IMPLEMENTING MIXED AUGMENTED AND VIRTUAL REALITY IN AN ANIMATED FLIPPED CLASSROOM FOR LOW-ACHIEVING WRITERS IN RURAL PRIMARY SCHOOLS

Ilyana JALALUDDIN*
Ramiza DARMI
Lilliati ISMAIL
Universiti Putra Malaysia, Malaysia
ilyana@upm.edu.my
ramiza@upm.edu.my
lilliati@upm.edu.my

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**Corresponding author*
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ABSTRACT

The study examined the implementation of mixed augmented and virtual reality in an animated flipped classroom for low-achieving writers in rural primary schools. A quasi-experimental study employing a pre-post, non-equivalent control group design was conducted. In a flipped classroom, students use digitised or online lectures as pre-class homework, then engage in active learning process in the classroom such as peer teaching, projects, problem solving and group activities. In other words, the typical classroom of lecturing only during class time is “flipped” now to active activities that involve problem solving and group project work in class. Results show that this flipped learning approach improves rural learners’ proficiency, particularly in vocabulary acquisition. It was found that there was a statistically significant difference in vocabulary level between trials at the midway time point. Apart from that, there is a statistically significant difference in the vocabulary level in the intervention trial at the end (post) of the trials. However, successful implementation of this technology necessitates a comprehensive approach considering cultural and infrastructural factors.

Keywords: mixed reality; augmented reality; virtual reality; rural area learners

Introduction

Results from the earlier research emphasise how crucial instructors' methods of teaching and the learning environment are when using technology, as this might have an impact on teaching (Celik & Ersanlı, 2022). The use of flipped classrooms has currently transformed the learning environment from a lecture-based, direct instruction setting to an electronic technology-based, and more learner-friendly setting. In tandem with the COVID-19 epidemic, a technology learning environment has emerged, where more flexible teaching methods like blended learning or online learning are frequently used. One type of blended learning is the flipped classroom, which combines in-person instruction with independent study, typically done with the use of technology. The primary pedagogical aim does not change with implementing the flipped classroom even though there is a combination of in-person and online instruction; rather, learners' active engagement in the classroom replaced passive learning and listening (Nolan & Washington, 2013).

The flipped classroom has changed the perspectives of educators and learners on learning (Sajana, 2018). Teachers can integrate their own technological experience with the learners to potentially improve learning and performance. There are numerous approaches to flipped classrooms as it can fully or partially flip the classroom, and no approach has been shown to be superior to another (Nouri, 2016). Either fully or partially, utilising technology in the classroom is crucial to flipping the classroom. However, because the sources must be as interactive as possible, the implementation of technology has become problematic. Emerging technology and innovative approaches to teaching and learning have come together to form the concept of flipping the classroom (Simanungkalit & Sembiring, 2019). In a flipped classroom, the teacher cannot establish good communication on their own; instead, technology and media, including video, play a crucial role as messengers that can engage learners (Khalidiyah, 2015). When learners are able to fully utilise all of their senses during learning activities, the flipped classroom approach is successful (Khalidiyah, 2015). For the flipped classroom to be successful, a more interactive medium called mixed reality—that is, augmented and visual reality—is therefore necessary.

Virtual reality (VR) and augmented reality (AR) are essentially computer-generated simulations that let users fully immerse themselves in the virtual environment. According to Brown et al. (1997), incorporating AR and VR into educational activities offers several unique benefits, including: 1) reducing learning limitations; 2) assisting learners in overcoming physical obstacles; 3) presenting a variety of events continuously to provide a unique visual experience for a deeper understanding; 4) allowing learners to create real action or imagine an event or process; and 5) assessing learners' knowledge or analytical skills in the learning activities of a particular subject. These benefits lead to the hypothesis that using mixed reality could enhance English language learners' acquisition and possibly will be more effective if implemented in a flipped classroom.

Nevertheless, before AR and VR can be implemented in a flipped classroom, a more comprehensive model is needed to support the use of AR and VR in flipped classrooms especially in rural areas. Previously, many systematic review studies have been done on flipped classrooms such as educational sciences (e.g., Lo & Hew, 2017), nursing education (e.g., Tan et al., 2017), mathematics (e.g., Lo et al., 2017) and engineering (e.g., Karabulut-Illgu et al., 2018). However, most of these studies focus on academic performance, and students' affective factors such as self-efficacy, perception, and attitude.

While there is some research on the use of the flipped classroom and AR or VR separately, there are still several gaps in the literature on their combined use. lack of facilities will bring more challenges in a rural area context.

Due to the limiting conditions of learning in rural areas, it is hoped that this mixed reality will be able to help low achievers improve their imagination and vision skills when learning English language. The study examined the implementation of mixed augmented and virtual reality in an animated flipped classroom for low-achieving writers in rural primary schools.

This study aims to assess the effectiveness of the mixed reality-supported flipped classroom as a learning tool for vocabulary when compared to normal instructional treatment classes. Mixed reality here refers to the use of Visual Reality and Visual Reality. The research objectives are to:

1) compare the changes of vocabulary level for low achiever learners across three different time-frames in the mixed reality assisted flipped classroom and traditional classroom; and
2) compare differences in vocabulary level among the low achievers in the mixed reality assisted flipped classroom and traditional classroom.

The two hypotheses tested are:

H_a There is a statistically significant difference in vocabulary level between trials at the midway time point.

H_a There is a statistically significant difference in the vocabulary level in the intervention trial at the end (post-) of the trials.

Literature Review

Rural-urban Gap in English Proficiency

The gap in English language performance between Malaysian rural and urban learners continues to be a critical concern (Ismail et al., 2020). The results of Year 6 and Form 3 in urban and rural areas differ by 2.43%. On average, pupils in urban areas outperformed those in rural areas in English, scoring 78.87%. In Form 3, pupils in urban and rural areas scored 74.48% and 71.68% on average, respectively, with a 3.1%-point difference in the English subject (Faudzi, 2020). This demonstrates that when it comes to English language proficiency at both national and school exams, the majority of learners attending urban schools score better than those attending rural ones. Since rural-area learners rarely get to use English outside of the classroom, rural learners frequently see it as a foreign language. Furthermore, the majority of parents in rural areas lack formal education and do not recognise the value of learning English, therefore they are generally uninformed of the language (Shahnaz & Ghandana, 2021). The stark discrepancy in academic achievement between urban and rural learners further emphasises the division between the two learner populations and suggests that the learners may speak English at varying levels (Ismail et al., 2020).

As we enter a new era of education, teachers should choose and employ instructional strategies that will promote learners' active engagement. Benzerroug (2021) emphasised that the learner's active participation in their own learning should be an integral part of any teaching strategy to develop the different aspects the learner's personalities mainly cognitive, social and psychological aspects. However, a lot of educators limit themselves to using a one-size-fits-all method or the conventional chalk-and-talk method of instruction. Sadly, adopting traditional lectures online instead of in-person did not change the way that learners learned (Ullah & Iqbal, 2020). This unaltered mode of instruction in the classroom could be a factor in Malaysia's English language standards, which have been steadily declining, particularly in Sabah, where 1191 secondary schools have been identified as having SPM English failure rates exceeding 23%, according to data released by PEMANDU (Ismail et al., 2020). This explains why some learners struggle to acquire and master the English language, despite having studied reading, writing, speaking, and listening for years in school. The reason for this is that rural learners' limited proficiency in the English language is due to English language teachers' lack of professional development, which makes them unable to employ efficient teaching strategies, methods, or approaches when teaching English (Milon, 2016, as cited in Shan & Abdul Aziz, 2022, p. 1958). On the other hand, traditional teaching, which focuses solely on using textbooks and instructional techniques in the classroom, bores learners and lowers their motivation and capacity for learning.

However, low learning capacity has more detrimental effects on the process of discovering new information, particularly for low achiever individuals. Nonetheless, educators must provide these pupils with the attention they need because it is evident that they are unable to learn most subjects—especially language and Mathematics—during regular class periods. Low achievers are typically defined as learners who receive a low grade on a test or course; they are frequently perceived as less competent, less successful, or unsuccessful learners (Samperio, 2019). Adnan Zahid et al. as cited in Samperio (2019), low achievers view English as a challenging subject and view their teacher as an authority figure. They also lack exposure to the target language, have a limited vocabulary, and lack motivation to learn the language, all of which contribute to a negative attitude toward learning English. The teachers indicated that they needed teaching and learning assistance specifically designed and created for low achiever learners' exercises, based on prior research (Ahmad & Abdul Mutalib, 2015; Bokhari et al., 2015; Hoon et al., 2009). They also pointed out that learning concepts in the form of computer-based learning are important to promote enjoyable learning experiences. Yaduvanshi and Sing (2019) corroborate this, stating that educators need to look for new and creative ways to improve the effectiveness of their instruction to provide all learners, regardless of ability level, with access to high-quality education. Presently, the majority of the educational resources are derived from conventional learning materials supplied by the Ministry of Education (Bokhari et al., 2015; Othman et al., 2011). Teachers make full use of the materials but relying just on these educational resources is insufficient since children would quickly become disinterested and lose interest in what they are learning (Hoon et al., 2009).

Implementing AR in Language Classroom

Using multimedia and computer-aided education models to teach scientific concepts has grown popular these days. When computer-aided learning started, Ma (2008) found that 3D animation education enhanced learners' immediate learning effects on the concepts of basic sciences. Ma (2008) discovered that the pupils comprehended the motions of the earth, sun, and moon, among other phenomena, as well as the times and causes of the lunar phases. He concluded that a simulation-based e-learning model is very beneficial for enhancing the learning efficiency of the concepts of fundamental principles in the sciences by offering instructional resources, such as 2D and 3D animation.

In a different science class, studies on the use of AR technologies to create teacher- and student-desired instructional materials have confirmed that AR materials can effectively boost students' academic motivation and help them achieve better learning outcomes (Alizadehsalehi et al., 2021). According to Sirohi et al. (2020), incorporating AR technologies into education can effectively address issues brought about by the following: concepts of certain subjects that may be overly abstract; environments for observation that are difficult to construct or meet the requirements because of financial constraints or technological limitations; or remote locations.

Furthermore, studies on simulation-based learning suggest that instruction supported using interactive 2D or 3D models, such as AR, can greatly improve students' comprehension of spatial ideas and create more immersive learning (Al Ansi et al., 2023). While most research has concentrated on science subjects, this work aims to apply AR in a new setting—English language learning classrooms, where there is currently a dearth of resources for low-achieving learners in particular. Research in VR and AR were limited due to the huge development of these technologies in different aspects and implementing it in a very specific context such as low achievers will add more to the challenges (Al-Ansi et al., 2023).

Spatial notion can help these learners—who struggle to understand basic concepts—see how what they have learned relates to the real world (Gargrish et al., 2020). It is hoped that they will receive this spatial concept using mobile augmented reality (AR plus VR), which will be able to provide them with a visual explanation.

Theoretical Perspective

This research is based on the sociocultural and constructivist theories of education, which hold that learners are responsible for their individual learning. According to Haase et al. (2014), constructivism emphasises that learners can only create their unique knowledge when they are allowed to reflect on their own experiences. This means that real-world or problem-based learning scenarios that are centred on authentic learning should be provided in the learning environment. According to Bruner (1961), learning is actively looking for solutions and answers rather than just absorbing what has been said and read. This means that lessons and activities in the classroom should be thoughtfully planned, very hands-on, and interactive. Instructors should employ games, storytelling, and other attention-grabbing strategies, such as

AR, to spark learners' curiosity and enthusiasm for learning and to help them think, act, and reflect in novel ways. Apart from imparting knowledge, a teacher's job is to support learners' learning. AR is appropriate within the context of active learning. Because mixed reality is interactive, the idea of "learning by doing" is the main emphasis of this study. This lets users create experiences in a secure setting without relying on the actual machine's availability. Here, there is an interactive exploration of the virtual learning environment including the functionality and components of the technical device (Haase et al., 2014).

Apart from constructivist theory, sociocultural theory is also used in this study to provide further context for the interactive inquiry. According to socio-cultural theory, child's development appears twice: first, on the social level, and later, on the individual level or in other words, first between people (interpsychological) and then inside the child (intrapsychological) (Vygotsky, 1978). The crucial thing to remember is that language and social contact both play a significant part in a learner's own learning process and help him or her solve problems and comprehend the world around them. "In Vygotsky's research, tasks that were beyond the abilities of the children were presented, and through assistance and artifacts that the learners could potentially use to solve the task, the procedure was followed" (Lantolf & Thorne 2006, p. 50). According to Vygotsky (1978), social interaction causes learners' thoughts and behaviours to gradually shift over time and might differ significantly between cultures. Based on this, learning in the writing classroom needs to go beyond self-initiated discovery and instead focus on assisted discovery, wherein the teacher provides explanations, demonstrations, and verbal prompts to guide the learner's learning while carefully adjusting their efforts to each child's zone of proximal development (Berk, 1994).

Research Methodology

Research Design

This study used a quasi-experimental methodology with a pre-post, non-equivalent control group design to investigate how well-mixed reality-aided flipped classrooms can help primary school low-achieving learners improve their vocabulary level. This is because it was not logistically feasible to conduct a randomised controlled trial in which specific groups, namely the low achiever learners were targeted to allow the researcher to follow closely the participants' development. Apart from that, the low achievers were also controlled by the school administration in which the selection part was done by the school principals themselves (not by the researcher).

Participants

This study included two different primary schools located in a rural area of Selangor selected based on the permission given by the Education Department Selangor (PPD Selangor). Later, these learners were selected using purposive sampling in which the learners that were categorised as low achievers based on their school examination performance were chosen for the study. These learners also had difficulty in reading, writing, and reading. For this study, each school had two classes that participated in the study. Every class had between 30 and 40 learners.

Two groups selected by the schools were assigned as experimental and control group. The experimental group received the same content using a mixed reality assisted flipped classroom approach while the control group received traditional instruction.

Instruments

British Picture Vocabulary Scale III (BPVS III)

The GL Education Group developed the one-to-one BPVS III test, which measures a child's level of receptive vocabulary (see Figure 1). For each question on the test, the learners had to choose a picture from four that best reflected the meaning of the term that the researchers had said. The exam has 12 levels that can be used to determine an individual's age-level achievement. GL Education Group (GLE Education Group, 2018) states that as there is no reading requirement for this examination, BPVSIII can be used to assess language progress in learners who cannot read, particularly those who have expressive language difficulties. Since there is no spoken answer needed, the evaluation can be completed by kids who have moderate autism, other communication disorders, or English as an Additional Language (EAL).

Figure 1
Teacher Using British Picture Vocabulary Scale III (BPVS III)

Mobile Apps

Over six months, the researcher used vocabulary materials embedded with AR and VR to teach the learners. Two apps were made specifically for the study: the first allowed users to explore two rooms filled with the objects they had learned, as seen in Figure 2, and the second allowed them to identify appropriate vocabularies that describe the objects (Figure 3).

Figure 2
Example of VR Setting

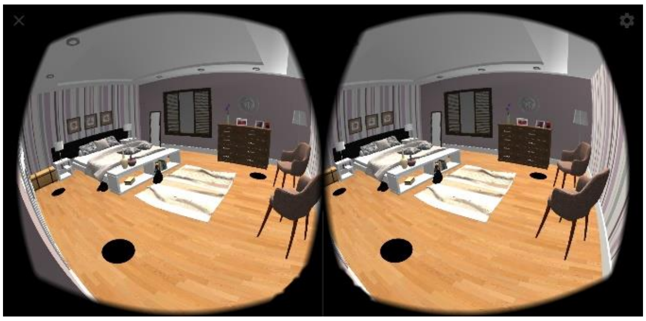
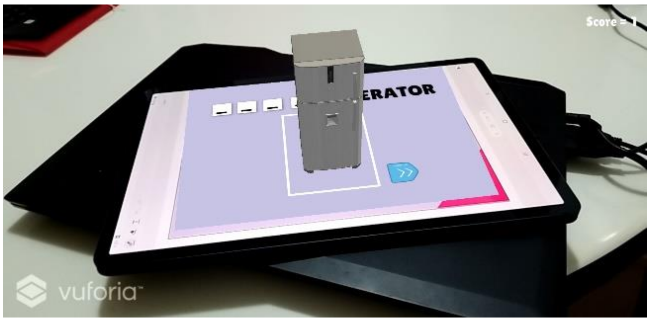


Figure 3
Example of AR Task



Data Collection Procedures

In this project, mixed reality learning materials for low achievers at primary school were designed and developed using the Analysis, Design, Development, Implementation, Evaluation (ADDIE) Instructional Design method as a framework. Figure 4 shows the five stages implemented for the mixed reality-enabled flipped classroom, namely, analysis (A), design (D), development (D), implementation (I), and evaluation (E).

The process of this study is divided into five phases:

A. Phase of Analysis: Review of Literature and Phenomenon

The target audience was the main focus of this phase, and the researcher's goal was to determine the level of competence, intelligence, and challenges that teachers and learners faced throughout the teaching and learning process.

B. Design Phase: Creating the Educational Animation Videos

During this stage, the investigator ascertained the aim and provided the resources necessary to accomplish the learning goals. At this point, the researcher essentially chose which media formats to utilise while creating the instructional materials and strategies. Figure 5 illustrates the process of discovering and designing animated video resources.

Figure 4

Phases of the ADDIE Instructional Design Model

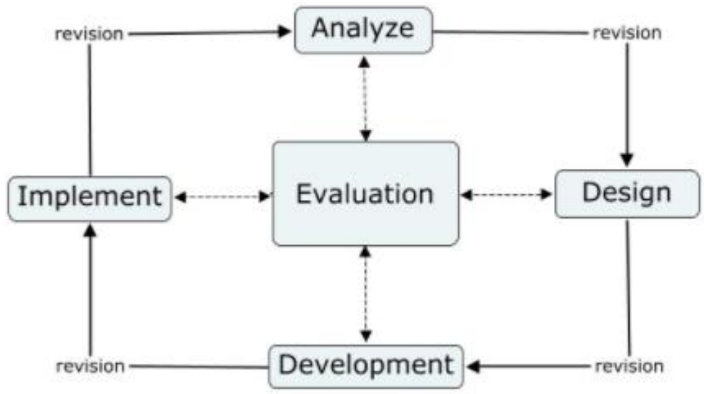
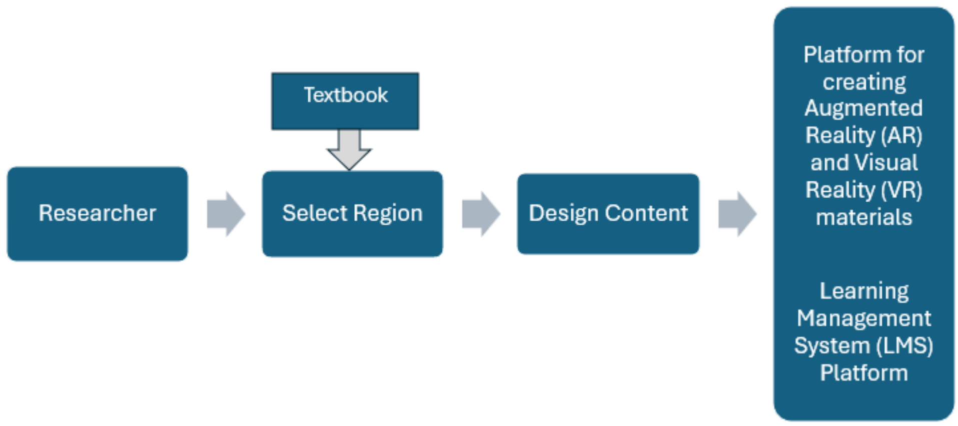


Figure 5

Designing Process



The second phase attempts to fulfil these aspects of the study

1. The content of the textbook was analysed to choose appropriate images and videos.
2. These images and videos were created and used to be uploaded to the Mixed Augmented Visual Reality (MAVR) platform.
3. They were reviewed by specialists in teaching and technology.

<u>C. Development Phase: Pilot study</u>

The creation and testing of the project's mixed reality flipped classroom learning materials began during the development stage.

<u>D. Implementation Phase: Actual study</u>

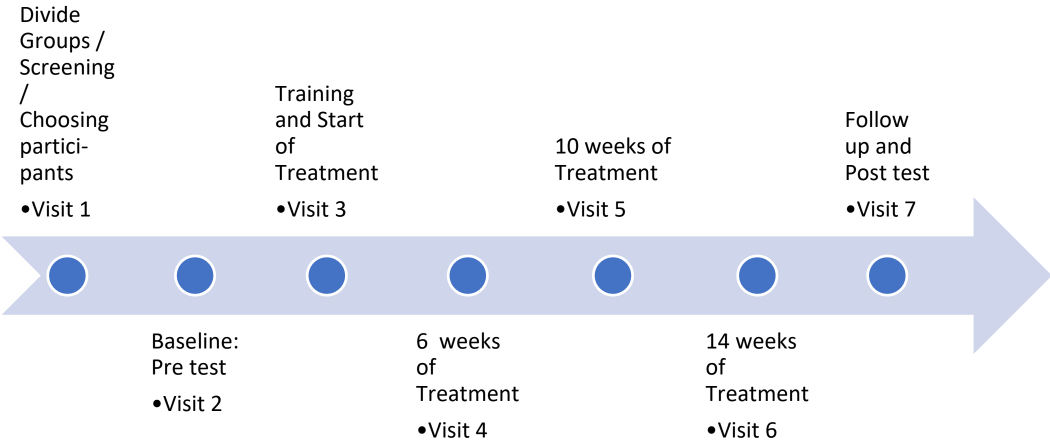
The materials were used in the real classroom. A pre-test, or screening test, was administered before the actual implementation. A mid-year screening test was administered later, and once all topics had been covered, a final screening test was delivered.

E. Evaluation Phase: Assessing the learning materials

The study underwent final testing at this point to determine whether or not the materials' *what, how, why, and when* achieved the desired goals. Determining the materials' efficacy was the primary objective of this phase, and some statistical analyses were done using the results of the study's pre- and post-tests as well as the questionnaire. Figure 6 illustrates the process and the timeline of the research process in conducting the procedure and collecting data.

Figure 6

Study Timeline



In summary, there were seven stages (Visit 1-7) involved in the Implementation and evaluation phase. The researcher took 14 weeks altogether to conduct the mixed reality assisted flipped classroom (Implementation phase) and at the end, follow up and post test were conducted before it was analysed (evaluation phase).

The use of AR and VR in language learning, like any technology, raises important ethical considerations. In this study, the participants' parents were briefed and given a consent form to be signed and they were informed as well that their names would be anonymous, and they could withdraw their children from the study any time. The study was conducted according to the guidelines of the Institutional Review Board (or Ethics Committee) of Universiti Putra Malaysia Ministry of Education, Malaysia and approved by the Ministry of Education, Malaysia (Ref KPM.600-3/2/3-eras(2882) Approval date: 18 January 2019)

Data Analysis Procedures

To gauge the learners' progress before treatment, pre-tests in vocabulary were given to both groups. At the end of the intervention, both groups took the same test as a post-test to examine any differences between the study groups. Descriptive statistics (mean, standard deviation) were computed to describe the distribution and pattern of the marks. Then mixed between-within-subjects ANOVA was used to examine the effects of the different approaches on the dependent measures and to see the differences.

Results

A two-way repeated measures ANOVA was run to determine the effect of different treatments overtime on the vocabulary level of low achievers in rural area schools. However, to avoid any potential outlier that may influence the regression model since ANOVA is sensitive to outliers, studentised residuals was referred to identify outliers. Analysis of studentised residuals showed that there was normality, as assessed by the Shapiro-Wilk test of normality and no outliers, as assessed by no studentised reseals greater than 3 standard deviations. Thus, this indicates that the data were constant and suitable for the next stage of analysis.

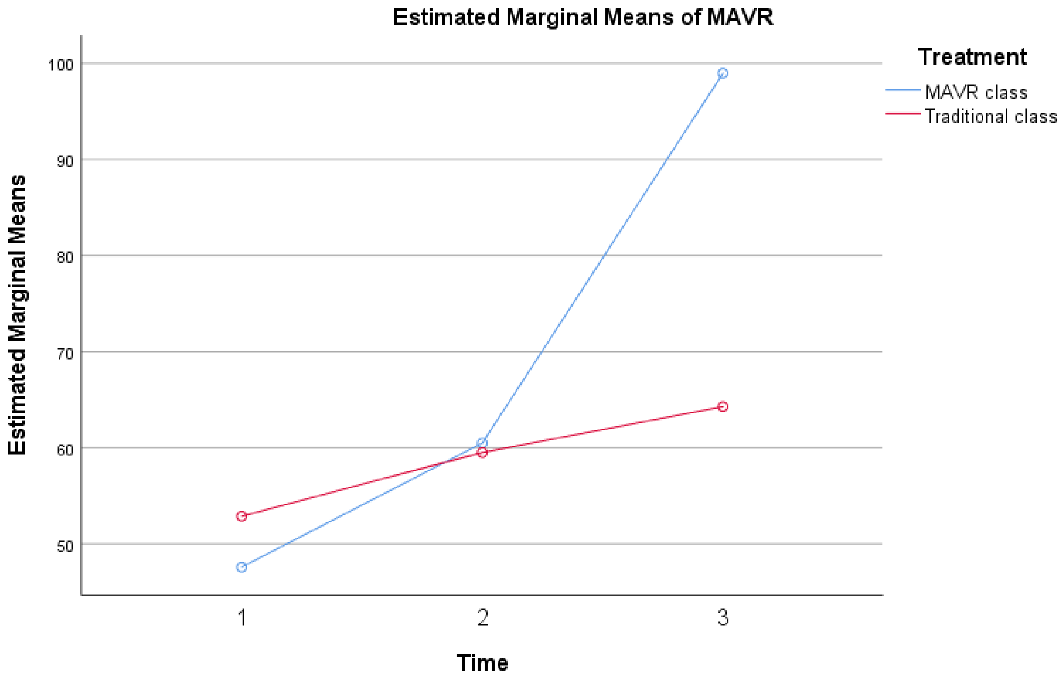
Table 1
Descriptive Statistics for Vocabulary Level

	Treatment	Mean	Std. Deviation	N
Pre_test	MAVR class	47.57	19.886	23
	Traditional class	52.86	20.587	22
	Total	50.16	20.179	45
Mid_test	MAVR class	60.48	22.246	23
	Traditional class	59.50	18.317	22
	Total	60.00	20.195	45
Post_test	MAVR class	98.96	18.192	23
	Traditional class	64.27	21.297	22
	Total	82.00	26.256	45

In general, the scores for vocabulary level increased over time in both groups. However, the scores for vocabulary increased more than in traditional class at the end, that is, the post-test. To gain the initial impression of whether there is likely an interaction between the between- and within-subjects factors, the profile plot (Figure 7) is produced and inspected visually.

From the plot, it can be seen that the two lines are not parallel to one another. On closer examination, it would appear that participants in the experimental group (the blue line) maintained a similar pattern like the control group but increased sharply over time. This means that vocabulary level increased moderately from pre to mid (a slight increase after three months), but then there was a more significant increase in mean vocabulary level from the mid to post time point. Visually, the most pronounced effect on mean vocabulary level was in the MAVR class group (the blue line) with a large increase in mean vocabulary level at both time points (i.e., midway and post-intervention). The different groups have similar increasing patterns of mean vocabulary level over time but only a slight increase in the control group. As such, from these results, we might expect to find an interaction effect.

Figure 7
Main Effects Plot for Vocabulary Scores among MAVR and Traditional Class Students



Before determining whether the two-way interaction effect is statistically significant or not, the assumption of sphericity was established to ensure that it has not been violated. Here, Mauchly's Test of Sphericity (Table 2) showed that it met the assumption of sphericity for the two-way interaction, $X^2(2)=74.41$, $p=.055$ even though it is borderline.

Table 2
Mauchly's Test of Sphericity[a]

Measure: MAVR

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Time	.170	74.407	2	.055	.546	.563	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.
a. Design: Intercept + class
Within Subjects Design: Time
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Since the data met the assumption of sphericity, tests of the within-subjects effects are thus interpreted as in Table 3:

Table 3
Tests of Within-Subjects Effects

Measure: MAVR		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	23226.213	2	11613.107	97.136	.000	.693
	Greenhouse-Geisser	23226.213	1.159	20044.663	97.136	.000	.693
	Huynh-Feldt	23226.213	1.198	19381.038	97.136	.000	.693
	Lower-bound	23226.213	1.000	23226.213	97.136	.000	.693
Time * class	Sphericity Assumed	10397.502	2	5198.751	43.484	.000	.503
	Greenhouse-Geisser	10397.502	1.159	8973.242	43.484	.000	.503
	Huynh-Feldt	10397.502	1.198	8676.162	43.484	.000	.503
	Lower-bound	10397.502	1.000	10397.502	43.484	.000	.503
Error(Time)	Sphericity Assumed	10281.772	86	119.555			
	Greenhouse-Geisser	10281.772	49.825	206.357			
	Huynh-Feldt	10281.772	51.531	199.525			
	Lower-bound	10281.772	43.000	239.111			

Table 3 indicates that there is a statistically significant interaction between the intervention and time on the vocabulary level, F (2, 86) = 43.48, p < .0005, partial η^2=.503. This means that there are different effects of different intervention groups on mean vocabulary levels over time. That is, mean vocabulary level changes differently over time depending on the traditional approach (i.e. the control group), or engage in mixed virtual augmented reality class (i.e. the experimental group). Since there are significant differences between the intervention and control groups, testing for the simple main effects of treatment at each level time is then run.

It was found that the mean Vocabulary level is 48.66 (95% CI, 42.623 to 54.711) which is lower at the beginning of the intervention trial as opposed to the control trial, a difference that is significant, F(1,44) = 412.38, p=.000). However, there was a statistically significant difference in vocabulary level between trials at the midway time point, F(1,44)=377.067, p=.000, a mean difference of 58.51 (95% CI, 52.44 to 64.58). Vocabulary level is also statistically significantly different in the intervention trial at the end (post-) of the trials, F(1,44)=412.375, a mean difference of 80.51 (95% CI, 72.52 to 88.50). The slow improvement in this study somehow contradicts some of the previous findings such as Bursali and Yilmaz (2019), Chen

(2020) and, Lai and Chang (2021). Bursali and Yilmaz (2019) found that AR-assisted activities allowed the learners to comprehend and memorise the information better from their reading. Chen (2020) found that it contributed to the development of learners' language skills by presenting a more manageable learning process. Similarly, Lai and Chang (2021) found that AR managed to significantly improve vocabulary skills among the first graders. Even though all these studies show similarity in terms of improvement, the rate of progress somehow differs from the current studies in which this current study depicts slower progress and the learners struggled to adapt to the technology used. Perhaps this is due to the context in which these learners from the current study came from rural area schools.

Challenges and Limitations of the Study

Collecting data for AR and VR research in rural areas posed several challenges. These challenges were related to technological, infrastructural, socio-economic, and cultural factors. Firstly, these rural areas often had limited or unreliable internet connectivity, hindering the download and streaming of AR and VR content. To mitigate the problem, the researcher developed offline solutions or used technologies that require minimal internet bandwidth. Here, Pre-load content onto devices was created to provide physical storage media for distribution. Secondly, rural area schools lacked access to high-quality AR and VR hardware, such as headsets and smartphones. Thus, the researcher had to opt for affordable and accessible hardware options. The researcher used low-cost VR devices, or design experiences that could run on smartphones with basic specifications. All in all, adapting AR and VR research to the specific challenges of rural areas requires a holistic approach that considers technological, cultural, and logistical factors. In addition, engaging with local communities and understanding their unique needs is crucial for successful implementation.

Conclusion

The study shows that the integration of Mixed Augmented and Visual Reality (MAVR) in the context of an animated flipped classroom for rural primary schools holds immense promise for reaching low-achieving young writers. This innovative approach harnesses the power of technology to enhance engagement, motivation, and the overall learning experience. The result of this study indicates that there is a significant increase in terms of vocabulary level across the different timeframes of six months. Here, it shows that by providing immersive and interactive learning environments, MAVR was able to facilitate language acquisition and the learners were able to develop vocabulary slowly. This gives us the impression that as we strive to bridge educational disparities and uplift low-achieving learners, MAVR in the animated flipped classroom represents a dynamic and inclusive solution that can empower these young writers with the essential skills and confidence needed for success. This approach not only addresses the immediate educational needs of low achievers but also paves the way for a more equitable and accessible education system, ensuring that no child is left behind in their journey to becoming proficient writers and lifelong learners.

However, the successful implementation of this technology requires a comprehensive approach that considers few implications. At the beginning of the study, the progress in vocabulary improvement seems a bit lower as compared to the control group of the traditional approach. The learners in the experimental group were nevertheless able to pick up and improve finally in the mid and final evaluation of vocabulary level. This shows that learners and teachers may need time and training to get used to the technology in their learning. As Kerr and Lawson (2020) have indicated that one of the major difficulties in integrating AR and VR is the lack of knowledge of theories and pedagogical principles. Developing effective methods for monitoring and assessing learner progress in this context is essential to ensure a more effective adaptation in learning. Educators need tools to gauge the impact of MAVR on low achievers' writing skills. Apart from that, there is a need for ongoing research to evaluate the long-term impact of MAVR technology in rural primary schools. Collecting data on learner performance, engagement, and learning outcomes will provide insights into the effectiveness of this approach. Parmaxi and Demetriou (2020) also emphasised that the majority of the AR and VR studies were conducted in tertiary education and there is a need to broaden the use of this technology in different contexts beyond tertiary education.

Overall, the significance of AR and VR in language learning research lies in their potential to revolutionise language education by offering innovative, immersive, and effective approaches to language acquisition. As technology continues to advance, these immersive technologies are likely to play an increasingly prominent role in language education. This is because the integration of AR and VR in language learning research provides opportunities for researchers to explore new methodologies, assess the effectiveness of immersive technologies, and contribute to the broader field of educational technology.

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