Letter Comes Alive: Enhancing Reading Skills Using Augmented Reality Flashcards in Kindergarten Pupils

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ABSTRACT

The mastery of letter names and sounds is an important foundation for children's early literacy success. However, many kindergarten pupils still struggle with basic reading skills. This study, "Letter Comes Alive: Enhancing Reading Skills Using Augmented Reality Flashcards in Kindergarten Pupils," examined the effectiveness of augmented reality (AR) flashcards in improving early reading skills among non-reader kindergarten pupils. It aimed to explore how interactive tools can support early literacy development. The study used a quasi-experimental design to determine whether augmented reality (AR) flashcards could improve letter-name and sound recognition compared to traditional methods. Guided by theories of constructivist learning theory, experiential learning theory, cognitive theory of multimedia learning, and cognitive load theory. The intervention involved the use of AR flashcards during literacy lessons, in which pupils interacted with animated letters, matched sounds, and simple multisensory activities to support more effective early literacy development. The modified Quick Letter Name Knowledge Assessment and Letter Identification and Sounds Assessment were used for the pretest and posttest assessments to measure kindergarten pupils' progress. The results showed that AR flashcards helped improve recognition of letters and sounds, which increased pupils' engagement, reduced learning difficulty, and encouraged a more positive attitude toward reading. The teachers and kindergarten pupils found that the AR flashcard was acceptable and useful as a teaching tool. The study adds to existing research on the use of AR in education by providing evidence from a local context. This supports the idea that the use of AR flashcards can help teach material that connects traditional and digital learning.

Keywords: augmented reality, early literacy, kindergarten pupils, reading skills, letter-sound recognition

INTRODUCTION

Early literacy provides the foundation for children's ability to recognize letter names and their corresponding sounds, skills that are essential for developing phonemic awareness. On the global scale, UNESCO (2025) reports that nearly 250 million children continue to struggle with basic literacy skills. In the local setting, the Department of Education's Kindergarten Curriculum Guide (KCG) in the Philippines clearly requires that kindergarten pupils demonstrate proficiency in both letter-name recognition and letter-sound recognition; it shows that early literacy is very important in the educational goal. However, the challenges remain, particularly due to limited resources and the need for targeted support for non-reader pupils.

Teachers are increasingly integrating technology to improve early literacy instruction. Digital tools make learning more interactive and engaging for young learners. Among these new innovations, augmented reality (AR) is gaining attention as a promising tool for learning and as the focus of this study. The AR technology covers the digital elements: visuals, animations, and sound in the real world that can be accessed via mobile devices (AIDAR Solutions, 2025). Augmented reality flashcards, according to Wulandari and Hafidah (2025), effectively support learners' early literacy development. The immersive and interactive features of AR can help maintain interest and support better thinking and understanding among young pupils. This feature supports the need for hands-on, interactive activities that match pupils' developmental needs and help address challenges in maintaining attention and improving retention in early literacy learning. The main goal and foundation of this

study is based on the idea that using AR-enhanced flashcards can help improve letter name and letter sound recognition among kindergarten pupils, supporting their early literacy by transforming traditional flashcards into an interactive and multisensory learning tool through animated letters and matching sounds. The approach is expected to be more engaging and effective in supporting early literacy development. The use of AR-enhanced flashcards to improve letter-sound recognition among kindergarten pupils supports faster alphabet learning (Korosodou & Griva, 2024).

Research shows AR increases engagement and improves letter recognition among young learners (Laksana et al., 2025), which is aligned with experiential learning theory, which emphasizes learning through direct engagement (Maulida et al., 2025). A strong case internationally and past studies have shown promising results of the use of augmented reality; however, there is a clear local gap. This constitutes a blind spot in current literature; there is a notable lack of published evidence that validates the effectiveness of this precise intervention model in a local public school setting in the Philippines, particularly focusing on the population of non-reader kindergarten pupils who require targeted intensive support intervention. The research problem that guides this investigation is "How can AR flashcards impact the reading skills of kindergarten pupils?" Using a quasi-experimental design, this research evaluates the effectiveness of AR in improving early literacy outcomes and supporting evidence-based teaching practices. This study is expected to contribute meaningful insights for teachers, curriculum developers, and future researchers by providing evidence on how technology-enhanced instruction can improve foundational literacy skills among early learners in low-resource classrooms while strengthening the relevance of augmented reality-based interventions in early childhood education research in the Philippine context for improved literacy outcomes among learners globally.

METHODOLOGY

Research Design

The study used a quasi-experimental research design to determine the effectiveness of augmented reality (AR) flashcards in enhancing the reading skills of kindergarten pupils. The independent variable of the study was the use of AR flashcards, and the dependent variable was the pupils' reading skills, specifically letter-name and letter-sound recognition. The sample was selected based on pre-test results using the modified Quick Letter Name Knowledge Assessment and the Letter Identification and Sounds Assessment, with the section showing the highest number of non-readers designated as the target group of the intervention. A pre-test and post-test procedure was conducted to measure progress before and after the intervention. The augmented reality flashcards had been systematically embedded into literacy lessons, allowing kindergarten pupils to actively engage with digital representations of letters and their corresponding sounds. After the intervention, the collected data were subjected to statistical analysis to ascertain whether significant improvements in reading skills had occurred. The design also incorporated evaluation of teacher and pupil acceptability, as well as alignment with the Learning Resources Management and Development System (LRMDS) standards.

Respondents

The respondents of the study were kindergarten pupils aged four to five who were enrolled in an integrated public school in Meycauayan, Bulacan, during the academic year 2025–2026. The sample had been drawn from the class section with the highest incidence of non-readers, as identified by pre-test results. The group represented the pupils with the most in need of targeted literacy support, thereby providing a suitable focus for examining the effectiveness of augmented reality flashcards in early reading development.

Instrument

The study used a modified literacy assessment to measure kindergarten pupils' recognition of letter names and sounds. The instrument was adapted from the Quick Letter Name Knowledge Assessment (Tortorelli et al., 2017) and supplemented with the sound-recognition component from the Letter Identification and Sounds Assessment (2020) developed by Literacy Resources, Inc. The item from the assessment required the pupils to identify letters and produce the corresponding sounds. The instrument was administered as both a pre-test and a post-test, allowing comparison of baseline and post-intervention performance.

Procedure

The process of collecting data involved gaining the necessary authorization through the preparation and sending of a letter requesting permission to the administration of one integrated school in Meycauayan, Bulacan, which subsequently facilitated the process of collecting data at times suitable for the learners, with emphasis on assessing their language literacy level. The collection of primary data entailed getting direct readings about the learners' reading abilities in order to assess the impact of the AR flashcards application in classroom learning. Confidentiality was ensured throughout the process, as participants remained anonymous while only results were recorded. The data collected was analyzed using descriptive statistics, whereby descriptive measures such as mean, frequency, and percentage were used to describe the literacy level of the learners, and inferential statistics using the paired t-test were used to show any significant differences in the performance of learners in the pretest and posttest. Reliability was ensured through consistency in administering reading tests and the use of the intervention, while validity was ensured by making sure that the assessment tools used met the curricular standards.

RESULTS AND DISCUSION

Part I. The Level of Reading Skills Before the Use of AR Flashcards.

Out of 19 pupils, 11 (57.89%) were classified as non-readers, with a mean score of 1.21 and SD = 0.82. This indicates limited recognition of letters and sounds. Three pupils (15.79%) were emerging readers, mean = 3.22, SD = 0.35, showing some progress with consistent performance. Five pupils (26.32%) were on-track readers, mean = 5.27, SD = 1.57, reflecting stronger literacy readiness but with greater variability.

Table 2. Distribution of Kindergarten Pupils According to Reading Level Before Using AR Flashcards (Pre-Test Results)

Reading Level	Frequency	Percentage	Mean	SD
Non Reader	11	57.89%	1.21	0.82
Emerging Reader	3	15.79%	3.22	0.35
On Track Reader	5	26.32%	5.27	1.57
Overall	**19**	**100%**		

Part II. The Key Features of an Effective AR Flashcard Design.

Content

The AR flashcards aligned with the DepEd MATATAG Kindergarten Curriculum Guide (2023), focusing on phonological awareness and letter-sound recognition. Using the Artivive application, each scanned letter animates and produces its phonetic sound. This dynamic, multisensory approach connects abstract symbols with accurate sounds.

Studies cited in the document (Revati, 2024; Castor & Buenviaje, 2024; Faunillan, 2023) confirm that digitized and multisensory materials improve phonemic awareness and comprehension. The flashcards provided structured letter-sound relationships, supporting foundational literacy skills.

Design

Figures 2–4 illustrate the flash cards' underwater theme with color-coded distinctions: vowels in blue and consonants in red. This design followed DepEd's LRMDS and curriculum standards.

Figure 2. The Design and Sample of AR Flashcard: Title

Figure 3. The Design and Sample of AR Flashcard: Vowels

Figure 4. The Design and Sample of AR Flashcard: Consonants

Color cues improved recognition and memory (Daengku, 2022), while thematic visuals supported motivation and retention (Mayer, 2005; Ceken & Taskin, 2002). The design also integrated aesthetic development, encouraging creativity alongside literacy.

Sound

Sound integration allowed pupils to hear phonetic pronunciations upon scanning. This reinforced phonological awareness, consistent with the DepEd MATATAG Curriculum (2024).

Repeated practice supported experiential learning (Kolb, 1984; McLeod, 2025). Mayer's Cognitive Theory of Multimedia Learning (2005) emphasized combining audio and visuals for stronger memory associations.

Part III. Integration of AR Flashcards in Teaching

Figure 5 illustrates an alphabet intervention using AR flashcards. Teachers incorporated them into guided practice activities such as the following:

- Showing flashcards randomly for pupils to identify letters and sounds.
- Allowing pupils to scan flashcards themselves for interactive engagement.

Objectives included identifying letters A–Z, producing initial sounds, and correctly saying letter names. Integration aligned with Piaget's constructivist theory (1936), emphasizing active knowledge construction.

The flashcards reinforced competencies in alphabet knowledge and phonological awareness per the MATATAG curriculum, ensuring structured literacy experiences

Figure 5. Alphabet Intervention Using Augmented Reality (AR) Flashcard

Part IV. Level of Reading Skills among Kindergarten Pupils after using the AR flashcards.

Table 3. Distribution of Kindergarten Pupils According to Reading Level After Using AR Flashcards (Post-Test Results)

Reading Level	Frequency	Percentage	Mean	SD
Non Reader	4	21.05%	1.63	0.44
Emerging Reader	4	21.05%	3.04	0.39
On Track Reader	11	57.89%	6.79	0.71
Overall	**19**	**100%**		

Post-test results showed improvement: non-readers decreased to 4 pupils (21.05%), emerging readers increased to 4 pupils (21.05%), and on-track readers rose to 11 pupils (57.89%). Mean scores improved across groups, with tightly clustered SD values indicating consistent performance.

The findings validated the effectiveness of AR flashcards in enhancing literacy readiness. Related studies (Korosidou et al., 2024; Al-Hunaiyyan et al., 2021) confirmed similar improvements in alphabet knowledge and recall using AR interventions.

Part V. The Level of Reading Skills After the Use of Augmented Reality Flashcards

Table 4. Significant Difference in the Reading Skills of Kindergarten Pupils after the Use of AR Flashcards

Reading Status	Mean Difference	t-value	df	p-value	Cohen's d	Decision
Non Reader	+0.36	-1.73	13	0.05	-1.01	Reject H_0
Emerging Reader	-0.18	0.63	5	0.28	0.48	Fail to Reject H_0
On Track Reader	+1.52	-2.73	14	0.01	-1.47	Reject H_0

The results showed that using AR flashcards improved kindergarten pupils' reading abilities in a statistically significant way. The success of the intervention was demonstrated by the post-test findings that revealed improved performance in letter name and sound recognition as compared to pre-test scores. The interactive and interdisciplinary aspects of AR, which promote improved engagement and cognitive processing, are responsible for this enhancement. The findings confirm that augmented reality flashcards are a useful tool for improving early literacy abilities.

Part VI. The Level of Acceptability of Teachers and Pupils on the AR flashcards

Table 5. Acceptability Level of AR Flashcards among Kindergarten Teachers

Indicators	Mean	SD	Description	Interpretation
1. AR Flashcards make learning more fun as it unlocks a learning difficulty among pupils.	5.00	0.00	Strongly Agree	Very Acceptable
2. AR Flashcards help children understand basic literacy concepts.	5.00	0.00	Strongly Agree	Very Acceptable
3. AR Flashcards serve as manipulatives that help pupils make physical representations of abstract ideas.	5.00	0.00	Strongly Agree	Very Acceptable
4. AR Flashcards are easy to use.	5.00	0.00	Strongly Agree	Very Acceptable
5. AR Flashcards are easily appropriate to the level of the pupils.	5.00	0.00	Strongly Agree	Very Acceptable
6. AR Flashcards promote active participation.	4.86	0.38	Strongly Agree	Very Acceptable
7. AR Flashcards consist of various functions in teaching literacy and they are well integrated.	5.00	0.00	Strongly Agree	Very Acceptable
8. AR Flashcards can be used everyday in teaching literacy.	4.71	0.49	Strongly Agree	Very Acceptable

9. I would recommend this AR Flashcards to my coteachers to use for teaching literacy.	5.00	0.00	Strongly Agree	Very Acceptable
10. AR Flashcards consist of student-centered activities.	5.00	0.00	Strongly Agree	Very Acceptable
Overall	**4.96**	**0.08**	**Strongly Agree**	**Very Acceptable**

Table 6. Acceptability Level of AR Flashcards among Kindergarten Pupils

Indicators	**Mean**	**SD**	**Description**
1. Are you satisfied with the use of AR Flashcards?	2.00	0.00	Highly Positive
2. Did you recognize the letters from A-Z / a-z?	2.00	0.00	Highly Positive
3. Did you learn about upper case letters / big letters?	1.95	0.23	Highly Positive
4. Did you learn lower case letters / small letters?	1.95	0.23	Highly Positive
5. Were you able to write the letters using the cards?	1.47	0.51	Moderately Positive
6. Is it enjoyable to use the AR Flashcards?	2.00	0.00	Highly Positive
7. Did you identify the letters using the AR Flashcards?	2.00	0.00	Highly Positive
8. Is it fun to use the cards for identifying objects?	1.58	0.51	Moderately Positive
9. Did you enjoy using the AR Flashcards?	2.00	0.00	Highly Positive
10. Is it easy to use the cards even when you're alone?	1.84	0.37	Highly Positive
Total	**1.88**	**0.19**	**Highly Positive**

Teachers reported that the AR flashcards are effective in enhancing learner engagement, facilitating instruction, and supporting differentiated teaching strategies. The integration of interactive digital elements was perceived as beneficial in addressing diverse learning needs and maintaining pupils' attention during literacy activities.

From the pupils' perspective, the AR flashcards contributed to a more engaging and enjoyable learning experience. The integration of animations and audio elements created an interactive environment that encouraged participation and sustained interest. This increased level of engagement is particularly important in early childhood education, where motivation plays a critical role in learning acquisition.

The findings reveal a high level of acceptability of AR flashcards among both teachers and pupils, indicating the practicality and relevance of the material in a classroom setting. The AR flashcards' overall acceptability shows that the content is both pedagogically good and easy to utilize. These results demonstrate AR technology's potential as a realistic and successful addition to traditional teaching methods in early literacy education.

Part VII. The Evaluation of AR flashcards based on the LRMDS Standard

Table 7. The Content Validation Result of the Expert: Factor A. Content

Indicators	**Mean**	**SD**	**Description**	**Interpretation**

1. Content reinforces/ enriches/leads to the learning competencies for the level and subject it was intended.	4.00	0.00	Very Satisfactory	Very Acceptable
2. Material has the potential to arouse interest of the target users.	4.00	0.00	Very Satisfactory	Very Acceptable
3. Facts are accurate.	4.00	0.00	Very Satisfactory	Very Acceptable
4. Information provided is up-to-date.	4.00	0.00	Very Satisfactory	Very Acceptable
5. Visuals are relevant to the text.	4.00	0.00	Very Satisfactory	Very Acceptable
6. Visuals are suitable to the age level and interests of the target user.	4.00	0.00	Very Satisfactory	Very Acceptable
7. Visuals are clear and adequately convey the message of the subject or topic.	4.00	0.00	Very Satisfactory	Very Acceptable
8. Typographic layout / design facilitates understanding of concepts presented.	4.00	0.00	Very Satisfactory	Very Acceptable
9. Size of the material is appropriate for use in school.	4.00	0.00	Very Satisfactory	Very Acceptable
10. Material is easy to use and durable	4.00	0.00	Very Satisfactory	Very Acceptable
Overall	**4.00**	**0.00**	**Very Satisfactory**	**Very Acceptable**

The evaluation of the AR flashcards based on the Learning Resources Management and Development System (LRMDS) standards indicates that the material meets established criteria for quality educational resources. In terms of content, the flashcards were found to be accurate, developmentally appropriate, and aligned with the domain of letter name and sound recognition. The results of the evaluation underscore the potential of AR flashcards as a high-quality instructional material that aligns with national standards and supports innovation in early childhood literacy instruction.

CONCLUSION

This study showed that Augmented Reality (AR) flashcards significantly improved kindergarten pupils' ability to recognize letter names and sounds. The findings concluded that the intervention process enhanced the kindergarten pupils' letter name and sound recognition. The pre-test and post-test outcomes confirmed the scores, which show the effectiveness of augmented reality (AR) flashcards in strengthening early literacy among the non-readers kindergarten pupils. Beyond the quantitative improvements, AR flashcards transformed literacy into an interactive and motivating experience that reduces the risks of long-term reading difficulties. For teachers and schools, the study offered practical, evidence-based tools for differentiated instruction, highlighting how AR can help close literacy gaps in under-resourced settings and strengthen early childhood learning outcomes. The positive results of the success of augmented reality flashcards highlight the potential of integrating interactive technology into early childhood education. Policymakers and curriculum developers should consider including well-designed AR flashcards in literacy programs. Teachers need ongoing training and easy access to these tools so they can build classrooms that are more engaging, inclusive, and supportive of every pupil's growth.

RECOMMENDATIONS

This study highlights the importance of thoughtfully designed interactive tools in strengthening early literacy among kindergarten pupils. For future research should widen to include other domains of literacy while also tracking the long-term effects of AR interventions through comparative work, as well as closer attention to the role of home literacy environments to add valuable insight. In practice, teachers are encouraged to integrate AR flashcards to support phonemic awareness and letter-sound recognition for this to continue to succeed, schools must provide meaningful training and for the curriculum developers should ensure that the content remains high-quality and relevant. At every time, to address resource gaps so that children from all backgrounds can benefit equitably from AR flashcards as a tool. These steps can help make AR flashcards not only effective but also accessible, ensuring that innovation truly serves every kindergarten pupil.

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