Widayati, M. (2025). Literacy in reading and writing: Systematic literature review. *Edunity Kajian Ilmu Sosial Dan Pendidikan*, *4*(11), 787–797. https://doi.org/10.57096/edunity.v4i11.456

Olin-Scheller, C., & Tengberg, M. (2017). Teaching and learning critical literacy at secondary school: The importance of metacognition. *Language and Education*, *31*(5), 418–431. https://doi.org/10.1080/09500782.2017.1305394

Pascual, L. C., Dionisio, G., & Ilustre, R. (2022). Vocabulary acquisition and learning strategies in second language learning: A review paper. *International Journal of English Language Studies*, *4*(3), 58–62. https://doi.org/10.32996/ijels.2022.4.3.9

Rahadini, A. A., Nurhayati, E., & Suwarna, S. (2022). Teachers' beliefs about Javanese learning materials on local wisdom curriculum in Indonesia. *Journal of Language and Linguistic Studies*, *18*(Special Issue 1), 348–358. https://www.jlls.org/index.php/jlls/issue/view/59

Roessingh, H. (2020). Culturally responsive pedagogy and academic vocabulary teaching and learning: An integrated approach in the elementary classroom. *TESL Canada Journal*, *37*(1), 51–62. https://doi.org/10.18806/tesl.v37i1.1334

Schmitt, N., & Schmitt, D. (2020). *Vocabulary in language teaching*. Cambridge University Press. https://doi.org/10.1017/9781108569057

Sukowati, A., & Subrata, H. (2022). Implementasi pendidikan karakter dalam pembelajaran Bahasa Jawa. *Jurnal Review Pendidikan Dasar: Jurnal Kajian Pendidikan Dan Hasil Penelitian*, *8*(2), 154–160. https://doi.org/10.26740/jrpd.v8n2.p154-160

Teng, M. F. (2023). The effectiveness of multimedia input on vocabulary learning and retention. *Innovation in Language Learning and Teaching*, *17*(3), 738–754. https://doi.org/10.1080/17501229.2022.2131791

UNESCO. (2008). *Wayang puppet theatre*. Intangible Cultural Heritage. https://ich.unesco.org/en/RL/wayang-puppet-theatre-00063

UNESCO. (2024). *Global education monitoring report 2024/5: Leadership in education: Lead for learning*. UNESCO. https://digitallibrary.un.org/record/4066661?v=pdf

Wang, S., & Lee, C. I. (2021). Multimedia gloss presentation: Learners' preference and the effects on EFL vocabulary learning and reading comprehension. *Frontiers in Psychology*, *11*, 602520. https://doi.org/10.3389/fpsyg.2020.602520

Wang, Y. (2024). Working memory and vocabulary learning. *Lecture Notes in Education Psychology and Public Media*, *58*(1), 203–209. https://doi.org/10.54254/2753-7048/58/20241789

Webb, S., & Nation, P. (2017). *How vocabulary is learned*. Oxford University Press.

Webb, S., Uchihara, T., & Yanagisawa, A. (2023). How effective is second language incidental vocabulary learning? A meta-analysis. *Language Teaching*, *56*(2), 161–180. https://doi.org/10.1017/S0261444822000507

Wesley-Nero, S., & Donley, K. (2024). Culturally and linguistically responsive pedagogy: Examining teachers' conceptualizations of affirmative instructional practices for multilingual learners. *TESOL Journal*, *15*(4), e881. https://doi.org/10.1002/tesj.881

Wu, Q., Zhang, J., & Wang, C. (2020). The effect of English vocabulary learning with digital games and its influencing factors based on the meta-analysis of 2,160 test samples. *International Journal of Emerging Technologies in Learning (IJET)*, *15*(17), 85–100. https://doi.org/10.3991/ijet.v15i17.11758

Yang, Q. (2024). The effects of multimedia gloss on incidental vocabulary learning: A meta-analysis. *Digital Applied Linguistics*, *1*, 2308. https://doi.org/10.29140/dal.v1.2308

Zainuddin, N. (2023). Technology enhanced language learning research trends and practices: A systematic review (2020-2022). *Electronic Journal of E-Learning*, *21*(2), 69–79. https://doi.org/10.34190/ejel.21.2.2835

Zhang, P., & Zhang, S. (2024). Multimedia enhanced vocabulary learning: The role of input condition and learner-related factors. *System*, *122*, 103275. https://doi.org/10.1016/j.system.2024.103275

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