Multimedia-Based E-Flashcards for Letter Recognition in Early Primary Education

*Putri Nabila Selvira[1], Hanum Rafidhah[2]
[1,2]Universitas Islam Negeri Ar-Raniry, Banda Aceh, Indonesia
*Email: 220209122@student.ar-raniry.ac.id

ABSTRACT

Letter recognition constitutes a fundamental component of early literacy development and plays a critical role in supporting beginning reading and writing skills in primary education. Difficulties in distinguishing letter forms, particularly visually similar letters, may hinder students' early reading progress and classroom participation. This study aimed to develop a multimedia-based e-flashcard learning medium and to examine its feasibility and effectiveness in supporting letter recognition among Grade 1 students. The study employed a research and development approach using the ADDIE model, followed by classroom implementation through a one-group pretest and posttest design involving 25 students. The developed e-flashcards integrated letter forms, supporting images, example words, and audio elements designed to reinforce visual recognition and letter–sound associations. Feasibility evaluation through expert validation demonstrated that the product met validity standards across media, content, and language domains. The effectiveness findings indicated a marked improvement in students' letter recognition performance, reflected in the increase from pretest to posttest scores. Statistical analysis using a paired-samples t-test indicated a statistically significant difference between pretest and posttest results. These findings indicate that multimedia-based e-flashcards can function as a supportive instructional medium for strengthening letter recognition, particularly in addressing difficulties related to visually similar letters in early primary classrooms.

Keywords: *Letter Recognition, Multimedia Learning, E-Flashcards, Early Literacy, Primary Education*

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A. INTRODUCTION

Early literacy forms the backbone of learning in the first years of primary school, because children's early success with print shapes later progress in reading and writing. A key component of this foundation is letter recognition, which involves identifying letter shapes, distinguishing visually similar letters, and linking letters to their corresponding sounds. Research consistently shows that early alphabet knowledge, including letter-name and letter-sound knowledge, is a strong predictor of later reading development in alphabetic writing systems (Noel Foulin, 2005; Piasta & Wagner, 2010; Treiman, 2000).

In Indonesian primary education, Bahasa Indonesia instruction is intended to build communicative competence through listening, speaking, reading, and writing. Within this framework, strengthening early literacy is essential because it supports children's

participation in classroom learning and their ability to access printed text (Ali, 2020). Classroom-based studies in Indonesia also underline that early-grade learners often need structured, engaging practice to develop stable early reading skills, particularly when foundational competencies are still emerging (Fuadah & Ruhaena, 2024; Zakiyyah et al., 2023).

A preliminary observation and an interview with the Grade 1 teacher at SDN Kuta Pasie, Aceh Besar, indicated that some students continued to struggle with differentiating letters that share similar visual features, particularly b/d/p/q, m/n, and v/f. These difficulties were visible in letter reversals during writing, inaccurate decoding during early reading practice, and slower progress when students were asked to read or write simple words and sentences. In this study, such challenges are treated as contextual early reading difficulties rather than being equated with clinical learning disorders such as dyslexia, which require specific diagnostic procedures and involve broader language-processing characteristics (Safitri et al., 2022). Evidence from literacy research also shows that letter learning is cognitively demanding, and specific letter features as well as instructional design can shape how quickly children master letter identification and sound mapping (Piasta & Wagner, 2010).

One practical factor that may contribute to these classroom difficulties is the limited use of varied learning media during instruction. In the observed classroom, letter introduction relied mainly on textbooks and simple printed letter cards displayed around the board. While these materials can be helpful, Indonesian studies suggest that flashcard-based practice, when designed and implemented well, can improve early literacy outcomes by increasing clarity, repetition, and active engagement during learning activities (Gultom & Mudiono, 2024; Rofiatun & Airlanda, 2024).

Advances in educational technology also create opportunities to design multimedia-based resources that integrate text, images, and audio to strengthen learning. Principles of multimedia learning indicate that combining verbal and visual information can support learning when the material is designed to guide attention and reduce unnecessary cognitive load (R. Mayer, 2020). In early literacy contexts, digital flashcards are especially promising because they can provide repeated exposure to letter forms while offering audio cues that reinforce pronunciation and letter–sound connections (Nur Azmi Alwi & Desi Aulia, 2023). Evidence from classroom-oriented research in Indonesia shows that digital flashcards can be feasible and effective as a supplementary medium for early reading learning when they are aligned with learner characteristics and instructional goals (Nur Azmi Alwi & Desi Aulia, 2023; Zakiyyah et al., 2023).

Based on these considerations, this study develops a multimedia-based e-flashcard learning medium to support Grade 1 students' letter recognition. The e-flashcards present letters together with supporting images, example words, and audio, with the aim of strengthening letter recognition and reducing confusion among visually similar letters. Accordingly, the research aims to develop the e-flashcard product and to examine its feasibility and effectiveness for improving letter recognition among Grade 1 students at SDN Kuta Pasie, Aceh Besar.

B. METHODS

This study employed a research and development (R&D) approach aimed at producing an instructional product and examining its feasibility and effectiveness in a classroom context. The development process followed the ADDIE model, which consists of analysis, design, development, implementation, and evaluation stages. To examine learning outcomes after product implementation, the study applied a one-group pretest and posttest design, in which the same group of students completed a letter recognition test before and after learning with the multimedia-based e-flashcards.

Setting and Participants

The study was conducted at SDN Kuta Pasie, Aceh Besar, with Grade 1 students as the target users of the developed product. The effectiveness analysis included 25 students who had complete pretest and posttest data.

Product Description

The developed product was a multimedia-based e-flashcard designed to support letter recognition. The e-flashcards presented uppercase and lowercase letters together with supporting images and example words. Audio elements and song-based reinforcement activities were incorporated to facilitate repetition, sustain learner engagement, and strengthen recognition of letter forms. The instructional content was organized using familiar themes for early-grade learners, including fruits, animals, and everyday objects.

Development Procedures (ADDIE)

1) Analysis: At the analysis stage, classroom needs were identified through observation of Bahasa Indonesia instruction and an interview with the Grade 1 teacher. The analysis indicated that several students experienced difficulty distinguishing visually similar letters, while classroom instruction relied primarily on textbooks and simple printed materials. Based on these findings, the need for more engaging and supportive instructional media was established.

2) Design: During the design stage, the structure and visual presentation of the e-flashcards were planned. The design emphasized clarity of letter forms, alignment between letters and supporting visuals, and a learner-friendly layout appropriate for Grade 1 students. Instructional sequencing and reinforcement activities were also determined at this stage.

3) Development: At the development stage, the e-flashcard product was produced based on the design specifications. The product was subsequently evaluated through expert validation covering media, content, and language domains. Revisions were made in response to validators' feedback until the product met feasibility criteria.

4) Implementation: The finalized e-flashcard medium was implemented in Grade 1 learning activities. Students completed a pretest prior to using the e-flashcards and a posttest following the instructional sessions. Teacher and student feedback was also collected to inform product refinement.

5) Evaluation: At the evaluation stage, validation outcomes and classroom trial results were reviewed to refine the product. Evaluation focused on feasibility results derived from expert validation and effectiveness results derived from student learning outcomes.

Instruments

1) Expert Validation Sheets: Feasibility was assessed using expert validation instruments covering three domains: media, content/material, and language. The product was reviewed by six validators, consisting of two media experts, two content experts, and two language experts. Each instrument used a Likert-type scoring format, and scores were converted into percentages to determine feasibility categories.

2) Letter Recognition Test (Pretest and Posttest): A letter recognition test was administered as both a pretest and posttest to measure students' performance before and after learning with the e-flashcards. Test scores were used to calculate descriptive statistics and learning gains.

3) User Response Instruments: Teacher and student response instruments were used to capture perceptions of practicality, usability, and learning experience. Open-ended feedback was collected to inform product refinement.

Data Analysis

1) Feasibility Analysis: Expert validation scores were analyzed descriptively by converting total scores into percentage values. Higher percentage values indicated stronger validity and feasibility for classroom use.

2) Effectiveness Analysis: Effectiveness was examined by comparing pretest and posttest scores from the same group of students. Mean scores and standard deviations were calculated, and a paired-samples t-test was used to determine whether posttest performance was significantly higher than pretest performance.
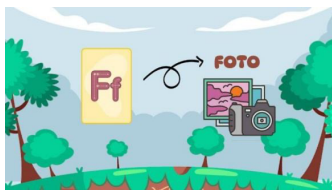
C. RESULTS AND DISCUSSION

1. Results

Product Design and Development Output

This study resulted in the development of a multimedia-based e-flashcard learning medium designed to support Grade 1 students' letter recognition. The e-flashcards integrated uppercase and lowercase letters with supporting images, example words, and audio elements. The design emphasized visual clarity, learner-friendly presentation, and repeated exposure to letter forms accompanied by pronunciation cues. In addition, the instructional sequence incorporated reinforcement activities intended to sustain learners' attention and strengthen recall. The design components and learning sequence of the developed e-flashcards are summarized in Table 3.

Table 3.
E-Flashcard Design and Learning Sequence

Step	Design Component and Function	
1	The e-flashcards were produced using Canva by selecting visuals aligned with each letter and applying colors and backgrounds suitable for Grade 1 learners.	
2	The opening display presented cards containing uppercase and lowercase letters along with example words and supporting images.	
3	Each card incorporated guidance for correct letter formation to reinforce recognition of letter shapes.	
4	Reinforcement activities included song-based elements to support memorization and maintain learner engagement.	
5	Learners were guided to recall letters sequentially from A to Z as part of structured repetition.	

Source: Product design documentation and development records

Table 3 illustrates the instructional structure of the multimedia-based e-flashcards. The design prioritizes clarity of letter presentation, integration of visual and auditory elements, and systematic reinforcement through guided recall activities. The inclusion of letter-formation guidance and song-based repetition reflects an effort to align the product with the cognitive and attentional characteristics of early-grade learners.

Media Validation Results

Following the development stage, the feasibility of the e-flashcard medium was evaluated across three domains: media, content, and language. Six expert validators participated in the assessment process. Media validation assessed visual and audio quality, clarity of instructional messaging, alignment with learning objectives, suitability for learner characteristics, and technical usability. The results of the media validation are presented in Table 4.

Table 4.
Media Validation Summary

Aspect	Validator 1 (%)	Validator 2 (%)	Category
Visual and audio quality	100	100	Very valid
Relevance to learning objectives	100	100	Very valid
Suitability for learner characteristics	100	100	Very valid
Technical feasibility	100	100	Very valid
Overall	100	100	Very valid

Source: Expert media validation sheets

As shown in Table 4, both validators rated all evaluated aspects at the highest feasibility level. These results suggest that the visual presentation, audio integration, instructional clarity, and technical functionality of the e-flashcard medium met the feasibility criteria for Grade 1 instructional contexts. Revisions were made based on validator feedback during the development stage to ensure the product satisfied feasibility requirements.

Content Validation Results

Content validation evaluated instructional organization, format clarity, relevance to learning objectives, and overall instructional feasibility. The results are summarized in Table 5.

Table 5.
Content Validation Summary

Sub-aspect	Validator 1 (%)	Validator 2 (%)
Format	87.50	87.50
Content	83	100
Language within material	83	92
Overall Content Feasibility: 90.62% (Very valid)		

Source: Expert content validation sheets

Table 5 shows that both validators rated the instructional content within the valid to very valid range. The strongest ratings were observed in the content domain, while format and language aspects also demonstrated strong feasibility levels. Overall, the results indicate that the instructional substance and organization of the e-flashcards were considered appropriate for classroom use.

Language Validation Results

Language validation assessed language use, language accuracy, and developmental suitability. The results are presented in Table 6.

Table 6.
Language Validation Results

Language Domain	Validator 1 (%)	Validator 2 (%)
Language use	87.50	75
Language accuracy	100	75
Developmental suitability	87.50	75
Overall Language Feasibility: 87.50% (Very valid)		

Source: Expert language validation sheets

As presented in Table 6, language validation results fall within the valid to very valid range across domains. These findings suggest that the wording, instructional clarity, and developmental suitability of the language used in the e-flashcards were considered acceptable and appropriate for Grade 1 learners.

Effectiveness Results (Pretest and Posttest)

Effectiveness was examined using pretest and posttest scores from the same group of learners. The effectiveness analysis included 25 students who completed both the pretest and posttest. A statistical summary is presented in Table 7.

Table 7.
Pretest and Posttest Summary Statistics and t-Test Result (N = 25)

Measure	Mean	SD
Pretest	51.60	8.50
Posttest	86.00	9.13
Gain	34.40	10.03
t-test: t = 17.14; df = 24; α = 0.05		

Source: Student pretest and posttest scores

Table 7 shows an increase in students' letter recognition scores after the implementation of the multimedia-based e-flashcards. The mean score increased from pretest to posttest, and the paired-samples t-test result (t = 17.14, df = 24, α = 0.05) indicates that the difference was statistically significant.

2. Discussion

The findings of this study highlight two principal outcomes: the high feasibility of the multimedia-based e-flashcard and its association with an increase in Grade 1 students' letter recognition scores from pretest to posttest. These outcomes warrant interpretation within broader perspectives of early literacy development, cognitive processing, and instructional media design.

The consistently high feasibility ratings across media, content, and language domains indicate that the e-flashcard medium was perceived as instructionally appropriate and developmentally suitable. In early literacy contexts, the design quality of instructional materials is closely tied to learning effectiveness because young learners rely heavily on perceptual clarity and attentional guidance (Takacs et al., 2015). Studies examining multimedia learning environments show that well-structured visual

presentation can reduce extraneous cognitive demands and support learners' ability to process essential instructional elements (Sweller, 2011).

From a cognitive perspective, the effectiveness of the e-flashcards can be understood through principles of dual-channel processing. Learning research suggests that combining visual representations with auditory reinforcement facilitates stronger encoding and retrieval processes, particularly in symbol-based learning tasks such as letter recognition (R. E. Mayer, 2003). This aligns with empirical findings demonstrating that multimodal presentation enhances learners' ability to establish stable associations between visual symbols and phonological information (Shams & Seitz, 2008).

The substantial improvement in letter recognition scores observed in this study suggests that the multimedia-based e-flashcards supported learning not only through motivation, but also through structured exposure to letter forms and audio reinforcement. Early literacy research consistently identifies letter knowledge as a critical predictor of reading acquisition (Valcárcel Jiménez et al., 2024). Instructional interventions that strengthen letter–sound mapping contribute directly to the development of decoding skills and early word recognition (Share, 1995). In this context, the integration of letter forms, images, and audio cues likely supported learners' ability to consolidate letter representations. One plausible explanation for the observed gains lies in the role of repeated exposure. Research on early reading development emphasizes that repetition is central to stabilizing orthographic knowledge (Nation & Hulme, 2011). Multimedia-supported repetition may further enhance this process by sustaining learner attention while reinforcing perceptual discrimination between visually similar letters (Ducrot & Grainger, 2025; Saneyoshi & Inada, 2025).

Empirical studies examining digital learning media report comparable patterns. Bus et al. (1995) found that visual-symbol reinforcement strategies improve children's early literacy engagement and recognition accuracy. More recent investigations into digital flashcard-based instruction indicate that structured multimedia presentation supports early reading competencies by facilitating attention, recall, and symbol discrimination (Takacs et al., 2015). Importantly, the improvement observed in this study may also reflect reductions in visual confusion. Letter recognition requires learners to differentiate subtle visual features, a process influenced by perceptual discrimination abilities (Gibson & Levin, 1975). Instructional supports that enhance visual clarity and consistency contribute to more stable letter identification (Evans et al., 2006). Beyond effectiveness, the feasibility findings carry pedagogical significance. Instructional media that align with learners' cognitive characteristics tend to yield stronger learning outcomes (R. E. Mayer, 2003). Classroom-oriented research suggests that media usability, clarity, and developmental suitability function as critical instructional variables rather than peripheral design considerations (Moreno & Mayer, 2007).

While the effectiveness results indicate meaningful improvement, interpretation must consider methodological constraints. The one-group pretest and posttest design in a single classroom context limits causal inference and generalizability, because observed gains may reflect multiple interacting factors beyond the intervention (Saputri &

Mardiati, 2025; Triastuti et al., 2024). Nevertheless, the magnitude of improvement suggests that the multimedia-based e-flashcards likely served as a supportive instructional resource within the observed classroom context. Despite these limitations, the findings offer important implications. Multimedia-based flashcards may represent a practical supplementary medium for strengthening letter recognition, particularly in early primary classrooms where learners encounter difficulties with visually similar letters. These implications are consistent with broader multimedia learning research emphasizing alignment between instructional design and cognitive processing mechanisms (R. E. Mayer, 2003; Sweller, 2011).

D. CONCLUSION

This study developed a multimedia-based e-flashcard learning medium to support letter recognition among Grade 1 students. Feasibility evaluation indicates that the product meets validity standards across media, content, and language domains, suggesting that the e-flashcards are appropriate for classroom use. The effectiveness findings show a clear improvement in students' letter recognition performance following the implementation of the multimedia-based e-flashcards. The increase in posttest scores indicates that combining visual presentation, audio reinforcement, and structured repetition supports students' ability to identify letters and distinguish visually similar forms. This study is limited by the use of a one-group pretest and posttest design and a single classroom context. Future studies employing controlled experimental designs and broader participant groups are recommended to strengthen empirical evidence on the instructional role of multimedia-based flashcard media in early literacy learning.

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