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The Use of Audio Flashcard Educational Media to Support Early Literacy Development Through an Animal Recognition Theme

Nisrina Khairunnisa[1]✉, Eriqa Pratiwi[1], Ervin T. Echague[2], Jerome C. Hilario[3]

[1]Universitas Trunodjoyo Madura, Bangkalan, Indonesia; [2]Philippine Normal University, The Philippines;
[3]University of the Philippines, Diliman, The Philippines

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ABSTRACT

Background of the study: Early literacy development in early childhood requires learning media that can engage children through multisensory experiences. Conventional flashcards primarily provide visual and printed information, whereas integrating audio may provide additional support for children's recognition, pronunciation, and understanding of letters and words.

Aims and scope of paper: This study examined whether participation in audio flashcard activities was associated with improvements in early literacy-related performance among children aged 4–5 years using an animal-recognition theme. The study specifically focused on children's abilities to imitate animal sounds, write letters contained in animal names, and pronounce letters in animal names.

Methods: The study used a quantitative, one-group pretest–posttest design. The participants were 30 children aged 4–5 years in Group A at TK Ya Bunaiya, Cerme, Gresik, Indonesia. Data were collected through performance-based assessment sheets, pretest and posttest learning sheets, and documentation. Differences between pretest and posttest scores were analyzed using the Wilcoxon signed-rank test.

Results: The findings indicated improvements across all three assessed outcomes. Mean scores increased from 9.17 to 12.93 for animal-sound imitation (Test I), from 24.10 to 35.57 for letter writing in animal names (Test II), and from 22.67 to 34.87 for letter pronunciation in animal names (Test III). The Wilcoxon signed-rank test showed statistically significant pretest–posttest differences for all three tests ($p < .001$), with large within-group effect sizes ($r = .80–.88$).

Contribution: This study provides preliminary empirical evidence that audio-integrated flashcards can serve as a multisensory educational medium to support early literacy learning in early childhood. The findings also highlight the potential of combining visual, print, and auditory stimuli within a thematic learning context to facilitate children's early literacy and language-related skills.

✉ **Corresponding Author**
Address : Bangkalan, Indonesia
Email : nisrina1270@gmail.com

INTRODUCTION

Play is a fundamental context for young children's learning because it gives children opportunities to actively interact with objects, language, people, and symbolic representations. In early childhood education, learning activities should provide developmentally appropriate experiences that let children explore and construct meaning rather than merely receive information. (Skene et al., 2022). Educational media can support this process by making abstract or unfamiliar concepts more accessible through concrete and engaging representations. Multimedia and interactive learning resources may give children multiple ways to access information through visual, auditory, and interactive features (Yeni Lestari et al., 2024; Gahrizsangi et al., 2026; Ibrahim & Suminar, 2026). Recent research on early childhood education indicates that digital and technology-supported learning can support young children's language and literacy development when educators integrate technology into pedagogical activities rather than using it merely as a substitute for conventional materials (Liu et al., 2024; Verhoeven et al., 2020).

Early literacy is an important part of children's development because it includes the knowledge and skills that precede conventional reading and writing. Among these skills, alphabet knowledge, print knowledge, phonological awareness, vocabulary, and oral language are particularly relevant to children's subsequent literacy development. (Liu et al., 2024; Rachmani, 2020). A recent systematic review of digital technologies in early childhood identified print knowledge, alphabet knowledge, phonological awareness, early vocabulary, and narrative skills as major literacy outcomes investigated in research involving young children (Liu et al., 2024). Alphabet knowledge matters because children's ability to recognize letter forms and names, connect letters to their corresponding sounds, and reproduce letters provides a strong foundation for later reading and writing. (Liu et al., 2024; Rachmani, 2020). Thus, early literacy instruction should provide children with repeated and meaningful opportunities to see, hear, pronounce, and represent letters and words.

One instructional medium that may facilitate these processes is the flashcard. Flashcards offer a simple format that presents visual representations and written symbols together, potentially helping children associate objects or concepts with their corresponding linguistic representations. This approach is particularly relevant in early childhood, as concrete visual representations can provide opportunities to connect familiar experiences with new vocabulary, word forms, and meanings. Research on word-card learning has examined the contribution of flashcards to word recognition and vocabulary acquisition, although learning outcomes may vary according to instructional conditions, learner characteristics, and the format of the materials (Miles et al., 2017; Webb et al., 2020; Lei & Reynolds, 2022). Research on mobile and gamified flashcards further suggests the importance of considering how the design and delivery of card-based activities shape vocabulary learning (Soyoof et al., 2026). However, much of this research has focused on vocabulary acquisition rather than the broader components of emergent literacy. For example, recent studies involving young learners report positive vocabulary and language outcomes, as well as engagement, associated with flashcard use (Apriliani et al., 2025; Fadhilah et al., 2025; Mafulah & Adhi, 2025).

However, conventional flashcards are predominantly visual. Children see a picture and its associated written word, but the auditory dimension of the learning experience generally depends on the teacher's explanation or pronunciation. Integrating audio into flashcards may therefore provide an additional representational channel through which children can hear relevant sounds and verbal information while simultaneously observing pictures and printed words. This proposition is consistent with evidence from research on technology-supported early literacy, which indicates that multimedia features such as audio narration, highlighted print, animation, and interactive elements can attract children's attention to print and support specific literacy outcomes. For example, multimedia features such as audio narration and animated illustrations have been associated with greater attention to print. In contrast, digital spelling activities that incorporate audio and video support have produced stronger learning outcomes than versions without these features (Liu et al., 2024).

The potential value of combining visual and auditory information is also supported by broader evidence concerning technology-mediated literacy instruction. Verhoeven et al. (2020), in a meta-analysis of 59 studies involving 6,786 preschool and kindergarten children, found a small but positive overall effect of computer-supported early literacy interventions (g = 0.28). However, the effects varied considerably across studies and were stronger when technology was integrated into broader classroom learning systems. Similarly, Bautista et al. (2024) reviewed 67 studies on educational technology and preschoolers' early literacy development. They concluded that technology-based interventions show some evidence of effectiveness, with medium-to-large effect sizes in only some studies, while emphasizing that the contribution of specific technological features remains insufficiently investigated.

These findings point to an important research gap. Existing research has increasingly examined digital books, educational applications, tablets, digital storytelling, and computer-supported literacy interventions. However, it has paid comparatively less attention to simple audio-integrated learning media that combine physical flashcards, printed words, visual representations, and immediate auditory feedback. This gap is important because not all early childhood educational settings require sophisticated digital applications or screen-based technologies. A relatively simple audio flashcard can provide multimodal learning opportunities while remaining tangible, teacher-mediated, and potentially easier to integrate into classroom activities. Moreover, systematic reviews note that the specific features of educational technology and their relationship to literacy outcomes remain under-investigated (Bautista et al., 2024; Liu et al., 2024).

The animal-recognition theme provides a meaningful context for investigating this type of medium. Animal pictures and associated sounds offer concrete, recognizable referents for theme-based language activities and can provide opportunities to connect pictures, spoken language, environmental sounds, and printed words. A child can observe an animal image, hear its associated sound, identify the animal, and subsequently attend to the letters contained in its name. Such multimodal associations may create richer opportunities for children to connect oral and written representations. This approach is consistent with research indicating that technology-supported and multimodal learning experiences can provide opportunities to develop young children's vocabulary, phonological awareness, alphabet knowledge, print knowledge, and narrative skills (Liu et al., 2024). Research on educational media has also shown that presenting information through complementary visual and auditory channels can support vocabulary learning among preschool-aged dual-language learners (Wong & Samudra, 2021).

Furthermore, experimental evidence suggests that visual and auditory enhancements in digital picture books can support children's comprehension and incidental word learning, although their effectiveness may vary according to children's age and the way the enhancements are combined (2023). A meta-analysis of computer-supported early literacy interventions likewise reported positive overall effects on early literacy outcomes, particularly when digital activities were integrated into classroom learning systems (Verhoeven et al., 2020). Evidence from a systematic review of early childhood language and literacy interventions further underscores the importance of combining developmentally appropriate instructional strategies with opportunities to engage with language and print (Chambers et al., 2016). Taken together, these findings provide a rationale for examining audio flashcards as a medium that integrates animal images, associated sounds, spoken animal names, and printed letters within a single learning activity. This matters because early literacy develops not through isolated letter memorization, but through children's gradual understanding of relationships among spoken language, sounds, symbols, and print. Research on multimedia literacy activities suggests that interactive, multimodal features can increase children's attention to print and support specific components of emergent literacy (Liu et al., 2024).

Nevertheless, the use of audio flashcards should not be assumed to be effective simply because multiple sensory channels are involved. Research on technology-supported literacy emphasizes that learning outcomes depend on how media features are designed and implemented, including the nature of the content, children's age and prior experience, instructional organization,

and adult mediation (Bautista et al., 2024; Liu et al., 2024). Therefore, empirical examination is necessary to determine whether a relatively simple audio flashcard can produce measurable improvements in specific early literacy outcomes among preschool children.

Against this background, the present study examines the use of an animal-recognition-themed audio flashcard educational medium for children aged 4–5 years. The study focuses on three observable learning outcomes: children's ability to imitate animal sounds, write the letters in animal names, and pronounce the letters in animal names. Using a pretest–posttest design, this study examines these outcomes to provide empirical evidence on the potential of audio-integrated flashcards as a developmentally appropriate and relatively accessible medium for supporting early literacy in early childhood education. The study contributes to the existing literature by extending research on educational technology beyond screen-based applications and digital storytelling toward a tangible, audio-enhanced, multimodal learning medium that integrates visual, auditory, and print representations within thematic early literacy activities..

METHOD

Research Design

This study used a quantitative pre-experimental, one-group pretest–posttest design to examine changes in children's early literacy performance after implementing audio flashcard educational media. The design consisted of three stages: pretest measurement (O_1), intervention using audio flashcards (X), and posttest measurement (O_2). The design can be represented as follows:

$$O_1 \rightarrow X \rightarrow O_2$$

Figure 1. One-group pretest–posttest research design

The pretest was administered before the intervention to establish children's baseline performance, followed by a learning intervention using audio flashcards with an animal-recognition theme. The researchers then administered the posttest using the same assessment indicators to identify changes in children's performance after the intervention.

Because the study did not include a control or comparison group, the findings are interpreted as changes associated with participation in the intervention rather than definitive causal effects. This distinction is important because a one-group pretest–posttest design cannot fully control for alternative explanations such as maturation, testing effects, or other experiences occurring during the study period.

Participants and Sampling

The study was conducted at TK Ya Bunaiya, Cerme, Gresik, Indonesia. The participants were 30 children aged 4–5 years enrolled in Group A. The study used total sampling (census), in which all children in the identified Group A class who met the study criteria were included as participants.

The inclusion criteria were: (1) being enrolled in Group A at TK Ya Bunaiya, (2) being within the target age range of 4–5 years, and (3) participating in the pretest, intervention, and posttest activities. No participant was excluded from the study based on the reported sampling criteria.

The sample size was determined by the number of children enrolled in the target classroom rather than by statistical sampling estimation. Therefore, the findings primarily represent the participants and educational context included in the study and should not be generalized to broader populations without consideration of differences in context and participant characteristics.

Audio Flashcard Intervention

The intervention used audio flashcards designed around an animal-recognition theme. Each flashcard showed an animal and its corresponding written name. Participants used an audio-

producing device that generated animal-related sounds and verbal information when they inserted a card.

The intervention was designed to provide children with simultaneous exposure to visual, auditory, and print information. During the learning activities, children were encouraged to observe the animal picture, identify the animal, listen to the associated sound or verbal information, imitate the animal sound, attend to the letters in the animal's name, and pronounce or reproduce the letters presented in the activity.

The learning activities focused on three outcome areas: (a) animal-sound imitation, referring to children's ability to imitate the sound associated with the animal presented on the flashcard; (b) letter writing in animal names, referring to children's ability to reproduce letters contained in the animal names presented during the activity; and (c) letter pronunciation in animal names, referring to children's ability to pronounce the letters presented in the animal names.

The teacher/researcher provided instructions and demonstrations before the children performed the activities. The teacher/researcher maintained the same instructional sequence and assessment indicators across participants to ensure consistent implementation.

Research Instruments and Measures

Data were collected using performance-based assessment sheets, pretest and posttest learning sheets, and documentation. The primary quantitative outcome data came from children's pretest and posttest performance.

The assessment instrument operationalized the three learning outcomes into observable indicators related to animal-sound imitation, letter writing, and letter pronunciation. Children's performance was rated using a four-level developmental scale (Table 1).

Table 1. Developmental assessment criteria

Symbol	Developmental category	Score	Percentage range
BSB	Developing Very Well	4	75%–100%
BSH	Developing as Expected	3	50%–74%
MB	Beginning to Develop	2	25%–49%
BB	Not Yet Developed	1	1%–24%

The scoring system classified children's observed performance at the individual assessment level. The percentage score for each assessment was calculated using the following formula:

$$P = \frac{X}{X_{max}} \times 100$$

Where P represents the percentage score, X represents the child's score, and Xmax represents the maximum possible score.

For group-level descriptive reporting, the resulting percentage scores were interpreted using the categories in Table 2:

Table 2. Interpretation of percentage scores

Percentage	Interpretation
0–20%	Very weak
21–40%	Weak
41–60%	Moderate
61–80%	Strong
81–100%	Very strong

The developmental categories in Table 1 were used to rate individual performance on each indicator. In contrast, the percentage categories in Table 2 served only as descriptive labels for percentage scores and were not treated as an additional developmental scale. Because test-specific maximum scores cannot be established from the available report, Table 2 was not applied to interpret the present raw-score results.

Data Collection Procedure

Data collection occurred in three main stages. First, the researchers administered the pretest to measure children's baseline performance on the predetermined indicators. The assessment was conducted before the children received the audio flashcard intervention.

Second, the children participated in learning activities using the audio flashcard media. The intervention involved introducing animal pictures and names, listening to the corresponding audio, imitating animal sounds, identifying letters in animal names, writing the relevant letters, and pronouncing the letters. The teacher/researcher guided the activities while recording children's responses using the assessment instrument.

Third, after completion of the intervention, the same assessment indicators were administered in the posttest. The researchers also collected documentation throughout the research process to provide supporting evidence of the implementation of the learning activities.

Data Analysis

The quantitative data were analyzed using descriptive and inferential statistics. Descriptive statistics summarized children's performance before and after the intervention, including raw scores and changes in performance.

The pretest and posttest scores were initially examined for distributional characteristics. Because the study involved paired observations from the same participants, the inferential analysis focused on whether posttest scores differed significantly from the corresponding pretest scores.

The Wilcoxon signed-rank test was used to evaluate pretest–posttest differences because the assessment data came from an ordinal developmental rating scale and the study used paired observations. Statistical significance was evaluated at $\alpha = .05$. A p-value below .05 was interpreted as evidence of a statistically significant difference between pretest and posttest performance. Effect sizes were calculated as $r = |Z|/\sqrt{N}$, where N is the number of paired observations ($N = 30$), and $r \geq .50$ was interpreted as a large effect. The magnitude threshold is a descriptive convention, not a test of causal impact.

The analysis was conducted separately for the three outcome areas: (1) animal-sound imitation, (2) letter writing in animal names, and (3) letter pronunciation in animal names, hereafter referred to as Test I, Test II, and Test III, respectively. The results were reported using the pretest and posttest descriptive statistics and the corresponding Wilcoxon signed-rank test results.

Ethical Considerations

The participants were children aged 4–5 years. The available study report does not document the institutional ethical review decision, school authorization, parental or guardian consent procedures, or data-protection arrangements. These details must be verified against the original study records before submission; the absence of reporting should not be interpreted as evidence that the procedures did not occur.

RESULTS

Implementation of the Audio Flashcard Intervention

The intervention employed audio-integrated flashcards presenting animal pictures, printed animal names, and corresponding animal sounds. The combination of visual and auditory representations was designed to give children multiple opportunities to link concrete animal representations with spoken and printed language. This approach aligns with reviews suggesting that technology-supported, multimodal learning environments can provide additional opportunities for young children to develop language and emergent literacy skills when technology is appropriately integrated with teacher-guided instruction (Bautista et al., 2024; Liu et al., 2024).

The study assessed three outcomes: (1) children's ability to imitate animal sounds, (2) children's ability to write letters contained in animal names, and (3) children's ability to pronounce letters contained in animal names. These outcomes represent related but conceptually distinct developmental domains. The first primarily reflects oral language and auditory response, whereas the second and third are more directly related to emerging writing and alphabet knowledge.

Descriptive Statistics

Descriptive statistics were calculated for the three pretest–posttest comparisons. Table 3 summarizes the results. Percentage classifications in Table 2 were not assigned because the test-specific score maxima remain undocumented.

Table 3. Descriptive Statistics of Pretest and Posttest Scores

Outcome	Phase	N	Minimum	Maximum	Mean	SD	Median	IQR
Test I: Animal-sound imitation	Pretest	30	6	15	9.17	2.21	9.00	3.00
	Posttest	30	7	19	12.93	2.85	13.00	1.00
Test II: Letter writing	Pretest	30	13	39	24.10	7.77	23.50	13.75
	Posttest	30	19	40	35.57	5.08	37.00	3.75
Test III: Letter pronunciation	Pretest	30	20	35	22.67	3.03	22.00	2.00
	Posttest	30	23	39	34.87	3.49	36.00	3.00

The descriptive results show consistent increases across all three outcomes. The mean score for Test I increased from 9.17 to 12.93, representing a mean gain of 3.77 points. Test II increased from 24.10 to 35.57 (gain of 11.47 points), while Test III increased from 22.67 to 34.87 (gain of 12.20 points). The Test I posttest interquartile range shown in Table 3 requires confirmation from the original participant-level scores.

The largest absolute gain was observed in Test III, followed by Test II and Test I. Because the three tests do not necessarily share the same maximum score, these absolute gains should not be compared directly across tests. The relatively high posttest scores for Tests II and III indicate that children's performance in letter-related activities increased substantially after the intervention. This pattern is theoretically plausible because alphabet learning requires children to establish associations between visual letter forms and verbal information. Previous experimental research shows that explicit instruction linking letter forms to letter names and sounds can produce measurable gains in preschool children's alphabet knowledge (Rachmani, 2020; Roberts et al., 2018, 2020).

Distributional Assessment and Choice of Inferential Test

As the scores were derived from ordinal developmental ratings and paired measurements, the primary analysis used a paired nonparametric procedure. The original distributional-test statistics were not available for independent verification and are therefore not reported.

Because the same 30 children were assessed at two time points and the developmental assessment was based on an ordinal rating structure, the Wilcoxon signed-rank test was used as the primary inferential procedure. This approach avoids treating developmental rating scores as interval-level measurements and is appropriate for paired observations when the assumptions of the paired-samples *t* test are not sufficiently supported.

Systematic reviews also note that early literacy intervention studies use diverse designs and outcome measures (Bautista et al., 2024; Verhoeven et al., 2020), underscoring the importance of transparently justifying analytic choices.

Wilcoxon Signed-Rank Test Results

Table 4 presents the Wilcoxon signed-rank test results. For Test I, 28 children obtained higher posttest scores than pretest scores, one child obtained a lower score, and one child showed no change. The Wilcoxon signed-rank test indicated a statistically significant difference between pretest and posttest performance, $Z = -4.399$, $p < .001$. The corresponding effect size was $r = .803$, indicating a large within-group effect.

Table 4. Wilcoxon Signed-Rank Test Results

Outcome	Positive Ranks	Negative Ranks	Ties	Z	p	Effect size r
Test I: Animal-sound imitation	28	1	1	−4.399	< .001	.803
Test II: Letter writing	27	3	0	−4.477	< .001	.817
Test III: Letter pronunciation	30	0	0	−4.792	< .001	.875

For Test II, 27 children improved, whereas three children obtained lower scores. No ties were observed. The difference between pretest and posttest scores was statistically significant, $Z = -4.477$, $p < .001$, with a large effect size ($r = .817$).

The strongest pattern was observed for Test III. All 30 children obtained higher posttest scores than pretest scores, with no negative ranks or ties. The Wilcoxon test showed a statistically significant difference, $Z = -4.792$, $p < .001$, with a large effect size ($r = .875$).

Taken together, the inferential results indicate consistent within-group improvement across all three outcomes following participation in the audio flashcard activities. Nevertheless, because the study did not include a control group, these findings should be interpreted as statistically significant pretest–posttest improvements associated with the intervention, rather than definitive evidence of a causal treatment effect.

DISCUSSION

Audio Flashcards and Children's Oral-Language/Auditory Performance

The first finding indicates that children's ability to imitate animal sounds improved significantly after the audio flashcard activities. The mean score increased from 9.17 at pretest to 12.93 at posttest, and 28 of 30 children scored higher at posttest. The large Wilcoxon effect size ($r = .803$) indicates a substantial within-group change.

The multimodal structure of the intervention helps explain the result. Children were shown an animal picture and exposed to an auditory representation they could immediately reproduce. This repeated association between a visual referent and an auditory response may have increased children's opportunities to attend to, discriminate, and reproduce sounds. Research on shared book reading indicates that repeated exposure, active participation, and interaction support young children's word learning and language development (Flack et al., 2018; Noble et al., 2019).

However, this finding should not be interpreted as direct evidence of improved early literacy. Animal-sound imitation is more appropriately classified as an oral-language or auditory-response outcome. This distinction matters because early literacy is multidimensional and includes skills such as alphabet knowledge, phonological awareness, print knowledge, vocabulary, and narrative abilities (Liu et al., 2024). Thus, the audio flashcards' contribution to Test I is better described as supporting a language-related foundation that may accompany emergent literacy development.

The finding is nevertheless relevant because language and literacy development are interconnected during the preschool period. (Noble et al., 2019; Liu et al., 2024). A meta-analysis of shared book reading reported a positive but modest effect on children's language skills, with the effect moderated by study design and the type of control group (Noble et al., 2019). Similarly, a meta-analysis of shared storybook reading found that word learning was moderated by dialogic reading styles and by the number of exposures to target words (Flack et al., 2018).

The present finding therefore suggests that the auditory component of the flashcard may have provided an additional learning cue. Because no conventional flashcard comparison was included, however, this cannot be established from the present data. This interpretation aligns with recent reviews suggesting that technology-supported early childhood language and literacy interventions can provide additional representations and learning opportunities when paired with appropriate instructional mediation (Bautista et al., 2024; Liu et al., 2024).

Audio Flashcards and Letter Writing in Animal Names

The second outcome showed a larger mean improvement than Test I. Children's mean score increased from 24.10 to 35.57, a gain of 11.47 points. Twenty-seven children improved, while three children showed lower posttest scores. The Wilcoxon result was statistically significant, $Z = -4.477$, $p < .001$, with a large effect size ($r = .817$).

This finding is particularly relevant to emergent literacy because writing individual letters requires children to recognize and reproduce orthographic forms. Alphabet learning is not simply a matter of memorizing letter labels; children must establish associations among visual forms, verbal labels, and sounds and, in the case of writing, produce the letter forms motorically. Roberts et al. (2018) reported that explicit instruction in letter names and sounds supported preschoolers' alphabet learning and that paired-associate and articulation-referencing learning processes were related to alphabetic growth. Roberts et al. (2020) found that instruction emphasizing the relation between verbal letter labels and letter forms supported preschoolers' alphabet learning, and Roberts et al. (2019) examined how cognitive processes, teaching sequence, and English proficiency influence that learning. These studies, however, targeted letter names and sounds rather than letter writing. Because the cited alphabet-instruction studies primarily concern letter names and sounds, they do not independently establish benefits for handwriting; evidence about letter writing should therefore be interpreted as specific to the present assessment.

The audio flashcard intervention may have supported this association by placing the written animal name alongside a recognizable animal image and an auditory cue (Gfeller, N., & Kayali, F. 2026). The child could therefore encounter several related representations within the same learning event: the animal as a concrete referent, its printed name, and its corresponding sound. This multimodal structure may have reduced the abstraction of isolated letter learning by embedding letters in meaningful and recognizable words. This explanation should nevertheless be treated cautiously: Roberts et al. (2020) found that preschoolers taught letters in isolation made greater gains in letter-sound identification and phonemic awareness than those taught letters within meaningful words, so embedding letters in animal names should not be assumed to be advantageous.

The finding is also broadly consistent with evidence that explicit alphabet instruction can strengthen letter-related outcomes among preschool children, although evidence on letter writing specifically is limited. For example, Rachmani (2020) reported significant gains in uppercase letter naming, letter-sound awareness, and beginning-sound awareness among four-year-old kindergarten children in a structured intervention, whereas gains in name writing were not significant. Roberts et al. (2020) likewise found that explicit instruction emphasizing relationships between verbal letter labels and letter forms supported preschool children's learning of letter names and sounds. These findings are consistent with experimental research demonstrating that explicit alphabet instruction can promote preschool children's acquisition of letter names and sounds, particularly when instructional activities engage relevant cognitive learning processes (Roberts et al., 2018; Roberts et al., 2019). Further evidence indicates that structured print-to-sound instruction can improve preschool children's letter-sound reading (Wolf, 2016), while integrating letter-shaped visual mnemonics into instruction can facilitate letter-sound learning. More recent research also suggests that differentiating alphabet instruction according to children's learning needs can support the acquisition of letter names, sounds, and forms (2022). Nevertheless, improvements in letter recognition and letter-sound knowledge should not automatically be interpreted as improvements in letter-writing performance, because these outcomes represent related but distinct early literacy skills.

Importantly, the present study should not conclude that audio flashcards independently caused children's writing development. Children's classroom instruction, repeated exposure to print, teacher guidance, maturation, and practice effects may also have contributed to the observed improvement. The large within-group effect is encouraging, but a comparison condition would be required to distinguish the specific contribution of the audio flashcard intervention from these alternative explanations.

Audio Flashcards and Letter Pronunciation

Test III produced the largest improvement. The mean score increased from 22.67 to 34.87, a gain of 12.20 points. All 30 children obtained higher posttest scores, resulting in $Z = -4.792$, $p < .001$, and a large effect size ($r = .875$).

The consistent direction of change matters because letter pronunciation requires children to link visual symbols to verbal labels or sounds. Such associations are central to alphabet knowledge and constitute an important foundation for later literacy learning. Research on preschool alphabet instruction has shown that explicit attention to letter names and sounds can produce measurable gains in alphabet-related skills (Roberts et al., 2018, 2020). Wang et al. (2022), for example, taught preschool children letter–sound mappings and described letter-sound knowledge as a fundamental component of learning to read.

The audio component of the intervention may have been particularly relevant to this outcome because it provided an immediate auditory model. Rather than requiring children to infer pronunciation exclusively from a printed form, the activity linked the visual card with an auditory stimulus and teacher-mediated repetition. This design aligns with broader evidence that technology-supported literacy activities can provide linked representations and interactive opportunities for young children (Bautista et al., 2024; Liu et al., 2024).

Nevertheless, the construct measured here should be specified carefully. "Pronouncing letters" may refer to letter-name production, letter-sound production, or pronunciation of the entire animal name. These are not equivalent literacy outcomes. Previous research distinguishes letter-name knowledge from letter-sound knowledge, and instructional outcomes may differ depending on which is taught (Roberts et al., 2018, 2020). The construct assessed in Test III is therefore defined in the Method section, and the results should be interpreted accordingly. The original assessment rubric is needed to determine whether the outcome represents letter names, letter sounds, or whole-word pronunciation.

Why the Effects Were Stronger for Letter-Related Outcomes

Across the three outcomes, the largest effect size was observed for Test III ($r = .875$), followed by Test II ($r = .817$) and Test I ($r = .803$). Because these effect sizes differ only slightly, their ordering should be interpreted cautiously, and they should not be interpreted as causal treatment effects. Nevertheless, the pattern provides a useful basis for discussing how the intervention may have interacted with the targeted learning tasks.

The greater changes in Tests II and III may be related to the close correspondence between the instructional content and the measured outcomes. The cards explicitly displayed animal names and therefore provided children with repeated exposure to printed letters. The audio component added an auditory cue that could support children's attention to verbal information. In contrast, Test I involved imitation of animal sounds, which is less directly connected to alphabetic learning.

This interpretation is supported by research showing that explicit instruction in alphabet content can promote preschool children's alphabet learning. Roberts et al. (2018) found that explicit letter-name and letter-sound instruction supported growth in taught alphabet content, while Roberts et al. (2020) found that instruction emphasizing the relation between verbal letter labels and letter forms supported alphabet learning. Similarly, Rachmani (2020) reported gains in uppercase letter naming, letter-sound awareness, and beginning-sound awareness following a structured early literacy intervention.

The results also support the argument that the value of educational technology does not necessarily lie in technology itself. Instead, learning outcomes may depend on how particular technological features are integrated into pedagogical activities. Bautista et al. (2024) found some evidence for the effectiveness of educational technology in preschool early literacy. However, they noted that the contribution of specific features has been little investigated, and Liu et al. (2024) synthesized technology use across print knowledge, alphabet knowledge, phonological awareness, early vocabulary, and narrative skills. Thus, the audio component of the present

flashcard should be viewed as an instructional affordance rather than as an independent source of learning. Research on multimodal learning with tablets similarly emphasizes the role of pedagogical design in creating meaningful learning opportunities (Yelland, 2018). Taken together, these findings suggest that technology should be evaluated in relation to its instructional purpose, the characteristics of its users, and the learning activities in which it is embedded. Thus, the audio component of the present flashcard should be viewed as an instructional affordance rather than as an independent source of learning.

Comparison With Previous Flashcard and Technology Research

The present findings are broadly consistent with recent research examining flashcards and language learning among young children. In a qualitative case study based on observation and interviews, Mafulah and Adhi (2025) reported that children, the teacher, and parents perceived flashcards as supporting engagement, retention, and language acquisition. Apriliani et al. (2025) similarly reported positive vocabulary outcomes among young learners following flashcard use. Recent preschool research has also reported improvements in language development following flashcard-based activities (Fadhilah et al., 2025).

However, the present study differs from conventional flashcard research in one important respect: the flashcards were audio-integrated, rather than being limited to static visual representations. This feature creates a potentially useful bridge between traditional physical learning materials and technology-supported multimodal learning. Recent research on technology and early literacy indicates that different technological affordances can support different components of literacy, including alphabet knowledge, phonological awareness, vocabulary, print knowledge, and narrative skills (Liu et al., 2024).

The results should nevertheless be interpreted in light of the broader evidence base. Verhoeven et al. (2020), in a meta-analysis of 59 studies involving 6,786 preschool and kindergarten children, found a small positive average effect for computer-supported early literacy interventions but also substantial variation between studies. Importantly, the effects were stronger in integrated learning systems, suggesting that technology works most effectively when embedded within broader instructional practices rather than treated as an isolated intervention.

This point is highly relevant to the present study. We used the audio flashcards within teacher-guided learning activities rather than as an autonomous learning tool. The teacher/researcher introduced the cards, guided children's responses, encouraged repetition, and connected the visual and auditory information to the target learning activities. Therefore, the observed improvement may reflect the combined contribution of the media, teacher mediation, repeated practice, and structured learning tasks.

Implications

The results suggest that audio-integrated flashcards can be used as a relatively simple multimodal instructional resource to support children's engagement with animal-related vocabulary, letter forms, and pronunciation. Unlike more complex digital learning applications, audio flashcards can provide auditory and visual stimulation while remaining embedded within face-to-face teacher–child interaction. This characteristic may be particularly relevant in early childhood settings where access to sophisticated digital infrastructure is limited.

Research Contributions

The study contributes empirical evidence concerning three distinct child outcomes: animal-sound imitation, letter writing, and letter pronunciation. Differentiating these outcomes matters because it prevents oral-language performance from being treated as equivalent to emergent literacy. The findings indicate that letter pronunciation improved most, followed by letter writing and animal-sound imitation. However, these differences should not be interpreted as evidence that the intervention differentially affected outcomes.

Limitations

The sample comprised only 30 children from a single educational setting. The relatively small and context-specific sample limits the generalizability of the findings to children from other schools, regions, socioeconomic backgrounds, or educational contexts. Replication with larger and more diverse samples is therefore necessary. In addition, the one-group pretest–posttest design cannot rule out maturation, testing effects, or concurrent classroom experiences as explanations for the observed gains. The teacher/researcher guided the activities and recorded children's responses, which may introduce observer bias. The study did not include a delayed posttest to examine whether the gains were retained. In addition, the available report does not specify the number of assessment items, maximum scores, evidence of validity, or inter-rater reliability, preventing an independent evaluation of measurement quality.

Suggestions

Future research should strengthen the methodological design by incorporating a control or comparison group, validated outcome measures, and a delayed posttest. A quasi-experimental design comparing audio-integrated flashcards, conventional visual flashcards, and teacher-led activities without flashcards would be particularly informative. Such a design could help determine whether improvements are attributable to the flashcard format generally or to the addition of auditory features specifically.

CONCLUSION

This study found consistent improvements in children's performance following participation in audio-integrated flashcard activities across animal-sound imitation, letter writing, and letter pronunciation. Mean scores increased from 9.17 to 12.93, 24.10 to 35.57, and 22.67 to 34.87, respectively, with Wilcoxon signed-rank tests indicating statistically significant pretest–posttest differences across all outcomes ($p < .001$) and large within-group effect sizes ($r = .803$, .817, and .875). The findings suggest that audio-integrated flashcards may provide a simple multimodal instructional resource that combines visual and auditory cues to support children's engagement with oral-language and emerging alphabet-related learning, particularly when implemented through teacher-guided activities. However, these results show significant within-group improvement rather than definitive evidence of a causal intervention effect because the study lacked a control group and included only 30 children from a single educational setting. Future research should therefore use larger, more diverse samples and comparison groups to determine the specific contribution of audio-integrated flashcards to children's oral-language and emergent literacy development.

AUTHOR CONTRIBUTION STATEMENT

Nisrina Khairunnisa: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – Original Draft, Project administration. **Eriqa Pratiwi:** Conceptualization, Methodology, Investigation, Data curation, Writing – Review & Editing, Validation. **Ervin T. Echague:** Supervision, Methodology, Validation, Writing – Review & Editing. **Jerome C. Hilario:** Supervision, Validation, Writing – Review & Editing, Resources.

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