Penerbit Akademia Baru

Journal of Advanced Research Design

Journal homepage:
https://akademiabaru.com/submit/index.php/ard
ISSN: 2289-7984

Analysis of the Level of Engagement and Motivation for Early Childhood Sundanese Language Learning with Media Augmented Reality Based Learning

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ARTICLE INFO

Article history:
Received 24 February 2025
Received in revised form 7 March 2025
Accepted 15 July 2025
Available online 11 August 2025

Keywords:
Augmented reality; Sundanese language; early childhood; engagement; motivation

ABSTRACT

Sundanese, as one of the largest regional languages in Indonesia, is facing challenges in maintaining its relevance among the younger generation in the digital era. Research indicates a decline in children's interest in learning Sundanese, which poses a threat to its preservation. This study aims to explore the effectiveness of Augmented Reality (AR)-based learning media in increasing engagement and motivation among early childhood children to learn Sundanese. Using a comparative experimental design with a mixed-method approach, this research involved 30 children aged 4–6 years at KB An Nur Muttaqin. Participants were divided into two groups: one using AR-based learning media and the other using animation videos. Data were collected through pre-tests and post-tests, pictorial Likert scales, structured observations, semi-structured interviews and participatory observation. Results revealed that the AR group showed a significant increase in engagement (mean difference of 3.8) compared to the control group (mean difference of 2.1), with $p<0.001$. Motivation also improved more significantly in the AR group (mean difference of 0.25) than in the animation group (mean difference of 0.23), with $p<0.001$. This study demonstrates the potential of AR technology in revitalizing Sundanese language education for young children. By enhancing engagement and motivation, AR provides an innovative approach to addressing the challenges of regional language preservation. This solution not only supports language learning but also ensures that Sundanese culture and heritage are passed on to future generations in the digital age.

1. Introduction

1.1 Research Background

As one of Indonesia's largest regional languages, Sundanese plays a crucial role in preserving the cultural heritage and identity of its community [1]. Sundanese language indeed serves as a crucial pillar in preserving the cultural heritage and identity of the Sundanese people. Moreover, Sundanese also functions as a unique daily communication tool, rich in local wisdom. However, globalization and

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https://doi.org/10.37934/ard.142.1.3650

modernization have threatened the sustainability of this language, especially among the younger generation. Research by Susanti *et al*., [2] indicates a decline in children's interest in learning the Sundanese language. This trend raises concerns among educators and stakeholders regarding efforts to preserve the Sundanese language and culture. Therefore, an innovative approach is needed in teaching Sundanese language, especially for young children, who are in a critical phase of language development and cultural identity formation.

Augmented Reality (AR) has emerged as a promising technology in the field of education, including language learning [3]. The research conducted by Garzón *et al*., [4] has shown the effectiveness of AR in enhancing student motivation and engagement in the learning process. This technology allows the integration of virtual elements into the real environment, creating a more interactive and engaging learning experience. In the context of Sundanese language learning, AR can be used to visualize abstract concepts, bring folktales to life and present Sundanese culture in a more dynamic way [5]. This has the potential to create a more immersive and engaging learning environment for children, thus increasing their interest in the Sundanese language and culture.

Recent research on the use of AR in language learning shows promising results. A study by Korosidou [6] found that students who used AR applications in foreign language learning showed significant improvements in vocabulary mastery and learning motivation. Meanwhile, Ardila *et al*., [7] reported that the use of AR in English language learning in elementary schools is effective in improving students' comprehension, motivation and engagement. This technology provides a more interesting and interactive learning experience, which in turn can enhance students' learning outcomes [8,9]. These findings indicate the great potential of AR in supporting language learning, including Sundanese. However, further research is still needed to explore the effectiveness of AR in the specific context of Sundanese language learning for young children.

Although several studies have shown the benefits of AR in language learning, there is still a gap in understanding how this technology can be optimized for regional language learning, particularly Sundanese language for young children. The majority of previous studies have focused on foreign or second language learning at higher educational levels. Additionally, there is no comprehensive research analysing the level of engagement and motivation of young children in learning Sundanese language using AR media. This research holds significant importance as it can provide new insights into the effectiveness of AR in supporting the preservation of regional languages and the development of cultural identity in young children. Therefore, the aim of this research is to analyse the level of engagement and motivation of young children in learning Sundanese language using AR-based learning media.

1.2 Literature Review

Teaching regional languages, including Sundanese, faces challenges in remaining relevant and appealing in the digital age. Hidayat *et al*., [10] found a decline in the use of Sundanese among the younger generation in West Java. This indicates the need for innovation in Sundanese language teaching methods, especially for early childhood. Kurniawati *et al*., [11] reported that the vitality of Sundanese in Cianjur City is at level 4 (unsafe) by UNESCO standards. Despite some positive indicators, the decline is particularly evident in intergenerational transmission. Meanwhile, Poetri *et al*., [12] identified the relationship between language attitudes and language choices among Sundanese teenagers, which have significant implications for language preservation. These findings highlight the urgency of developing effective and engaging learning strategies to sustain the interest and involvement of children in learning the Sundanese language.

AR has become a promising technology in language education, offering an innovative approach to enhance the learning experience. Research conducted by Marrahí-Gómez *et al*., [13] found that the use of AR in language learning can improve students' performance and their attitudes towards learning. This research demonstrates the significant potential of AR as an educational tool that can make the language learning process more interactive and enhance student motivation. The research conducted by Simonova *et al*., [14] suggests that AR technology plays a crucial role in enhancing foreign language education, particularly English. The use of this technology can help develop various essential competencies, such as speaking, linguistic, communicative and sociolinguistic skills. Additionally, it can boost students' motivation in learning English by making the process of learning complex grammar and vocabulary more engaging through a more interactive experience. This finding indicates the great potential of AR in enhancing student engagement and motivation in language learning, which can be applied in the context of Sundanese language learning.

The research shows that motivation plays a crucial role in language acquisition. Tsai [15] revealed that the use of AR in English language learning demonstrates a significant improvement in learning performance and intrinsic and extrinsic motivation of learners in using learning materials. They observed that the interactive and visual components of AR create a more engaging and challenging learning environment, thereby promoting active student participation in the learning process. In line with these findings, Khan *et al*., [16] stated that the use of mobile AR applications increases students' learning motivation, particularly in the factors of attention, self-confidence and satisfaction. In the context of Sundanese culture, Yoseptry [17] conducted a study that examined the implementation of Sundanese local cultural wisdom in shaping nationalist character in early childhood at Puji Handayani Kindergarten, Cimahi. The study found that the school has successfully carried out planning and implementation of the learning process, which includes four stages: planting, growing, carrying out and stabilizing. Although it has a positive impact on the formation of children's nationalist character, some challenges were encountered, such as difficulties with the Sundanese language and lack of parental awareness. Using AR in Sundanese language learning can potentially address these challenges by presenting cultural content dynamically and engagingly, thus enhancing student motivation.

Involvement of students in language learning is a key aspect of language acquisition success. Wedyan *et al*., [18] concluded that AR enhances language skills and academic achievement. AR also reduces students' anxiety levels, increases students' creativity and improves student cooperation and engagement. Additionally, students have a positive attitude towards the use of AR in English language learning. These findings have important implications for the integration and development of AR in education. Furthermore, Zikra *et al*., [19] stated that Sundanese language should be taught at an early age, specifically between 0-8 years old, so that children can communicate politely and know how to speak to elders, peers and younger individuals. The lack of Sundanese language usage at home results in first-grade students at SDN 02 Sukapura being less proficient in using Sundanese. Therefore, the authors propose the development of an AR based Sundanese Language Learning Application for Android. Integrating AR into early childhood Sundanese language learning offers great potential to enhance language vitality and learning effectiveness. However, its implementation should be done carefully, considering the local context and supported by an environment that encourages the use of Sundanese in daily life.

Although research on the use of AR in language learning shows promising results, there is still a lack of information in the literature regarding the effectiveness of AR in local language learning, especially for young children. Most studies have focused on foreign or second language learning at higher education levels. According to Di Fuccio *et al.,* [20], the use of AR through the EULALIA application significantly enhances students' cultural knowledge and engagement in language learning

at the university level. The use of game-based and collaborative learning methods through applications like EULALIA can yield better results compared to traditional teaching methods. Zhang *et al.,* [21] argued that AR technology has the potential to significantly enhance English language learning experiences by fostering more interactive, collaborative and motivating learning environments. The implementation of AR in language education should consider relevant learning theories to optimize academic outcomes and future pedagogical practices. Additionally, there has been no comprehensive research analysing the use of AR for Sundanese language learning in young children. Therefore, further research is needed to explore the potential of AR in enhancing the engagement and motivation of young children in learning the Sundanese language, as well as its impact on the preservation of Sundanese language and culture.

2. Methodology

2.1 Participants and Context

2.1.1 Participants

This study involved a total of 30 early childhood children aged 4 to 6 years from KB An Nur Muttaqin. Although the sample size in this study is relatively small, consisting of 30 children, the experimental design with randomly assigned balanced groups ensures good internal validity for measuring the impact of AR on Sundanese language learning. To determine the research sample, the researchers used the convenience sampling method. This method involves selecting participants based on their availability and willingness to participate [22,23]. Convenience sampling was chosen for its practicality, allowing for quick data collection from respondents who were easily accessible without strict requirements for probability or representativeness of the entire population.

In the context of this study, KB An Nur Muttaqin was selected as the research site because it provided a single location that was easily accessible to the researchers. This approach was particularly appropriate given the variation in respondents' willingness to participate, allowing the researchers to adjust the sample size according to the availability of respondents in the field. To enhance generalizability, future research will involve larger and more diverse samples, including populations from various educational institutions and geographic regions, to ensure the relevance of the results in a broader context.

The sample comprised 17 girls and 13 boys, who were randomly divided into two balanced groups, each consisting of 15 children. The randomization process was conducted using a simple lottery method to ensure unbiased group allocation. Each participant’s name was written on a slip of paper and randomly drawn to assign them alternately to Group A or Group B. This process was repeated until both groups had an equal number of participants (15 children each).

To control for potential confounding variables, a short parental questionnaire was administered prior to group assignment. The questionnaire collected information about participants’ exposure to the Sundanese language at home and in their daily environment, as well as the socio-economic background of their families. The data from the questionnaire were used after the randomization process to validate whether the groups were balanced in terms of these variables. If significant imbalances were found, minor adjustments were made to ensure equilibrium between the groups.

Additionally, consistency in teaching materials and schedules was carefully maintained to ensure uniformity in treatment. The only difference between the groups was the learning media used: Group A utilized simple animation videos for Sundanese language learning, while Group B employed AR-based videos for the same purpose. This division enabled a comparative analysis of the effectiveness of the two learning methods.

2.1.2 Context

This study was conducted at KB An Nur Muttaqin is a preschool located in Kalijati, Subang Regency, West Java. The institution focuses on early childhood education, integrating Islamic values and local culture, including the teaching of the Sundanese language as part of its curriculum. In the context of efforts to enhance the effectiveness of Sundanese language learning for early childhood children through the utilization of digital technology. KB An Nur Muttaqin, located in the West Java region, was chosen as the research site because they have a Sundanese language learning program as part of their curriculum. The study compares two technology-based learning approaches:

i. Simple animation videos (representing a commonly used digital learning method)
ii. AR videos (representing a more advanced and interactive technology in learning). The content of Sundanese language learning will be standardized for both groups, with the only difference being the delivery method (animation videos *vs.* AR).

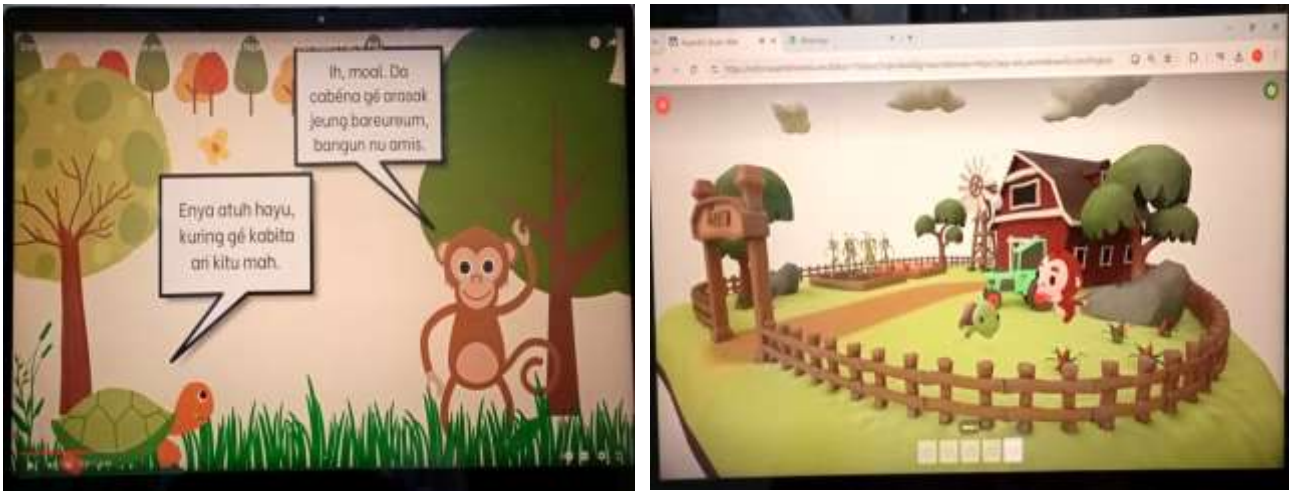
This study utilizes an experimental design with two groups. It is a direct head-to-head comparison between the use of simple animation videos and AR videos in Sundanese language learning. The selection of these two methods is based on the consideration that children aged 4-6 years are already exposed to digital technology but still require concrete and interactive learning approaches [24]. This comparison aims to analyse the level of engagement and motivation of children in learning Sundanese language using two different types of digital learning media. The socio-cultural context is also an important consideration, as Sundanese language is a regional language that is declining in usage among the younger generation. This research is expected to provide insights into effective methods to maintain and enhance children's interest in learning regional languages in the digital era.

2.2 Materials

In the research methodology titled "Analysis of the Level of Engagement and Motivation for Early Childhood Sundanese Language Learning with Media Augmented Reality Based Learning" conducted at KB An Nur Muttaqin, we employ a variety of materials to support the learning process and data collection. These materials can be categorized into several main components: Digital Learning Media, Physical Learning Aids, Data Collection Instruments and Technical Equipment. Each component plays a crucial role in the implementation of the research methodology and the achievement of the study's objectives.

Digital Learning Media includes AR based applications and simple animation videos. Physical Learning Aids consist of picture flashcards and supporting printed materials. Data Collection Instruments encompass structured observation sheets, simple pictorial questionnaires and semi-structured interview guidelines. Technical Equipment used includes tablets or smartphones to run the AR application, a laptop to display animation videos and recording devices for interviews.

Simple animation videos and AR based applications, both media are specifically designed for Sundanese language learning for early childhood children, with a focus on introducing basic vocabulary and simple phrases.



(a) (b)

Fig. 1. (a) Display of a simple animation video (b) An Augmented Reality (AR) based application

The simple animation videos are created using 2D animation software, with a duration of about 5-6 minutes. The 2D animation software used in this research is Adobe Animate, which enables the creation of interactive animations for learning media. The video content includes a Sundanese folktale titled "Sakadang Kuya Jeung Sakadang Monyet Ngala Cabe" and simple interactive games that introduce words in the Sundanese language. The characters and backgrounds in the videos are designed with bright colours and visually appealing styles for children.

The AR application is developed using the AR development platform called Assemblr. This application can be run on tablets or smartphones with Android or iOS operating systems. The AR content includes interactive 3D objects representing everyday objects, animals and characters from Sundanese folktales. Each AR object is equipped with audio pronunciation of words in the Sundanese language and their translation in Indonesian.

In addition to digital media, this research also uses picture flashcards as triggers to activate the AR content. These cards are printed with colourful images representing target words in the Sundanese language.

To support data collection, this research uses structured observation sheets to record the level of children's engagement during the learning sessions. Simple pictorial questionnaires are also prepared to measure children's responses and preferences towards both learning methods.

Supporting equipment such as tablets or smartphones with adequate specifications to run the AR application, as well as a laptop to display the animation videos, are also part of the research material. All devices are ensured to have consistent specifications to maintain consistency in the learning experience among participants.

The Sundanese language learning materials used in both media are tailored to the curriculum and developmental level of children aged 4-6 years, with a focus on themes relevant to the daily lives of children in the KB An Nur Muttaqin environment.

2.3 Research Design

This research adopts a comparative experimental research design with a mixed-method approach. Data collection will be conducted through quantitative and qualitative methods. The quantitative methods include:

i. Pre-test and post-test to measure the improvement in Sundanese language proficiency
ii. Pictorial Likert scale to measure the level of children's motivation
iii. Structured observation to assess the level of children's engagement during the learning sessions.

The qualitative methods include:

i. Semi-structured interviews with teachers and parents to gain insight into children's development
ii. Participatory observation to capture nuances of children's interaction with the learning media.

The research utilizes a quasi-experimental design with two groups: an experimental group using AR based learning media and a control group using simple animation videos. The research also employs a within-subject design to compare children's responses to both types of media. After the main research period, the two groups will switch learning methods for one week to allow for direct comparison.

(a) (b)

Fig. 2. (a) The child is watching animation videos (b) interacting with AR

This research was conducted over a six-week period, with Sundanese language learning sessions held three times a week for each group. Each session will last for 30 minutes. Both groups will learn the same Sundanese language materials, with the only difference being the delivery method. Data analysis will involve statistical methods for quantitative data (such as paired t-tests and ANOVA) and thematic analysis for qualitative data. Data triangulation will be conducted to enhance the validity of the research findings.

The research design aims to provide a comprehensive understanding of the effectiveness of AR media in enhancing the engagement and motivation of early childhood children in Sundanese language learning, compared to conventional digital methods such as animation videos.

2.4 Data Collection and Analysis

2.4.1 Data collection

This research was conducted at KB An Nur Muttaqin, involving 30 early childhood children aged 4 to 6 years, consisting of 17 girls and 13 boys. All participants underwent identical pretests and post-tests, administered by the researcher. These tests were designed to assess the engagement and

motivation of children in Sundanese language learning before and after the intervention. The children were asked to understand the content of the stories presented and recognize vocabulary in the Sundanese language. The tests involved the presentation of stories and words using predetermined media, namely simple animation videos and AR-based videos. The researcher recorded the number of correctly recognized words and the children's understanding of the story content.

Observations were conducted to assess children's engagement and behaviour during the learning sessions. The researcher carried out direct, non-participant observations during each learning session, which lasted for 30 minutes and occurred three times a week throughout the 6-week research period. A structured observation sheet was used to record children's behaviours, including their level of engagement with the learning media, verbal interactions and non-verbal expressions. Additionally, field notes were employed to capture qualitative observations and critical incidents. The researcher maintained a non-participatory role during observations to minimize disruption to the natural learning process. Photographs and videos were also taken to document children's behaviour while using the learning media, which were later analysed to identify key moments indicative of engagement and motivation.

Additionally, data were collected from teachers through semi-structured interviews. The semi-structured interview method allows for deeper exploration of information by providing flexibility to ask follow-up questions based on the respondents' answers.

2.4.2 Analysis

After data collection, several analysis methods were employed to provide a comprehensive overview of the research findings. Data collected from teachers through semi-structured interviews was analysed using constant comparative analysis. This process involved three stages: identifying relevant statements, consolidating ideas and revising and refining emerging themes. The interview results were analysed to identify themes related to teacher feedback and reactions after using AR media in the classroom. The main themes that emerged included student motivation, engagement in learning and challenges associated with using augmented reality-based learning media.

Additionally, data was analysed using descriptive and inferential statistical methods to describe and test the differences between the control and experimental groups. Descriptive statistics were used to describe the basic characteristics of the collected data, including means, standard deviations and frequencies. T-tests were used to determine the significance of differences between the control group (using simple animated videos) and the experimental group (using AR-based videos) in terms of children's engagement and motivation. Bayesian analysis was also used to interpret the results by providing statements that are more easily understood by stakeholders such as teachers, parents and developers. This analysis produces probability distributions of parameters based on the obtained data, providing deeper and more reliable insights.

3. Results

3.1 Quantitative Results

3.1.1 Level of engagement

The level of engagement of children in both groups, the experimental group (using AR-based learning) and the control group (using animated videos), is measured using a structured observation sheet. Engagement is recorded based on the number of correctly recognized words and comprehension of the story content.

This table illustrates the engagement levels of children before (Pre-test) and after (Post-test) using different learning media, namely AR and animation videos:

i. The Pre-test Mean indicates the average engagement score before the intervention. The experimental group has an average of 18.5, while the control group has an average of 17.8. This indicates that before the intervention, the engagement levels of children in both groups were almost the same.
ii. Standard Deviation (SD Pre-test) indicates the standard deviation of the pre-test scores, measuring how far individual scores spread from the average. The experimental group has an SD of 2.4, while the control group has an SD of 2.6. This shows that the score variations in both groups were quite similar before the intervention.
iii. The Post-test Mean indicates the average engagement score after the intervention. The experimental group has an average of 22.3, while the control group has an average of 19.9. This indicates that after using different learning media, the engagement levels increased in both groups, with a greater increase in the experimental group.
iv. SD Post-test: Indicates the standard deviation of the post-test scores. The experimental group has an SD of 2.1, while the control group has an SD of 2.3. This indicates that the score variations after the intervention slightly decreased in both groups but still showed consistency in the increase in engagement.
v. Mean Difference: Indicates the average score increase from pre-test to post-test. The experimental group experienced an average increase of 3.8, while the control group experienced an average increase of 2.1. This indicates that the use of AR media is more effective in increasing children's engagement compared to animation videos.
vi. SD of Difference: Indicates the standard deviation of individual score changes from pre-test to post-test. The experimental group has a difference SD of 1.5, while the control group has a difference SD of 1.8. This indicates that the score changes in the experimental group are more consistent compared to the control group.
vii. t-value and p-value: Indicates the t-test results to determine the statistical significance of the mean difference. A high t-value and a very low p-value (< 0.001) indicate that the difference in engagement improvement in both groups is statistically significant. This means that the observed improvement did not occur by chance.

Table 1
Engagement levels before (pre-test) and after (post-test) using different learning media

Group	Mean Pre-test	SD Pre-test	Mean Post-test	SD Post-test	Mean Difference	SD Difference	t-value	p-value
Experimental (AR)	18.5	2.4	22.3	2.1	3.8	1.5	7.23	<0.001
Control (Animation)	17.8	2.6	19.9	2.3	2.1	1.8	4.89	<0.001

Based on the table, student engagement levels increased significantly in both groups, namely the experimental group using AR and the control group using animation videos ($p < 0.001$). The AR group recorded a higher average score increase (3.8) compared to the animation group (2.1), with more consistent data (SD difference of 1.5 compared to 1.8). The t-test results indicated that the score improvements in both groups were statistically significant; however, the AR group demonstrated a greater advantage in enhancing student engagement. This indicates that AR is more effective than animation videos in improving learning engagement.

The Figure 3 illustrates the level of children's engagement before (Pre-test) and after (Post-test) the intervention for both groups. The experimental group using AR media shows a greater improvement compared to the control group using animation videos.

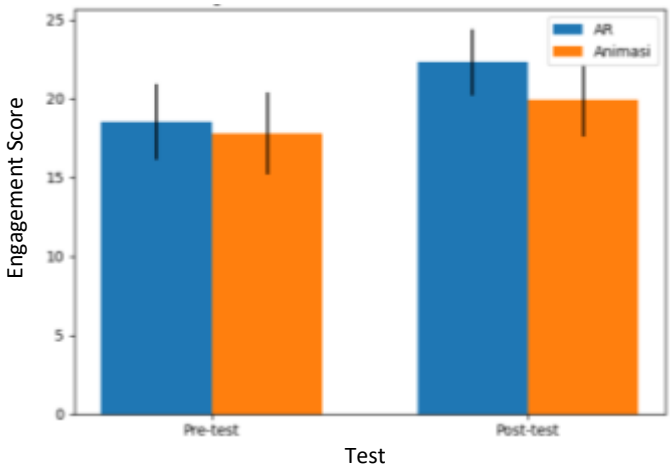


Fig. 3. Pre-test and post-test engagement levels

3.1.2 Motivation level

The motivation level of children was measured using a pictorial Likert scale. The average motivation scores for both groups were recorded. This table shows the motivation levels of children before (Pre-test) and after (Post-test) the intervention:

i. Pre-test Average: Indicates the average motivation scores before the intervention. The experimental group had an average of 2.17, while the control group had an average of 2.11. This shows that before the intervention, the motivation levels of children in both groups were nearly the same.
ii. Pre-test SD: Indicates the standard deviation of pre-test scores, which measures how far individual scores spread from the average. The experimental group had an SD of 0.08, while the control group had an SD of 0.09. This shows that the variation in scores in both groups was quite similar before the intervention.
iii. Post-test Average: Indicates the average motivation scores after the intervention. The experimental group had an average of 2.42, while the control group had an average of 2.35. This shows that after using different learning media, motivation levels increased in both groups, with a slightly larger increase in the experimental group.
iv. Post-test SD: Indicates the standard deviation of post-test scores. The experimental group had an SD of 0.08, while the control group had an SD of 0.09. This shows that the variation in scores after the intervention remained similar in both groups, indicating consistency in the increase in motivation.
v. Average Difference: Indicates the average increase in scores from pre-test to post-test. The experimental group experienced an average increase of 0.25, while the control group experienced an average increase of 0.23. This shows that the use of AR media was slightly more effective in increasing children's motivation compared to animated videos.

vi. SD Difference: Indicates the standard deviation of the individual score changes from pre-test to post-test. The experimental group had an SD difference of 0.11, while the control group had an SD difference of 0.13. This indicates that the changes in scores in both groups had similar variation.

vii. t-value and p-value: Indicates the results of the t-test to determine the statistical significance of the average differences. A high t value and a very low p value (< 0.001) indicate that the observed differences in motivation increases in both groups are statistically significant. This means that the observed increase did not occur by chance.

Table 2
Motivation levels before (pre-test) and after (post-test) using different learning media

Group	Mean Pre-test	SD Pre-test	Mean Post-test	SD Post-test	Mean Difference	SD Difference	t-value	p-value
Experimental (AR)	2.17	0.08	2.42	0.08	0.25	0.11	6.27	<0.001
Control (Animation)	2.11	0.09	2.35	0.09	0.23	0.13	5.08	<0.001

The results of the study indicate that both groups, the experimental group using AR and the control group using animation videos, showed significant increases in scores from pre-test to post-test ($p < 0.001$). Both AR-based learning media and animation videos were effective in enhancing students' motivation. The AR group recorded a slightly higher average score increase (0.25) compared to the animation group (0.23), with more consistent data (SD difference of 0.11 compared to 0.13). The t-test results confirmed that the score improvements in both groups were statistically significant, with AR demonstrating a slight advantage in effectiveness and consistency. This highlights the potential of AR as an innovative and effective learning medium.

This Figure 4 illustrates the motivation levels of children before (Pre-test) and after (Post-test) the intervention for both groups. The experimental group using AR media showed a greater increase compared to the control group using animated videos.

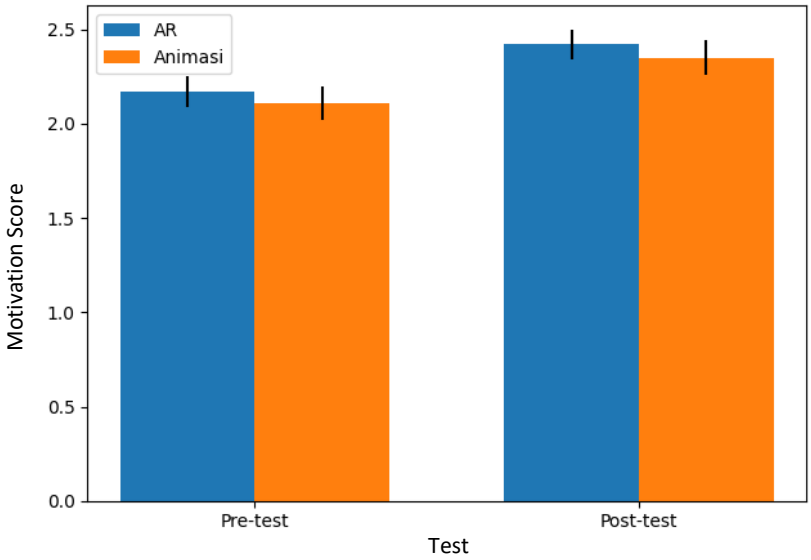


Fig. 4. Pre-test and post-test motivation levels

3.2 Qualitative Results

3.2.1 Teacher feedback

Semi-structured interviews with teachers revealed several key themes regarding the use of AR in the classroom. Teachers noted an increase in student engagement and motivation when using AR. However, they also mentioned some challenges, such as initial difficulties in managing the technology and ensuring all children had equal access to AR devices.

3.2.2 Observation results

Participant observations identified several specific behaviour patterns, including:

i. Increased Verbal Interaction: Children asked more questions about objects or words appearing in AR. They frequently repeated words in Sundanese displayed by AR. There was an increase in spontaneous discussions among children about what they saw in AR.
ii. Focus and Attention: Longer focus duration when using AR compared to conventional teaching methods. Reduced behaviours indicating boredom or distraction (such as looking around the room or playing with other objects).
iii. Emotional Expression: More expressions of excitement, such as smiling, laughing or exclaiming with joy while interacting with AR elements. Expressions of surprise or amazement when seeing 3D objects or animations.
iv. Body Language: More upright and forward-leaning posture, indicating interest. More active hand movements, attempting to "touch" or interact with AR objects.
v. Initiative in Learning: Children appeared more proactive in trying new features within the AR application. They might request to repeat or view more AR content.
vi. Collaboration and Social Interaction: Increased sharing of AR experiences with peers. More discussions and Q&A among children about what they saw in AR.
vii. Response to Instructions: Quicker and more accurate responses to instructions given through AR. Reduced need for repeated instructions from the teacher.
viii. Creativity: Children could create stories or imaginative scenarios based on the AR objects they saw. Increased use of Sundanese words in new or creative contexts.
ix. Physical Engagement: More active body movements, such as pointing, reaching out or even dancing in response to AR content.
x. Persistence: Greater desire to continue the learning session, even after the scheduled time ended. Fewer complaints or signs of fatigue during the learning session.

3.3 Summary of Results

Overall, the results of the study indicate that the use of AR in Sundanese language learning significantly increases the level of engagement and motivation of early childhood children compared to traditional animation videos. Quantitative data show a significant increase in engagement and motivation scores for the AR group. Qualitative data support these findings, with feedback from teachers and observations highlighting the positive impact of AR on student interaction and interest.

3.4 Implications

These findings suggest that integrating AR into early childhood education can be an effective strategy for enhancing student engagement and motivation. The use of AR can make learning more interactive and enjoyable, which is crucial for maintaining the interest of young children. Future research should explore the long-term effects of AR on language acquisition and other areas of learning.

3.4.1 The potential long-term impact of AR on language learning

This study demonstrates that the use of AR can enhance children's engagement and motivation in Sundanese language learning. However, to fully understand its long-term effects, further research is needed to explore how AR influences language acquisition, knowledge retention and cultural mastery over an extended period. These impacts are crucial to ensuring that technologies like AR not only provide short-term benefits but also create sustainable outcomes in language learning.

Previous studies by Korosidou [6] indicate that children exposed to AR-based learning tend to have higher knowledge retention compared to traditional methods. In the future, longitudinal studies should be conducted to evaluate how the use of AR over a year or more affects children's language proficiency, including vocabulary development, speaking fluency and the ability to understand the cultural context of the Sundanese language.

Aligned with the recommendations of Khan *et al.,* [16], who found that AR-based learning significantly improves students' motivation in the long term, we recommend the implementation of similar methods across various age groups and educational backgrounds to examine its impact on language retention and communicative skill mastery.

"However, further research is needed to fully understand the long-term effects of AR on language acquisition and retention." Therefore, further testing of AR usage, particularly in primary education curricula, is expected to provide more comprehensive insights into the effectiveness of AR in culturally-based language learning, such as Sundanese.

4. Conclusions

This study aims to analyse the level of engagement and motivation of early childhood children in learning the Sundanese language using AR-based learning media. The results of the study indicate that AR-based learning significantly increases the level of engagement and motivation in learning Sundanese for early childhood children compared to traditional animated videos. The main findings of this study include the experimental group using AR showing a significantly higher increase in engagement (average difference of 3.8) compared to the control group using animated videos (average difference of 2.1). This difference is statistically significant ($p < 0.001$), indicating that AR is more effective in attracting and retaining children's attention during Sundanese language learning. Both groups showed increased motivation; however, the AR group showed a slightly higher increase (average difference of 0.25) compared to the animation group (average difference of 0.23). Although the difference is small, it is statistically significant ($p < 0.001$), suggesting that AR has a positive impact on children's motivation to learn Sundanese. Teacher feedback and participant observations support the quantitative findings, revealing increased verbal interaction, longer focus duration, greater emotional engagement and higher initiative in learning when using AR.

These findings suggest that AR technology can be an effective tool for enhancing engagement and motivation in early childhood Sundanese language learning. The interactive and immersive

nature of AR appears to create a more stimulating learning environment, which is crucial for maintaining young learners' interest in preserving regional languages. However, it is important to note that while these results are promising, further research is needed to fully understand the long-term effects of AR on language acquisition and retention. Future studies should explore the impact of prolonged use of AR on Sundanese language proficiency and cultural understanding. Additionally, practical considerations such as technology management and equal access to AR devices in educational settings require further investigation.

In conclusion, this study provides strong evidence of the potential of AR in revitalizing Sundanese language education for early childhood children. It offers a new approach to addressing the challenges of regional language preservation in the digital age, potentially contributing to the broader goal of maintaining linguistic and cultural diversity in Indonesia.

Acknowledgement
This research was funded by an internal grant from, Indonesian University of Informatics and Business (UNIBI).

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