



The Implementation of Assemblr Augmented Reality in Teaching English Vocabulary Mastery to Deaf Students

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Abstract. This study examines the effectiveness of Assemblr Augmented Reality (AR) in improving English vocabulary mastery among deaf students in an inclusive classroom setting. The research was conducted at SD N 2 Bengkulu using a quantitative pre-experimental design with a one-group pre-test and post-test approach. The participants were Grade 5 deaf students selected through purposive sampling. Data were collected using a researcher-developed vocabulary test consisting of 15 items, which was validated through expert judgment and demonstrated high reliability (Cronbach's Alpha = 0.815). Descriptive statistical analysis revealed a substantial improvement in students' vocabulary scores, with the mean increasing from 45.00 in the pre-test to 76.50 in the post-test. The minimum score improved from 40 to 73, and the maximum score increased from 50 to 80. Inferential analysis using the Wilcoxon Signed-Rank Test showed a significance value of 0.180, indicating no statistical significance due to the small sample size. However, the observed improvement indicates strong practical significance. The findings suggest that Assemblr AR enhances vocabulary learning by providing visual and interactive learning experiences that support deaf students' cognitive processing. This study highlights the potential of AR technology as an effective instructional medium in inclusive education environments.

Keywords: Assemblr; Augmented Reality; Deaf Students; Pre-test; Vocabulary Mastery.

1. INTRODUCTION

English functions as a global lingua franca that enables communication, access to information, and participation in international contexts. However, learning English poses considerable challenges for deaf students, particularly due to their limited access to auditory input. As a result, deaf learners rely heavily on visual input, contextual cues, and sign language to construct meaning. The learning process becomes more difficult for students who depend on visual cues because English words that lack sign language equivalents need visual and contextual support to understand (Aldemir, Solís-Campos, Saldaña, & Rodríguez-Ortiz, 2023). This condition requires the implementation of teaching strategies that emphasize visual and interactive learning.

In Indonesia, English teaching at the primary school level faces several systemic challenges, including limited teaching resources, insufficient teacher training, and inconsistent curriculum implementation. Besides that, an overemphasis on examination-oriented learning and rote memorization in Indonesian schools typically makes becoming good at taking tests more important than developing actual language skills, and this may reduce emphasis in terms of communicative competence (Daud, 2024). Moreover, the shift towards digital instructional paradigms requires teachers to be proficient in integrating technology-based platforms to foster more interactive environments. These challenges are more pronounced in inclusive educational settings such as SD N 2 Bengkulu, where students with diverse learning needs, including deaf

students, are taught together in one classroom. Teachers are required to adapt instructional materials to accommodate different learning styles, yet they often lack appropriate tools and support. Research confirms these implications that teachers face many obstacles while trying to adapt the national curriculum, which means that they have to create their own simplified materials for students with short attention spans or developmental disabilities (Padmadewi, Sukma, Sukadana, & Artini, 2024; Putri & Maharsi, 2024).

Vocabulary mastery is a fundamental component of language learning. It serves as the foundation for developing other language skills such as reading, writing, speaking, and listening (Santosa, Pratama, & Putra, 2020). For deaf students, vocabulary acquisition becomes more difficult because they cannot rely on auditory exposure. Students who are Deaf face challenges in reading comprehension and writing because of their limited vocabulary (Zhao, Wu, Sun, & Chen, 2021). Therefore, vocabulary instruction must be supported by visual and contextual representations to facilitate understanding and retention. The learning process of vocabulary for Deaf students differs from others because they acquire word meanings through alternative methods which need explicit teaching approaches that connect words to their real-world contexts (Warner-Czyz, Anderson, Graham, & Uhler, 2024). Vocabulary learning itself is a complex and gradual process where many students face significant obstacles, yet mobile-assisted strategies can promote enhanced acquisition through portable and diverse activities (Sintya Dewi, Santosa, & Suta, 2020). Furthermore, in such digital contexts, students tend to adopt deep learning approaches that are dynamic in adjusting to the learning process (Santosa, Ratminingsih, & Adnyani, 2021). Structured programs that combine text, pictures, and signs such as AR are very helpful for deaf students.

The integration of technology in education offers opportunities to address these challenges. One such technology is Augmented Reality (AR), which combines real-world settings with virtual sensory information that includes sound and visual and written data. The platform delivers virtual environments which unite with actual surroundings to provide users with interactive digital environments that stimulate multiple senses for improved cognitive learning (Vaishnav, 2024). AR creates immersive and interactive learning experiences which resolve numerous educational difficulties found in conventional teaching methods (Christou, Vassiliou, & Parmaxi, 2025). Students can interact with digital content in real time while they are in their physical environment. The way AR interacts with and adds to the real environment has a lot of potential for education. AR provides immersive and interactive learning experiences that can enhance student engagement and comprehension (Binhomran & Altalhab, 2021).

Assemblr Edu is one of the AR platform that enables teachers to create interactive learning content without requiring advanced technical skills (Nafi & Asih, 2024). Assemblr Edu offers an engaging educational experience that directly supports vocabulary learning by turning written content into 3D models. This makes learning more engaging and may enhance understanding and memory by giving words a visual and interactive representation (Nurjanah, 2024). Its learning potential, and particularly for learning vocabulary, is the potential to provide learners with contextual, visual, and auditory cues helps in vocabulary mastery.

AR has been shown to improve education (Amores-Valencia, Burgos, & Branch-Bedoya, 2022), but its use in inclusive schools, particularly in rural areas, is still limited. Even while previous research has shown improvements in both immediate and delayed vocabulary outcomes, there is still little data on short-term vocabulary mastery when utilising AR in inclusive classrooms, especially with deaf students and the Assemblr platform. This study employs the Assemblr AR platform at SD N 2 Bengkala to address existing gaps and the specific needs of deaf learners who primarily depend on visual input.

2. LITERATURE REVIEW

Vocabulary mastery is widely recognized as a key component of language proficiency, encompassing the ability to recognize, understand, and use words appropriately in different contexts. It involves not only knowing the meaning of words but also understanding their forms, functions, and usage in communication (Rahmah, M.Tahir, & A.Talib, 2023). The development of vocabulary mastery is influenced by factors such as exposure, repetition, and meaningful context, which are often limited for deaf learners. Deaf students typically rely on visual and spatial processing, making it essential to present vocabulary through images, gestures, and contextual representations (Marschark, Morrison, Lukomski, Borgna, & Convertino, 2013). As a result, effective vocabulary instruction for deaf students must integrate visual reinforcement and interactive learning strategies to support comprehension and retention.

Deaf students have unique linguistic and cognitive characteristics that influence their learning process, particularly in acquiring a second language such as English. Due to their limited access to auditory input, they depend on visual modalities, including sign language, written text, and visual cues, to construct meaning (Duniangella, Santosa, & Budiarta, 2024). Theories such as dual coding theory emphasize that combining visual and verbal information enhances memory and learning outcomes (Paivio, 1990). In addition, multimodal teaching approaches that integrate images, gestures, and interactive media have been shown to reduce

cognitive load and improve understanding (Ratriyana & Nuswantoro, 2022). Therefore, instructional strategies for deaf students should prioritize visual accessibility and contextual learning to ensure effective language acquisition.

Augmented Reality has emerged as a powerful educational tool that enhances learning through interactive and immersive experiences. By overlaying digital content onto the real world, AR enables students to interact with visual representations of abstract concepts, making learning more engaging and meaningful (Carmigniani et al., 2011). In language learning, AR can support vocabulary acquisition by providing contextualized and visualized representations of words, which align with the learning needs of deaf students (Fernandes, Leite Junior, Marçal, & Viana, 2024). Previous studies have demonstrated that AR improves student motivation, engagement, and learning outcomes across various educational settings (Lampropoulos, Keramopoulos, Diamantaras, & Evangelidis, 2022). However, research on the implementation of AR in inclusive classrooms, particularly for deaf students in rural contexts, remains limited, highlighting the need for further investigation in this area.

3. RESEARCH METHOD

The research was conducted at SD N 2 Bengkala in Buleleng Regency, Bali, Indonesia, which is recognized for its inclusive educational model where deaf and hearing students learn in the same classroom environment. This study utilized a mixed-method research design, where qualitative data served as the primary approach supported by quantitative evidence. The quantitative phase employed a pre-experimental one-group pre-test and post-test design to measure changes in vocabulary mastery, while the qualitative phase involved classroom observations to record student engagement and behavioral responses. All research activities took place during the second semester of the 2025 academic year within the Grade 5 classroom during regular English instruction time to maintain environmental validity.

Participants of this study were selected by purposive sampling targeting grade 5 students of SD N 2 Bengkala. The research focused on the needs of deaf students who primarily use visual and sign language to communicate. In total, 11 students (9 regular and 2 deaf) took part in the study but the primary analysis focused on the effectiveness of the intervention for the deaf learners in an inclusive setting. This group was selected to examine the potential application of Augmented Reality (AR) technology to overcome communication barriers and assist students with hearing impairments in learning languages.

Data collection utilized several instruments, including a 15-item vocabulary test, Assemblr Edu AR media, observation sheets, and six structured lesson plans. The vocabulary

test was based on the 5th grade curriculum topics like parts of the body and their functions. The post-test was similar to the pre-test in terms of indicators and levels of difficulty, but varied in item order and presentation to minimize the effects of test familiarity. The AR media were developed by using the Assemblr Edu platform, providing 3D visualizations and digital labels to help students associate the English words with their meanings in the real world. Classroom observations were conducted at all six meetings to record levels of participation and emotional reactions during the treatment sessions.

Data analysis was performed by both quantitative and qualitative techniques. The quantitative data for the regular students were analyzed using paired-sample t-test, while the data for the deaf students were analyzed using the Wilcoxon Signed-Rank Test as a result of the small sample size. Descriptive statistics (mean scores, minimum/maximum scores, and standard deviation) were used to get an overview of the performance before and after the treatment. The observation results were qualitatively analysed in a descriptive way to provide context to the numerical data, especially about how the students interacted with the AR technology and their engagement during the learning process.

4. FINDINGS AND DISCUSSION

The outcome of this study gives a comprehensive analysis of the data obtained from the grade 5 deaf students at SD N 2 Bengkala. The main data is pre-test and post-test score to measure the progress of English vocabulary mastery after the implementation of Assemblr Augmented Reality (AR) intervention. The analysis is divided into two parts, descriptive statistics and inferential statistical testing in order to provide a holistic view of the impact of the media.



Figure 1. Implementation of Assemblr Augmented Reality in Classroom.

Descriptive Statistics

The descriptive analysis was conducted to determine the central tendency and dispersion of the scores before and after the treatment. The results indicate a notable upward shift in all measured parameters.

Table 1. Descriptive Statistics of Pre-test and Post-test Scores.

Statistic	Pre-test	Post-test
Number of Students	2	2
Minimum Score	40	73
Maximum Score	50	80
Mean Score	45.00	76.50
Standard Deviation	7.07	4.95

Based on the data in Table 1, the mean score for the deaf students during the pre-test was 45.00, which falls into the "Very Low" category. This initial score reflects the significant challenges these students faced when attempting to acquire English vocabulary through traditional methods. However, after four sessions of intervention using Assemblr AR, the mean score rose to 76.50, moving the students into the "High" mastery category. The minimum score improved by 33 points (from 40 to 73), and the maximum score increased by 30 points (from 50 to 80). The decrease in standard deviation from 7.071 to 4.950 suggests that the students' scores became more consistent and clustered closer to the mean after the treatment, indicating that the AR medium provided a stabilized learning effect for both participants.

Inferential Statistical Analysis

To evaluate the hypothesis regarding the effectiveness of the treatment, the Wilcoxon Signed-Rank Test was utilized. This non-parametric test is specifically designed for small sample sizes where normal distribution cannot be assumed.

Table 2. Wilcoxon Signed-Rank Test Results.

Metric	Value
Total N	2
Test Statistic	3.000
Standardized Test Statistic	1.342
Asymptotic Significance (2 tailed)	0.180

The statistical analysis presented in Table 2 shows a Z-value of 1.342 and an Asymptotic Significance (2-tailed) of 0.180. In standard statistical conventions, a p-value lower than 0.05 is required to reject the null hypothesis. However, in the context of this study, the p-value of 0.180 is interpreted as a direct consequence of the extremely small sample size ($N = 2$). Despite the lack of statistical significance at the 0.05 level, the descriptive gains are substantial and demonstrate a clear positive trajectory in the students' learning outcomes.

Qualitative Observation

Qualitative observations conducted throughout the intervention sessions revealed a transformative shift in classroom dynamics, characterized by heightened student engagement and a significant increase in focused attention toward the three-dimensional visualizations. Students demonstrated a proactive approach to learning, consistently increasing their responsiveness across sessions as they actively identified vocabulary, matched words with corresponding digital images, and followed instructional cues with greater ease. Notably, deaf students exhibited particularly robust participation, as the visual and interactive affordances of the AR platform directly addressed their specific learning needs, facilitating a more equitable educational experience. The emotional climate of the classroom remained overwhelmingly positive, fostering an atmosphere of confidence and motivation where students appeared genuinely interested in the interactive materials. By effectively reducing the cognitive hurdles associated with abstract vocabulary, the implementation of Assemblr AR created a supportive and accessible learning environment that successfully enhanced both student participation and overall instructional motivation.

Discussion

The findings of this study indicate that the implementation of Assemblr Augmented Reality (AR) contributed positively to the improvement of English vocabulary mastery among deaf students at SD N 2 Bengkulu. The descriptive statistics demonstrated a substantial increase in students' vocabulary achievement, as reflected in the rise of the mean score from 45.00 in the pre-test to 76.50 in the post-test. In addition, both the minimum and maximum scores increased significantly after the intervention, suggesting that all participants benefited from the use of the AR-based learning media. Although the Wilcoxon Signed-Rank Test did not show statistical significance at the conventional level ($p = 0.180$), the improvement observed in the raw scores indicates meaningful practical significance, especially considering the extremely limited sample size.

The improvement in vocabulary mastery can be associated with the visual and interactive characteristics of Assemblr AR. Deaf students primarily rely on visual modalities to process and understand information because of their limited access to auditory input (Duniangella et al., 2024). Therefore, instructional media that provide strong visual representation are highly beneficial in supporting their language learning process. The three-dimensional visualization provided by Assemblr AR allowed students to observe vocabulary items in more concrete and contextual forms, making abstract English words easier to understand and remember. This finding supports the theory proposed by Paivio (1990), who

explains through Dual Coding Theory that combining verbal and visual information can strengthen memory retention and improve learning outcomes.

Furthermore, the implementation of AR created a more meaningful learning environment for deaf students because the learning process became more contextualized and interactive. Unlike conventional vocabulary learning that often depends on memorization and text-based instruction, AR enabled students to directly associate English words with visual objects displayed in real-time. Such contextual learning is particularly important for deaf learners, as they require explicit visual support to connect words with meaning (Warner-Czyz et al., 2024). The findings are also consistent with Aldemir, Solís-Campos, Saldaña, and Rodríguez-Ortiz (2023), who state that vocabulary interventions for deaf and hard-of-hearing students are more effective when supported by visual and multimodal instructional strategies.

Another important finding of this study is the increase in students' engagement during the learning activities. Classroom observations revealed that students became more enthusiastic, attentive, and motivated when interacting with the AR media. The use of 3D objects and interactive digital elements attracted students' attention and encouraged them to participate more actively during the lessons. This finding aligns with previous studies which found that AR technology enhances motivation, engagement, and participation in language learning contexts (Lampropoulos et al., 2022). Similarly, Binhomran and Altalhab (2021) explain that AR-based learning environments can increase vocabulary acquisition because students are more interested and emotionally involved in the learning activities.

The effectiveness of Assemblr AR in this study can also be explained through cognitive learning perspectives. AR reduced the cognitive burden experienced by students by simplifying the process of understanding unfamiliar vocabulary. Instead of relying solely on written explanations, students were able to observe visual representations directly connected to the target vocabulary. This helped students focus on one vocabulary item at a time and minimized confusion during the learning process. Ratriyana and Nuswantoro (2022) argue that multimodal instructional media reduce cognitive overload and improve comprehension among deaf learners because information is delivered through multiple accessible channels. In the context of this study, the integration of visual objects, text labels, and classroom interaction created a supportive learning environment that accommodated the students' specific learning characteristics.

In addition, the findings of this study support previous research regarding the educational potential of Augmented Reality in language learning. Fernandes, Leite Junior, Marçal, and Viana (2024) found that AR provides accessible and engaging learning

experiences for deaf and hard-of-hearing students because it combines visual representation with interactive learning activities. Similarly, Christou, Vassiliou, and Parmaxi (2025) explain that AR supports language learning by increasing immersion, contextual understanding, and learner interaction. The present study extends these findings by demonstrating that Assemblr AR can also be implemented effectively in an inclusive elementary school context, particularly in rural educational settings such as SD N 2 Bengkala.

The findings additionally highlight the importance of adapting instructional strategies and educational technology to the needs of inclusive classrooms. Inclusive schools require teachers to design learning experiences that accommodate students with diverse learning characteristics and abilities. However, many teachers still experience difficulties in adapting materials and selecting appropriate instructional media for students with disabilities (Padmadewi et al., 2024; Putri & Maharsi, 2024). In this study, Assemblr AR functioned as an alternative instructional medium that successfully supported visual learning and promoted equal participation among deaf students. The implementation of AR not only improved vocabulary learning outcomes but also created a more inclusive and accessible classroom environment.

Despite these positive findings, several limitations should be acknowledged. The study involved only two deaf students, which limited the statistical power of the analysis and prevented the findings from being generalized to broader populations. In addition, the study employed a pre-experimental design without a control group, making it difficult to determine the extent to which the observed improvement was solely influenced by the AR intervention. Nevertheless, the consistent increase in students' scores and the positive classroom observations suggest that Assemblr AR has considerable potential as a supportive instructional tool for vocabulary learning among deaf students.

Overall, this study demonstrates that the integration of Assemblr Augmented Reality provides meaningful educational benefits for deaf students in inclusive classrooms. By offering interactive, contextual, and visually accessible learning experiences, AR can support vocabulary mastery, improve engagement, and facilitate more inclusive English language learning practices. Therefore, the implementation of AR-based media may serve as a valuable alternative for teachers who seek to develop more adaptive and student-centered instructional approaches in inclusive educational settings..

5. CONCLUSION

This study concludes that the implementation of Assemblr Augmented Reality contributed to an improvement in the English vocabulary mastery of Grade 5 deaf students at SD N 2 Bengkulu, as reflected in the increase of the mean score from 45.00 in the pre-test to 76.50 in the post-test. Although the Wilcoxon Signed-Rank Test indicated that the improvement was not statistically significant ($p = 0.180$), this result should be interpreted cautiously due to the very small sample size, which limits statistical power. The consistent improvement across all observed indicators suggests that Assemblr AR provides meaningful support for vocabulary learning through visual and interactive representation, aligning with the learning characteristics of deaf students. However, the findings cannot be generalized broadly, and the study is limited by the small number of participants and the use of a pre-experimental design without a control group. Therefore, it is recommended that future research involve larger sample sizes, apply more rigorous experimental designs, and explore the use of AR in other language skills to obtain more comprehensive and generalizable results.

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