JOLLT Journal of Languages and Language Teaching
https://e-journal.undikma.ac.id/index.php/jollt
Email: jollt@undikma.ac.id
DOI: https://doi.org/10.33394/jollt.v13i3.13444

July 2025. Vol.13, No. 3
p-ISSN: 2338-0810
e-ISSN: 2621-1378
pp. 1101-1116

EXAMINING THE IMPACTS OF VIRTUAL REALITY (VR) ON SELF-DIRECTED LEARNING IN EFL: A MIXED-METHODS STUDY

[1]Panji Tanashur, [2]Sonia Octavia, [3]*Dedi Aprianto
[1]English Lecturer, Faculty of Humanities, Law & Tourism, Bumigora University, Indonesia
[2]Digital Business Study Program, Insan Cita Indonesia University, Indonesia
[3]English Lecturer, Faculty of Engineering, Bumigora University, Indonesia

*Corresponding Author Email: dedi@universitasbumigora.ac.id

Article Info

Article History
Received: January 2025
Revised: May 2025
Published: July 2025

Keywords
Virtual reality;
Self-directed learning;
EFL learning;
Online learning;

Abstract

The study examines how VR enhances self-directed learning in EFL by overcoming traditional methods' limitations, boosting autonomy and engagement. While previous studies highlighted VR's positive effects on student engagement in language learning, its impact on SDL remains underexplored, with limited quantitative evidence and scarce qualitative insights into subjective experiences. This study used a mixed-methods approach, combining quantitative analysis to identify measurable trends and qualitative insights for a deeper understanding of VR's influence on SDL. A survey of 194 EFL students used VR and SDL questionnaires, analyzed through simple linear regression. To enrich findings, semi-structured interviews with 13 participants explored their experiences. The findings showed that there is a positive effect of VR use on SDL, as indicated by the regression coefficient of 0.945, meaning that a 1% increase in the level of VR use is related to a 0.945 increase in self-directed learning $p<0.05$. The ANOVA results confirmed the reliability of the regression model in explaining the relationship between VR and SDL, with a significance of 0.000. R-squared value of 0.927, indicating that 92.7% of SDL variability is explained by VR. This demonstrates VR's strong enhancement of SDL in EFL students, improving their autonomy and engagement in language learning. Adjusted R-squared value of 0.926 further confirms VR's significant impact on SDL. Qualitative findings identified three key benefits of VR: higher engagement and motivation, improved access and flexibility, and cognitive reflection through self-reflection. The findings highlight VR's effectiveness as an active learning strategy that promotes independent learning by enhancing learner autonomy and engagement. In EFL contexts, VR-based strategies support interactive, self-paced learning, contributing to increased motivation and language retention.

How to cite: Tanashur, P., Octavia, S., & Aprianto, D. (2025). Examining the Impacts of Virtual Reality (VR) on Self-Directed Learning in EFL: A Mixed-Methods Study, *JOLLT Journal of Languages and Language Teaching*, 13(3), 1101-1116. Doi: https://doi.org/10.33394/jollt.v13i3.13444

INTRODUCTION

Today, the Virtual Reality (VR) technology is found as an effective multimedia tool for improving teaching-learning process in different fields. Due to its capabilities of developing fully interactive environments, VR promises new possibilities of changing traditional learning models. The integration of VR in English language learning has shown significant potential in enhancing self-directed learning (SDL) by providing immersive and interactive experiences that foster engagement and motivation. Studies indicate that VR environments allow learners to practice language skills in realistic contexts, which can lead to foster retention and comprehension compared to traditional methods (Shadiev et al., 2021; Hung et al., 2023). VR facilitates repeated practice in a safe environment, which is crucial for developing confidence in language use (Huang, 2024). When comparing VR to previous effective English learning methods, research suggests that VR outperforms traditional techniques, such as flashcards and

textbook learning, in promoting vocabulary acquisition and overall language proficiency (Xiang, 2024; Cokay et al., 2023). Additionally, VR's ability to simulate real-world interactions enhances learners' communicative competence, which is often lacking in conventional classroom settings (Yuan, 2024). It is compared to the previous methods like YouTube-based learning, while beneficial for self-regulated learning, often lack the interactive and immersive qualities that VR offers (Wang & Chen, 2019). Traditional approaches can lead to disengagement and limited practical application of language skills, as they do not simulate real-life interactions effectively (Bai & Wang, 2020). Therefore, these suggests that VR not only enhances SDL but also surpasses traditional methods in fostering independent language learning. Given the nature of knowledge, skills and competencies needed in today's dynamic world of work, and the problems associated with conventional forms of learning, VR technology has the potential for learning that can meet the needs and preferences of learners in a fully interactive and effective manner.

Several studies highlight the effectiveness of Virtual Reality (VR) and Augmented Reality in enhancing EFL learning by increasing motivation and participation. VR enables real-time oral skill evaluation, boosting engagement and language acquisition (Bahari, 2021). It also enhances aviation learners' engagement, improves context-oriented vocabulary learning, and generates higher motivation compared to non-VR methods (Chen et al., 2021). Additionally, a visual stylizer-based VR approach fosters higher motivation and positive attitudes due to its tangible learning experience (Wang et al., 2021). VR provides authentic contexts for language practice, improving English communication competence. It also supports engaging and socially interactive learning, fostering collaboration and learner autonomy (Luan et al., 2020). Furthermore, VR integrates well with experiential learning strategies in language education (Hu-Au & Lee, 2017). These studies affirm VR's role in enhancing motivation, engagement, and learning outcomes in EFL education.

Furthermore, the constructivist theory suggests that learners build knowledge through experience and interaction (Makransky & Petersen, 2021). VR supports this by creating immersive environments where students engage in realistic scenarios, enhancing language comprehension and retention (Parong & Mayer, 2018). Moreover, experiential learning theory, particularly Kolb's cycle, emphasizes the importance of concrete experiences followed by reflective observation, abstract conceptualization, and active experimentation (Chen et al., 2024). VR facilitates experiential learning, where learners can reflect on their interactions and language use, thereby reinforcing their learning outcomes (Hamilton et al., 2020). Thus, integrating VR into EFL education can effectively leverage these learning theories to promote deeper, more meaningful language acquisition.

Although VR has been beneficial in language learning, quantitatively its particular contribution in enhancing EFL students' self-learning abilities remains uncharted and developed. Furthermore, there is still very little literature showing evidence of VR's role in enhancing one's autonomy and self-learning skills, and more importantly, very little qualitative work regarding the subjective experiences of EFL students using VR for self-learning. This study aims to address this gap by providing insights into VR-based strategies and student experiences, thereby contributing to the development and implementation of VR-enhanced self-directed learning in EFL contexts. Based on the research gaps mentioned above, the researcher addressesed two important research questions, namely, (1) To what extent does VR affect the EFL students' self-directed learning? (2) How is the learning experience of EFL students in using VR in order to promote their self-directed learning? This research highlights VR's advantages in enhancing self-directed learning, making it a practical and meaningful tool for English language learning.

RESEARCH METHOD

Research Design

This study utilized a mixed methods research design, specifically an explanatory sequential approach, to comprehensively explore how Virtual Reality (VR) fosters self-directed learning (SDL) in language learning. The design began with a quantitative phase, employing surveys with two questionnaires; one focused on VR and the other on SDL, to assess the impact of VR on SDL among EFL students. This phase aimed to identify broad patterns and relationships. Subsequently, the qualitative phase involved semi-structured interviews with a subset of participants to delve deeper into the quantitative findings, uncovering students' experiences, perceptions, and attitudes toward VR-based learning. This sequential design allowed the research to first measure VR's effects quantitatively and then explore the underlying cognitive and affective mechanisms qualitatively, providing contextual support for the numerical data. Alternative designs, such as convergent mixed-methods or qualitative-first approaches, were considered but deemed unsuitable, as they either required simultaneous data collection or prioritized subjective interpretations over initial quantitative insights. The explanatory sequential design was chosen to enhance quantitative findings with qualitative depth, making it ideal for investigating VR's role in SDL.

Population and Sample

The population of study is 374 undergraduate students enrolling in a compulsory English course at the Computer Science Department of Bumigora University in Mataram. For the quantitative phase, Slovin's formula was applied with a 5% margin of error to determine a statistically representative sample size, resulting in 194 randomly selected students. This approach minimizes sampling error while ensuring feasibility in data collection and analysis. The sample selection criteria included students who were actively learning English, had an understanding of technology and VR applications, and consented to participate, ensuring the relevance and usefulness of the data. In the qualitative phase, 13 English as a Foreign Language (EFL) students were purposively selected to capture diverse perspectives on VR-based English learning. The selection process aimed to achieve data saturation, a point where no new significant themes or insights emerged during interviews. This aligns with established qualitative research practices, which suggest that a sample size of 10 to 15 participants is typically sufficient to reach thematic saturation (Guest et al., 2006). Achieving saturation ensures comprehensive data on students' SDL experiences with VR, balancing quantitative representativeness and qualitative depth to enhance validity and reliability.

Table 1
The Information of Selected Samples and Subjects of the Study

No.	Smt/Classes	Virtual Reality	Self-Directed Learning	In-depth Interview	Total (n) Per-class
		(n)	(n)	(n)	
1.	II/a	50 (25.8%)	40 (20.6%)	4 (30.8%)	94 (48.5%)
2.	II/b	30 (15.5%)	35 (18.0%)	3 (23.1%)	68 (35.1%)
3.	II/c	25 (12.9%)	30 (15.5%)	2 (15.4%)	57 (29.4%)
4.	II/d	45 (23.2%)	42 (21.6%)	2 (15.4%)	89 (45.9%)
5.	II/e	44 (22.7%)	47 (24.2%)	2 (15.4%)	93 (48.0%)
Total (n)		194 (100%)	194 (100%)	13 (100%)	194 (100%)

Instruments

The research instruments included two questionnaires: a VR questionnaire measuring VR use in EFL learning and an SDL questionnaire assessing students' self-learning. The VR questionnaire covered effectiveness, motivation, independence, self-confidence, ease of access,

perceived effectiveness, preferences, skill development, and material understanding. The SDL questionnaire focused on goal setting, learning progress evaluation, independent learning ability, initiative, self-exploration, development, ability testing, and task completion. Both used a 4-point Likert scale: 4 (Very Agree), 3 (Agree), 2 (Disagree), 1 (Very Disagree). Validity and reliability were tested using Pearson product-moment, with Cronbach's Alpha for VR (0.761 > 0.6) and SDL (0.761 > 0.6), indicating high reliability. A semi-structured interview provided qualitative insights, ensuring validity through question relevance and reliability via inter-rater consistency. Potential biases in self-reported data were mitigated using triangulation, which compared quantitative questionnaire data with qualitative interview data to verify findings. Source triangulation was applied by sampling from different classes to avoid group-specific bias, while researcher triangulation involved multiple analysts to ensure objectivity and reduce individual bias. Response consistency was checked by aligning questionnaire and interview answers, with discrepancies clarified, thereby enhancing the validity and reliability of the results. In addition, the original questionnaires included 15 items each for VR and SDL, but only 5 VR's items and 4 SDL's items are presented here, corresponding to their respective categories. This selection ensures category representation and data clarity.

Table 2
The Questionnaires' Items of VR and Self-Directed Learning

No.	VR Questionnaire's Items		SDL Questionnaire's Items	
	Questionnaire's Category	**Items**	**Questionnaire's Category**	**Items**
1.	Effectiveness of VR	The use of VR helps me understand the material better.	Goal Setting and Evaluation of Learning Progress	I can evaluate my learning progress with VR.
2.	Motivation and Independence	I prefer to use VR for self-directed learning compared to other methods.	Independent Ability and Initiative to Learn	I choose VR topics or materials that interest me for English learning.
3.	Perceived effectiveness and preferences	The use of VR helps me overcome learning difficulties.	Self-Exploration and Development	I use VR to improve my English independently.
4.	Perceived effectiveness and preferences	VR makes learning more interactive and fun.	Ability Testing and Task Completion	I am satisfied with managing my learning using VR.
5.	Skill development and understanding of materials	Using VR improves my technical skills in learning.		

Data Collection

Quantitatively, Quantitative data were collected through a survey targeting a large number of respondents. Participants completed two questionnaires (VR and SDL) in the classroom to ensure a high response rate and comfortable participation. Additionally, semi-structured interviews with 13 EFL learners provided qualitative insights into VR use and self-directed learning experiences. Data collection occurred in two contexts: (1) VR use in a controlled classroom setting under teachers' supervision (2) independent VR use outside the classroom, offering insights into different learning situations. The interview protocol used a written response format to minimize bias and allow free expression. Participants answered six predefined questions on VR's impact on self-directed learning activities, motivation, and

technical challenges. This structured approach ensured systematic analysis and deeper insights into students' independent learning with VR, as follows.

Table 3
Interview Questions on VR and Self-Directed Learning

Category	Interview Questions
VR for Language Skills	1) How does VR help you improve your speaking skills in English? 2) Do you use VR to improve your reading comprehension? If so, how? 3) Have you found VR helpful in improving your writing skills in independent learning? Explain how.
Independent Learning Strategies	4) How do you set learning goals and track your progress within VR English learning experiences? 5) Do you find VR motivates you to study English independently? Why? 6) How do you manage potential distractions or technical difficulties while learning English in VR?

Data Analysis

The simple linear regression was used to analyze the quantitative data, aiming at investigate the relationship between VR as the independent variable and SDL as the dependent variable. Initially, the researchers organized the quantitative data gathered from the VR and SDL questionnaires, ensuring accurate coding of responses. Descriptive statistics, such as means and standard deviations were calculated to provide an overview of the VR and SDL scores. The researchers then verified the assumptions necessary for linear regression, checking for linearity and normality of residuals. A normality test by using the Shapiro-Wilk model, then followed by a linearity test. To find out whether the data is normally distributed or not, the Kolmogorov-Smirnov (K-S) showed the *p*-value 0.298 > 0.05 (Data on VR usage on SDL is normally distributed .H_1 and Data is not normally distributed (accepted if $p < 0.05$)). The linearity test on the independent variable and the dependent variable, it is known that the *Sig.* deviation from linearity value of 0.057 > 0.05. Therefore, this assumption test was concluded that there is a linear relationship between the use of VR and SDL strategy. Subsequently, With the fulfillment of these assumptions, simple linear regression analysis could be done. Despite the significant findings, this model has certain limitations. The simple linear regression only establishes an associative relationship and does not confirm causality. Additionally, other external factors influencing SDL were not controlled in this study, and the accuracy of results depends on the fulfillment of classical assumptions. The qualitative analysis identified patterns and themes from interview data on VR's use in self-directed learning through five stages: familiarization with transcriptions, initial coding of relevant segments, grouping codes into themes, reviewing themes for consistency, and naming/describing each theme. To assess VR's efficacy, statistical measures were applied, including the level of correlation, the coefficient of determination, and the adjusted R square, to evaluate the relationship and impact of VR on self-directed learning, here is the table:

Table 4
The Classifications of Regression Values

No.	R Values	The levels of R, R^2 & Adjusted R^2
1.	0.00 - 0.10	Very Low
2.	0.10 - 0.30	Low
3.	0.30 - 0.50	Neutral
4.	0.50 - 0.70	Strong
5.	0.70 - 0.90	Very Strong
6.	0.90 - 1.00	Perfect

RESEARCH FINDINGS

Descriptive Analysis of VR Usage Level and its Relationship with Self Learning

The descriptive statistics analysis summarizes VR usage and SDL data through mean, standard deviation, and score ranges. It reveals distribution trends, guiding researchers before conducting inferential tests on their relationship.

Table 5
Profiles of VR Use and Self-Directed Learning among Respondents

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
The Use of Virtual Reality	194	70.00	98.00	89.2680	5.97667
Self-Directed Learning	194	70.00	98.00	88.7887	5.86830
Valid N (listwise)	194				

The descriptive statistical analysis revealed that among 194 respondents, the average usage levels of VR and self-directed learning were relatively high, at 89.27 and 88.79, respectively. Scores for both variables ranged from 70.00 to 98.00, showing a fairly wide spread. The standard deviations were moderate (5.98 for VR and 5.87 for SDL), indicating balanced and consistent data distribution. However, this analysis was descriptive and could not determine if there was a significant relationship or influence between VR use and SDL. To assess this, a simple linear regression was conducted to evaluate the strength and significance of VR's impact on self-directed learning.

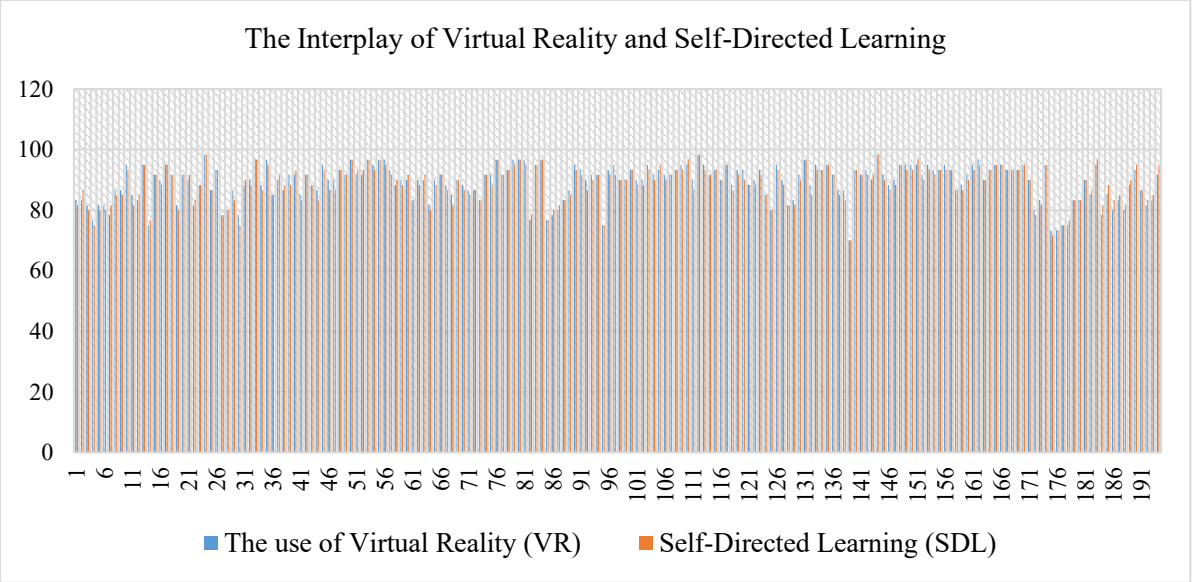

Figure 1.The Relationship of Virtual Reality (VR) and Self-Directed Learning (SDL)

The grouped bar chart compares the use of VR and SDL across multiple categories. The data shows a consistent pattern, with both variables having closely aligned values, mostly ranging between 80 and 100. There are minor fluctuations, but no significant upward or downward trends, indicating a strong correlation between VR usage and SDL. The similarity in bar heights suggests that increased VR use is associated with higher levels of self-directed learning.

The Effects of Virtual Reality on EFL Students' Self-Directed Learning

The results emphasized the coefficient showing VR's impact on self-directed learning, providing key values like coefficient magnitude, t-values, and statistical significance for assessment, as follows:

Table 6
Significance of the effect of Virtual Reality on Self-Directed Learning

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	4.416	1.717		2.572	0.011
	VR	0.945	0.019	0.963	49.241	0.000
a. Dependent Variable: Self-directed learning						

Based on the results, the value of Constant (a) with a value of 4.416, while the value of VR (b/regression coefficient) is 0.945, so that the regression equation can be formulated, as follows; Y = a + bX or Y = 4.416 + 0.945X. Thus, this equation can be interpreted that the constant of 4.416 means that the consistent value of the self-directed learning variable is 4.416. The regression coefficient of Virtual Reality (X) is 0.945 which states that every 1% addition of VR value, the value of self-directed learning variable increases by 0.945. The regression coefficient is positive, so it can be said that the direction of the influence of the VR variable on the self-directed learning variable is positive. The constant (a) with a value of 4.416, while the value of VR (b/regression coefficient) is 0.945, so the regression equation can be formulated, as follows; Y = a + bX or Y = 4.416 + 0.945X. Thus, this equation can be interpreted that the constant of 4.416 means that the consistent value of the self-directed learning variable is 4.416. The regression coefficient of Virtual Reality (X) is 0.945 which states that every 1% addition of VR value, the value of self-directed learning variable increases by 0.945. The regression coefficient is positive, so it can be said that the direction of the influence of the VR variable on the self-directed learning variable is positive. As results, the use of VR has a significant effect on self-directed learning. The *Sig.* value 0.000 < 0.05 indicates that this effect is highly significant (p < 0.05). The t-value of 49.241 > t-table of 1.65275. Thus, it means that the use of Virtual Reality significantly fosters SDL.

Furthermore, the ANOVA's data presented is the result of a regression test aiming at assessing the correlation between the use of Virtual Reality and the level of self-directed learning in the context of language learning.

Table 7
Regression Model of the Effect of Virtual Reality on Self-Directed Learning

ANOVA[b]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	6158.651	1	6158.651	2.425	0.000[a]
	Residual	487.684	192	2.540		
	Total	6646.335	193			
a. Predictors: (Constant), VR						
b. Dependent Variable: Self-directed learning						

The ANOVA analysis presented that the overall regression model was significant in explaining the self-directed learning variable which was influenced by the use of Virtual Reality as the independent variable. The F-value of 2.425 with the *sig.* value of 0.000 < 0.05. It showed

there is enough evidence to reject (H_0), that there is no effect of Virtual Reality use on self-directed learning. Therefore, it can be inferred the use of VR is significantly affected, indicating VR has the potential impacts to foster self-directed learning ability in ELL. Finally, the *model summary* evaluates the regression model's effectiveness in explaining SDL variability through VR use. The *R-squared* value indicates how much variability is accounted for, where a higher value signifies a stronger correlation between VR use and self-directed learning.

Table 8
The Summary of Regression Analysis of VR and Self-Directed Learning

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.963[a]	.927	.926	1.594
a. Predictors: (Constant), VR				

It revealed that the correlation value *(R)* 0.963 and the regression model has an *R-squared* value of 0.927, which indicates that 92.7% of self-directed learning can be explained by the use of Virtual Reality. The *Adjusted R-squared* value 0.926 revealed the use of VR improves self-directed learning effectively. In short, according to the adjusted R^2 value of 0.926, which implies that the influence of VR variables on self-directed learning is 92.6%. These results can graphically presented in the following figure bellow:

Figure 2. The Summary of Regressions in VR on SDL

Investigating EFL Students' Experiences of Using VR in Promoting SDL
Increasing Students' Engagement and Learning Motivation

The qualitative study on VR in EFL learning highlights its effectiveness in engaging and motivating students. VR transforms passive learning into an interactive process, allowing students to actively produce authentic language in immersive environments. This interactivity contextualizes language skills, reinforcing the idea that interaction is central to language learning. VR enhances students' presence, increasing motivation through immersive engagement. Unlike traditional methods, VR maintains learners' attention and fosters autonomy, boosting confidence and enabling self-paced learning. This aligns with learning psychology principles, emphasizing autonomy as a key driver of intrinsic motivation.

VR enhances active learning through gamification, problem-solving, and interactive storytelling, addressing both cognitive and emotional needs. It encourages participation in speaking activities, vocabulary practice, and peer collaboration, especially for those with anxiety in traditional settings. By creating an immersive and supportive environment, VR reduces barriers, fosters linguistic practice, and improves language acquisition. It simulates

authentic, context-rich environments for experiential learning, helping learners grasp cultural nuances and improve listening comprehension. Immediate corrective feedback reinforces accurate language use, builds confidence, and sustains motivation, making VR a valuable tool for language learning. In addition, VR utilizes the multimodal learning approach; visual, auditory, and kinesthetic learning styles and this deepens cognitive processing and enhances learning. Such integration promotes metacognitive practices as learners reflect on how far they have come and what they need to change to be better learners, hence increasing engagement and motivation. In a nutshell, the results support the view that, in the case of EFL teaching, VR enhances not only the dynamism, individualization, and flexibility of the process, but also its relevance to the contemporary needs of education. The use of VR in EFL teaching surrounds the learners in the environment, which allows them to develop a better sense of language use, increasing their confidence level, which is a huge step forward in language learning.

To clarify the findings on how learners' experiences with VR in enhancing self-directed learning in the aspect of increase of Engagements and motivation, the researchers have summarized the key themes in the following table below:

Table 9
The Effects of VR: Active Engagements and Strong Motivation

Themes	**Description**	**Key Findings/Examples**
Increased engagement & Motivation	VR transforms passive learning into an interactive process, leading to heightened student engagement and motivation.	Students shift from passive receivers to active participants, resulting in sustained attention and a boost in intrinsic motivation.
Active learning & Autonomy	The immersive VR environment fosters learner autonomy by allowing self-paced learning and encouraging authentic language use.	Learners build confidence and ownership over their learning process, enhancing their ability to use language authentically in real-life contexts.
Immersive & Multimodal Experience	VR provides a rich, contextually authentic environment that integrates multiple sensory modalities and interactive storytelling methods.	The integration of gamification, problem-solving, and immediate feedback addresses both cognitive and emotional needs, thereby improving language acquisition.

Providing Access and Flexibility to Learning

The use of VR allows students to easily access English learning materials and resources whenever needed to support their learning in a variety of contexts. According to EFL learners, VR helps bring learning experiences that are usually difficult or unavailable in conventional classrooms; EFL learners can study complex scientific concepts and theories through immersive simulations that help them understand abstract ideas more tangibly. This engagement not only enhances their understanding, but also gives access to learning resources that might otherwise be limited by distance and cost. In addition, the controls or features that VR has provided are important that allow students to determine their own pace, strategy and learning style. With the ease of VR features, students can decide when to repeat material or how to explore certain concepts. This provides flexibility, allowing students to learn more independently and purposefully, according to the strategies and styles that make them feel comfortable and more effective in understanding the material. The independent learning approach is supported by students as it gives them the freedom to grasp difficult concepts whenever they feel ready. This independence supports a more individualised approach to learning, as students can tailor their learning according to their individual academic goals and interests. This freedom in how they interact with the content proved to be a source of motivation and satisfaction, as students felt in control of their EFL learning.

Additionally, the findings highlighted that the application of VR accommodates a wide array of learning styles and preferences, effectively catering to visual, auditory, and kinesthetic learners. The multisensory experiences facilitated by VR not only heighten engagement but also promote deeper cognitive processing. Participants noted that the interactive nature of VR tools allowed them to experiment and practice skills within a safe, controlled environment, thereby fostering confidence and competence in their abilities. This adaptability positions VR as a powerful instrument for inclusive education, ensuring that all learners, regardless of their backgrounds or learning preferences, can benefit from enriched educational experiences. Thus, the effectiveness of VR in enhancing access and flexibility within learning environments. The integration of VR technology into educational frameworks not only addresses traditional barriers to learning but also empowers learners to engage more meaningfully with educational content. By improving access to diverse resources and providing flexible learning pathways, VR possesses the potential to revolutionize the educational landscape, fostering a more personalized and inclusive approach to education. This research emphasizes the need for continued exploration of VR's role in various educational contexts to fully leverage its transformative potential. For a clearer description of the influence of VR on SDL, the following is a thematic summary of how EFL students experience using VR in learning English in increasing learning autonomy.

Table 10
The Effects of VR: Ease and Flexibility

Themes	**Description**	**Key Findings/Examples**
Enhanced access to learning resources	VR provides students with instant access to diverse materials and simulations.	Immersive simulations enable learners to access complex and abstract content, overcoming distance and cost limitations.
Flexibility & self-paced learning	VR enables students to pace themselves, review materials, and tailor strategies for independent learning.	VR's interactive features enable students to tailor learning activities, fostering autonomy and personalized learning.
Inclusive multisensory learning	VR combines visual, auditory, and kinesthetic elements to support diverse learning styles.	VR fosters confidence, competence, and deeper cognitive processing by adapting to diverse learning styles.

Cognitive Skill Development and Self-Reflection

The qualitative analysis indicated that Virtual Reality significantly enhances cognitive skill development and fosters self-reflection among learners. Participants reported that immersive VR environments create unique opportunities for engaging with complex tasks that necessitate critical thinking, problem-solving, and decision-making skills. For example, learners participated in VR simulations that presented real-world scenarios, enabling them to analyze situations, formulate strategies, and implement solutions within a dynamic context. Such hands-on experiences promote higher-order thinking, as students must evaluate information, synthesize knowledge, and apply their skills in ways that traditional educational methods may not facilitate. Furthermore, the interactive nature of VR supports active learning, which is crucial for cognitive development. Participants noted that the ability to manipulate virtual objects and environments encouraged exploration and experimentation, allowing them to learn from both successes and failures. This iterative process of trial and error not only enhances the understanding of complex concepts but also cultivates a growth mindset, motivating learners to overcome challenges and develop resilience. These experiences contribute to the enhancement of cognitive skills, as learners actively engage in reflective practices that assess their thought processes and problem-solving approaches.

VR enhances self-reflection by offering immediate feedback on learners' actions and decisions. Participants highlighted the importance of real-time performance insights, which encourage strategy adjustments and deeper reflection. This feedback loop fosters metacognitive awareness, helping students recognize their learning processes, strengths, and areas for improvement. Through structured reflections integrated into VR experiences, learners develop critical self-assessment skills that enhance their overall cognitive competencies. The findings further highlight the innovative application of VR in facilitating collaborative learning experiences that enhance cognitive skill development. The integration of reflective practices within VR settings not only promotes deeper learning but also cultivates metacognitive skills essential for lifelong learning. To understand VR's impact on students' cognitive ability and self-reflection, several key findings serve as indicators of self-directed learning, as follows.

Table 11
The Effects of VR: Developing Cognitive Skills and Self-reflection

Themes	**Description**	**Key Findings/Examples**
Enhanced cognitive skill development	VR immerses learners in real-world tasks, fostering critical thinking, problem-solving, and decision-making.	Participants engaged in simulations that promoted critical thinking, experimentation, and a growth mindset.
Self-reflection & metacognitive awareness	Immediate feedback in VR fosters reflection, performance assessment, and strategy adjustment.	Learners valued real-time feedback for identifying strengths and weaknesses, enhancing learning.
Collaborative learning & critical thinking	VR enhances virtual teamwork, encouraging diverse perspectives, critical thinking, and problem-solving.	VR-enabled collaborative problem-solving fostered shared inquiry and peer reflection.

Discussion

The study highlights the growing use of Virtual Reality (VR) and Self-Directed Learning (SDL) in English as a Foreign Language (EFL) learning. VR enhances student engagement and emotions, leading to better learning outcomes (Vesisenaho et al., 2019). It provides an immersive and interactive learning experience, supporting knowledge acquisition and offering timely feedback, which aids students in directing their own learning processes. The combination of VR and SDL creates a more engaging and effective learning environment, increasingly adopted in educational contexts. The integration of VR in English learning significantly improves students' SDL abilities. VR's interactive, immersive, and personalized nature fosters a proactive approach, enabling students to organize and direct their learning. Immersive environments promote learner autonomy and responsibility, as students engage more deeply with the material (Jia & Qi, 2023). VR's interactivity boosts motivation and encourages independent exploration and mastery of the language, particularly in realistic and engaging contexts (Riyana & Setiawan, 2023; Suh et al., 2023). These immersive experiences not only enhance language proficiency but also empower learners to manage their learning processes effectively, underscoring the importance of SDL in language learning (Pataquiva & Klimova, 2022). Overall, VR integration in language education represents a significant advancement in promoting SDL, leading to more successful language learning outcomes (Xu, 2022).

The integration of VR in language learning creates immersive environments that closely mimic real-world scenarios, enhancing students' ability to apply language skills contextually. This experiential learning fosters confidence and independence, as students actively engage with the material, which is crucial for self-directed learning (SDL). Several studies indicate that VR not only increases motivation and engagement but also transforms traditional passive

learning into dynamic, interactive experiences (Yu & Xu, 2022). By facilitating authentic interactions and providing immediate feedback, VR significantly bolsters language comprehension and encourages continuous practice (Makransky et al., 2019). Furthermore, elements such as gamification and interactive storytelling within VR environments promote collaborative learning and reduce anxiety, making language learning more enjoyable and effective (Taguchi, 2021). The supportive nature of VR environments empowers learners, ultimately leading to the development of lifelong skills essential for personal and professional growth.

Incorporating multimodal elements in Virtual Reality enhances cognitive processing and facilitates deeper learning experiences. By engaging visual, auditory, and kinesthetic modalities, VR creates immersive environments that promote active learning and reflection on personal progress, thereby strengthening metacognitive strategies among learners. This multimodal approach allows students to identify areas for improvement more effectively, fostering a sense of independence and confidence in their language learning journey (Dooly et al., 2023; Yuan, 2024). Moreover, VR's capacity for personalized and dynamic learning experiences is pivotal in language education. It enables facilitated interactions that improve individual proficiency levels, allowing for collaborative learning opportunities across diverse cultural contexts. This flexibility not only enhances motivation but also significantly improves linguistic and affective outcomes, as evidenced by various studies demonstrating the positive impact of VR on language learning (Chen et al., 2022). Overall, the utilization of VR in educational settings represents a transformative approach to language learning, promoting engagement and effective skill acquisition.

This research emphasizes VR's transformative role in EFL learning by providing immersive experiences that surpass traditional classroom limitations. VR democratizes access to resources, overcomes geographical and financial barriers, and makes abstract concepts more tangible. Its immersive nature fosters self-directed learning, boosting motivation and engagement (Sung et al., 2020). By navigating VR environments, students sustain interest through enjoyment and curiosity. Additionally, VR supports diverse learning styles; visual, auditory, and kinesthetic enhancing cognitive processing through experiential learning (Brugada-Ramentol et al., 2022). Overall, VR offers a more engaging, effective, and inclusive approach to EFL education. Virtual Reality (VR) effectively supports diverse learning styles, namely visual, auditory, and kinesthetic by enhancing engagement and cognitive processing. VR caters to visual learners through immersive graphics, auditory learners via soundscapes, and kinesthetic learners through hands-on interaction with virtual objects (Grewe, 2023). This multimodal approach fosters deeper understanding and knowledge retention by aligning with students' preferred learning styles (Fortunasari et al., 2022; Erviana, 2023). Additionally, VR significantly impacts personalized language learning by providing immersive, realistic experiences, such as interacting with native speakers or practicing in specialized scenarios tailored to individual needs. Research highlights VR's ability to support personalized learning, offering customized experiences that enhance language acquisition (Holopainen et al., 2020).

The integration of Virtual Reality in language learning enhances cognitive skills and self-reflection by immersing learners in complex, real-world tasks that require critical thinking and problem-solving (Hamilton et al., 2020). VR fosters creativity, emotional engagement, and deeper understanding, significantly improving cognitive processes (Hwang et al., 2022). It also boosts motivation, confidence, and critical thinking, reshaping education through experiential learning (Parong & Mayer, 2020). Additionally, real-time feedback in VR enhances metacognitive awareness and adaptive learning strategies (Makransky et al., 2019; Hao, 2024). Collaborative VR experiences further develop cognitive growth by promoting teamwork and interactive problem-solving (Garderen et al., 2018; Sims et al., 2022). Overall, VR's immersive nature supports cognitive development, self-reflection, and

emotional engagement, improving knowledge retention and understanding (Allcoat & Mühlenen, 2018; Vesisenaho et al., 2019).

Despite VR's educational benefits, several challenges hinder its integration, with cost being a major concern. The high expense of VR hardware and software often deters institutions from adoption (Evans, 2019). Limited access to quality VR tools may create learning disparities among students from different socio-economic backgrounds. Additionally, infrastructure limitations, such as internet connectivity and institutional readiness, affect VR-based SDL effectiveness. These barriers undermine VR's educational potential, as highlighted by Sánchez et al., who emphasize the need for further exploration into these challenges (Sánchez et al., 2022). Without addressing these issues, VR-based SDL benefits may remain unrealized (Farsi et al., 2021). Another key factor is technological familiarity, which may influence learning outcomes. Students with prior experience using digital tools adapt more easily to VR-based SDL, creating variations in results. Future research should assess students' technological proficiency before VR learning and conduct longitudinal studies to examine how familiarity evolves over time.

CONCLUSION

The research investigated the impact of Virtual Reality on self-directed learning in EFL learning. The quantitative analysis revealed a significant positive correlation between VR use and SDL, with a regression coefficient of (0.945) and a significance level of ($p < 0.05$). This indicates that a 1% increase in VR use leads to a 0.945% increase in SDL. The ANOVA analysis further confirmed the significance of the regression model, with an *F*-value of (2.425) and a significance level of ($p < 0.05$). The *R-squared* value of (0.927) suggests that (92.7%) of the variance in SDL can be explained by VR use. Furthermore, the qualitative point of view, the findings suggest that VR not only increases students' motivation and engagement but also provides better access to learning materials as well as flexibility in the learning process. English teachers need to adopt VR as a learning medium to increase students' learning independence and develop a curriculum that integrates VR independently. Meanwhile, policy makers should design a curriculum that supports the use of VR inside and outside the classroom, ensure adequate infrastructure, and provide training for teachers to optimize VR technology in English learning. The students felt a significant increase in engagement, ability to learn independently, and development of cognitive skills through the immersive experience offered by VR. The study confirms VR as an effective tool for independent learning, motivation, and cognitive development in EFL learning. It enhances autonomy and confidence in self-directed learning. Future research should compare its impact on SDL between under teacher supervision and independence-based virtual reality use outside classroom.

REFERENCES

Bahari, A. (2021). Affordances and challenges of teaching language skills by Virtual Reality: A systematic review (2010–2020). *E-Learning and Digital Media, 19*(2), 163–188. https://doi.org/10.1177/20427530211036583

Bai, B. and Wang, J. (2020). The role of growth mindset, self-efficacy and intrinsic value in self-regulated learning and english language learning achievements. *Language Teaching Research, 27*(1), 207-228. https://doi.org/10.1177/1362168820933190

Brugada-Ramentol, V., Bozorgzadeh, A., & Jalali, H. (2022). Enhance VR: a multisensory approach to cognitive training and monitoring. *Frontiers in Digital Health, 4*. 1-7. https://doi.org/10.3389/fdgth.2022.916052

Chen, C., Hung, H., & Yeh, H. (2021). Virtual Reality in problem-based learning contexts: Effects on the problem-solving performance, vocabulary learning and motivation of

English language learners. *Journal of Computer Assisted Learning, 37*(3), 851–860. https://doi.org/10.1111/jcal.12528

Chen, B., Wang, Y., & Wang, L. (2022). The Effects of Virtual Reality-Assisted Language Learning: A Meta-Analysis. *Sustainability, 14*(6), 1-18. https://doi.org/10.3390/su14063147

Chen, P., Ho, H., Chen, H., Tam, K., Liu, J., & Lin, L. (2024). Virtual Reality experiential learning improved undergraduate students' knowledge and evaluation skills relating to assistive technology for older adults and individuals with disabilities. *BMC Medical Education, 24*(1). https://doi.org/10.1186/s12909-024-05085-y

Cokay, C., Dinçer, N., & Balkan, O. (2023). Immersive Virtual Reality in tertiary level EFL education a systematic review of recent applications.. *Innovational Research in ELT, 4*(2), 59-69. https://doi.org/10.29329/irelt.2023.623.6

Cowie, N., & Alizadeh, M. (2022). The Affordances and Challenges of Virtual Reality for Language Teaching. *International Journal of TESOL Studies. 4*(3), 50-65. https://doi.org/10.46451/ijts.2022.03.05

Dooly, M., Thrasher, T., & Sadler, R. (2023). "Whoa! Incredible!:" Language Learning Experiences in Virtual Reality. *RELC Journal, 54*(2), 321-339. https://doi.org/10.1177/00336882231167610

Evans, L. (2019). Barriers to vr use in he. *Proceedings of the Virtual and Augmented Reality to Enhance Learning and Teaching in Higher Education Conference 2018, 3-13*. https://doi.org/10.1255/vrar2018.ch2

Erviana, V. Y., & Fajaruddin, S. (2023). Exploring diverse learning styles in elementary schools: A study on student preferences. *International Journal of Education and Learning, 5*(2), 124-131. https://doi.org/10.31763/ijele.v5i2.1241

Farsi, G., Yusof, A., Romli, A., Tawafak, R., Malik, S., Jabbar, J., & Rsuli, M. (2021). A review of Virtual Reality applications in an educational domain. *International Journal of Interactive Mobile Technologies (IJIM), 15*(22), 99. https://doi.org/10.3991/ijim.v15i22.25003

Fortunasari, F., Ali, R. M., Lestari, L., Harja, H., Sari, S. R., & Hidayati, S. (2022). The EFL Undergraduate Students and English Reading Styles: Evidence from One English Education Program. *Edukasi Jurnal Pendidikan Dan Pengajaran, 9*(2), 183-192. https://doi.org/10.19109/ejpp.v9i2.15759

Garderen, D.V., Scheuermann, A., & Poch, A. L. (2018). Special education teachers' perceptions of students' with disabilities ability, instructional needs, and difficulties using visual representations to solve mathematics problems: Teacher education and special education: *The Journal of the Teacher Education Division of the Council for Exceptional Children, 42*(2), 175-188. https://doi.org/10.1177/0888406418793929

Grewe, M., & Gie, L. (2023). Can Virtual Reality have a positive influence on student engagement? *South African Journal of Higher Education, 37*(5). 124-141. https://doi.org/10.20853/37-5-5815

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods, 18*(1), 59–82. https://doi.org/10.1177/1525822X05279903

Hamilton, D., McKechnie, J., Edgerton, E., & Wilson, C. (2020). Immersive Virtual Reality as a pedagogical tool in education: a systematic literature review of quantitative learning outcomes and experimental design. *Journal of Computers in Education, 8*(1), 1-32. https://doi.org/10.1007/s40692-020-00169-2

Holopainen, J., Lähtevänoja, A., Mattila, O., Södervik, I., Pöyry, E., & Parvinen, P. (2020). Exploring the learning outcomes with various technologies-proposing design principles for Virtual Reality learning environments. In Tung X. Bui (Eds.), *Proceedings of the 53th*

Annual Hawaii International Conference on System Sciences (pp.13-21). University of Hawaii. https://doi.org/10.24251/hicss.2020.004

Huang, O. H. L. (2024). Enhancing english oral communication skills through Virtual Reality: a study on anxiety reduction and authentic learning. *English Language Teaching, 17*(5), 1. https://doi.org/10.5539/elt.v17n5p1

Hung, C., Lin, Y., Yu, S., & Sun, J. C. (2023). Effects of ar- and vr-based wearables in teaching english: the application of an arcs model-based learning design to improve elementary school students' learning motivation and performance. *Journal of Computer Assisted Learning, 39*(5), 1510-1527. https://doi.org/10.1111/jcal.12814

Huang, Y. (2024). Empowering Virtual Reality with feedback and reflection in hands-on learning: Effect of learning engagement and higher-order thinking. *Journal of Computer Assisted Learning, 40*(4), 1413-1427. https://doi.org/10.1111/jcal.12959

Hu-Au, E., & Lee, J. J. (2017). Virtual Reality in education: A tool for learning in the experience age. *International Journal of Innovation in Education, 4*(4), 215-226.

Hwang, G., Chang, C., & Chien, S. (2022). A motivational model-based Virtual Reality approach to prompting learners' sense of presence, learning achievements, and higher-order thinking in professional safety training. *British Journal of Educational Technology, 53*(5), 1343-1360. https://doi.org/10.1111/bjet.13196

Jia, Y. and Qi, R. (2023). Influence of an immersive virtual environment on learning effect and learning experience. *International Journal of Emerging Technologies in Learning (iJET), 18*(6), 83-95. https://doi.org/10.3991/ijet.v18i06.37815

Luan, L., Hong, J., Cao, M., Dong, Y., & Hou, X. (2020). Exploring the role of online EFL learners' perceived social support in their learning engagement: A structural equation model. *Interactive Learning Environments, 31*(3), 1703-1714. https://doi.org/10.1080/10494820.2020.1855211

Makransky, G. and Petersen, G. (2021). The cognitive affective model of immersive learning (CAMIL): a theoretical research-based model of learning in immersive Virtual Reality. *Educational Psychology Review, 33*(3), 937-958. https://doi.org/10.1007/s10648-020-09586-2

Makransky, G., Borre-Gude, S., & Mayer, R. E. (2019). Motivational and cognitive benefits of training in immersive Virtual Reality based on multiple assessments. J*ournal of Computer Assisted Learning, 35*(6), 691-707. https://doi.org/10.1111/jcal.12375

Parong, J. and Mayer, R. (2018). Learning science in immersive Virtual Reality. *Journal of Educational Psychology, 110*(6), 785-797. https://doi.org/10.1037/edu0000241

Parong, J., & Mayer, R. E. (2020). Cognitive and affective processes for learning science in immersive Virtual Reality. *Journal of Computer Assisted Learning, 37*(1), 226–241. https://doi.org/10.1111/jcal.12482

Pataquiva, F. D. P. F. and Klímová, B. (2022). Systematic review of Virtual Reality in the learning of second language. *International Journal of Emerging Technologies in Learning (iJET), 17*(15), 43-53. https://doi.org/10.3991/ijet.v17i15.31781

Raman, K., Hashim, H. & Ismail, H.H. (2023). Enhancing English verbal communication skills through Virtual Reality: A study on engagement, motivation, and autonomy among English as a second language learners. *International Journal of Learning, Teaching and Educational Research, 22*(12), 237-261. https://doi.org/10.26803/ijlter.22.12.12

Riyana, C. and Setiawan, B. I. (2023). 3d interactive Virtual Reality media to improve learning outcomes in thematic subjects. *JPI (Jurnal Pendidikan Indonesia), 12*(2), 223-233. https://doi.org/10.23887/jpiundiksha.v12i2.58472

Sánchez, M., Palos-Sánchez, P., & Folgado-Fernández, J. (2022). Systematic literature review and bibliometric analysis on Virtual Reality and education. *Education and Information Technologies, 28*(1), 155-192. https://doi.org/10.1007/s10639-022-11167-5

Shadiev, R., Yu, J., & Sintawati, W. (2021). Exploring the impact of learning activities supported by 360-degree video technology on language learning, intercultural communicative competence development, and knowledge sharing. *Frontiers in Psychology, 12*. https://doi.org/10.3389/fpsyg.2021.766924

Sims, R., Chang, B. M., Bennett, C. V., Krishnan, A., Aboubakar, A., Coman, G., & Karnik, A. (2022). Step into my mind palace: Exploration of a collaborative paragogy tool in vr. In Andreas Dengel, Marie-Luce Bourguet, Daniela Pedrosa, James Hutson, Kai Erenli, Daphne Economou, Anasol Pena-Rios, Jonathon Richter (Eds.), *Proceedings of 2022 8th International Conference of the Immersive Learning Research Network, iLRN 2022* (pp.1-8), IEEE. https://doi.org/10.23919/ilrn55037.2022.9815936

Suh, I. H., McKinney, T., & Siu, K. (2023). Current perspective of metaverse application in medical education, research and patient care. *Virtual Worlds, 2*(2), 115-128. https://doi.org/10.3390/virtualworlds2020007

Sung, B., Mergelsberg, E., Teah, M., D'Silva, B., & Phau, I. (2020). The effectiveness of a marketing Virtual Reality learning simulation: A quantitative survey with psychophysiological measures. *British Journal of Educational Technology, 52*(1), 196-213. https://doi.org/10.1111/bjet.13003

Taguchi, N. (2021). Immersive Virtual Reality for pragmatics task development. *TESOL Quarterly, 56*(1), 308-335. https://doi.org/10.1002/tesq.3070

Vesisenaho, M., Juntunen, M., Häkkinen, P., Pöysä-Tarhonen, J., Fagerlund, J., Miakush, I. & Parviainen, T. (2019). Virtual Reality in education: Focus on the role of emotions and physiological reactivity. *Journal for Virtual Worlds Research, 12*(1). https://doi.org/10.4101/jvwr.v12i1.7329

Wang, H. and Chen, C. (2019). Learning english from youtubers: english l2 learners' self-regulated language learning on youtube. *Innovation in Language Learning and Teaching, 14*(4), 333-346. https://doi.org/10.1080/17501229.2019.1607356

Wang, Z., Guo, Y., Yan, W., Tu, Y., & Liu, C. (2021). Technological solutions for sustainable development: effects of a visual prompt scaffolding-based Virtual Reality approach on EFL learners' reading comprehension, learning attitude, motivation, and anxiety. *Sustainability, 13*(24), 13977. https://doi.org/10.3390/su132413977

Xiang, H. (2024). The impact of Virtual Reality technology in improving English language proficiency. *Applied Mathematics and Nonlinear Sciences, 9*(1). https://doi.org/10.2478/amns-2024-2084

Yinhui Hao, F. Q. (2024). Virtual Reality technology in practical teaching methods. *Journal of Electrical Systems, 20*(3), 1787-1798. https://doi.org/10.52783/jes.1718

Yu, Z. and Xu, W. (2022). A meta-analysis and systematic review of the effect of Virtual Reality technology on users' learning outcomes. *Computer Applications in Engineering Education, 30*(5), 1470-1484. https://doi.org/10.1002/cae.22532

Yuan, S. (2024). Practice and exploration of university English teaching reform based on Virtual Reality technology. *Journal of Electrical Systems, 20*(6), 1528-1540. https://doi.org/10.52783/jes.3072