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Can Augmented Reality Revive Vocabulary Learning? A Study on Motivation Among Secondary EFL Learners

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Abstract

Augmented Reality (AR) is increasingly seen as a powerful educational tool that provides immersive and interactive learning experiences. However, its influence on English vocabulary learning among secondary school students remains underexplored. This study examines the effectiveness of AR in improving English vocabulary mastery and learning motivation among Grade VII students in Serang City, Indonesia. Using a randomized mixed-methods approach, 75 students (aged 12–13) were divided into an experimental group (n = 38), which received AR-based vocabulary instruction, and a control group (n = 37), which was taught using traditional image-based media. Quantitative data were collected through pre- and post-tests of vocabulary skills and motivation questionnaires, both showing high reliability (α = 0.932 and α = 0.890, respectively). Qualitative data were gathered via semi-structured interviews and analyzed thematically. Results from the Mann-Whitney U test and independent samples t-test indicated a significant improvement in vocabulary learning and motivation among students exposed to AR. The experimental group performed better than the control group in satisfaction, engagement, and interest. Interview results further supported these findings, emphasizing AR's ability to increase interactivity, support memory retention, cater to diverse learning styles, and boost overall learner enthusiasm. These results highlight the pedagogical potential of AR in fostering vocabulary development and motivation in secondary English education.

Keywords: Augmented reality; learning motivation; secondary students, vocabulary acquisition, EFL.

INTRODUCTION

Vocabulary acquisition plays a fundamental role in English language learning, yet it remains one of the most persistent challenges for Indonesian secondary students. Learners at this level frequently struggle to retain and apply new vocabulary effectively, which limits their reading comprehension, speaking fluency, and overall communicative competence (Komalasari, 2022; Machfudi & Afidah, 2022; Nanda & Azmy, 2020; Rosyada-As & Apoko, 2023). This difficulty is often linked to continued reliance on traditional instructional methods, such as textbook-based drills, rote memorization, and static image aids, which

provide limited context for meaningful vocabulary use (Hermagustiana et al., 2017; Jayanti & Norahmi, 2015). Additionally, English textbooks used in Indonesian classrooms often lack structured vocabulary progression and pedagogical coherence, which impedes learners' ability to internalize and apply new words (Aziez & Aziez, 2018). While digital technologies have become more common in EFL instruction, their role in vocabulary teaching is frequently shallow and underutilized. In many cases, educational technology is guided more by administrative policy than pedagogical need, resulting in minimal opportunities for contextualized or interactive vocabulary learning (Dewi et al., 2019; Ningsih et al., 2022).

Beyond instructional methods, motivation plays a vital role in second and foreign language learning. It influences how much effort learners put in, how long they stay engaged, and how willing they are to participate in meaningful language practice (Darvin & Norton, 2021; Mochklas et al., 2023; Tinto, 2022). In EFL classrooms, especially at the secondary level, students with higher motivation are more likely to take risks, engage with learning materials outside the classroom, and persevere through challenges. Conversely, low motivation, often caused by monotonous instruction and lack of relevance, can result in disengagement and poor language outcomes (Atmowardoyo et al., 2023; Zhou, 2024). Therefore, instructional practices must support vocabulary learning cognitively and foster affective factors like interest, enjoyment, and purpose. Innovative tools that encourage active participation and contextual learning, such as Augmented Reality (AR), hold promise for addressing both the cognitive and motivational aspects of vocabulary development.

One emerging technology that provides new opportunities for improving vocabulary learning is Augmented Reality (AR). AR superimposes digital content, such as 3D images, animations, and sounds, onto real-world settings using mobile devices, allowing learners to interact with vocabulary through multimodal and engaging experiences (Al-Ansi et al., 2023; Dargan et al., 2022; Rohman et al., 2024). This method is especially helpful for visual and kinesthetic learners, as it connects words to tangible objects and contexts, making abstract language more concrete and memorable. Weerasinghe et al. (2022) and Monteiro and De Souza Ribeiro (2020) highlight that AR allows learners to explore vocabulary in real-life scenarios, supporting retention and usage beyond simple memorization.

In addition to promoting vocabulary acquisition, AR also holds strong potential to enhance learning motivation. Motivation remains a critical factor in the success of EFL instruction in Indonesia, yet many secondary students continue to show low levels of engagement due to repetitive materials, limited modality exposure, and restricted opportunities for active participation (Astuti, 2016; Hanifa et al., 2024; Kisyani et al., 2019). AR, grounded in multimodal learning and situated cognition principles, fosters greater interest, enjoyment, and perceived relevance of classroom content. Its capacity to deliver dynamic, engaging, and context-rich learning experiences positions AR as a promising tool for addressing vocabulary learning difficulties and motivational challenges in Indonesian EFL classrooms.

Recent studies have explored the potential of Augmented Reality (AR) to support vocabulary acquisition and learner motivation in EFL contexts. Belda-Medina and Marrahi-Gomez (2023) investigated the impact of AR-based instruction among secondary students. They found increased motivation and positive perceptions, although no statistically significant gains in vocabulary performance were observed. In contrast, studies involving younger learners, such as Sadikin and Martyani (2020) and Agata et al. (2021), demonstrated

that AR significantly enhanced vocabulary mastery compared to traditional methods, with learners displaying higher engagement and better recall. Wahyuni et al. (2020) extended this work in higher education by integrating AR with the Picture Word Inductive Model (PWIM), suggesting that AR-PWIM designs offer pedagogically relevant and motivating experiences for vocabulary learning. Similarly, Megawati et al. (2023) highlighted positive perceptions from pre-service teachers, who saw AR as a valuable tool for enriching vocabulary instruction. Beyond learner attitudes, Chen and Wang (2015) revealed that AR's effectiveness may vary depending on learning styles and prior proficiency, particularly benefiting field-dependent learners. Studies by Tsai (2020) and Ustun et al. (2022) confirmed that AR-supported instruction can significantly enhance vocabulary performance and student motivation through its dynamic, multimodal, and contextual nature. Collectively, this growing body of research affirms the pedagogical value of AR in EFL vocabulary instruction, although its application in Indonesian secondary education remains underexplored.

Although Augmented Reality (AR) has shown significant promise in language education, its implementation in Indonesian secondary school vocabulary instruction remains largely unexplored. Much of the existing literature has focused on primary or tertiary education contexts, leaving a notable gap in understanding how AR supports vocabulary learning and student motivation at the secondary school level. This study aims to address that gap by examining cognitive and affective outcomes, specifically vocabulary mastery and learning motivation, while capturing students' lived experiences during AR-based English instruction. Guided by the hypotheses that (1) Augmented Reality significantly improves vocabulary mastery, and (2) Augmented Reality considerably enhances students' learning motivation, this study seeks to provide a thorough evaluation of AR's educational value. To test these hypotheses, the study explores the following research questions: How does AR influence secondary students' vocabulary mastery? How does AR affect their learning motivation? Additionally, what are students' experiences after learning English vocabulary with AR?

METHOD

This study employed a sequential explanatory mixed-methods design, integrating quantitative and qualitative approaches to investigate the effects of Augmented Reality (AR) on vocabulary mastery and learning motivation among Indonesian secondary school students. This design allows researchers to use initial quantitative results to inform and refine subsequent qualitative inquiries, resulting in a more comprehensive understanding of educational phenomena (Creswell & Creswell, 2017; McCrudden & McTigue, 2018). The research began with a quantitative phase to identify patterns and measure learning outcomes, followed by qualitative data collection to explore student experiences and provide a deeper contextual understanding of the intervention. The study was conducted at a public secondary school in Serang City and involved Grade VII students. A total of 75 students were selected through simple random sampling, a technique valued for ensuring representativeness and reducing sampling bias in school-based educational research (Banerjee & Chaudhury, 2010). The participants were divided into two groups: the experimental group (n = 38), which received AR-based instruction, and the control group (n = 37), which received instruction using traditional image-based media. The demographic

profile of the participants indicated a higher proportion of female students (58.7%) compared to male students (41.3%). Regarding age, the majority were 13 (61.3%), while the remaining 38.7% were 12.

This study used a pre-test and post-test with 30 items to measure students' vocabulary mastery, adapted from Belda-Medina & Marrahi-Gomez (2023). The test included 20 gap-filling tasks and 10 image-word matching questions focusing on English vocabulary related to animals. Designed to assess recognition and contextual understanding, the test aligned with the Merdeka curriculum, which emphasizes flexible, student-centered, and contextualized learning experiences (Haq & Wakidi, 2024). The instrument's reliability was confirmed through Cronbach's alpha analysis, resulting in a high internal consistency value of 0.932, which exceeds the standard threshold of 0.70 for educational testing (Tavakol & Dennick, 2011). Additionally, item validity was verified through Pearson correlation analysis, with all items surpassing the minimum r-value of 0.361 at $\alpha = 0.05$ ($N = 30$), and all p-values below 0.05, indicating acceptable item discrimination and construct validity (Fraenkel et al., 2012).

A 10-item Likert-scale questionnaire was administered after the intervention to measure students' learning motivation. The instrument, also adapted from Belda-Medina and Marrahi-Gomez (2023), included seven general items applicable to all participants and three items tailored to the distinct experiences of either the experimental or control group. The questionnaire was grounded in established motivational frameworks for second language learning, incorporating indicators such as learning satisfaction, perceived usefulness, interest, engagement, and sustained motivation (Dörnyei & Ushioda, 2011). The instrument demonstrated strong internal consistency, with a Cronbach's alpha of 0.890, reflecting high reliability for measuring student motivation (DeVellis, 2017). Together, the test and questionnaire provided robust and psychometrically sound tools to examine AR-based vocabulary instruction's cognitive and affective impacts.

The study was conducted over five consecutive weeks to examine the impact of Augmented Reality (AR) on vocabulary acquisition and motivation. In Week 1, both experimental and control groups completed a vocabulary pre-test. The experimental group was introduced to Octagon's 4D+ Animal AR Flashcard application, while the control group began conventional vocabulary instruction using printed images. During Weeks 2 and 3, the control group received teacher-led vocabulary instruction using static images, whereas the experimental group engaged with the AR flashcards using smartphones under teacher-supervised conditions. Students scanned the AR cards to interact with animated 3D animal models and used the information to write descriptive texts. Additionally, they completed app-integrated quizzes that encouraged active retrieval and reinforcement of vocabulary—a strategy to strengthen vocabulary learning in immersive environments.

In Week 4, both groups completed the vocabulary post-test and a learning motivation questionnaire. Quantitative data were analyzed using SPSS 25. The vocabulary data were found to be non-normally distributed; thus, the Mann–Whitney U test was used to compare vocabulary performance between groups, a common non-parametric alternative for small samples (Pallant, 2020). An independent samples t-test was employed to compare motivation questionnaire results, which met the assumptions of normality.

In Week 5, semi-structured interviews were conducted with selected experimental group students to explore their AR-based learning experiences. Interview questions targeted

key constructs such as engagement, motivation, interactivity, and perceived learning benefits. The qualitative data were transcribed and analyzed using Braun and Clarke's (2021) six-step thematic analysis procedure, which is widely recognized for its flexibility and clarity in identifying recurring patterns in educational research. The qualitative phase supported methodological triangulation (Creswell & Plano Clark, 2018), allowing for deeper interpretation of the quantitative results and enhancing the study's overall validity by converging multiple data sources.

FINDINGS

This section presents the study's results concerning the research questions, which examined the effects of Augmented Reality (AR) on Indonesian secondary school students' vocabulary mastery, motivation to learn, and their experiences with AR-based learning. The findings are organized according to the two quantitative hypotheses and the qualitative exploration. Quantitative results come from pre- and post-tests of vocabulary and motivation questionnaires, while qualitative data were gathered through semi-structured interviews with selected students from the experimental group.

Hypothesis 1

Table 1. Rank of the post-test vocabulary score

Class	N	Mean of Rank	Sum of Ranks
Control	37	29.46	1090.00
Experiment	38	46.32	1760.00

Regarding Hypothesis 1 (H1), Table 1 displays the rank distribution of students' vocabulary post-test scores for both the control and experimental groups. The control group (n = 37) obtained a mean rank of 29.46, while the experimental group (n = 38), which received Augmented Reality (AR)-based instruction, achieved a significantly higher mean rank of 46.32. The sum of ranks for the control group was 1,090.00, compared to 1,760.00 for the experimental group. These figures indicate that students in the experimental group consistently outperformed their peers in the control group on the vocabulary post-test. The substantial difference in mean ranks suggests a positive effect of AR integration on students' vocabulary mastery.

Table 2. Result of Mann-Whitney Vocabulary Mastery

Mann-Whitney U	387.000
Wilcoxon W	1090.000
Z	-3.370
Asymp. Sig (2-tailed)	0.001

Furthermore, table 2 presents the results of the Mann–Whitney U test conducted to examine the difference in vocabulary mastery between the control and experimental groups. The Mann–Whitney U value is 387.000, with a Z-score of -3.370, and the Asymptotic Significance (2-tailed) value is 0.001. Since the p-value is less than 0.05, this result indicates a statistically significant difference between the two groups. Specifically, the experimental group, which used Augmented Reality (AR) in vocabulary learning, showed significantly better post-test performance than the control group. This finding confirms that AR-based instruction had a meaningful impact on improving students' vocabulary mastery.

Hypothesis 2

Table 3. Levene's test

Variable	F	Sig.
Motivation Questionnaire	1.418	0.238

The results of Levene's Test for Equality of Variances were conducted to determine whether the assumption of equal variances holds for the motivation questionnaire scores between the experimental and control groups. The test produced an F-value of 1.418 and a significance level (p-value) of 0.238. Since the p-value is greater than 0.05, the result is not statistically significant, indicating no significant difference in variance between the two groups. This means that the assumption of homogeneity of variances is met, allowing the study to interpret results from the "equal variances assumed" row in the independent samples t-test. Meeting this assumption strengthens the validity of the t-test results used to evaluate differences in student motivation between the AR-based and traditional instruction groups.

Table 4. T-test equality of means

					95% confidence interval of the difference	
		t	df	Sig. 2(tailed)	lower	upper
Motivation questionnaire	Equal variance assumed	-4.143	73	.000	-6.546	-2.294
	Equal variance not assumed	-4.153	71.4	.000	-6.542	-2.298

The t-test yielded a t-value of -4.143 with 73 degrees of freedom (df) and a significance level (2-tailed) of 0.000. Since the p-value is less than 0.05, the result is statistically significant, indicating a meaningful difference in motivation scores between the two groups. The mean difference was -4.420, showing that the experimental group, which used Augmented Reality (AR), reported significantly higher motivation scores than the control group, which received conventional instruction. The 95% confidence interval for the difference ranges from -6.546 to -2.294, suggesting a high level of confidence that the actual difference in means lies within this interval. This result supports the conclusion that the AR-based learning intervention positively affected students' learning motivation.

Table 5. Learning motivation

No.	Indicator	CG		EG	
		M	SD	M	SD
1	Learning Satisfaction	6.03	1.922	8.16	1.346
2	Interest	3.51	0.932	6.89	1.624
3	Perceived Usefulness	6.86	1.159	6.92	1.600
4	Engagement	5.70	1.884	7.00	1.560
5	Further Interest	7.32	1.313	7.50	1.428

The results in Table 5 show that students in the experimental group consistently performed better than those in the control group across all measures. For learning satisfaction, the experimental group reported a higher average score (M = 8.16, SD = 1.346) compared to the control group (M = 6.03, SD = 1.922), indicating that AR-based instruction increased enjoyment and fulfillment. Regarding interest, the experimental group again scored significantly higher (M = 6.89, SD = 1.624) than the control group (M = 3.51, SD = 0.932), showing that AR activities were more engaging and stimulating. For perceived usefulness, the difference was small but still favored the experimental group (EG: M = 6.92, SD = 1.600; CG: M = 6.86, SD = 1.159), suggesting both groups found the content helpful, but AR slightly improved this perception. In terms of engagement, students in the AR group (M = 7.00, SD = 1.560) felt more actively involved than those in the control group (M = 5.70, SD = 1.884). Finally, the desire to continue learning was slightly higher in the experimental group (M = 7.50, SD = 1.428) than in the control group (M = 7.32, SD = 1.313), implying that AR instruction may also promote ongoing motivation.

Student experiences with AR-based vocabulary learning

Thematic analysis of the semi-structured interviews revealed four interconnected themes reflecting students' experiences with Augmented Reality (AR) in vocabulary learning: enhanced engagement and interaction, improved memory and comprehension, learning style compatibility, and increased motivation through novelty and enjoyment. These themes illustrate how AR-based instruction reshaped students' perceptions of vocabulary learning, making it more interactive, personalized, and meaningful.

One of the most prominent experiences reported by students was the increased engagement and interactivity offered by AR. Unlike traditional vocabulary lessons, which relied heavily on static images or teacher explanation, AR allowed students to actively explore content through 3D animal models viewed on their smartphones. This interactive environment transformed the learning atmosphere, making it more dynamic and enjoyable. One student (P3) shared, "*Learning English using AR is intriguing and fun because I can engage in learning and interact directly with animals*." Another (P5) commented, "*Learning vocabulary using AR is interesting and practical*." A different participant (P6) added, "*It felt like I was playing a game, but at the same time, I was learning. That made me pay more attention*." Students consistently emphasized how the hands-on nature of AR made them feel more connected to the material and less distracted during lessons.

AR also significantly enhanced memory and comprehension by linking vocabulary to visual and interactive stimuli. Students found it easier to remember and understand new words when presented through animated 3D representations and supported by textual descriptions. As P2 explained, "*When learning using AR, it is easier for me to remember new words because the explanations are visualized with exciting pictures*." Another student (P5) reinforced this by saying, "*The words in AR are simple and connected to 3D images, making it easy for me to understand."* Several students noted that being able to manipulate or rotate the images of animals helped them internalize the vocabulary more deeply. "*I can remember the words better because I can see the animal from all angles and read the information again and again,"* said P7. The visual and experiential nature of AR enabled stronger word-image associations, which helped anchor vocabulary in students' long-term memory.

The compatibility of AR with diverse learning styles was another important theme. Students with visual and kinesthetic preferences found AR especially helpful, as it combined

movement, visuals, and audio. "*Learning using AR suits my style*," said P4. "I'm a visual learner, and the 3D models help me absorb information better than just reading a textbook." Similarly, P1 shared, "*I prefer to learn by interacting, not just sitting and listening. AR is perfect because I can scan, watch, and respond*." Other students appreciated the flexibility to review content at their own pace. One noted, "*If I didn't understand something, I could just scan the card again and read the explanation. That's not possible when the teacher moves on to the next topic.*"

Finally, students consistently described AR as a tool that increased their motivation through novelty and enjoyment. The immersive and game-like nature of AR made vocabulary lessons feel fresh and exciting, breaking away from the monotony of traditional learning methods. As P3 described, "*Compared to other methods, learning vocabulary with AR is much more fun because I can see, listen, and interact directly with the material*." P5 agreed, noting, "*With AR, I can search for objects in an interesting way. It makes me want to learn more*." Another student (P8) said, "Usually, I get bored in class, but AR made me curious to see what the next animal would be." Some students expressed a desire to use AR beyond the classroom. "*If we had more AR at home, I would be more motivated to study vocabulary after school*," said P9. This enthusiasm suggests that AR enhanced momentary engagement and fostered longer-term interest in language learning.

DISCUSSION

The findings of this study underscore the pedagogical potential of Augmented Reality (AR) in improving vocabulary mastery and learning motivation among Indonesian secondary school students. Quantitatively, students who received AR-based instruction significantly outperformed their peers in the control group, with the Mann-Whitney U test revealing a substantial difference in post-test scores ($U = 387.000$, $Z = -3.370$, $p = 0.001$). This suggests that integrating AR offers a more effective alternative to traditional image-based learning methods, particularly in vocabulary acquisition. Drawing on theories of multimodal and multimedia learning (Lai, 2024; Mayer, 2009; Vu et al., 2022), combining visual, verbal, and interactive input enabled learners to form richer mental representations and engage in more meaningful lexical processing. In EFL classrooms, where vocabulary learning often lacks contextual grounding, AR helps bridge this gap by making vocabulary both visual and experiential (Belda-Medina & Marrahi-Gomez, 2023; Lan et al., 2018; Vedadi et al., 2019).

The motivational benefits of AR were equally clear. An independent samples t-test showed a significant difference in motivation scores ($t(73) = -4.143$, $p = 0.000$), with the AR group scoring much higher in areas like learning satisfaction, interest, engagement, and desire to keep learning. For example, students in the AR group reported an average satisfaction score of 8.16, compared to 6.03 in the control group, and interest increased from 3.51 to 6.89. These findings support the main ideas of Self-Determination Theory (Deci & Ryan, 2000), indicating that AR settings promote autonomy, competence, and relatedness, which are key to intrinsic motivation (Han, 2021; Kam & Umar, 2023). The gamified and exploratory aspects of AR seemed to boost emotional involvement and focus, tackling one of the biggest issues in secondary education: learner disengagement (Atmowardoyo et al., 2023; Nagle, 2021).

Beyond engagement and enjoyment, students also reported improved comprehension and memory retention. Many credited their success to the ability to interact with content

repeatedly and at their own pace, scanning, rotating, and exploring 3D animal models while reading accompanying explanations. This supports Mayer's (2009) claim that dual-channel learning (visual and verbal) enhances memory encoding. Furthermore, AR's compatibility with different learning styles allowed students to customize their experience. As highlighted by Noviska and Anastasia (2023) and Younas and Dong (2024), aligning learners' preferred styles, such as visual learners benefiting from animated imagery and kinesthetic learners engaging through hands-on manipulation, and AR-based instruction likely boosted self-efficacy and sustained motivation. Additionally, when learners feel in control and see progress, they are more likely to persevere and develop independent learning habits—key qualities for long-term language growth (Ozer & Yukselir, 2021; Yu, 2022; Shengyao et al., 2024).

These findings carry pedagogical relevance for the Indonesian secondary school EFL context, where instruction is still predominantly textbook-centered and often lacks interactive or contextual vocabulary practice (Jayanti & Norahmi, 2015; Komalasari, 2022; Yuliansyah & Ayu, 2021; Zheng & Zhou, 2022). The use of AR in this study, aligned with the Merdeka curriculum's emphasis on contextual and student-centered learning, provides a practical illustration of how digital tools can be meaningfully embedded into classroom instruction (Amiruddin et al., 2023; Haq & Wakidi, 2024; Hunaepi & Suharta, 2024). While most prior research on AR in education has focused on early childhood or tertiary-level learners (Sadikin & Martyani, 2020; Ustun et al., 2022), this study contributes to a growing body of work suggesting that secondary-level students may also engage positively with AR-based vocabulary instruction. The integration of AR appeared to support vocabulary learning and students' affective responses, such as increased motivation and interest. The convergence of improved test performance and students' reported engagement suggests that, when thoughtfully implemented, AR may offer complementary benefits to traditional instruction by supporting varied learning styles and fostering more active participation.

CONCLUSION

The integration of digital tools in English language education has gained growing attention, yet the use of Augmented Reality (AR) in Indonesian secondary schools remains underexplored, particularly for vocabulary instruction. The present study examined how AR can support both cognitive and affective dimensions of vocabulary learning within this context. The findings reveal that when AR is thoughtfully integrated into classroom practice, it enhances measurable learning outcomes and transforms students' engagement with the learning process. Rather than acting merely as a novelty, AR functioned as a pedagogical bridge, connecting visual, kinesthetic, and interactive input modes to support diverse learner needs. The increased motivation observed among students was not limited to momentary interest but extended to a deeper sense of autonomy, enjoyment, and perceived relevance of vocabulary learning. These outcomes suggest that AR's value lies not simply in the technology but in how it reconfigures students' relationships with language content and classroom tasks.

Nevertheless, the scope of this study presents limitations that warrant consideration. Its implementation in a single public secondary school with a modest sample size may restrict the breadth of applicability across different educational contexts. The short intervention period also limited the ability to evaluate delayed learning effects or long-term

retention. Moreover, the study focused on a specific AR tool with limited content range, which may not fully represent the potential of AR across broader curriculum areas or skill domains. Additionally, student perceptions were collected only from the experimental group, without comparative qualitative data from the control group, which could have provided a more nuanced understanding of instructional differences.

Future research should adopt a broader sampling frame involving diverse school settings, age groups, and socio-demographic backgrounds to extend the insights gained from this study. Longitudinal studies are also needed to explore the sustained impact of AR on vocabulary retention and learner autonomy over time. Comparative studies using different types of AR platforms or integrating AR into other language domains—such as speaking or writing—could yield richer pedagogical implications. Furthermore, incorporating teacher perspectives and classroom observations would offer a more holistic view of AR-enhanced instruction's implementation challenges and affordances. Such investigations can inform more scalable and context-sensitive strategies for embedding AR within the evolving landscape of EFL education.

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