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Augmented Reality (AR) in ESL Classrooms: A Quasi-Experimental Study on Enhancing Speaking Skills

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ABSTRACT

Augmented Reality (AR) has the potential to revolutionize language learning by providing immersive and interactive experiences. In the context of English as a Second Language (ESL), AR can help engage students and enhance their speaking skills. However, traditional teaching methods often fail to provide the necessary engagement and real-world application needed to improve speaking proficiency. This study aims to examine the effectiveness of AR in enhancing the speaking skills of Year 3 ESL learners, specifically focusing on pronunciation, fluency and confidence. A quasi-experimental design was used, with 60 Year 3 students from a Chinese primary school in Kajang, Selangor participating in the research. The experimental group engaged with AR-based activities using the Assemblr application, while the control group received traditional ESL instruction. Data were collected through pre-tests and post-tests, assessing the students' speaking proficiency. The results revealed that the experimental group showed significantly improvement in pronunciation, fluency and confidence compared to the control group. The study concludes that AR, through real-time feedback and contextual learning, could significantly enhance speaking skills, making it an effective and innovative tool for ESL educators to foster more engaging language learning environments.

1. Introduction

The integration of technology in language learning has revolutionized education, particularly with the rise of Augmented Reality (AR) as an innovative tool for enhancing learning experiences. AR creates multimodal environments that merge digital and physical interactions, providing students with immersive experiences often lacking in traditional methods [1]. Unlike conventional approaches that emphasize passive learning, AR fosters experiential learning through real-time engagement with

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3D virtual objects and contextual dialogues, which are crucial for developing fluency and pronunciation [2]. Research highlights that AR-based applications significantly enhance language acquisition by offering interactive simulations, allowing learners to practise real-world conversations in a controlled setting [3]. As educational technology advances, AR is proving highly effective in improving speaking skills, vocabulary acquisition and pronunciation accuracy among ESL learners [4].

Speaking proficiency is a fundamental component of ESL learning, yet many young learners struggle with fluency due to limited exposure to real-life interactions, pronunciation difficulties and communication anxiety [5]. Traditional ESL instruction often prioritizes passive reading and writing over oral communication, which restricts opportunities for fluency development [6]. AR addresses these challenges by creating interactive, game-based learning experiences that encourage active participation, reinforcing vocabulary retention and pronunciation skills [4]. Additionally, AR reduces language anxiety by providing a low-risk environment, allowing learners to practice speaking without fear of making mistakes [2].

Given the potential of AR in ESL education, this study seeks to explore its impact on the speaking proficiency of Year 3 ESL learners. The research questions are designed to investigate the overall effects of AR integration on speaking proficiency and compare the differences between AR-enhanced learning and traditional ESL instruction. These questions directly align with the study's objectives, which aim to assess the effectiveness of AR-based activities and determine whether they offer significant advantages over conventional ESL teaching methods.

Despite growing interest in AR's role in language learning, significant gaps remain in the literature. While studies have examined AR's effects on vocabulary acquisition and learner engagement, there is a lack of comprehensive research focusing on AR's impact on speaking proficiency, particularly regarding fluency, pronunciation and confidence. Many existing studies focus on short-term outcomes and limited language skills, leaving the long-term effects and its potential to foster authentic communication and fluency underexplored.

1.1 Problem Statement

Despite the increasing integration of technology in language learning, the direct impact of augmented reality (AR) on speaking proficiency, fluency, pronunciation and confidence among primary ESL learners remains underexplored. Existing research tends to focus on vocabulary acquisition and learner motivation, with limited empirical studies addressing AR's influence on oral communication skills. Furthermore, there is a lack of comparison between AR and conventional teaching methods, which often emphasize rote memorization, grammar drills and scripted dialogues—methods that offer limited opportunities for real-world conversational practice. This gap leaves uncertainty about whether AR offers a significant advantage over traditional approaches in improving speaking proficiency.

Many ESL learners struggle with speaking due to limited interactive opportunities and high levels of anxiety when practicing oral communication in traditional classroom settings. While AR is recognized for its engagement and gamification benefits, there is insufficient research examining its potential to enhance fluency, pronunciation accuracy and overall speaking confidence. Moreover, long-term studies exploring the sustainability of AR's effects on language retention and spontaneous speech production remain scarce.

This study aims to address these gaps by investigating the effectiveness of augmented reality (AR) in improving speaking proficiency among Year 3 ESL learners. Specifically, it explores how AR enhances fluency, pronunciation, vocabulary retention and confidence, while also comparing its impact to traditional ESL instruction. Through a quasi-experimental approach, this research seeks to

provide empirical evidence on the role of AR in developing oral language skills in young learners. The findings are expected to offer new insights into effective digital learning strategies and the unique benefits of AR for ESL learners. Given the growing potential of AR in ESL education, this study will address the following research questions:

1. How does the integration of Augmented Reality (AR) impact the overall speaking proficiency of Year 3 ESL learners?
2. What are the differences in speaking proficiency between ESL learners who engage in AR-enhanced learning and those who receive traditional ESL instruction?

To address these questions, the study sets forth the following objectives:

1. To evaluate the impact of AR-enhanced learning on the speaking proficiency of Year 3 ESL learners.
2. To compare the speaking proficiency outcomes of students exposed to AR-integrated learning with those following conventional ESL teaching methods.

1.2 Literature Review

Existing research highlights the growing potential of Augmented Reality (AR) in enhancing vocabulary acquisition, speaking proficiency and learner engagement. Studies indicate that AR-based applications provide interactive, gamified and immersive experiences that make language learning more engaging and effective [7]. By integrating visual and contextualized learning, AR helps students retain new vocabulary, improve pronunciation and develop fluency in real-world communication. Research has also shown that AR reduces language anxiety by creating a low-risk environment where students feel more comfortable practising their speaking skills [8].

Several empirical studies have demonstrated AR's impact on language acquisition and learner motivation. Hashim, Md Yunus and Norman [9] explored AR's effectiveness among children with autism, showing that interactive and visually stimulating learning environments improve focus and retention. Similarly, Kaufmann [10] found that AR enhances cognitive skills, spatial awareness and problem-solving abilities, making it a valuable tool in language learning. Binhomran *et al*., [11] further emphasized that AR strengthens cognitive connections by merging authentic and virtual learning experiences, promoting higher engagement and motivation. However, long-term studies on AR's impact on sustained speaking proficiency remain limited and more research is needed to compare AR-based speaking interventions with traditional ESL teaching methods.

Furthermore, the study by Jafini *et al*., [12] developed and validated an AR application for teaching electronics in Design and Technology (D&T) subjects. The application, designed using the ADDIE model, demonstrated high content validity (CVI=1.00), indicating its effectiveness in enhancing visualization and comprehension through multisensory learning. Another study by Othman *et al*., [13] explored the impact of AR-based learning modules on microcontroller courses, revealing significant improvements in student learning outcomes, reinforcing AR's role in education.

Apart from that, the effectiveness of AR-based learning tools in the study by Mohd Erfy Ismail *et al*., and Ramli [14,15] has shown positive outcomes in enhancing students' visualization, understanding and motivation, as well as fostering an engaging learning experience. Additionally, Mohd Ekram and Noraini [16] found that augmented reality based mobile applications have the potential to be one of the most effective learning aids to enhance the comprehension of Orang Asli students about two-dimensional or three-dimensional design and animation.

To understand why AR enhances language learning, its role can be analyzed through Social Interaction Theory and Constructivist Learning Theory. Social Interaction Theory suggests that language acquisition occurs through meaningful communication, where learners develop linguistic

skills through social interaction with more knowledgeable individuals [5]. Vygotsky [17] further supports this view, arguing that language development is facilitated through social interactions that help learners internalize linguistic structures and expand their vocabulary. This theory suggests that students acquire language most effectively when engaging in authentic conversations that expose them to new vocabulary and linguistic structures within a social context. AR applications align with this perspective by facilitating role-playing scenarios, peer collaboration and interactive dialogue exercises, reinforcing spoken language skills [4].

Similarly, Constructivist Learning Theory posits that learners construct knowledge through direct experience rather than passive memorization [1]. Piaget [18] emphasized that learning is most effective when students engage with their environment and apply new concepts in practical settings, a principle that AR supports through simulated real-world interactions [4,19]. By integrating interactive vocabulary tasks, real-time feedback and role-playing exercises, AR fosters active learning, confidence building and fluency development [3]. Bruner [20] suggested that learners actively construct their knowledge through discovery and meaningful interactions, reinforcing AR's role in promoting real-time engagement and practical language use.

Although research highlights AR's potential, its long-term impact on speaking proficiency remains underexplored. Many existing studies focus on short-term vocabulary acquisition, while fewer explore how AR impacts fluency, pronunciation and sustained oral communication over time. This study seeks to address these gaps by evaluating whether AR-based learning significantly enhances speaking proficiency and comparing its outcomes with traditional ESL instruction.

2. Methodology

This quasi-experimental study aimed to evaluate the effectiveness of Augmented Reality (AR) in enhancing speaking skills among Year 3 ESL learners. The research was conducted with 60 Year 3 students from a Chinese primary school in Kajang, Selangor, Malaysia, who were randomly assigned to either the experimental group or the control group. The experimental group engaged in AR-based speaking activities using the Assemblr application, while the control group followed traditional ESL teaching methods. To assess the impact of the intervention, all participants underwent pre-test and post-test assessments designed to measure improvements in fluency, pronunciation, vocabulary and confidence. The intervention lasted four weeks and incorporated structured AR-based activities designed to improve students' speaking abilities.

The study implemented three AR-enhanced activities to create an immersive, interactive language-learning experience for the experimental group, engaging them in structured AR-based tasks designed to improve speaking proficiency. The first activity, the AR-Based Treasure Hunt (Language Scavenger Hunt), required students to scan AR markers placed around the classroom or school to receive clues and complete language-based challenges in English. Each marker triggered a visual or audio prompt requiring students to describe objects, answer questions and engage in structured speaking tasks. This activity encouraged students to practice speaking in full sentences, formulate questions and answers and improve fluency and comprehension. For example, students found and scanned an AR marker that displayed an animated fruit basket and were prompted to describe the fruits using adjectives, form complete sentences and answer comprehension questions.

The second activity, AR Flashcards & Vocabulary Games, involved students scanning AR-enabled flashcards featuring 3D objects such as animals, household items or transportation modes and describing them in English. This interactive approach provided a multi-sensory learning experience, allowing students to visualize and interact with vocabulary in a real-world context. The focus was on expanding vocabulary, improving pronunciation and reinforcing sentence structure through

descriptive language exercises. For instance, a student scanned an AR flashcard that projected a 3D model of a tiger and was asked to describe its appearance, habitat and behaviour using appropriate vocabulary and grammatical structures.

The third activity, AR Role-Playing Scenarios, required students to interact with AR-generated environments to engage in simulated real-world conversations. They acted out everyday situations such as ordering food at a restaurant, asking for directions or visiting a doctor's clinic. The AR environment provided audio and visual cues to guide the interaction, making the experience more immersive. This activity aimed to enhance fluency, practise real-life dialogues, boost confidence in speaking and apply language in practical contexts. For example, in a restaurant scenario, students scanned an AR menu, listened to a virtual waiter's prompt and practiced placing their orders using complete sentences and appropriate expressions.

Both groups completed pre-test and post-test assessments designed to evaluate their speaking proficiency across three key tasks. The picture description task required students to describe an image or an augmented reality (AR) object in English, assessing their lexical range, syntactic accuracy, fluency and ability to convey descriptive details with coherence. The role-playing task involved simulated real-world interactions, such as ordering food at a restaurant or asking for directions, measuring students' fluency, grammatical accuracy, pragmatic competence and confidence in spontaneous speech production. Lastly, the question-and-answer task assessed students' ability to respond to open-ended prompts on familiar topics, evaluating their fluency, pronunciation, syntactic complexity and comprehension skills. These tasks collectively provided a comprehensive measure of students' spoken language proficiency and communicative competence.

A structured rubric was used to assess students' performance across six key criteria: fluency, pronunciation, vocabulary, grammar, comprehensibility and confidence. Each criterion was evaluated on a five-point scale, ranging from poor to excellent. To ensure consistency and accuracy in scoring, students' spoken responses were recorded via audio or video to facilitate detailed post-assessment review. Multiple raters independently evaluated each recording to reduce potential bias and ensure reliability in scoring. Final scores were calculated by aggregating ratings across all criteria, using the overall score instead of the mean score for each criterion, enabling a comparative analysis of pre-test and post-test performance.

A quantitative approach was employed to analyze the collected data. Pre-test and post-test scores were compared within each group using the Paired Samples t-Test to determine the impact of the AR intervention. Additionally, the Independent Samples t-Test was utilized to compare post-test scores between the experimental and control groups. This statistical analysis provided empirical evidence on whether AR-based activities contributed to significant gains in speaking performance when compared to conventional ESL instruction.

Ethical considerations were strictly observed throughout the study. Informed parental consent was obtained before student participation, ensuring transparency and adherence to ethical research protocols. Confidentiality was maintained by anonymizing student identities and securely storing collected data. The study complied with institutional ethical guidelines for research involving minors, prioritizing student well-being and fostering a supportive learning environment.

3. Results

To establish the initial comparability of speaking proficiency levels, a paired samples t-test was conducted on pre-test scores between the experimental and control groups. The results indicate that the experimental group had a mean score of 7.40 (SD = 1.94), while the control group had a mean score of 7.17 (SD = 1.83). The mean difference of 0.23 was not statistically significant ($t(58) = 0.47$, p

= 0.49), confirming that both groups started at a similar proficiency level before the intervention. This similarity in baseline scores ensures that any subsequent changes in speaking proficiency could be attributed to the intervention rather than pre-existing differences between the groups.

Table 1
Result of paired samples t-test in pre-test

Test	Group	N	Mean	SD	Mean difference	t	Df	Sig
Pre	Experimental	30	7.40	1.94	0.23	0.47	58	0.49
	Control	30	7.17	1.83				

Following the intervention, the post-test results showed a significant improvement in the speaking proficiency of the experimental group compared to the control group. The experimental group's mean score increased to 10.6 (SD = 2.77), while the control group achieved a mean score of 7.4 (SD = 2.13). An independent samples t-test revealed a mean difference of 3.2, with a t-value of 5.02 and a p-value of < 0.001. Since the p-value is significantly below the 0.05 threshold, the null hypothesis (which suggests no difference in post-test means between the groups) is rejected. This confirms that the experimental group significantly outperformed the control group in speaking proficiency.

Table 2
Result of paired samples t-test in post-test

Test	Group	N	Mean	SD	Mean difference	t	Df	Sig
Pre	Experimental	30	10.6	2.77	3.2	5.02	58	0.64
	Control	Post	7.4	2.13				

The pre-test results confirmed that both groups had similar initial speaking proficiency levels, ensuring that any observed improvements in the post-test were due to the AR intervention. The post-test mean score of the experimental group (10.6, SD = 2.77) was substantially higher than the control group's mean score (7.4, SD = 2.13), with a mean difference of 3.2. The statistical significance of these findings indicates that the use of AR technology had a measurable and positive impact on the learners' speaking proficiency.

The results align with previous research indicating that AR-based learning environments enhance language acquisition, particularly in speaking skills, by providing immersive and interactive experiences. The heightened engagement and motivation stimulated by AR technology likely contributed to increased language practice, improved fluency, pronunciation and intonation, as well as greater confidence and willingness to speak. The ability of AR to create realistic learning environments may have facilitated more meaningful and contextually relevant communication practice, thereby supporting improved language production.

3.1 Discussion

The visual and interactive elements provided by AR applications engage learners in meaningful communication contexts, allowing them to develop their speaking skills naturally and effectively [21]. Moreover, the multisensory learning approach used in AR helps learners retain vocabulary and practice sentence structures more engagingly. The inclusion of auditory, visual and kinesthetic elements likely played a role in reinforcing language acquisition by catering to different learning styles and preferences. This multisensory engagement may have contributed to better retention and application of learned vocabulary and structures in speaking tasks.

A comparison of post-test results further highlights the effectiveness of AR-enhanced learning. The experimental group's higher mean score (10.6) compared to the control group (7.4) underscores the effectiveness of AR-based instruction in improving speaking proficiency. The most notable improvements in the experimental group are likely due to the interactive and immersive nature of AR tools, which offer real-world simulations, character interactions and personalized conversations, contrasting with traditional ESL methods that rely more on textbook exercises and teacher-led discussions. This active engagement with the language in realistic contexts may have played a critical role in enhancing speaking proficiency.

The contextualized learning environment provided by AR reduces language anxiety, enhances pronunciation practice, and encourages authentic communication, all of which contribute to the significant gains observed in speaking proficiency. Learners may feel more comfortable experimenting with language use in AR-based settings, as these environments provide a supportive and low-risk atmosphere for language practice. The reduction of language anxiety could be a crucial factor in encouraging more frequent and spontaneous spoken language production [22].

Conversely, the control group exhibited only a slight improvement from their pre-test scores. This suggests that while traditional ESL instruction remains effective, it may not provide the same level of engagement, interactivity and contextual learning as AR-enhanced methods. The findings indicate that passive learning techniques in traditional classrooms may not sufficiently engage learners to improve their speaking proficiency as effectively as AR-based methods. The limited progress in the control group highlights the potential limitations of conventional teaching approaches that rely heavily on rote learning and teacher-centered instruction.

While we acknowledge the importance of a larger and more diverse sample for generalizability, this study was limited by logistical and resource constraints, particularly time and accessibility during the data collection phase. Nonetheless, the current sample provides valuable insights into the potential of AR in ESL learning. Although the findings indicate positive results, expanding the sample size and including a more varied population would help validate and extend these findings. Future studies should aim to replicate this research with larger and more diverse samples to strengthen the evidence base and improve generalizability. This would also help explore the broader applicability of AR in different educational settings, ensuring that its benefits can be fully understood across various contexts [23].

The lack of a significant difference in pre-test scores indicates that both groups performed equivalently before the intervention, bolstering the study's internal validity. The notable improvement in the experimental group's post-test scores suggests a positive impact from the intervention. Employing an independent samples t-test is suitable here, as it assesses whether the means of two independent groups differ significantly—a common approach in educational research for evaluating intervention effectiveness. However, while statistical significance shows that the observed effect is unlikely due to chance, it doesn't reflect the effect's practical importance or magnitude. Calculating the effect size would offer deeper insights into the intervention's practical impact [24].

Additionally, it is crucial to confirm that the assumptions underlying the t-test, such as the normality of data and the homogeneity of variances, are met to ensure the validity of the results. In conclusion, the intervention appears to have significantly improved the performance of the experimental group, as demonstrated by the notable increase in post-test scores relative to the control group. This finding emphasizes the potential benefits of the intervention and reinforces the importance of employing rigorous statistical methods in the evaluation of educational strategies.

4. Conclusions

This study demonstrates that integrating Augmented Reality (AR) into ESL classrooms significantly enhances students' speaking proficiency, particularly in pronunciation, fluency, vocabulary retention and confidence. The quasi-experimental findings revealed that students engaged in AR-based learning showed greater improvements compared to those who received traditional ESL instruction. Pre-test results confirmed that both groups started at a similar proficiency level, while post-test results indicated that the experimental group outperformed the control group, with statistically significant gains in speaking skills.

The results suggest that AR-based learning is more effective than conventional ESL instruction in fostering oral communication skills. The interactive and immersive nature of AR provided real-time feedback, reduced language anxiety and encouraged active participation, contributing to improved fluency and pronunciation. Additionally, AR-based activities facilitated contextual learning and authentic conversational practice, effectively bridging the gap between traditional language instruction and real-world communication needs.

These findings have important implications for ESL educators, curriculum designers and policymakers. First, integrating AR technology into language learning offers an engaging and interactive platform that enhances student motivation and active participation. ESL curriculum developers should consider incorporating AR-based tools and activities alongside conventional instruction, particularly for improving speaking proficiency.

Second, AR's ability to simulate real-world scenarios and provide instant feedback highlights its potential as a powerful tool for personalized learning. Teachers can leverage AR to create customized learning experiences tailored to individual students' needs, ultimately improving learning outcomes. Additionally, institutions and policymakers should explore investments in AR infrastructure and professional development programs to equip educators with the skills necessary to implement AR effectively in classrooms.

While this study provides valuable insights into the benefits of AR in ESL education, certain limitations should be acknowledged. The sample size and duration were constrained by logistical and resource factors, particularly time and accessibility during the data collection phase, which may limit the generalizability of the findings. Additionally, the study's duration was restricted by academic scheduling and institutional timelines, preventing a long-term assessment of AR's impact. Despite these constraints, the current sample provides valuable insights into the potential of AR in ESL learning and the positive trends observed highlight the immediate benefits of AR integration in ESL contexts.

To enhance the generalizability and robustness of the findings, future research should include a larger, more diverse sample from a variety of schools and regions, offering a broader perspective on the effectiveness of AR and its impact on ESL learners across different demographics and educational contexts. Additionally, extending the intervention period to better evaluate the long-term effects of AR on language acquisition—ideally to at least eight weeks or more—will provide a more comprehensive understanding of its broader applicability and sustained impact on ESL learning. This longer duration will allow for a more thorough assessment of improvements in fluency, pronunciation and confidence, providing valuable insights into the lasting effects of AR on language learners. These efforts will strengthen the evidence base and facilitate more comprehensive recommendations for integrating AR technology into language education.

Future studies could also examine:

- The integration of AR with other language skills—reading, writing and listening to assess its overall impact on language learning.
- The effectiveness of AR for learners at different proficiency levels, including beginner and advanced ESL students.
- The role of AR in fostering collaborative learning and peer interaction in language classrooms.
- The cost-effectiveness and scalability of AR-based language learning in various educational settings, including under-resourced schools.

Overall, AR presents a promising avenue for transforming ESL instruction, making language learning more interactive, accessible and engaging. By embracing AR technology, educators can bridge the gap between traditional teaching methods and modern digital learning and enhance students' speaking proficiency and overall language acquisition. As technology continues to evolve, the integration of AR in ESL education has the potential to redefine how language learning is delivered, ensuring more effective and immersive learning experiences for students worldwide.

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