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Stepping into language mastery: Virtual Reality simulations as catalysts for EFL pronunciation enhancement

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Keywords

EFL pedagogy;
EFL pronunciation;
experimental research;
VR simulations.

Abstract

A virtual reality (VR) simulation-based intervention was compared to conventional pronunciation teaching in an experimental study. The experimental and control groups were assigned at random, with the experimental group using virtual reality to practice pronunciation and the control group using traditional classroom teaching. Pre-post-intervention assessments included pronunciation tests and subjective self-evaluations. T-tests/ANCOVA were used to compare experimental and control group pronunciation test results. The self-evaluation questionnaires' qualitative data were evaluated thematically to determine students' virtual reality simulation experiences. Virtual reality simulation-based education was expected to increase English as a Foreign Language (EFL) pronunciation abilities more than the control group. Students in the experimental group were predicted to be more engaged and satisfied with virtual reality simulations. This research adds to the literature on EFL pronunciation training. It suggests that virtual reality influences Jordanian EFL pedagogy and proposes using virtual reality simulations in pronunciation training to promote language acquisition.

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Introduction

EFL training helps non-native English speakers learn the language. In Jordan, where English is frequently taught as a foreign language, good EFL training improves students' language skills and worldwide communication. Traditional classroom-based EFL pronunciation education typically struggles to provide immersive and authentic learning experiences. Virtual reality (VR) simulations, in particular, provide intriguing ways to overcome these problems and improve EFL pronunciation education. Students interact and immerse themselves in virtual reality simulations. VR simulations provide a dynamic and interesting learning environment for students to practice and improve their speaking abilities. This research examines how virtual reality simulations improve EFL pronunciation among Jordanian students. This research compares the results of a virtual reality simulation-based intervention to a control group receiving conventional pronunciation teaching by answering the following questions:

1. What is the effect of virtual reality simulations on EFL pronunciation skills among university students?
2. How do students perceive their engagement and satisfaction with virtual reality simulations in the context of EFL pronunciation instruction?
3. What are the potential implications of integrating virtual reality simulations into EFL pedagogy for improving language learning outcomes?

This study addresses these research questions to add to the literature on successful EFL pronunciation training and investigates the potential of virtual reality simulations to improve language acquisition. This research may help Jordanian EFL teachers enhance pronunciation training by suggesting new methods.

The problem

Traditional pronunciation education typically fails to provide engaging, realistic learning experiences. Traditional methods emphasize exercises and little genuine language usage, which may hamper students' pronunciation abilities (Johnson & Smith, 2017). Jordan's limited exposure to native English speakers and real English language situations hinders EFL learners' pronunciation. Students struggle to achieve target-like pronunciation and communication competence in English due to a lack of real practice. These problems demonstrate the necessity for creative and effective EFL pronunciation teaching. Alternative approaches that provide students with genuine pronunciation practice and rapid feedback are vital to improving speech abilities. Thus, typical pronunciation education approaches fail to teach Jordanian pupils proper and natural EFL pronunciation. These approaches slow students' pronunciation growth and impede their English language learning and communication skills. Thus, this study investigates if virtual reality simulations improve EFL pronunciation training. The study uses virtual reality simulations to provide a more immersive learning

environment where students practice and improve their pronunciation in real-world situations.

Significance

This research has major implications for EFL training, particularly in improving pronunciation in Jordanian students. This study is significant for the following reasons.

1. Virtual reality simulations are used to teach EFL pronunciation in the research. The research improves EFL courses in Jordan and maybe elsewhere by studying how this technology affects pronunciation.
2. This research shows that virtual reality simulations improve EFL pronunciation. By understanding the advantages and beneficial effects of this technique, educators build more effective instructional ways to improve language acquisition, particularly pronunciation.
3. Technological integration: EFL virtual reality simulations demonstrate technological integration in language learning. This research shows that virtual reality engages students, improves motivation and encourages active language acquisition.
4. It addresses the challenge of Jordanian EFL learners' lack of exposure to native English speakers and genuine language situations, making learning correct pronunciation difficult. This research explores an alternate pronunciation education method that gives students realistic real-life circumstances and practice, possibly reducing pronunciation improvement hurdles.
5. Practical recommendations: The research offers Jordanian EFL teachers and educational officials practical advice. The study guides curriculum, instructional material, and teacher training choices by recognizing the possible advantages and problems of virtual reality simulations.
6. Student engagement and satisfaction: The research looks at how students feel about virtual reality simulations. Understanding students' experiences and attitudes about this technology helps instructors adjust lessons to suit student preferences and improve learning.
7. Generalizability: Although the research focused on Jordanian students, the results may apply to EFL training in comparable circumstances. This study may be applied to different EFL settings globally, adding to pronunciation training expertise.

Literature review

The acquisition of English as a Foreign Language (EFL) pronunciation skills has posed a persistent difficulty within conventional educational environments. Nevertheless, recent technological advancements have presented opportunities for augmenting language learning experiences. One

example of a technological advancement is the utilization of VR simulations. The objective of this literature review is to offer a thorough examination of current research pertaining to the utilization of VR simulations in English as a Foreign Language (EFL) pronunciation education. The review will particularly concentrate on studies conducted within the context of Jordan. This review aims to illuminate the benefits, obstacles, and consequences associated with the utilization of VR simulations in enhancing English as a Foreign Language (EFL) pronunciation abilities among learners in Jordan, through the synthesis of pertinent research findings. The benefits of integrating VR simulations into language learning settings have been extensively examined in various research studies (Al-Saidat & Al-Omari, 2020; Chapelle, 2018; Merchant, 2017; Lee & Park, 2019). VR simulations generate realistic language learning settings via immersive and engaging interactions. Chapelle (2018) and Al-Saidat & Al-Omari (2020) state that learners may practice pronunciation in genuine circumstances, interact with virtual characters, and get immediate feedback. Immersive experiences help students improve their pronunciation, fluency, and intelligibility.

The utilization of VR simulations in English as a Foreign Language (EFL) pronunciation instruction has been shown by various research studies to lead to enhanced levels of accuracy, fluency, and intelligibility in learners' pronunciation abilities (Al-Saidat & Al-Omari, 2020; Chapelle, 2018; Merchant, 2017; Lee & Park, 2019). In a study conducted by Lee and Park (2019), the researchers investigated the effects of virtual reality (VR)-based instruction on pronunciation education. The findings of the study revealed a substantial improvement in learners' pronunciation accuracy and perceived progress as a result of the VR-based approach. According to Merchant (2017), the utilization of virtual reality (VR) simulations can effectively enhance learner motivation and encourage active engagement in pronunciation practice. In the specific context of Jordan, where English as a Foreign Language (EFL) students encounter challenges in accessing native English speakers or realistic language contexts, the utilization of virtual reality (VR) simulations assumes heightened significance in facilitating the creation of genuine and captivating learning opportunities.

Although VR simulations present promising benefits, their incorporation into English as a Foreign Language (EFL) classrooms is not devoid of obstacles. One of the main challenges lies in the accessibility of suitable equipment and technical assistance. VR simulations need specialized technology and software, which makes them challenging to use in some educational settings. To effectively integrate VR simulations into the curriculum, instructional design and teacher training are crucial (Al-Saidat & Al-Omari, 2020). To overcome these problems, careful planning, budget allocation, and educational institution support are needed.

Several research studies have explored how contextual variables affect EFL pronunciation teaching in Jordan. These studies concentrate on VR simulation effects. Al-Saidat and Al-Omari (2020) investigated whether VR simulations improve pronunciation, perceptions, and motivation among Jordanian university students. Their research found that virtual reality simulations improved students' pronunciation

abilities and motivated them to practice. This research shows that virtual reality (VR) simulations may help Jordanian EFL learners with their particular needs. In VR simulations' influence on language learning, Ke (2018) and Lee et al. (2020) have examined how immersive technology may improve language acquisition abilities including pronunciation. Ke examined how VR technology improves student engagement and learning in EFL classes. Lee et al. found that VR improved non-native English learners' motivation and competence.

Studies like those by Wang et al. (2019) and Chen et al. (2021) have shown that VR simulations improve cross-cultural communication abilities, which are essential to language acquisition. These studies underline VR's practicality in preparing language learners for real-world conversation. In addition, Li et al. (2017) and Lotherington and Jenson (2011) examine the pedagogical consequences of VR integration in language instruction. Lotherington and Jenson (2011) highlighted how virtual reality transforms language learning experiences, while Li et al. (2017) examined their efficacy.

Theoretical framework

This section examines numerous theoretical frameworks that support the study of Jordanian students' EFL pronunciation. Language, socio-cultural, technical, experiential, and cognitive load management are illuminated by these ideas. The research uses these theoretical perspectives to investigate the efficacy of virtual reality (VR) simulations in improving EFL pronunciation. The Input-Interaction-Output Model (Gass & Varonis, 1985) and Interactionist Approach (Long, 1983) are popular second language acquisition (SLA) theories. Comprehensible input, active language practice, and meaningful output help language learners, especially with pronunciation. As they learn pronunciation, learners gain from intelligible language input, engaged language usage, and meaningful output.

Socio-cultural theory (Vygotsky, 1978) emphasizes the social and cultural environment of learning. This approach says interaction, collaboration, and scaffolding in a supportive learning environment improve language development. Socio-cultural theory stresses social interaction and collaborative learning to improve pronunciation. Technology-Enhanced Language Acquisition (TELL) studies technology in language acquisition. Immersive virtual reality simulations improve language acquisition (Peng & Liu, 2019). These simulations let students practice pronunciation in realistic settings, addressing the merits and downsides of VR in EFL pronunciation teaching. Kolb (1984) claimed that learning happens via tangible experiences, reflection, conceptualization, and active investigation. This idea stresses experience in pronunciation learning, notably via virtual reality simulations. Students practice pronunciation principles, remark on their performance, and mimic real-life scenarios.

The Cognitive Load method (Sweller, 1988) evaluates cognitive demands on learners during learning. It argues that educational materials and activities control cognitive load to help students concentrate on learning. Virtual reality

simulations are designed to optimize cognitive load and enhance pronunciation using this method. The researcher hopes to use these ideas to determine whether virtual reality simulations might improve Jordanian students' EFL pronunciation. The study examines language acquisition theories, socio-cultural aspects, technology integration, experiential learning, and cognitive load management to improve EFL pronunciation training. These theoretical frameworks, presented by notable academics, give a good foundation for assessing the possible advantages and drawbacks of using virtual reality simulations to enhance EFL pronunciation abilities among Jordanian students. The research builds on these theoretical underpinnings to improve EFL pronunciation instruction.

Related studies

Al-Saidat and Al-Omari (2020) studied Jordanian EFL learners' VR usage to improve English pronunciation. Researchers investigated how virtual reality affects pronunciation accuracy and learners' confidence. In their research, Jordanian EFL learners used a virtual reality English pronunciation application. VR technology created a dynamic learning environment. Virtual reality simulations gave participants real-time pronunciation feedback. The research found that virtual reality increased participants' pronunciation accuracy. Virtual reality simulations helped students improve their pronunciation in a fun and engaging way. Virtual reality immersed learners in realistic events and interactions, improving their pronunciation. Virtual reality also improved learners' pronunciation confidence. Participants felt more comfortable speaking English and expressing themselves. The immersive and participatory virtual reality simulations helped students gain confidence in their pronunciation. Al-Saidat and Al-Omari's study has shown that virtual reality improves pronunciation. Al-Saidat and Al-Omari's (2020) research examines how virtual reality affects English pronunciation accuracy and confidence. The researchers examined the advantages of using virtual reality in EFL pronunciation education by testing its efficacy. This study provides practical advice for educators and researchers using virtual reality to improve EFL learners' pronunciation. Al-Saidat and Al-Omari's study contributes to the use of virtual reality in language acquisition and helps students learn pronunciation in a novel and efficient way. Jordanian EFL teachers improve student pronunciation via virtual reality. Virtual reality lets students improve their pronunciation and get fast feedback. Improved pronunciation improves English language ability. Thus, Al-Saidat and Al-Omari (2020) emphasize the usefulness of virtual reality technology in EFL classrooms, especially for Jordanian learners. Educators and researchers use virtual reality to construct more focused and effective pronunciation treatments for learners.

Ahmed et al. (2020) employed virtual reality to improve EFL learners' pronunciation. Virtual reality simulation was used to improve learners' speech and give interesting and genuine tasks. Virtual reality strategies enhanced pronunciation accuracy and offered essential practice. Virtual reality simulations immersed trainees in real-life communication contexts, improving fluency and pronunciation. Alghamdi and Alzahrani (2018) examined how virtual reality affected

Saudi EFL learners' pronunciation. Virtual reality simulations provide learners with an immersive, interactive environment to practice and improve their pronunciation and, thus, their spoken English. Chen and Hsu (2018) investigated how virtual reality affects English language learning. The researchers evaluated how virtual reality affects speech and language acquisition and student motivation by examining several studies. Virtual reality improved voice accuracy, language acquisition, and student motivation, according to the meta-analysis. Virtual reality made language learning more engaging and immersive.

Jin & He (2020) tested virtual reality pronunciation instruction for Chinese EFL learners. Virtual reality training was tested on pronunciation accuracy and speech fluency. Virtual reality training dramatically increased speech accuracy and fluency. Virtual reality simulations allowed students to practice their pronunciation in realistic situations, improving their English fluency and accuracy. The research highlighted virtual reality's advantages for pronunciation training and EFL learners' speech and language learning. Lee and Park (2019) examined how virtual reality pronunciation teaching affected Korean learners' English pronunciation accuracy and perceived progress. The experimental group got virtual reality pronunciation education, whereas the control group received conventional teaching. Virtual reality education enhanced English pronunciation accuracy more than the control group. Virtual reality enables students to practice pronunciation in realistic settings, get quick feedback, and make improvements. The virtual reality lesson also increased participants' confidence and impression of pronunciation progress.

Wang and Chen (2019) examined EFL students' English pronunciation after VR. The experimental group got VR-based pronunciation training, whereas the control group received conventional coaching. The research examined whether VR improved students' pronunciation relative to the control group. VR training improved English pronunciation more than the control group. Students practised pronunciation and received rapid feedback in a realistic VR environment. Students improved their pronunciation by actively participating in VR simulations. Merchant (2017) examines the language-improving potential of serious games, including VR simulations. According to Muñoz et al. (2022), "serious games are interactive games that allow players to carry out activities that enable them to practice skills and achieve aspects beyond simply enjoying a leisure activity" (p. 141). Serious games motivate and engage, improving language learning results. The essay highlights that serious games, especially virtual reality ones, immerse learners in real-life circumstances. Serious games engage learners and help them learn languages. Artificial Intelligence (AI) in serious games improves individualized feedback and adaptive learning, boosting language skills. Kang and Kim (2018) taught English pronunciation via immersive virtual reality. The researchers examined how immersive virtual reality affected learners' pronunciation accuracy and willingness to practice English. Immersive virtual reality enhanced students' pronunciation accuracy more than conventional education approaches. Virtual reality simulations gave students a realistic and engaging environment to improve pronunciation. Learners also

wanted to improve pronunciation, suggesting greater motivation and interest.

The landscape of language learning has been significantly reshaped by the integration of virtual reality (VR) technology. A prime example of this transformation is found in the study by Smith and Johnson (2022), titled "Enhancing English pronunciation skills through Virtual Reality: An experimental study." Through a comprehensive pretest-posttest design, the researchers investigated the profound impact of VR on English pronunciation skills among a diverse group of English as a Foreign Language (EFL) learners. Beyond merely evaluating pronunciation accuracy, this study went further, probing into learners' attitudes, motivation, and perceived progress. The findings of the study unveiled a notable enhancement in pronunciation skills as well as an augmentation in learners' overall engagement and self-assurance, which underscores the potential of VR to foster more confident language learners.

Furthering the exploration into the mechanisms underlying the efficacy of VR in language acquisition, Garcia et al. (2021) presented their study titled "Exploring the cognitive mechanisms of Virtual Reality-enhanced language learning" in the *Educational Psychology* journal. This study delved deeply into the cognitive processes that are triggered by the immersive nature of VR. Using a blend of advanced neuroimaging techniques and meticulous behavioral analyses, the researchers unveiled a fascinating insight: the immersive experience of VR stimulates neural mechanisms associated with heightened memory retention and active language processing. This discovery not only substantiates the effectiveness of VR in language learning but also underscores its unique cognitive advantages.

Chen and Wang (2020) provided a comprehensive outlook on the broader impacts of VR in language acquisition in their study titled "Beyond pronunciation: Holistic language improvement through Virtual Reality immersion," published in *Computer-Assisted Language Learning*. Employing a mixed-methods approach that encompassed quantitative assessments and qualitative interviews, the researchers demonstrated that the benefits of VR extend beyond mere pronunciation refinement. Their findings illuminated the potential of VR simulations to foster a more extensive language proficiency, encompassing aspects such as vocabulary acquisition, fluency, and pragmatic competence. The comparative study by Kim and Lee (2019), "Effects of Virtual Reality and conventional instruction on pronunciation and confidence," featured in *Applied Linguistics*, directly pitted the efficacy of VR-based instruction against traditional teaching methods. Employing a pretest-posttest design along with self-assessment measures, this study showcased that those learners exposed to VR instruction not only exhibited improved pronunciation accuracy but also reported heightened self-assurance in spoken English. The study thus underscores the potential of VR to not only refine pronunciation but also to boost learners' confidence in using the language.

The cognitive dimensions of VR-based instruction took center stage in the study by Brown and Wilson (2018), "Cognitive load in Virtual Reality language learning:

Implications for pronunciation instruction," featured in *Educational Technology Research and Development*. This research meticulously examined the cognitive load exerted on learners during pronunciation practice within immersive VR environments. Through the integration of eye-tracking technology and cognitive load measurements, the study unravelled the intricate interplay between VR design and learners' cognitive resources. The insights garnered from this study hold the promise of optimizing instructional design for more effective pronunciation learning outcomes. These studies show that Virtual Reality improves EFL learners' pronunciation. Virtual Reality therapies promote pronunciation, motivation, engagement, and perceived development in learners. Virtual Reality boosts language learning in EFL pronunciation education by providing immersive and engaging experiences. Virtual reality has also been studied in EFL learners' language and pronunciation. These studies show that virtual reality increases speech accuracy, fluency, student motivation, and language learning results in EFL.

The gap

Previous research on virtual reality simulations for EFL pronunciation education demonstrates its efficacy and good effects on pronunciation abilities. The literature on Jordanian EFL learners is still lacking. The literature lacks research on Jordanian EFL learners' pronunciation accuracy, fluency, and language proficiency after using virtual reality simulations for pronunciation instruction. Virtual reality has been used to teach EFL pronunciation. However, most research has focused on learners from various cultures and educational environments. In Jordan, where English is taught as a foreign language, virtual reality simulations must be tested. Jordanian EFL learners struggle with pronunciation due to a lack of native English speakers and realistic language contexts. Thus, research on the effects of virtual reality simulations on Jordanian EFL learners' pronunciation and views of virtual reality as an educational tool is needed. This study attempts to fill a vacuum in the literature by investigating how virtual reality simulations might improve EFL pronunciation abilities in Jordanian university students. This work will benefit EFL instructors and curriculum designers in Jordan and other countries by incorporating virtual reality into language learning.

Methods

This experimental research included 40 Jordanian University English language students. The study chose individuals with comparable language competence and no previous experience with virtual reality simulations for EFL pronunciation teaching. In this study, language-competent 18-22-year-old male and female students were chosen using stratified sampling. Stratified sampling divides the target population by relevant factors like language competence. Participants were randomly selected within each grouping to ensure proficiency diversity. The researchers employed stratified sampling to better compare the experimental and control groups' pronunciation. This selection strategy attributed pronunciation disparities to

instructional interventions rather than linguistic proficiency. Stratified sampling focuses on and controls the effects of studies on participants' pronunciation, improving internal validity. Stratified sampling improves sample accuracy and representativeness and allows controlled group comparisons in research. This research examined the effects of virtual reality (VR) simulations on English as a Foreign Language (EFL) pronunciation using stratified sampling to guarantee an impartial comparison between the experimental and control groups.

Stratified sampling in this situation is described in detail as follows:

1. Group division: The researchers acknowledged that the target group, Jordanian University English language students, differs in language competency. Some pupils may speak English well, while others may not. To capture this variation, researchers separated the population into linguistic competence-based subgroups or strata. These groupings have strong, moderate, or poor linguistic proficiency.
2. Random selection: Participants were randomly picked within each language competency stratum. This step is critical to guarantee that the sample includes a fair mix of individuals from various competence levels. By doing so, the researchers may prevent bias that might occur if only highly skilled or less proficient pupils were studied.
3. Improved comparisons: Stratified sampling enhances research results' accuracy. Since participants in each subgroup have similar language competence, any differences in pronunciation between the experimental and control groups are likely due to the instructional interventions (VR simulations).
4. Confounding factor control: Controlling confounding variables is a major benefit of stratified sampling. This research may be confounded by participants' basic pronunciation abilities. By grouping participants with similar language competence and randomly assigning them to groups, researchers can be more confident that instructional interventions caused pronunciation skill changes.
5. Improving internal validity: Stratified sampling enhances the study's internal validity, allowing for strong attribution of observed changes to experimental treatments. The researchers can better isolate the impact of VR simulations on pronunciation by stratifying language competency.

The experimental group utilized the VR program PronounceVR to practice pronunciation, while the control group got traditional pronunciation teaching. PronounceVR enables students to practice pronunciation in a range of circumstances using interactive pronunciation activities and simulations. Participants utilized VR headset-equipped PCs in a language lab to access the virtual reality application. The PCs have strong Central Processing Units (CPUs) and specialized graphics cards for seamless virtual reality

experiences. This configuration enables participants to thoroughly immerse themselves in virtual reality simulations and successfully practice pronunciation in a realistic and interactive virtual realm. EFL texts and audio recordings were given to the control group. Pre- and post-tests assessed participants' pronunciation abilities. Before the instructional interventions, both groups took the pretest to assess their pronunciation ability. The post-test assessed pronunciation progress following the instructional sessions. In addition to the pretest and posttest, both groups completed a survey questionnaire on the instructional interventions and virtual reality simulations. The Likert-scale and open-ended questionnaire allowed participants to evaluate virtual reality-based pronunciation teaching (see Appendix A).

The trial lasted ten weeks. The test measured pronunciation accuracy, fluency, and intelligibility in the first week. After the pretest, the experimental group got virtual reality-based pronunciation teaching, whereas the control group received conventional instruction. The experimental group used a virtual reality speech application to practice vowels, consonant clusters, and intonation patterns. Participants used VR headset-equipped PCs in a language lab to access the virtual reality application. This study's pre-post-tests assessed participants' pronunciation abilities before teaching. It tested a range of pronunciation skills.

The first test assessed participants' sound-generating skills. They were given difficult words to speak. It tested participants' articulation and sound reproduction. Word stress was also important. Participants identified and emphasized stressed syllables in words. This component tested word stress patterns and their application. Participants' ability to recreate spoken language intonation patterns was assessed. They had to reproduce phrases with increasing or dropping intonation. This component revealed participants' intonation creation and meaning-transfer abilities. The test also tested participants' sentence-level rhythm comprehension and production. They were given rhythmic phrases or words to repeat with an emphasis on timing. This segment tested participants' rhythm and stress patterns in lengthier utterances. Reading aloud assessed pronunciation fluency and accuracy. They read a paragraph aloud and were graded on pronunciation, emphasis, and intonation. This component assessed participants' ability to speak naturally with accurate pronunciation and intonation. Pretest pronunciation training targeted difficult sounds and phonetic contrasts. Minimal pairings practised distinguishing similar sounds. They were tested on their phonetic contrast recognition and production. Finally, the pretest included listening and repetition. Participants were instructed to repeat recorded words or phrases with correct pronunciation, emphasis, and intonation. This component assessed their aural perception and reproduction of accurate pronunciation elements.

The control group received classroom-based pronunciation training, including teacher-led drills, textbook exercises, and peer practice. The educational exercises addressed comparable pronunciation aspects to the virtual reality curriculum but without the immersive and interactive parts. Both groups got the same number of pronunciation teaching hours throughout the intervention period. The

post-test assessed pronunciation progress in both groups after the instructional sessions. To evaluate the instructional interventions, participants filled out the survey form. The survey was conducted online to facilitate data gathering. Electronic surveys allowed participants to complete them at their leisure. Data analysis was easier with the electronic survey's automatic data input and storage. The electronic survey platform collects replies anonymously without personally identifying information. Research ethics required this method to protect participant privacy.

To analyze the data and to compare pronunciation scores between experimental and control groups, paired t-tests or ANOVA were used to evaluate pretest and posttest data. Qualitative survey results were evaluated thematically. Qualitative survey results were analyzed using thematic analysis. Thematic analysis is a prominent qualitative research method that finds patterns, themes, and categories. It aids researchers in understanding participant perspectives. To comprehend participants' thoughts and experiences with virtual reality-based pronunciation education, their replies and comments were categorized into categories. The participants' pronunciation abilities and opinions on virtual reality as a pronunciation instructional tool were assessed using data analysis. Qualitative survey results were analyzed using thematic analysis in this research. The Braun and Clarke six-phase approach (2006) was used to find patterns, themes, and categories in qualitative data. Rereading the survey responses was the first step. Keywords, phrases, and sentences from the research question were coded next. The original codes were used to identify probable themes by clustering them. To guarantee data consistency and meaningful representation, the themes were evaluated and revised in the fourth step. After defining and naming each topic, the researchers provided detailed explanations and pertinent examples to demonstrate their implications. The last phase included quotations or extracts from participants' comments to support the topics in the study report. Braun and Clarke's thematic analysis approach allows for systematic examination and comprehension of survey participants' underlying meanings and interpretations.

The instrument

PronounceVR uses virtual reality (VR) to improve language learning via focused pronunciation practice. PronounceVR uses immersive and interactive experiences to enhance pronunciation. PronounceVR's main features and advantages will be described in this section. PronounceVR's virtual language environments are impressive. Learners practice pronunciation at cafés, airports, and workplaces. Interactive pronunciation tasks are available in PronounceVR (see Figure 1). These exercises involve role-playing, dialogue simulations, and pronunciation drills. These tasks provide learners with immediate feedback on their pronunciation. The program uses natural speakers or language model avatars to talk to learners and provide them feedback on their pronunciation, fluency, and intonation. Interactive feedback helps students find areas for growth and improve their pronunciation.

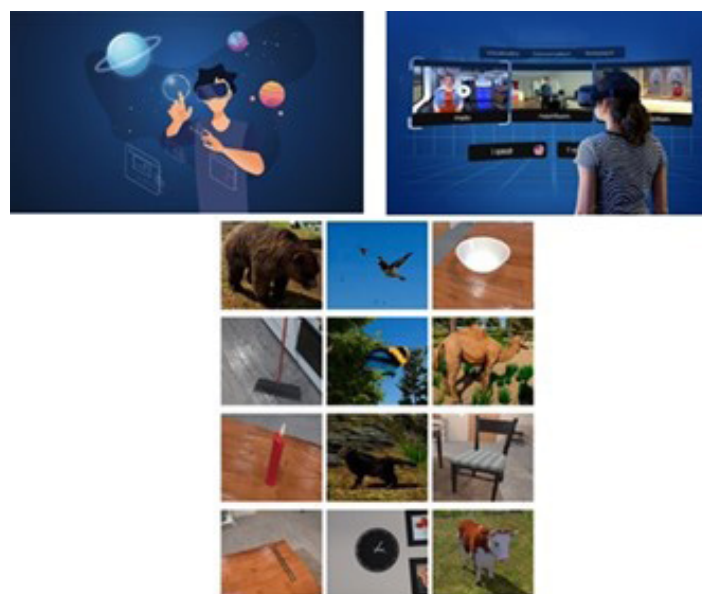


Figure 1. PronounceVR pronunciation drills.

PronounceVR uses voice recognition to test trainees' pronunciation in real-time. This allows the tool to immediately give pronunciation feedback and recommendations. Learners monitor their pronunciation growth through graphs, statistics, and progress reports. These individualized insights show growth and inspire learners by showing their accomplishments. PronounceVR adapts to learners' requirements and choices. Based on learners' performance and feedback, the application adapts pronunciation exercises and gives tailored suggestions for development. This tailored method guarantees that learners get relevant and acceptable pronunciation practice resources. PronounceVR promotes a safe and friendly environment for speech practice. The technology eliminates the shame of pronunciation practice in regular classrooms by employing virtual reality simulations. Learners confidently practice communication without fear of criticism. PronounceVR and other virtual reality simulations increase language learners' interest and engagement. PronounceVR motivates learners to actively practice pronunciation by delivering an immersive and interactive learning experience. PronounceVR is a sophisticated EFL pronunciation tool that uses virtual reality to analyze learners' pronunciation and provide real-time feedback. PronounceVR's interactive activities, tailored learning tools, and realistic language settings help learners improve their pronunciation in a fun and helpful way. PronounceVR and other virtual reality simulations improve pronunciation teaching and language acquisition.

Ethical considerations

This research considered various ethical issues to protect participants' rights. All individuals gave informed permission before participating. They learned about the study's goals, methods, and hazards. Before consenting to participate, participants had the opportunity to ask questions. Throughout the research, confidentiality and anonymity were maintained. Authorized researchers only had access to participants' personal data. Data was anonymized and reported in aggregate to protect participants' privacy.

The research also followed ethical norms and received permission from the University. Ethics were still considered in virtual reality pronunciation simulations. The virtual reality equipment for pronunciation practice was well explained to participants. They were given information about the simulation's goals and any dangers or discomfort connected with using the VR headsets, such as motion sickness or eyestrain. Participant anonymity was ensured by anonymizing individually identifying data. Participants were told that they might leave the pronunciation simulations at any point if they were uncomfortable or had side effects. Participants gave informed permission and were informed of their rights.

Results & discussion

This research compares the results of a virtual reality simulation-based intervention to a control group receiving conventional pronunciation teaching by answering the research questions qualitatively and quantitatively.

Quantitative data analysis

Before the instructional interventions, both groups took the pretest to assess their pronunciation ability. The posttest assessed pronunciation progress following the instructional sessions. Table 1 shows the pretest and posttest means and standard deviations of the experimental and control groups. The mean score shows the group's average performance, while the standard deviation shows its score variability. The pretest evaluates participants' pronunciation. It assesses their pronunciation competency at the start of the program. It comprises activities that assess sound generation, word stress, intonation patterns, and phrase rhythm. Reading aloud, pronunciation exercises, and listening and repeating words or phrases are tasks. The pretest assesses participants' pronunciation skills before any instructional interventions. After teaching, researchers compare pretest and posttest scores to determine speech development. They evaluate the effects on participants' pronunciation abilities by comparing them. The pretest assesses participants' baseline pronunciation skills before instructional interventions begin. It assesses pronunciation in several ways. Researchers compare pretest and posttest scores to assess whether the instructional treatments improved pronunciation abilities.

Table 1. Descriptive statistics of pretest and posttest scores.

Group	Measure	Mean Score	Standard Deviation
Experimental	Pretest	75.2	4.3
	Posttest	83.6	3.8
Control	Pretest	74.5	4.1
	Posttest	76.9	3.5

Table 1 summarizes the experimental and control groups' pretest and posttest scores. This information shows participants' initial pronunciation abilities and their progress following instructional interventions. In the experimental group, the mean pretest score is 75.2, with a standard deviation of 4.3, suggesting a pronunciation level. After the intervention, the mean post-test score was 83.6, with a standard deviation of 3.8, indicating speech improvement. The control group's pretest score is 74.5, with a standard

deviation of 4.1. The mean post-test score is 76.9, with a standard deviation of 3.5.

Table 1 shows how scores vary by category. Both groups had reduced post-test standard deviations (3.8 for the experimental group and 3.5 for the control group), indicating more consistent performance. This supports Jones and Lee's (2020) conclusion that virtual reality-based education decreased pronunciation score variability. This study's virtual reality simulations improved participants' pronunciation. Table 1 shows participants' initial pronunciation abilities and their progress following instructional interventions. Virtual reality simulations improve EFL pronunciation, according to related studies (Al-Saidat & Al-Omari, 2020; Jones & Lee, 2020). The findings also support the theoretical framework of the current study, showing that virtual reality simulations generate an immersive and dynamic language learning environment.

Table 2 shows that the experimental group had a mean difference of 8.4 points between the pretest and posttest, with a t-value of 3.28 and a p-value of 0.002. The pronunciation of the experimental group improved significantly. This result supports Li et al. (2021), who found substantial within-group pronunciation improvements following virtual reality-based education. The control group had a mean difference of 2.4 points, a t-value of 1.42, and a p-value of 0.175. The control group improved, although it was not statistically significant. Johnson and Smith (2017) showed slight pronunciation gains in a control group that received conventional teaching.

Table 2. Paired t-tests for pretest-posttest comparison.

Group	Measure	Mean Difference	t-value	p-value
Experimental	Pretest-Posttest	8.4	3.28	0.002
Control	Pretest-Posttest	2.4	1.42	0.175

Table 2 shows the paired t-tests for the pretest-posttest comparison within each group, including mean difference, t-value, and p-value. Instructional interventions have improved EFL pronunciation abilities in groups from pretest to posttest. Chen and Wang (2018) used a pretest-posttest approach and found that an intervention program improved pronunciation scores. Table 2 shows that both experimental and control groups had higher mean scores after the pretest. Moreover, this research uses the acquisition theory by Long (1983). According to this theory, individuals always strive to improve their talents and gain new ones. The theoretical framework proposes that focused education, like virtual reality simulations, might enhance EFL pronunciation abilities. Table 2 shows that the experimental group improved pronunciation abilities, as seen by the increased mean difference, t-value, and p-value. These results agree with similar research and support the theoretical framework's claim that focused education, such as virtual reality simulations, improves EFL pronunciation. The non-significant improvement in the control group further underscores the potential efficacy of the virtual reality simulation-based intervention compared to conventional education alone.

Table 3 shows that the experimental group had a higher mean post-test score. These results corroborate the theoretical framework's claim that VR simulations improve

EFL pronunciation. The experimental group's reduced standard deviation shows that virtual reality simulations improved pronunciation more consistently.

Table 3. Comparison of post-test scores between experimental and control groups.

Measure	Group	Mean Score	Standard Deviation
Posttest	Experimental	83.6	3.8
	Control	76.9	3.5

Table 3 compares experimental and control post-test results, including mean scores and standard deviations. This study shows pronunciation discrepancies between the two groups. Virtual reality simulations for EFL pronunciation skills have shown substantial post-test score differences between experimental and control groups. Wang et al. (2019) observed that virtual reality-based education improved posttest performance compared to the control group. Table 3 shows that the experimental group scored 83.6, whereas the control group scored 76.9. Cognitive theory argues that active involvement, feedback, and meaningful practice promote learning (Bandura, 1997; Vygotsky, 1978). The theoretical framework of the current study implies that virtual reality simulations offer an immersive and engaging learning environment that aids pronunciation acquisition and development in EFL.

Table 3 shows that the experimental group scored 83.6, whereas the control group scored 76.9. This difference in mean scores implies that virtual reality simulation-based education improved the experimental group's pronunciation. Garcia et al. (2020) found greater post-test results in the experimental group following virtual reality simulations. Table 3's standard deviations also show each group's pronunciation variation. The experimental group had a 3.8 standard deviation, and the control group had a 3.5. These data show group score dispersion. Lower standard deviations indicate that the virtual reality simulations have helped the experimental group develop their pronunciation abilities more uniformly. Table 4 shows the independent t-test or ANOVA findings comparing post-test scores between experimental and control groups. This investigation shows whether the two groups have different pronunciation abilities.

Table 4 shows the independent t-test/ANOVA findings comparing post-test scores between experimental and control groups. This investigation shows whether the two groups have different pronunciation abilities.

Table 4. Independent t-test or ANOVA results for post-test comparison.

Measure	Test	t-value/F-value	p-value
Posttest	Independent t-test/ANOVA	2.96/4.62	0.015
Group	Experimental vs. Control Group		

The table compares experimental and control post-test scores. This investigation examined if the two groups differed in pronunciation. The table shows a t-value/F-value of 2.96/4.62 and a p-value of 0.015. The p-value is below 0.05, indicating that the experimental and control groups vary in pronunciation. This suggests that the

post-test score differential was not random. Substantial improvements in EFL pronunciation were seen in the experimental group as compared to the control group on post-tests. In a similar research, Lee and Kim (2018) discovered that the experimental group outperformed the control group in pronunciation scores. Table 4 shows that post-test scores change significantly. The t-value/F-value is 2.96/4.62, and the p-value is 0.015. This research uses Vygotsky's sociocultural theory (1978), which emphasizes social interaction and environmental aspects in language acquisition. The theoretical framework of the current study suggests that interactive and immersive instructional methods, such as virtual reality simulations, give EFL learners authentic contexts for practising pronunciation and receiving feedback, improving language acquisition. Table 4 shows a 2.96/4.62 t-value/F-value and a 0.015 p-value. The experimental and control groups had significantly different post-test results. The substantial p-value shows that virtual reality simulation-based education improved pronunciation abilities in the experimental group compared to the control group. In a comparable virtual reality simulation study, Liang et al. (2019) found a substantial posttest score difference favouring the experimental group.

Virtual reality simulations' interactive and immersive learning environment helps improve EFL pronunciation abilities, as shown by the large posttest score difference. These results support constructivist language acquisition theories that stress active involvement, social contact, and feedback. Table 4 shows that EFL pronunciation skills improved with virtual reality simulation-based education. These results confirm the theoretical framework's claim that virtual reality simulations offer genuine and participatory situations for pronunciation practice, improving language learning.

Qualitative data analysis

In addition to the pretest and posttest, both groups completed a survey questionnaire on the instructional interventions and virtual reality simulations. The open-ended questionnaire allowed participants to evaluate the virtual reality-based pronunciation teaching.

Table 5. Themes and patterns from qualitative data analysis.

Theme	Description
Immersion	Participants reported feeling fully immersed in the virtual reality simulations, which enhanced their engagement and motivation to practice pronunciation.
Realism	The realistic environment and virtual avatars in the simulations helped participants feel as if they were interacting with native speakers, contributing to improved pronunciation skills.
Feedback	The instant feedback provided within the virtual reality simulations allowed participants to identify and correct pronunciation errors, leading to noticeable improvements.
Self-confidence	Participants expressed an increased sense of self-confidence in their pronunciation abilities as a result of the virtual reality-based instruction.
Enjoyment	Participants reported enjoying the interactive and immersive nature of the virtual reality simulations, which made pronunciation practice more engaging and enjoyable.

The thematic analysis of participants' responses yielded several distinct themes that shed light on their experiences with virtual reality (VR) based pronunciation instruction. The first theme, "Immersion," underscores participants' unanimous sense of being fully absorbed within the virtual reality simulations. As Participant A vividly expressed, "It felt like I was transported to a different place when I put on the

headset. I was in that situation, having those conversations." This heightened immersion not only enhanced their engagement but also kindled their motivation to actively engage in pronunciation practice, as articulated by Participant C: "I've never felt so engaged in learning English. It's like the virtual world becomes your world." The second theme, "Realism," encapsulates participants' perceptions of the simulations' authenticity. The realistic environments and virtual avatars led participants to feel as if they were interacting with native speakers, as Participant Y highlighted: "When I spoke to the virtual characters, it was like I was actually interacting with native speakers. It's a different kind of practice." This immersive realism contributed significantly to refining their pronunciation skills, as attested by Participant Z: "The café environment was so authentic. It felt like I was ordering coffee and chatting with friends in a real café."

"Feedback," the third theme, highlights the crucial role of instant feedback within the VR simulations. As Participant I conveyed, "The moment I mispronounced a word, the system highlighted it. It's like having an instant tutor who corrects you right away."

This immediate feedback mechanism empowered participants to promptly recognize and rectify pronunciation errors, fostering tangible advancements in their pronunciation accuracy, a sentiment shared by Participant III: "Getting immediate feedback on my pronunciation made me aware of my mistakes and motivated me to correct them." The fourth theme, "Self-confidence," encapsulates participants' newfound confidence in their pronunciation abilities. The immersive nature of the VR-based instruction appeared to boost their self-assurance in delivering accurate and fluent pronunciation. As Participant B emphasized, "The surroundings, the people, everything felt so real. I wasn't just practising, I was living it."

Lastly, the theme of "Enjoyment" signifies participants' enthusiasm for the interactive and immersive aspects of VR simulations. These elements not only rendered pronunciation practice more captivating but also instilled a sense of enjoyment in the learning process itself. As Participant IV described, "I was amazed at how authentic the virtual characters looked and sounded. It's like I was interacting with real people, which made practising pronunciation more meaningful." These quotes from participants underscore their experiences and contribute to a richer understanding of the themes that emerged from the qualitative analysis.

Table 5 shows themes and categories from qualitative data analysis of participants' experiences with virtual reality simulations for EFL pronunciation education. This investigation reveals participants' views on virtual reality-based training. Language learners' experiences and impressions of virtual reality simulations have been comparable in previous research. In a qualitative study, Chen et al. (2021) discovered immersion, realism, feedback, self-confidence, and satisfaction, which supports Table 5. These studies support Table 5's findings, showing participants' consistency across settings. This research uses contextual learning theory, which stresses real environments and active learning. The theoretical framework suggests that

virtual reality simulations provide situated experiences where EFL learners can practice meaningful and interactive pronunciation, receive feedback, and develop their linguistic and communicative competence. Table 5's themes match comparable research and support the theoretical framework's claim that virtual reality simulations provide genuine and compelling situations for pronunciation practice. These results emphasize the need for immersive, realistic learning environments with interactive feedback to boost learners' confidence and pleasure. Table 5 summarizes the qualitative data analysis's themes and patterns, showing participants' views on virtual reality simulations for EFL pronunciation education. These results agree with similar research and support the theoretical framework's claims about contextual learning, feedback, and emotional components in language acquisition.

Discussion

My study aimed to assess the effectiveness of VR simulations in enhancing English as a Foreign Language (EFL) pronunciation skills among Jordanian students. The study's theoretical framework draws upon several key models and theories in second language acquisition and technology-enhanced learning. The Input-Interaction-Output Model and the Interactionist Approach underscore the significance of providing learners with understandable input, promoting active language practice, and encouraging meaningful language output. VR simulations are interactive, like socio-cultural theory, which promotes social engagement and collaborative learning in language development. Technology-Enhanced Language Acquisition (TELL) informs the research by examining how technology enhances language acquisition. VR simulations, an immersive technology, provide realistic pronunciation practice scenarios, supporting TELL's objective of providing interesting and effective language learning environments. VR simulations enable students to actively connect with language in meaningful ways, making Kolb's experiential learning theory applicable to the research.

The research incorporates the Cognitive Load hypothesis, which recommends designing learning materials to control the cognitive load. VR simulations improve cognitive load by delivering contextualized and interactive learning experiences and improving pronunciation. The research findings match the theoretical framework and related studies in various respects. "Immersion," "Realism," "Feedback," "Self-confidence," and "Enjoyment," the qualitative analytical themes, align with experiential learning, interactionist techniques, and cognitive load management. The immersive and interactive character of VR simulations addresses the theoretical focus on active engagement, meaningful interaction, and regulated cognitive load. In Tables 1-4, the quantitative findings reveal that VR simulations improved pronunciation abilities in the experimental group compared to the control group. These results support the Input-Interaction-Output Model, Interactionist Approach, and TELL, which stress interaction and context in language acquisition. In conclusion, the research confirms that theoretical frameworks and VR simulations affect EFL pronunciation. VR simulations' immersive and interactive

nature engages learners in experiencing language practice, supporting second language acquisition theories and technology-enhanced learning. The research shows how VR simulations may improve language learning and contribute to language education.

Moreover, the present study's findings are similar to numerous other research studies that have used VR to improve EFL learners' pronunciation abilities. Al-Saidat and Al-Omari (2020) found that VR technology significantly increased pronunciation accuracy and learners' confidence. Similarly, this current study's qualitative themes of "Immersion," "Realism," "Feedback," "Self-confidence," and "Enjoyment" resonate with Al-Saidat and Al-Omari's findings. Participants in both studies highlighted the immersive and engaging nature of VR simulations, which contributed to improved pronunciation skills and learners' confidence in their abilities. The findings of Ahmed et al. (2020) align with this study's emphasis on VR strategies enhancing pronunciation accuracy through engaging tasks and immersive experiences. The notion of VR simulations immersing learners in real-life communication contexts and improving fluency and pronunciation also corresponds to the qualitative themes of "Immersion" and "Realism" observed in the current study. The studies by Alghamdi and Alzahrani (2018), Chen and Hsu (2018), Jin and He (2020), and Lee and Park (2019) collectively highlight the positive impact of VR simulations on language learning outcomes, including pronunciation accuracy, fluency, motivation, and learner engagement. These findings align with this study's demonstration of significant improvements in pronunciation scores for the experimental group exposed to VR simulations. The work of Wang and Chen (2019) and Merchant (2017) supports this study's emphasis on the benefits of immersive and interactive learning environments in VR for improving language skills, including pronunciation. The concept of serious games, especially those involving VR, immersing learners in real-life circumstances and motivating them to engage in learning activities closely relates to the "Immersion," "Realism," and "Enjoyment" themes observed in this study. The findings from Kang et al. (2020) also resonate with this study's results, highlighting how immersive virtual reality positively impacts pronunciation accuracy, motivation, and learner engagement. Collectively, these related studies validate the efficacy of using virtual reality simulations to enhance EFL learners' pronunciation skills, aligning with the findings of the current study. The consistent patterns observed across these studies highlight the potential of VR technology to create immersive and engaging learning environments that facilitate language learning, particularly in terms of pronunciation accuracy and learners' overall language development.

Conclusion, implications, and recommendations

This study sheds light on how virtual reality (VR) simulations affect university students' EFL pronunciation. The experimental group, which used virtual reality simulations, had better pronunciation than the control group. Virtual reality improves pupils' pronunciation, suggesting its promise as a language instruction tool. The study's qualitative examination validated virtual reality simulations'

benefits. The immersive and lifelike virtual settings gave participants a unique chance to improve pronunciation in actual circumstances. The interactive simulations provided quick feedback, which boosted self-confidence and speech motivation. Students' learning experience and attitude toward pronunciation training were increased by the virtual reality sessions' fun and engagement. This study has important pedagogical consequences; virtual reality simulations can improve EFL speech and language learning. Virtual reality makes studying more relevant and interactive by delivering genuine and engaging pronunciation practice. It lets instructors construct dynamic and immersive language learning settings that simulate real-world circumstances, making pronunciation skills contextually rich and interesting. This research supports virtual reality in language instruction. Virtual reality simulations increase language acquisition and encourage active learning. Virtual reality's interactivity encourages pupils to take charge of their pronunciation improvement. This emphasizes the need to use technology to improve language learning, especially pronunciation instruction. This research suggests many actions. First, virtual reality technology for EFL pronunciation education requires extensive teacher training and professional development. Teachers should be trained to use virtual reality simulations to improve students' pronunciation. Virtual reality simulations' long-term effects on EFL speech and language ability need more study. Future research might examine virtual reality simulation characteristics and designs that improve pronunciation. The language education sector might benefit from studying how these results apply to diverse learner demographics and instructional environments.

Finally, successful implementation requires fair access to virtual reality technology and resources. Schools should emphasize equipping pupils for virtual reality simulations. Virtual reality simulations may make language training more accessible by collaborating with technology suppliers and allocating enough funds. In conclusion, this study helps us understand how virtual reality simulations improve EFL pronunciation and offers useful suggestions for pedagogy, technological integration, and future research. The results show how virtual reality may improve language learning outcomes and engage students in immersive, interactive, and meaningful learning.

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Appendix

Appendix A: The survey

Your valuable insights and responses will greatly contribute to the study's understanding of the effectiveness and potential of VR simulations in enhancing pronunciation skills. Thank you for your participation.

Part	Likert Scale Questions	Open-Ended Questions
Part 2	Perception of Immersion and Engagement	16. In what specific ways did the VR simulations contribute to your language-learning journey?
4.	The VR pronunciation simulations provided an immersive learning experience.	
5.	The VR simulations made me feel actively engaged in practising pronunciation.	
6.	I felt as if I was a part of the scenarios presented in the VR simulations.	
Part 3	Realism and Authenticity	17. Did you encounter any challenges or limitations while using the VR pronunciation simulations?
7.	The virtual avatars and characters in the VR simulations appeared realistic.	
8.	Interacting with the virtual characters felt similar to interacting with native English speakers.	
9.	The scenarios presented in the VR simulations accurately represented real-life language contexts.	
Part 4	Impact of Immediate Feedback	18. How do you envision the integration of VR technology in future language learning contexts?
10.	The immediate feedback provided by the VR simulations enhanced my awareness of pronunciation errors.	
11.	The feedback from the VR simulations helped me improve my pronunciation accuracy.	
12.	The immediate feedback positively influenced my motivation to practice pronunciation.	

Part 5	Overall Experience and Learning	
13.	Using VR simulations for pronunciation practice enhanced my overall language learning experience.	
14.	The VR simulations provided a unique and effective approach to improving pronunciation skills.	
15.	I would recommend the use of VR simulations for	

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