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Utilizing of Augmented Reality (AR)-Based Flashcards Media on Increasing Vocabulary and Language Understanding in Early Children

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Abstract

Background of study: Utilizing contemporary technology in the classroom has many advantages in the field of early childhood education. The usage of Flashcards based on Augmented Reality (AR) is one of the most recent breakthroughs. this approach can significantly enhance learning engagingly and enjoyably.
Aims and scope of paper: The purpose of this study is to investigate an effect after applying AR based flashcards on language development in early childhood.
Methods: Participants This study was conducted as a quantitative experimental method one group pretest–posttest design, and 14 children were included in the analysis. Data analysis was performed with one-sample t-tests.
Result: The result show that the avarege pre-test (Before treatment) language ability of 11.21 was statistically much lower than the test score (20), t value = -27.664, P value=0.000. The item mean score at posttest was 22.21, which was significantly higher than the test score (t = 4.387, p-value = 0.001). There was a significant difference before and after therapy, according to the 95% confidence interval (CI).
These findings suggest that using flashcards based on augmented reality can effectively enhance children's language abilities. This notable distinction suggests that flashcards based on augmented reality successfully enhance kids' vocabulary acquisition.
Conclusion: Thus, this study comes to the conclusion that flashcards based on augmented reality (AR) have a beneficial effect on the vocabulary acquisition of young children, making them a promising new learning aid for enhancing language proficiency. According to the study's findings, early childhood vocabulary and language understanding are greatly enhanced by augmented reality (AR)-based flashcards.

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INTRODUCTION

In the world of early childhood education, the use of modern technology in the learning process can provide numerous benefits. One of the latest innovations is the use of Augmented Reality (AR)-based Flash Cards (Sari et al., 2024) This method not only engages children but can also significantly enhance learning in an interactive and fun way. AR-based flash cards combine visual and digital elements to create a more immersive learning experience, which is particularly suitable for children aged 5-6, or Group B (Aditama et al., 2023).

Augmented Reality (AR) is a technology that allows the addition of digital information, such as images, text, or animations, into a real-world view through devices such as tablets or smartphones (Agustine et al., 2023). AR enriches the learning experience by providing a visual context that cannot be achieved through conventional media alone. In language learning, AR can make vocabulary and concepts more tangible and easier for children to understand. For example, by using AR-based flash cards, children not only see images or words but can also interact with these elements in a three-

dimensional format, which makes the information more engaging and easier to remember (Bauer, 2023)

Vocabulary is a crucial part of a child's language comprehension. Good vocabulary skills support more effective communication skills and facilitate future reading and writing development (Aryadari & Sari, 2024) At the age of 5-6, children are at a crucial stage in their language development. At this stage, they quickly absorb new vocabulary and use it in everyday communication. Engaging learning methods, such as AR-based flash cards, can accelerate this process in a fun and stimulating way. AR-based flash card learning utilizes technology to add elements such as interactive animations and audio, which can help children better understand word meanings. Research shows that AR can increase student engagement and learning effectiveness in ways that traditional methods cannot. AR provides more dynamic visualizations, enabling children to see and interact with vocabulary in a more realistic context. For example, a flash card with a picture of an animal can be complemented with animations showing the animal moving or making sounds, which can strengthen children's understanding of the word (Ayuna et al., 2022).

By integrating AR-based flash cards into kindergarten learning, it is hoped that there will be a significant increase in children's vocabulary and language comprehension. Interactive and engaging learning experiences can help children more easily understand and remember new vocabulary. Good language development at an early age is crucial for future academic and social success. By using innovative learning media such as AR-based flash cards, it is hoped that children can learn in a more fun and engaging way. This will help increase their engagement in the learning process and strengthen their understanding and use of new vocabulary in everyday life. One major problem is the traditional learning approach. This method tends to be less engaging, leaving children bored and disengaged. Research by Cahya & Sari (2023) indicates that less interactive methods can reduce children's motivation to learn a language. Furthermore, the lack of variety in teaching methods can lead to monotony Dinayusadewi et al. (2020) suggest that the use of innovative media such as AR can capture students' attention and increase their engagement in the learning process.

The use of AR-based flash cards also allows teachers to create more personalized and adaptive learning experiences. With the interactive features offered, children can learn according to their own pace and learning style. For example, children who are more visual can more easily understand vocabulary through 3D images displayed in AR, while children who tend to have a kinesthetic learning style can engage in physical activities related to the vocabulary. According to Febriza et al. (2021) AR can enhance the learning experience and allow for adjustments to students' different learning styles.

This study seeks to examine the influence of using AR-based flashcards on enhancing the vocabulary and language comprehension of Group B children at Al-Mubarak Integrated Islamic Kindergarten, Jember. This study will involve measurements before and after the application of the AR method to assess its impact on vocabulary mastery and overall language skills The integration of AR technology into learning media is expected to offer a more effective and engaging alternative for early childhood education while also supporting the advancement of innovative and adaptive instructional practices.

METHOD

The study used a quantitative experimental method. Quantitative research is a type of research activity that is systematic, planned, and clearly structured from the beginning to the end of the study (Sugiayono, 2020).

Research Design

In this quantitative study, a one-group pretest and posttest design was used to assess the effectiveness of the treatment. One Group Pretest-Posttest Design is a quasi-experimental research design used to measure the effect of a treatment on one group of subjects by comparing the results before and after the treatment. One group pretest–posttest design was chosen with several considerations, including the limited number of research subjects, which is common in early childhood education research, ethical considerations, because not all children can be excluded from the use of innovative learning media, suitability with the research objectives, namely to see changes

in children's abilities before and after the use of AR media, ease of implementation in early childhood education environments that have limited time and resources. Limitations of This Research Design, while this design was able to demonstrate changes before and after treatment, the study openly acknowledged methodological limitations, particularly the lack of a control group. Without a control group, it is not entirely possible to determine that the improvement in children's learning outcomes was solely due to the use of AR-based flashcards. By comparing the pretest and posttest results of the group, researchers were able to assess the effect of AR-based flashcard media in improving children's language skills (Indahsari & Sumirat, 2023) This study was designed to enrich children's learning experiences through interactive and visual media, and was expected to positively impact their language skills (Zahroni & Mahariani, 2021) This method serves as a basis for comparison to evaluate the extent to which AR-based flashcard media provides additional benefits compared to traditional approaches. The following table shows the research design used:

Table 1. One Group Pretest/Posttest

Pretest	Treatment	Posttest
O1	X	O2

Information:
01: Pretest Scores of Vocabulary Improvement and Language Comprehension
X: AR-based flash card
02: Posttest Scores of Vocabulary Improvement and Language Comprehension.

Research Subjects

The population of this study includes all research subjects. The population and sample of this study included all children in group B (aged 5-6 years) with a total of 14 children, consisting of 6 boys and 8 girls at the Al-Mubarak Integrated Islamic Kindergarten in Jember. This population was selected because group B is in a period of vocabulary and language development that is very important for preparation for basic education. According to Sugiayono (2020) purposive sampling is a sampling method with special considerations. This sample selection was carried out to ensure that the children studied had characteristics that align with the research objectives, namely to measure the effect of using AR-based media on improving children's vocabulary and language comprehension.

Research Instruments

To assess how AR-based flash cards contribute to enhancing children's vocabulary and language comprehension, this study used an observation instrument designed for teachers. The purpose of the observation was to gather information regarding teachers' experiences and assessments of the application of AR-based flashcards in the learning process. The following is the observation sheet and its assessment criteria.

Table 1. Observation sheet for teachers

No.	Question	Indicator	Grid	Assessment criteria
1	How often do you use AR-based flashcard media in learning?	Frequency of Use of AR-based flashcard media	Measuring how often teachers use AR-based flashcard media in learning activities	- Never: 0 points - Sometimes: 1 point - Frequently: 2 points - Always: 3 points
2	How do you assess the level of student engagement when using AR-based flash card media?	Student Engagement Level	Measuring the level of student engagement when using AR-based flashcard media in learning	- Very Low: 1 point - Low: 2 points - Medium: 3 points - High: 4 points
3	Do you feel that AR-based flash	Students' Understanding	Measuring teachers' perceptions of the	- Strongly Disagree: 1 point

	card media helps in improving students' understanding of new vocabulary?	of New Vocabulary	effectiveness of AR-based flashcard media in improving students' understanding of new vocabulary.	- Disagree: 2 points - Neutral: 3 points - Agree: 4 points - Strongly Agree: 5 points
4	What are the main obstacles you face in using AR-based flashcard media in learning?	Obstacles to Using AR-Based flashcard media	Identifying the main obstacles faced by teachers in using AR-based flashcard media	- Technical limitations: 1 point - Lack of training: 2 points - Integration difficulty: 3 points - No significant obstacles: 4 points - Others: 1-4 points (depending on the explanation)
5	How do you rate the ease of use of AR-based flashcard media for students in the learning process?	Ease of Use of AR-based flashcard media for Students	Measuring the ease of use of AR-based flashcard media for students in the learning process	- Very Hard: 1 point - Difficult: 2 points - Fairly Easy: 3 points - Easy: 4 points - Very Easy: 5 points
6	How do students respond to learning using AR-based flashcard media?	Student Responses to Learning with AR-Based flash cards	Measuring student responses to the use of AR-based flash card media in learning	- Strongly Dislike: 1 point - Dislike: 2 points - Likes: 3 points - Realy Like: 4 points

Table 2. Vocabulary observation sheet

No.	Question	Indicator	Grid	Assessment criteria
1	Name the ne vocabulary that wa taught this week.	Ability to remember new vocabulary	Measuring students' ability to remember and name new vocabulary taught during the week	- 0 vocabulary: 0 points - 1 vocabulary: 1 point - 2 vocabulary: 2 points - 3 or more vocabulary words: 3 points
2	Make simple sentences using the new vocabulary.	Ability to make sentences	Measuring students' ability to use new vocabulary to create simple, appropriate and relevant sentences.	- Irrelevant or incorrect sentences: 0 points - Simple but unclear sentence: 1 point - Clear and precise sentences: 2 points - Creative and appropriate sentences: 3 points
3	Arrange the letters to make a word.	Ability to compose letters	Measuring students' ability to arrange letters into correct words	- Inaccurate: 0 points - Not quite right: 1 point - Exactly: 2 points - Very accurate: 3 points

Table 3. Language Comprehension Observation Sheet

No.	Question	Indicator	Grid	Assessment criteria
1	Follow several commands given simultaneously.	Ability to follow instructions	Measuring students' ability to follow instructions given simultaneously	- Not following orders: 0 points - Partially following instructions: 1 point - Follow all commands: 2 points
2	Answer the following complex question: "What do you do if it rains?"	Ability to answer complex questions	Measures students' ability to provide relevant and complete answers to complex questions.	- Irrelevant or incomplete answer: 0 points - Partially relevant answer: 1 point - Relevant and complete answer: 2 points
3	Make simple sentences using the new vocabulary.	Ability to make simple sentences	Measuring students' ability to use new vocabulary to create simple, appropriate and relevant sentences.	- Irrelevant or incorrect sentences: 0 points - Simple but unclear sentences: 1 point - Clear and precise sentences: 2 points - Creative and appropriate sentences: 3 points
4	Make sentences from the given pictures.	Ability to compose sentences from pictures	Measuring students' ability to construct relevant sentences based on the images provided	- Irrelevant or incorrect sentences: 0 points - Simple but unclear sentence: 1 point - Clear and precise sentences: 2 points - Creative and appropriate sentences: 3 points

Implementation of Learning Using AR-Based flash cards

Table 4. Learning Implementation

No.	Step	Activity	Objective
1	Preparation	- AR-Based flash cards.	- Ensure all tools and media are ready to use.
		- Set up AR devices (tablets/smartphones).	- Create a learning environment that supports the use of Augmented Reality (AR).
		- Prepare the classroom with the necessary equipment.	
2	Media Introduction	- Introducing AR-based flash cards to students.	- Educate students on how to use AR-based flash cards .
		- Explains how to use AR devices and learning media.	- Increase student enthusiasm and engagement.
3	Use of Flash Card Media in Learning	- Using AR-based flash cards to introduce new vocabulary.	- Improve vocabulary understanding through visuals and interactions.

		- Displays animations relevant to vocabulary.	- Help students remember vocabulary in a fun way.
		- Ask questions and ask students to interact with the media.	
4	Exercises and Activities	- Conduct group activities using AR-based flash cards.	- Apply vocabulary in a broader context.
		- Create games or exercises that involve the vocabulary being learned.	- Improve speaking skills and language comprehension.
		- Facilitate students to use vocabulary in sentences.	
5	Evaluation and Assessment	- Conducting assessments of students' vocabulary understanding through tests and observations.	- Measuring the effectiveness of AR-based flash cards in improving vocabulary.
		- Collect feedback from students about their experiences with Augmented Reality (AR) media.	- Assess student engagement and motivation.
6	Reflection and Adjustment	- Analyze assessment results and feedback.	- Improve and optimize the use of AR media.
		- Make adjustments to the use of AR-based flash cards based on evaluation results.	- Adjust learning methods to improve learning outcomes.
		- Plan improvements for the next learning session.	

Data collection technique

The quality of research results is highly dependent on the accuracy of the data collected. The accuracy of the data itself depends on the quality of the data collection instruments (Sugiayono, 2020). The data collection method in this study involved three main techniques: observation, documentation, and testing through a pretest, treatment, and posttest. By using these three methods, the study aimed to obtain comprehensive and accurate data on the effectiveness of using AR-based flash cards in improving children's vocabulary and language comprehension.

Data analysis

Data analysis is a crucial step in research, aiming to process the collected data to answer the research questions. In this study, data analysis was conducted using appropriate statistical techniques and SPSS (Statistical Product and Service Solutions) software.

Hypothesis Test

Hypothesis testing is conducted to verify initial assumptions regarding the influence of the independent variable on the dependent variable. In this study, the hypothesis testing was conducted using a One Sample T-Test. The One Sample T-Test is a quantitative research design used to test whether a sample mean differs significantly from a specific value (a hypothetical population). In a research context, it helps determine whether the data taken from the sample supports or rejects the proposed hypothesis.

RESULTS AND DISCUSSION

Results

Instrument Validity Test

According to (Zahroni & Mahariani, 2021) instrument validity testing is a critical stage in the research processto ensure that the data obtained truly reflects the variables to be measured. High instrument validity will provide stronger confidence in the research results and ensure accurate interpretation. Therefore, it is important for researchers to conduct instrument validity testing before proceeding to the data analysis and interpretation stages of the research results, so that the measuring instrument used is in accordance with the research objectives and is able to provide valid and relevant data. Based on the findings of the language validity assessment, it can be inferred that the variables P1, P2, P3, and P4 exhibit significant positive correlations with one another. The correlation between P1 and P2 is 0.873, between P1 and P3 is 0.849, between P1 and P4 is 0.948, all significant at the 0.01 level. The same thing also applies to the correlation between P2 and P3 (0.908), P2 and P4 (0.970), and P3 and P4 (0.955), all significant at the 0.01 level.

These results indicate that the instrument used to measure the language variables (P1, P2, P3, and P4) has good validity. The strong correlation between these variables indicates consistency and appropriateness between the questions or items related to the language aspects being measured. Therefore, the results of this validity test support the validity of the instrument used to measure the language variables in this study and provide confidence that the instrument is appropriate for the research objectives.

Instrument Reliability Test

Table 6. Reliability Test Results of AR-Based flashcards Media

Cronbach's Alpha	N of Items
0.94	6

Table 7. Item-Total Statistics AR-based flashcards

	Scale Mean if Item Deleted	Item Deleted	Correlation	Deleted	Decision
S1	30.79	12.181	0.873	0.399	Reliable
S2	30.14	14.901	0.698	0.513	Reliable
S3	29.64	12.555	0.845	0.418	Reliable
S4	30.14	29.363	-0.964	0.902	Reliable
S5	29.71	12.835	0.866	0.425	Reliable
S6	16.71	4.835	1	0.094	Reliable

The reliability test results for the AR-based flash card media showed a Cronbach's Alpha value of 0.941, indicating an excellent level of internal consistency. In general, a Cronbach's Alpha value above 0.7 is considered reliable, and a value above 0.9 indicates very high reliability. Although the instrument is generally reliable, the item-total analysis revealed several important findings. For example, items S1, S2, S3, and S5 have a high Corrected Item-Total Correlation, indicating a positive contribution to reliability. However, item S4 showed a negative correlation (-0.964), indicating a mismatch with other items and could decrease reliability if retained. Additionally, item S6 showed a perfect correlation (1.000) but overall decreased the Cronbach's Alpha if removed. Therefore, although this instrument can be considered reliable overall, item S4 needs to be reviewed and possibly removed to improve the quality and consistency of the instrument.

Table 8. Item Statistics Vocabulary Reliability Test

		P1	P2	P3	Decision
P1	Pearson Correlation	1	.830**	.953**	Reliable
	Sig. (2-tailed)		.000	.000	
	N	14	14	14	
P2	Pearson Correlation	.830**	1	.960**	Reliable
	Sig. (2-tailed)	.000		.000	
	N	14	14	14	
P3	Pearson Correlation	.953**	.960**	1	Reliable
	Sig. (2-tailed)	.000	.000		
	N	14	14	14	

The Reliability Statistics revealed a Cronbach's Alpha score of 0.914 across three items, indicating outstanding internal consistency and demonstrating that the instrument possesses a high level of reliability. A Cronbach's Alpha value above 0.7 is generally considered reliable, and a value of 0.914 indicates that this instrument is very consistent in measuring the same construct. In the Correlations table, all Pearson Correlations between items P1, P2, and P3 are very high, namely 0.830 between P1 and P2, 0.953 between P1 and P3, and 0.960 between P2 and P3. All of these values are significant at the 0.000 level, indicating that these items have a very strong and consistent correlation with each other. Overall, this instrument can be considered reliable with strong correlations between its items, which supports the consistency and reliability of the measurement.

Table 9. Item-Total Statistics Language Comprehension

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Decision
P1	17.21	22.951	.925	.832	Reliable
P2	16.36	21.940	.955	.814	Reliable
P3	16.07	23.918	.938	.846	Reliable
P4	9.93	8.225	1.000	.952	Reliable

Reliability Statistics showed a Cronbach's Alpha of 0.878 with 4 items, indicating that this instrument has good internal consistency. This value exceeds the threshold of 0.7, indicating adequate reliability. All these values indicate that each item correlates well with the total score and contributes positively to the instrument's reliability. However, item P4 has a perfect Corrected Item-Total Correlation (1.000) and the highest Cronbach's Alpha if Item Deleted (0.952), indicating that deleting P4 would not improve the instrument's reliability. In other words, although all items are found to be reliable, P4 performs exceptionally well in its contribution to the overall reliability.

Table 10. The Effect of Using AR-Based flashcards on Vocabulary Improvement

One-Sample Test						
	Test Value = 20					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Vocabulary Pretest	-13.371	13	.000	-5.357	-6.22	-4.49
Vocabulary Post Test	8.923	13	.000	7.000	5.31	8.69

In the table, the t-value = -13.371, with a p-value = 0.000 (< 0.05). This shows that the average pretest score (14.64) is significantly lower than the test score (20). Then, in the posttest results, the t-value = 8.923, with a p-value = 0.000 (< 0.05). This shows that the average posttest score (27.00) is significantly higher than the test score (20).
This indicates that implementing AR-based flashcards contributes to enhancing the vocabulary of group B children at Al-Mubarak Integrated Islamic Kindergarten in Jember. This can be seen from the significant value in the table, which shows that the final test or posttest score is 0.000, which is lower than the p-value (<0.05).

Table 5. The Effect of Using AR-Based flashcards on Language Comprehension

One-Sample Test						
	Test Value = 20					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Language Comprehension Pretest	-27.664	13	.000	-8.786	-9.47	-8.10
Posttest Language Comprehension	4.387	13	.001	2.214	1.12	3.30

According to the table above, before administering the treatment, the researcher conducted a pretest on the language comprehension of Group B children at Al-Mubarak Integrated Islamic Kindergarten, Jember. The average pretest score was -27.664. A negative value on the average score indicates that the sample average was below the test.

After administering the treatment using AR-based flashcards media, the average score on the final test (posttest) was 4.387. With this value, it can be seen that the final test score (posttest) is higher than the initial score (pretest). And the significant value in the table shows (0.001) or lower than the significant value (<0.05) on the posttest, indicating that there is an effect of the use of AR-based flashcard media on the language comprehension of group B children at Al-Mubarak Integrated Islamic Kindergarten Jember.

Discussion

The Use of AR-Based Flashcards Media to Improve Vocabulary

The results of data analysis using a one-sample t-test analysis indicated that implementing flashcards supported by AR significantly improved children's vocabulary acquisition, as reflected in the F-statistic with a p-value below 0.05. This indicates that children who used AR-based flashcards experienced a greater increase in vocabulary.

The average vocabulary gain in the experimental group was 85% higher. This indicates that AR technology could make vocabulary learning more effective and efficient. The 3D visualizations and animations generated by AR make words easier for children to remember, as they not only see two-dimensional images but also gain a more immersive visual experience (Kamaruddin et al., 2021).

The Use of AR-Based Flashcards Media for Language Comprehension

The integration of AR-based flashcards played a substantial role in enhancing children's language comprehension development. Based on research by Nanda et al. (2022) it was found that children in the experimental group who used AR-based flashcards showed greater improvements in various aspects of Language Comprehension (Tu et al., 2021). Aspects that improved included speaking skills, vocabulary comprehension, and sentence formation abilities. This was measured using statistical significance (<0.05), indicating that these differences did not occur by chance (Nurhaliza et al., 2022).

These findings align with the theory of multimedia learning. This theory states that the use of various types of media, such as visual, audio, and interactive elements, can improve comprehension and retention of information (Rahmawati & Azis, 2023). In the context of AR-based flashcards, this medium provides a more holistic and engaging learning experience. AR-based flashcards combine dynamic visual elements with audio and interactivity, which not only makes learning more engaging but also increases children's involvement (Fitriyah, 2023). By utilizing AR technology, children can see three-dimensional images and animations that clarify the meaning of words or concepts they are learning. This helps them better understand and retain information. For example, when learning new vocabulary, children can see a 3D object that they can rotate and explore, as well as hear the pronunciation of the word. This kind of interactivity can strengthen the connection between words and the concepts they represent, facilitating deeper understanding and longer retention (Pardomuan & Sulistyowati, 2022).

Furthermore, active involvement in learning using AR flashcards can also increase children's motivation. Because AR technology often involves elements of play and fun interactions, children become more motivated to participate in learning activities (Sari et al., 2024). This high motivation, in turn, can improve overall learning outcomes. Furthermore, the use of AR in education allows for the adaptation of learning materials to suit individual children's needs and abilities. By providing a personalized experience, AR can help meet the various learning styles and speeds of children, making learning more effective. Overall, the use of AR flash cards not only improves children's language comprehension but also makes the learning process more engaging and enjoyable. This demonstrates the immense potential of AR technology in education to support children's language development and cognitive skills.

Implications

The findings of this study have important implications for educational practice, particularly in early childhood education. The use of flash cards supported by Augmented Reality (AR) technology can enhance the learning process by making it more engaging and interactive. Unlike traditional flash cards that present information in a static format, AR-based flash cards provide dynamic visual and auditory elements that stimulate children’s curiosity. Through AR interaction, children can observe three-dimensional images, animations, and sounds, which help them better understand vocabulary and language concepts. This interactive learning experience encourages active participation and makes learning more enjoyable, potentially improving children’s retention and comprehension.

Research Contribution

This study contributes to the field of early childhood education by providing empirical evidence on the effectiveness of AR-based flash card media in improving vocabulary mastery and language understanding among early childhood and Kindergarten B students. The findings support the integration of digital and interactive learning media in early childhood classrooms and strengthen previous research indicating that AR technology can enhance motivation, engagement, and active learning experiences in young learners.

Limitations

Despite its contributions, this study has several limitations. The experiment was conducted in only one class with a relatively small population and sample size, which may limit the generalizability of the findings. In addition, the learning content was restricted to the topic of using AR-based flash cards for vocabulary and language understanding. Technical issues, such as limited internet access, also affected the implementation of the AR-based learning activities.

Suggestions

Future research is recommended to involve a larger sample size and multiple schools to improve the generalizability of the results. Further studies could also explore the use of AR-based flash cards for different learning topics and age groups. Additionally, improving technological infrastructure and minimizing internet connectivity issues would help optimize the implementation of AR-based learning media in early childhood education.

CONCLUSION

Based on the analysis results it can be concluded that the use of AR-based flash card media has a significant influence on improving vocabulary and language comprehension in Group B children in kindergarten. Overall, these data indicate that AR-based flash card media is effective in improving language skills, both in terms of vocabulary and language comprehension. This finding suggests that learning innovations that utilize AR technology can serve as a relevant approach to facilitate the development of language abilities in young children.

Drawing on the results and conclusions of this study, several recommendations can be proposed to enhance the effectiveness of AR-based flash cards in supporting children's language learning. To optimize benefits, developers and educators should expand the variety of AR content and adapt materials to children's specific learning needs. Schools and educators are advised to integrate AR-based flash cards into the educational curriculum more broadly. Incorporating this technology as part of a planned teaching strategy can help optimize its use and ensure that students get the maximum benefit from this tool. Additional studies are required to assess the sustained effectiveness of implementing AR flash cards. Studies exploring the lasting impact on children's language skills and comparing them with other learning methods could provide deeper insights into the benefits and limitations of this technology.

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AUTHOR CONTRIBUTION STATEMENT

The Author Contributions Statement should be included at the end of the manuscript before the References. The main author and researcher of the article, E.T; collected information, E.T; created an instrument to measure Vocabulary Improvement and Language Comprehension, E.T; made an evaluation, data processing and article writing, P.H; conducted observations, data management, P.H conducted instrument testing, classical assumption testing and hypothesis testing,

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