

Developing SINJAWA: An Augmented Reality Pop-Up Book to Improve Javanese Script Writing in Elementary Students

Rita Damayanti¹, Sri Sukasih²

¹ Universitas Negeri Semarang, Semarang, Indonesia; ritadamayanti118@students.unnes.ac.id

² Universitas Negeri Semarang, Semarang, Indonesia; srisukasih@mail.unnes.ac.id

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ABSTRACT

Students' low proficiency in writing Javanese script remains a significant challenge in Javanese language instruction at SD Negeri 1 Grantung, Purbalingga Regency. This issue is largely attributed to students' difficulties in mastering script forms and the limited use of varied and engaging instructional media. Therefore, innovative learning media are needed to improve students' writing skills. This study aimed to develop and evaluate the effectiveness of the SINJAWA Pop-Up Book integrated with augmented reality (AR) in improving fifth-grade students' Javanese script writing skills. The research employed a research and development (R&D) approach based on the ADDIE model. Participants included 25 fifth-grade students, consisting of six students in a small-group trial and 19 students in a large-group trial, as well as classroom teachers and material and media experts. Data were collected through observation, interviews, documentation, questionnaires, and pretest-posttest assessments. Data analysis involved feasibility validation, practicality analysis, normality testing, and N-Gain analysis. The validation results indicated that the learning media were highly feasible, with scores of 94.28% from material experts and 91.66% from media experts. Practicality assessment showed very positive responses from students (95.2%) and teachers (93.33%). Learning outcomes improved significantly, as reflected by an N-Gain score of 74.48%, categorized as effective. The SINJAWA Pop-Up Book integrated with AR is a feasible, practical, and effective learning medium for enhancing fifth-grade students' Javanese script writing skills.

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Corresponding Author:

Rita Damayanti

Universitas Negeri Semarang, Semarang, Indonesia; ritadamayanti118@students.unnes.ac.id

1. INTRODUCTION

Language plays a fundamental role in human life as a medium for communication, thought expression, and social interaction. Through language, individuals convey ideas, emotions, and perspectives, enabling meaningful engagement within society and supporting cognitive and emotional development (Hualai, 2017; Keraf, 1994). In the educational context, language learning is not only aimed

at developing communicative competence but also at shaping students' intellectual growth and character. This is reinforced by the Regulation of the Minister of National Education of Indonesia No. 22 of 2006, which emphasizes language education as an essential component of the curriculum to support students' academic, personal, and social development. Therefore, effective language instruction is a crucial foundation for holistic education.

Beyond its communicative function, language also serves as a marker of cultural identity and a means of preserving cultural heritage. Regional languages in Indonesia, including Javanese, represent rich cultural values, philosophies, and social norms that have been passed down through generations. Javanese, in particular, embodies principles of politeness, harmony, and respect that are deeply rooted in Javanese society. To ensure the sustainability of these cultural values, the Indonesian education system integrates regional languages into the local content curriculum, starting at the elementary school level (Sukasih, 2022). This early exposure is expected to foster cultural awareness and appreciation among young learners while maintaining the continuity of local wisdom.

In learning a language, students are required to master four core skills: listening, speaking, reading, and writing. Among these skills, writing is widely recognized as one of the most complex, as it involves cognitive processing, linguistic accuracy, and motor coordination. Writing in Javanese script presents even greater challenges due to its distinctive orthographic system, which differs significantly from the Latin alphabet commonly used in daily communication. Mastery of Javanese script requires students to recognize characters, understand writing rules, and apply them accurately in written form. Despite its difficulty, the ability to write Javanese script is culturally significant, as it contributes to the preservation of classical texts, literature, and historical records that form an integral part of Javanese cultural heritage.

However, in practice, students' proficiency in writing Javanese script remains relatively low. Field observations conducted at SD Negeri 1 Grantung, Purbalingga Regency, indicate that fifth-grade students experience difficulties in learning Javanese script. Students tend to show low motivation and limited engagement during lessons, often participating passively in classroom activities. Instruction is predominantly teacher-centered and relies heavily on conventional textbooks, with minimal use of interactive or innovative learning media. As a result, students struggle to grasp the structure and form of Javanese characters, leading to unsatisfactory learning outcomes. Initial assessment data reveal that only 44% of students achieved the minimum competency standard (KKTP ≥ 70), while the remaining 56% did not meet the expected criteria.

Several factors contribute to this condition. Monotonous teaching methods and the lack of engaging instructional media have been identified as major obstacles in Javanese script learning. In addition, teachers often face limitations in developing innovative media due to insufficient training, time constraints, and inadequate school facilities (Wibowo et al., 2023). These challenges not only affect students' academic performance but also threaten the sustainability of Javanese script literacy among younger generations. Without effective intervention, students may gradually lose interest in learning Javanese script, weakening efforts to preserve local culture through formal education.

Learning media play a vital role in addressing these challenges by enhancing student engagement and facilitating understanding of complex concepts. Kustandi (2020) explains that learning media function as tools to convey information more clearly, transform abstract material into concrete representations, and stimulate students' interest in learning. In the current digital era, the widespread availability of smartphones and digital technology provides new opportunities for implementing interactive and student-centered learning approaches. Nevertheless, many elementary school students primarily use smartphones for entertainment purposes, such as playing games or watching videos. This situation presents both a challenge and an opportunity for educators to redirect technology use toward meaningful and educational activities.

Previous studies have demonstrated the effectiveness of innovative learning media in improving students' interest and achievement in Javanese language learning. Kusumonungrum et al. (2021) found that the use of pop-up books with interactive visual elements significantly reduced student boredom and increased active participation in Javanese lessons. Similarly, Novita (2017) reported that the

implementation of a Javanese script pop-up book resulted in an 85% increase in students' test scores, indicating its effectiveness in enhancing literacy skills. These findings suggest that visually engaging and interactive media can positively influence students' motivation and learning outcomes.

In response to the need for innovative and effective instructional media, this study proposes the development of the SINJAWA Pop-Up Book (Sinaw Sastra Basa Jawa), a learning medium integrated with Augmented Reality (AR) technology. The SINJAWA Pop-Up Book combines traditional printed materials with digital AR features, including interactive tutorials, animated visualizations, and guided writing exercises. This integration is expected to create an immersive learning experience that supports students' understanding and practice of Javanese script writing. Therefore, this study aims to develop and examine the effectiveness of the SINJAWA Pop-Up Book with AR in improving the Javanese script writing skills of fifth-grade students at SD Negeri 1 Grantung. By blending cultural content with modern technology, the study seeks to enhance learning motivation, improve writing proficiency, and contribute to the preservation of Javanese cultural heritage through innovative educational practices.

2. METHODS

This study adopted a Research and Development (R&D) methodology using the ADDIE instructional design model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Sugiyono, 2019). The primary objective of this approach was to develop and assess the feasibility, practicality, and effectiveness of the SINJAWA Pop-Up Book, an instructional medium for learning Javanese script integrated with Augmented Reality (AR) technology.

The research was conducted at SD Negeri 1 Grantung, located in Purbalingga Regency. The participants comprised 25 fifth-grade students, representing the entire class population, which reflects the typical class size of elementary schools in the region. For testing purposes, the participants were divided into two groups: a small-scale trial involving six students and a large-scale trial involving 19 students. In addition to student participants, a Javanese language teacher and a panel of material and media experts were involved to provide professional validation of the developed product.

Prior to data collection, all participants were informed of the research objectives and procedures. Parental consent was obtained for all student participants. Ethical considerations were strictly observed, including voluntary participation, confidentiality of participant data, and anonymity in reporting research findings.

The development process followed the ADDIE model systematically. During the analysis stage, the researchers conducted classroom observations, interviews with the teacher, diagnostic assessments, and document analysis to identify students' learning needs and difficulties in writing Javanese script. The results revealed low learning motivation and limited mastery of Javanese characters, primarily caused by teacher-centered instruction and the lack of varied and engaging learning media.

In the design stage, the SINJAWA Pop-Up Book was planned by developing a detailed layout, learning flow, and interactive components aligned with curriculum standards. Canva was utilized to design the visual layout of the book, while Blender 3D was employed to create three-dimensional objects for AR integration. The instructional content included step-by-step tutorials, guided writing exercises, and AR-triggered visualizations accessed through QR codes. Design principles emphasized user friendliness, visual appeal, and instructional relevance.

The development stage involved producing the physical Pop-Up Book using scrapbook-based construction techniques. AR elements were embedded by integrating QR codes on selected pages, enabling students to access digital content through mobile devices. Before implementation, the media underwent expert validation by material specialists and media experts to ensure content accuracy, instructional suitability, and technical feasibility. Revisions were made based on expert feedback.

During the implementation stage, the finalized media was tested through small-scale and large-scale trials within regular Javanese language lessons. Students interacted directly with the SINJAWA Pop-Up Book during learning activities. To measure learning outcomes, pretests and posttests were

administered to assess improvements in students' Javanese script writing skills. In addition, questionnaires were distributed to students and the teacher to evaluate the practicality and usability of the media.

Finally, the evaluation stage focused on analyzing the effectiveness of the developed media based on learning outcome data, validation results, and user responses. Quantitative and qualitative feedback from students and the teacher was used to identify strengths and areas for improvement, providing recommendations for further refinement of the SINJAWA Pop-Up Book.

This study employed both test and non-test instruments for data collection. Test instruments consisted of pretests and posttests designed to measure students' Javanese script writing skills and to evaluate learning outcomes before and after the use of the developed media. Non-test instruments included observation sheets, interviews, documentation, and questionnaires to obtain qualitative data related to the learning process and media implementation. In addition, validation checklists were used by media and material experts to assess the feasibility and appropriateness of the content and instructional design. Student and teacher response questionnaires were administered using a five-point Likert scale, ranging from 1 (Very Poor) to 5 (Very Good), to measure perceptions of the practicality and quality of the learning media.

The validation and response data were converted into percentage scores. The feasibility and practicality criteria were interpreted as follows:

Table 1. Criteria for Interpreting Feasibility and Practicality Percentage Scores

Percentage	Criterion
86% – 100%	Highly Feasible
71% – 85%	Feasible
56% – 70%	Fairly Feasible
41% – 55%	Not Feasible
25% – 40%	Very Unfeasible

To evaluate the media's effectiveness, three statistical methods were used:

- Normality Test using Shapiro-Wilk via SPSS software.
- Paired Samples t-Test to assess significant differences between pretest and posttest scores.
- N-Gain Analysis to measure the rate of improvement. The N-Gain score was calculated to determine learning effectiveness

3. FINDINGS AND DISCUSSION

3.1 Findings

The development of the SINJAWA Pop-Up Book integrated with Augmented Reality (AR) began with the design of the initial media prototype using Canva for visual layout creation and Blender 3D software for developing AR components. The media development process followed three main stages of the ADDIE model, namely analysis, design, and development, before proceeding to implementation and evaluation.

During the analysis stage, interviews were conducted with the fifth-grade teacher of SD Negeri 1 Grantung, Mrs. Nungki Agustina, S.Pd. The findings revealed several instructional challenges in teaching Javanese script writing. Learning activities primarily relied on textbook reading and memorization methods, resulting in passive student participation. The use of technology-based learning media was minimal, largely due to limited school facilities for media development and the absence of professional training that would enable teachers to adopt more innovative and technology-adaptive teaching strategies. These conditions contributed to low student motivation and limited mastery of Javanese script writing skills.

These findings were reinforced by the results of an initial diagnostic test conducted to assess students' Javanese script writing abilities. Based on the Minimum Competency Achievement Criteria (KKTP) for local content subjects at SD Negeri 1 Grantung, set at a score of 70, the test results indicated that only 11 out of 25 students (44%) achieved the minimum standard. Meanwhile, 14 students (56%) failed to meet the KKTP. This data confirms that students' writing proficiency in Javanese script remained unsatisfactory and required immediate instructional intervention.

Observational data further revealed that SD Negeri 1 Grantung is equipped with several learning-support facilities, including Chromebooks, LCD projectors, and stable internet access. These facilities indicate that the school environment has sufficient technological potential to support innovative learning media implementation. Therefore, the development of the SINJAWA Pop-Up Book integrated with AR technology was considered a feasible and promising solution to enhance students' Javanese script writing skills by maximizing existing resources.

Following problem identification, the design stage focused on planning the structure and content of the SINJAWA Pop-Up Book. The media was designed to align with curriculum objectives and student learning needs, emphasizing ease of use, instructional clarity, and visual appeal. Special attention was given to the aesthetic quality of each pop-up page to attract students' interest and maintain engagement. The media integrates conventional printed materials with digital AR elements, combining concrete and virtual learning experiences.

Augmented Reality technology was embedded to enhance interactivity and visualization. AR integrates digital elements—such as images, animations, audio, text, and three-dimensional objects—into the real environment in real time through marker-based recognition (Qorimah & Sutarna, 2022). This technology allows virtual visualization of writing tools and learning content in 3D, making abstract concepts more concrete (Çöltekin et al., 2019). Previous studies have also shown that AR significantly contributes to interactive and engaging learning experiences, particularly in elementary education (Tasrif et al., 2020). Through the SINJAWA Pop-Up Book, students can scan QR codes to access AR-based demonstrations of correct Javanese script writing, enabling clearer understanding and more effective practice.

The implementation stage began with a small-group trial involving six fifth-grade students, conducted from January 21 to January 22, 2025. Students were first given a pretest to measure initial writing ability, followed by learning activities using the SINJAWA AR Pop-Up Book. Learning was conducted through repetitive writing (drilling) activities and interactive AR exploration. After the learning session, a posttest was administered. The results showed a noticeable improvement in students' writing performance, as evidenced by higher posttest scores compared to pretest results.

Based on the positive outcomes of the small-group trial, the study proceeded to a large-group implementation involving 19 fifth-grade students from January 23 to January 25, 2025, using the same instructional procedures. Upon completion of the learning activities, students and the homeroom teacher completed response questionnaires to evaluate the usability, attractiveness, and overall learning experience of the SINJAWA AR Pop-Up Book.

Media validation was conducted by Dr. Deni Setiawan, S.Sn., M.Hum., a lecturer in Elementary School Teacher Education at Universitas Negeri Semarang, who served as the media expert. Based on the validation results, the SINJAWA Pop-Up Book integrated with AR was declared valid and appropriate for instructional use. The expert assessment confirmed that the media met technical, visual, and functional criteria, supporting its feasibility for classroom implementation.

Table 2. Media Validation Assessment Results

No	Information	Score Presentation	Category
1.	Media Validation	91.66%	Highly Worth It

Based on the assessment conducted by media experts, the percentage results were obtained of 91.66% with the category of very feasible.

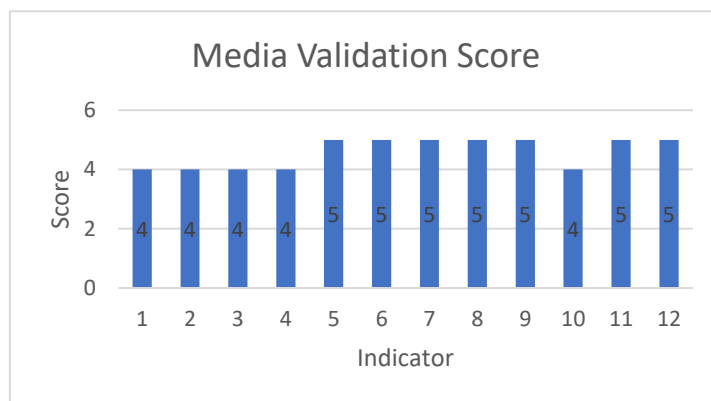


Figure 1. Media Validation Score

The media validation results were calculated using the following procedure:

$$P = \frac{\text{Score}}{\text{Total Score Max}} \times 100\%$$

$$P = \frac{55}{60} \times 100\%$$

$$P = 91.66\%$$

In the media validation assessment process, the validator also gave suggestions to the SINJAWA Pop Up Book media, namely the addition of pages to the media containing the author's profile, the form of page visualization that needs to be added in the media based on the suggestions of the media validator, namely the following.



Figure 2. Author Profile Page

The validation test of the material has been carried out by a material expert, namely Mrs. Ermi Dyah Kurnia, S.S., M.Hum. The results of the assessment that have been carried out by the material expert are as follows:

Table 3. Material Validation Assessment Results

No	Information	Score Presentation	Category
1.	Material Validation	94.28%	Highly Worth It

Based on the assessment conducted by material experts, a percentage result of 94.28% was obtained with the category of very feasible, so that this media can be tested at the next stage.

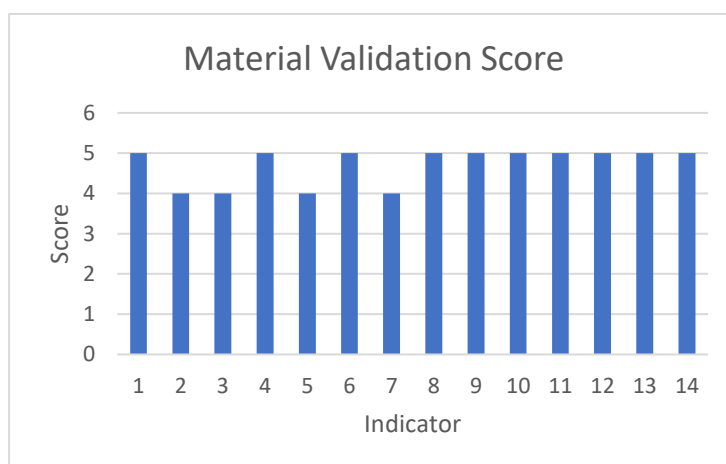


Figure 3. Material Validation Score

The material validation results were calculated using the following procedure:

$$P = \frac{\text{Total score}}{\text{Total Item}} \times 100\%$$

$$P = \frac{66}{70} \times 100\%$$

$$P = 94.28\%$$

The value of the practicality of the media that has been created by the researcher can be seen from the results of the response questionnaire that has been given to all grade V students and teachers of class V after they use the Pop Up Book media in learning. The media practicality test will be carried out on January 25, 2025. The following are the results of the teacher's response questionnaire to the SINJAWA Pop Up Book media:

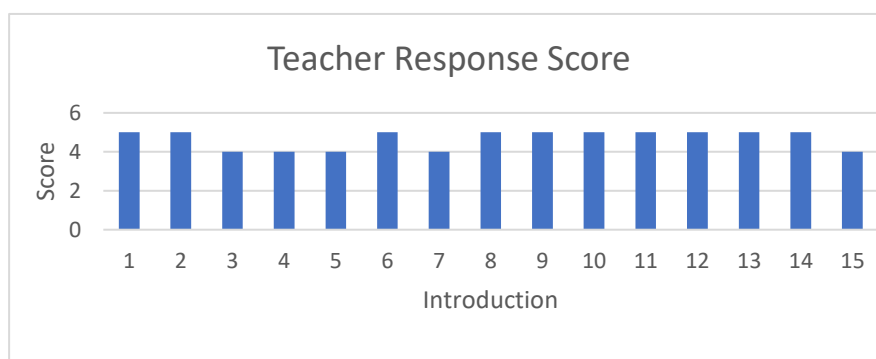


Figure 4. Teacher Response Questionnaire Score

The results of the teacher response questionnaire were calculated using the following procedure:

$$P = \frac{\text{Total score}}{\text{Total Item}} \times 100\%$$

$$P = \frac{70}{75} \times 100\%$$

$$P = 93.33\%$$

Based on the assessment conducted by the homeroom teacher of Grade V, a percentage result of 93.33% was obtained, categorised as very good.

The results of the media practicality test that have been carried out by the students also achieved satisfactory results. The following are the results of the media practicality test based on the student response questionnaire:

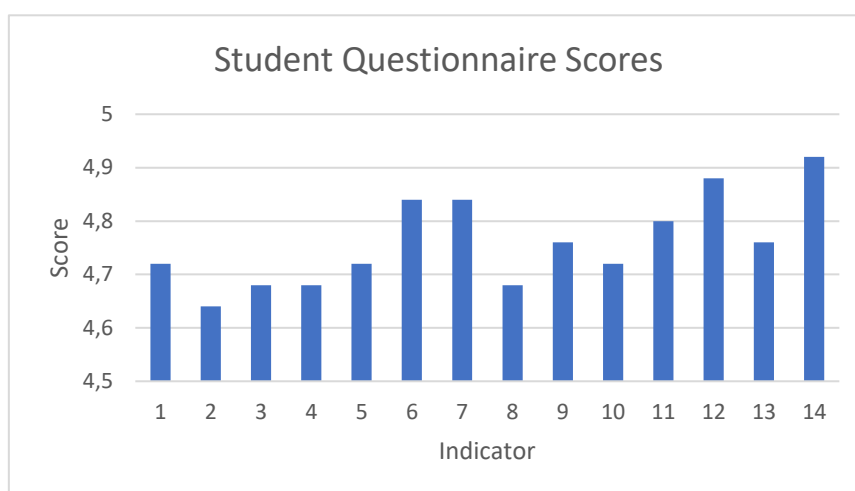


Figure 5. Student Questionnaire Scores

The results of the student response questionnaire were calculated using the following procedure:

$$P = \frac{\sum f}{N} \times 100\%$$

$$P = \frac{1666}{1750} \times 100\%$$

$$P = 95.2$$

Based on the assessments completed by fifth-grade students, the student response questionnaire yielded a percentage score of 95.2%, which falls into the very good category. This result indicates that students responded very positively to the use of the SINJAWA Pop-Up Book integrated with Augmented Reality.

Following the implementation of Javanese script writing instruction using the SINJAWA AR Pop-Up Book in both small- and large-group settings, pretest and posttest data were collected to determine the effectiveness of the media in improving students' Javanese script writing skills. These test results served as the primary basis for evaluating learning gains achieved through the use of the developed media.

Subsequent data analysis was conducted to examine the significance and magnitude of learning improvement. The analysis involved several statistical procedures, including the normality test, paired sample t-test, and N-Gain analysis. The normality test was performed to determine whether the pretest and posttest score distributions met the assumption of normality. This test was conducted using SPSS version 25. The results of the normality test are presented in the following section.

Table 4. Results of a large group normality test

	Kolmogorof Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	0.18	19	0.12	0.92	19	0.09
Posttest	0.22	19	0.02	0.91	19	0.06

The results of the normality test conducted on the large-group data of fifth-grade students using the Shapiro–Wilk method showed that the data were normally distributed. The significance value for the pretest scores was 0.099, while the posttest scores obtained a significance value of 0.60. Since both values exceeded the threshold of 0.05 (Sig. > 0.05), it can be concluded that the pretest and posttest data of the large-group fifth-grade students met the assumption of normality.

Following the confirmation of data normality, a paired sample t-test was conducted to determine whether there was a statistically significant difference in students' Javanese script writing abilities before and after the use of the SINJAWA AR Pop-Up Book media. The results of the paired sample t-test are presented in the following section.

Table 5. Large Group T-Test Results

	Mean	Std.Dev	Std. error	95% confidence interval		t	df	Sig.(2-tailed)
				Lower	Upper			
				Pair 1	-45.26			

The results of the T-Test in a large group of class V students showed a Sig. (t-tailed) value of 0.000. This value < 0.05 , so in conclusion, the SINJAWA AR Pop Up Book media has an effect on improving the ability to write Javanese script.

Table 6. Large Group N-Gain Test Results

	N	Minimum	Maximum	Mean	Std. deviation
NGain_Score	19	0.54	0.92	0.75	0.11
NGain_Persen	19	53.85	92.31	75.21	11.41
Valid (N)	19				

The results of the Large Group N-Gain test of grade V students of SDN 1 Grantung obtained a score of 0.7521 based on this number, so it can be concluded that in a large group of students in grade V, SDN 1 Grantung experienced an improvement in the ability to write Javanese characters after using the SINJAWA Pop Up Book learning media with a great improvement category. So, the SINJAWA Pop Up Book learning media with Augmented Reality content is very effective as a learning medium.

3.2 Discussion

The findings of this study demonstrate that the SINJAWA Pop-Up Book integrated with Augmented Reality (AR) is a valid, practical, and effective learning medium for improving fifth-grade students' Javanese script writing skills. This conclusion is supported by expert validation results, user responses, and statistical analyses of learning outcomes. The combination of traditional pop-up book media with AR technology offers an innovative instructional approach that aligns with students' developmental characteristics and learning needs.

The validity of the SINJAWA AR Pop-Up Book was confirmed through expert evaluations conducted by media and material specialists. The media expert validation score of 91.66% and the material expert score of 94.28% both fall within the "very feasible" category. These results indicate that the instructional content, visual design, and technical features of the media are appropriate and suitable for elementary school students. The high validity reflects careful alignment between the media content and curriculum objectives, as well as the accuracy and clarity of Javanese script writing materials. These findings support the assertion that well-designed instructional media can significantly enhance the quality of learning experiences (Kustandi, 2020).

From a developmental perspective, the effectiveness of the SINJAWA AR Pop-Up Book is consistent with Piaget's theory of cognitive development, which emphasizes that children at the elementary school level learn most effectively through concrete experiences, active involvement, and play-based activities. The pop-up book format allows students to interact physically with learning materials, while AR features provide dynamic visualizations that support abstract understanding. Through repetitive writing exercises integrated into engaging activities, students are encouraged to

actively practice and internalize Javanese script forms. This combination of hands-on learning and digital interactivity increases student engagement and promotes deeper conceptual understanding.

The practicality of the media was evidenced by the highly positive responses from both teachers and students. The teacher response questionnaire yielded a score of 93.33%, while the student response questionnaire resulted in a score of 95.2%, both categorized as "very good." These findings indicate that the SINJAWA AR Pop-Up Book is easy to use, engaging, and supportive of classroom instruction. High practicality suggests that the media can be implemented without imposing additional burdens on teachers or students, which is an essential consideration for sustainable instructional innovation. Similar findings were reported by Usman (2022), who found that technology-based learning media using Android applications and digital platforms were more effective and efficient than conventional paper-based methods, particularly when teachers could operate the media independently.

The effectiveness of the SINJAWA AR Pop-Up Book was further confirmed through statistical analysis of pretest and posttest results. The paired sample t-test revealed a significance value of 0.000 ($p < 0.05$), indicating a statistically significant improvement in students' Javanese script writing skills after using the media. Additionally, the N-Gain analysis produced values of 0.7217 for the small-group trial and 0.7521 for the large-group trial, both categorized as "very effective." These results demonstrate that the media not only improves learning outcomes but also facilitates substantial learning gains across different group sizes. The use of AR to visualize writing processes enables students to better understand stroke order, character structure, and writing techniques, thereby enhancing skill acquisition.

The findings of this study are consistent with previous research on the use of AR-based learning media. Saputra (2020) concluded that AR-based instructional media could be effectively implemented in learning with minor revisions. Similarly, Bakri et al. (2018) reported that AR book media developed for physics learning met instructional requirements and supported effective learning processes. Lubis and Dasopang (2020) also found that AR-based picture storybooks were feasible and practical for Generation Z students in mathematics learning. Furthermore, Kamiana et al. (2019) demonstrated that AR book applications were categorized as very good for use in educational settings. These studies collectively support the effectiveness of AR technology in enhancing student engagement and learning outcomes across various subjects.

In addition, the integration of local content and cultural elements within the SINJAWA AR Pop-Up Book contributes to meaningful learning. Mujiwati (2022) emphasized that learning media incorporating local wisdom can enhance student understanding and contextual relevance, although limitations may arise if assessment criteria are not explicitly included. In the present study, the focus on Javanese script writing directly supports cultural preservation efforts while improving students' literacy skills. This aligns with Barus (2022), who found that both learning media and foundational skills significantly influence learning outcomes, suggesting that optimizing instructional tools can lead to improved academic achievement.

Overall, the discussion highlights that the SINJAWA AR Pop-Up Book effectively addresses instructional challenges in Javanese script learning by combining interactive media, cultural content, and technology-based visualization. The high levels of validity, practicality, and effectiveness indicate that this media can serve as a viable alternative to conventional teaching methods. By fostering active learning, increasing motivation, and supporting cultural literacy, the SINJAWA AR Pop-Up Book contributes meaningfully to both educational innovation and the preservation of local heritage.

4. CONCLUSION

This study concludes that the SINJAWA Pop-Up Book integrated with Augmented Reality (AR) is a valid, practical, and effective learning medium for improving fifth-grade students' Javanese script writing skills, as evidenced by high expert validation scores, very positive teacher and student

responses, and a significant increase in learning outcomes between pretest and posttest results. The media successfully combines interactive printed materials and digital visualization to enhance student engagement and writing proficiency in Javanese script. Nevertheless, the study has several limitations, including a relatively small sample size restricted to one school and grade level, the absence of a long-term evaluation to measure learning retention, and potential accessibility issues related to the availability of devices capable of supporting AR features. Therefore, future research is recommended to involve larger and more diverse samples across different schools and regions, conduct longitudinal studies to examine sustained learning effects, and explore the application of AR-integrated media in other local content or language subjects to further support technology-enhanced learning and cultural preservation in elementary education.

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