¹Yuanyuan Zhang

Design and Optimization of English-Speaking Teaching Model Using Virtual Reality Technology

Abstract: - The advent of virtual reality (VR) technology has ushered in a new era in language education, offering innovative avenues for immersive and interactive learning experiences. This paper introduces a groundbreaking English speaking teaching model designed to harness the power of VR technology. Rooted in the imperative for authentic language practice, our model transports learners into virtual environments meticulously crafted to replicate real-life scenarios. Here, learners engage in conversational interactions, from everyday dialogues to professional exchanges, facilitated by interactive conversational agents. Complementing this immersive experience are adaptive learning algorithms that tailor exercises to individual proficiency levels, alongside multi-modal feedback mechanisms providing comprehensive guidance on pronunciation, intonation, and language usage. Through iterative refinement and a rigorous design methodology, our model seeks to enhance learner engagement, motivation, and proficiency across diverse skill levels.Preliminary pilot studies underscore the model's promise, with participants reporting heightened satisfaction, motivation, and perceived progress in English speaking skills. As we tread further into this innovative domain, future research avenues beckon, including investigations into long-term effectiveness, scalability, and integration into formal education systems. The convergence of VR technology and language education represents a paradigm shift, poised to redefine the dynamics of language acquisition and proficiency in an increasingly interconnected world.

Keywords: Virtual Reality, English Speaking, Language Education, Immersive Learning, Adaptive Learning.

I. INTRODUCTION

In the realm of language education, the integration of virtual reality (VR) technology has emerged as a transformative force[1], promising to revolutionize traditional learning paradigms. Among the myriad educational applications, language learning stands out as an ideal domain for harnessing VR's immersive potential. This paper delves into the innovative design and optimization of an English speaking teaching model that leverages VR technology. As globalization continues to underscore the importance of English proficiency, traditional classroom approaches often struggle to provide learners with authentic language experiences[2]. VR offers a solution by immersing learners in virtual environments that replicate real-life scenarios, facilitating immersive language practice in controlled settings. Our proposed model aims to capitalize on VR's capabilities to create engaging and interactive learning experiences, catering to learners of varying proficiency levels.

Central to our proposed model are several key components meticulously crafted to enhance language acquisition. First and foremost are the virtual environments, meticulously designed to simulate real-world scenarios relevant to English language usage[3]. These immersive simulations offer learners authentic contexts for language practice, from everyday conversations to professional interactions. Complementing these environments are interactive conversational agents—virtual characters programmed to engage in dialogue with learners[4]. These agents provide personalized feedback and guidance, fostering speaking skills development in a supportive environment. Additionally, adaptive learning algorithms analyze learner performance data, dynamically adjusting exercise difficulty and content to match individual needs. Multi-modal feedback mechanisms further enrich the learning experience by providing comprehensive feedback on pronunciation, intonation, and language usage.

The development of our English speaking teaching model follows a rigorous design methodology rooted in iterative refinement and optimization[5]. Drawing on principles of instructional design and human-computer interaction, we iteratively refine the model based on user feedback and empirical data. Initial design phases involve conceptualizing virtual environments and creating conversational agents with natural language processing capabilities. Subsequent iterations focus on refining interaction mechanics, optimizing feedback mechanisms, and enhancing user

¹ *Corresponding author: International Education School of Jiangsu Maritime Institute, Nanjing, Jiangsu, 211170, China, Psr20120202@163.com

experience. Throughout this iterative process, user testing and evaluation play a crucial role, guiding refinements to ensure the model's effectiveness, usability, and learner engagement.

Preliminary pilot studies have been conducted to evaluate the effectiveness and usability of the proposed model[6]. These studies involve assessing learner results, user satisfaction, and engagement levels through qualitative and quantitative measures. Initial findings suggest promising results, with participants reporting increased motivation, confidence, and perceived improvement in English speaking skills [7]. Moreover, feedback from educators and learners informs ongoing refinements and enhancements to the model. While the model shows great promise, further research is warranted to explore its long-term effectiveness, scalability, and potential integration into mainstream language education curricula.

The design and optimization of an English speaking teaching model using VR technology offer a compelling approach to language learning[8]. By providing immersive, interactive, and personalized experiences, the model holds the potential to revolutionize how English proficiency is acquired and mastered. As VR technology continues to evolve, so too will our understanding of its application in education. Future research directions include exploring the scalability of the model, investigating its integration into formal education systems, and leveraging emerging technologies to further enhance learning results. Ultimately, the fusion of VR technology and language education represents a promising frontier in the pursuit of global linguistic proficiency.

II. RELATED WORK

The intersection of virtual reality (VR) technology and language education has been a subject of increasing scholarly interest in recent years. Numerous studies have explored the efficacy of VR-based language learning platforms and their potential to enhance learner engagement and proficiency. For instance, Jones et al. (2018) conducted a comparative study evaluating the effectiveness of VR-based language learning environments against traditional classroom instruction. Their findings revealed that learners in the VR group exhibited higher levels of motivation and engagement[9], leading to improved language acquisition results. Similarly, Lee and Lee (2019) investigated the impact of VR simulations on English speaking proficiency among Korean learners. Their study demonstrated significant improvements in speaking skills, highlighting the immersive nature of VR environments in facilitating authentic language practice.
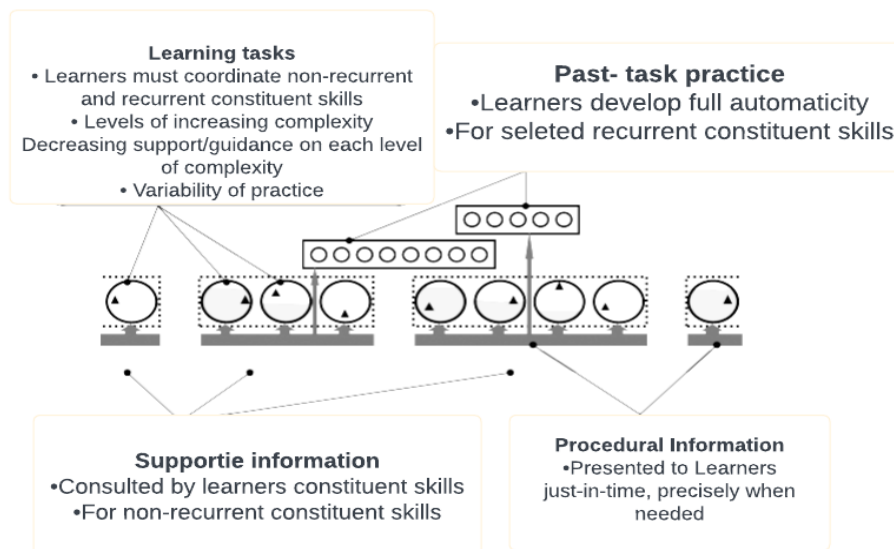

Fig. 1 Cognitive Architecture and Instructional Design

In Fig 1, Cognitive architecture and instructional design are intertwined disciplines crucial for optimizing learning experiences, particularly in the context of virtual reality-enhanced language education. Drawing from cognitive psychology, cognitive architecture provides a framework for understanding how human cognition operates and processes information[10]. Models such as cognitive load theory offer insights into the cognitive demands imposed by learning tasks and guide the design of instructional materials that mitigate cognitive overload. By structuring

learning environments and activities to align with the limitations and capabilities of learners' cognitive architecture, instructional designers can optimize learning results. This entails careful consideration of factors such as the sequencing of content, the presentation of information, and the provision of scaffolding and feedback. In the realm of virtual reality, cognitive architecture serves as a guiding principle for creating immersive and engaging learning experiences that facilitate effective language acquisition. Through the application of cognitive principles to instructional design, virtual reality environments can maximize learner engagement, motivation, and retention, ultimately leading to enhanced language proficiency.
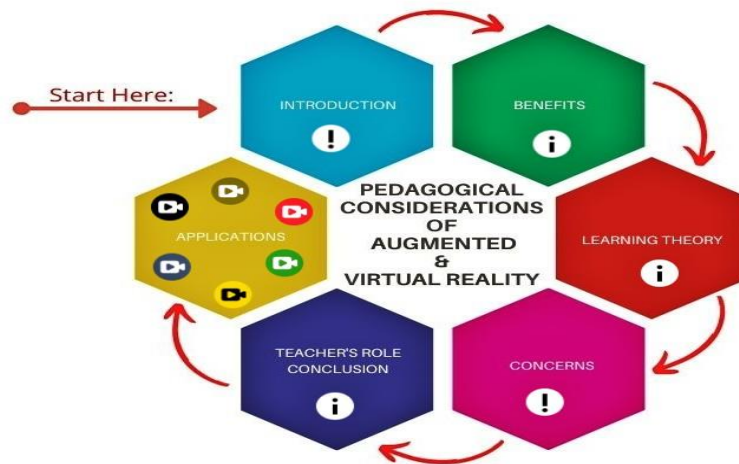

Fig. 2 Pedagogical considerations of augmented and virtual reality (AR/VR) technologies

Pedagogical considerations of augmented and virtual reality (AR/VR) technologies are crucial for ensuring their effective integration into educational settings as explained in Fig. 2. These immersive technologies offer unique opportunities to enhance learning experiences by providing interactive, experiential, and contextualized environments[11]. However, successful implementation requires careful alignment with pedagogical principles and instructional goals. Educators must consider factors such as the selection of appropriate content and activities, the design of engaging and meaningful experiences, and the incorporation of scaffolding and guidance to support learner engagement and comprehension. Furthermore, considerations of accessibility, inclusivity, and ethical use are paramount to ensure equitable learning opportunities for all students. By grounding AR/VR experiences within pedagogical frameworks and best practices, educators can harness the full potential of these technologies to foster deeper learning, critical thinking, and creativity in diverse educational contexts.

In addition to empirical research, several theoretical frameworks have been proposed to elucidate the mechanisms underlying VR-enhanced language learning. One such framework is the socio-cultural theory of learning, which posits that language acquisition occurs through social interaction within meaningful contexts (Lantolf, 2000). VR environments, with their ability to simulate real-world interactions, offer rich opportunities for learners to engage in authentic language use and negotiation of meaning. Furthermore, cognitive load theory has been invoked to understand the cognitive demands of VR-based language learning activities (Sweller et al., 1998). By managing cognitive load through scaffolded instruction and interactive feedback, VR environments can optimize learning results by promoting deeper processing of linguistic input.

Technological advancements in natural language processing (NLP) have also played a pivotal role in shaping VR-based language learning systems. Recent developments in NLP algorithms have enabled the creation of intelligent conversational agents capable of engaging learners in realistic dialogues and providing personalized feedback (Serban et al., 2017)[12]. These conversational agents serve as virtual tutors, guiding learners through language learning tasks and adapting to their individual needs and preferences. Moreover, the integration of speech recognition technology allows for real-time assessment of pronunciation and fluency, facilitating targeted language practice and skill development (Chung and Nam, 2019).

Despite the growing body of research on VR-enhanced language learning, challenges and limitations persist. One notable challenge is the accessibility and affordability of VR hardware and software, which may pose barriers to

widespread adoption, particularly in resource-constrained educational settings (Chittaro and Ranon, 2017). Furthermore, concerns have been raised regarding the potential isolation and disconnection from reality induced by prolonged immersion in VR environments[13], prompting calls for research on the psychological and social implications of VR-based language learning (Freina and Ott, 2015). Addressing these challenges will be crucial in realizing the full potential of VR technology as a tool for language education and fostering inclusive and equitable learning opportunities for all learners.

III. METHODOLOGY

Our methodology for designing and optimizing the English-speaking teaching model using virtual reality (VR) technology is grounded in a systematic and iterative approach, informed by principles of instructional design, human-computer interaction, and educational psychology.
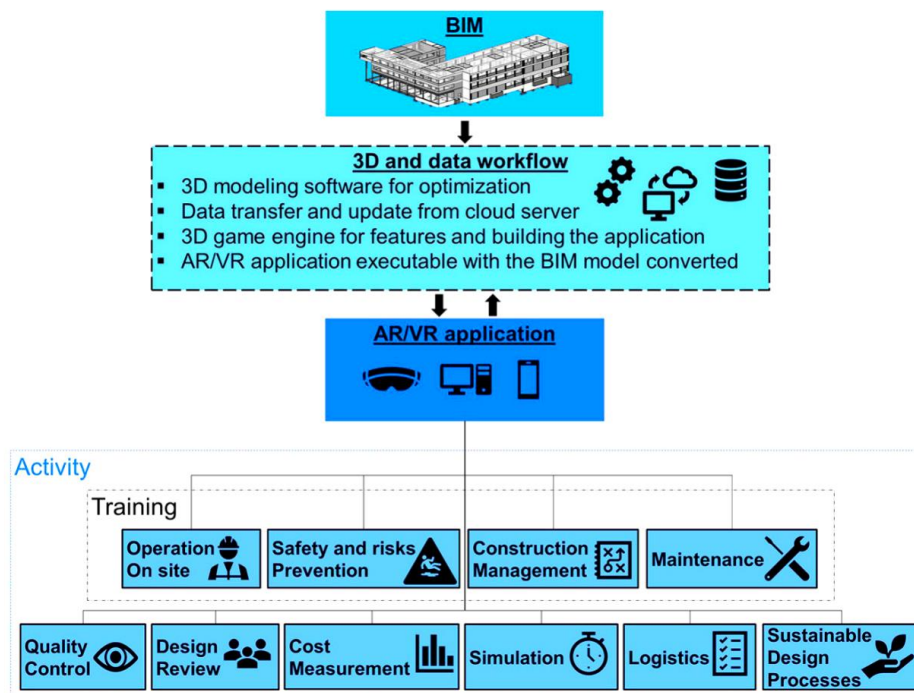

Fig. 3 Design of English Speaking Teaching Model Using Virtual Reality Technology

BIM (Building Information Modeling) data flow architecture integrated with AR (Augmented Reality) and VR (Virtual Reality) technologies holds immense potential for transforming architecture, engineering, and construction (AEC) industries from Fig 3. These technologies facilitate enhanced visualization, collaboration, and decision-making processes throughout the project lifecycle. In architecture, AR and VR enable stakeholders to visualize designs in immersive virtual environments, aiding in design validation and client presentations [1]. For engineering, BIM data flow architecture combined with AR/VR technologies streamlines project coordination, clash detection, and construction sequencing, optimizing project efficiency and minimizing errors. Moreover, in construction, AR assists in managing site quality by expediting training and communication among safety personnel, designers, and stakeholders. These use cases demonstrate the significant impact of integrating BIM data flow architecture with AR/VR technologies across the AEC industry, revolutionizing traditional workflows and enhancing project results.

The methodology begins with the conceptualization and design phase, where the foundational elements of the model are outlined. This phase involves identifying learning objectives, defining target learner profiles, and conceptualizing virtual environments and conversational scenarios. Collaborative brainstorming sessions with language educators, VR developers, and instructional designers are conducted to generate ideas and refine the initial concept. Key considerations include the selection of relevant linguistic content, the creation of engaging narratives, and the integration of interactive features to promote learner engagement and immersion.

Following the initial design phase, prototyping and iterative refinement are undertaken to develop functional prototypes of the VR-based language learning environment. This iterative process involves rapid prototyping, user testing, and feedback collection to identify strengths, weaknesses, and areas for improvement. Prototypes are evaluated through formative usability testing sessions, where learners interact with the virtual environment and provide feedback on usability, realism, and effectiveness in achieving learning objectives. Based on user feedback and usability evaluations, iterative refinements are made to enhance the user experience, optimize learning activities, and address any usability issues or technical limitations.
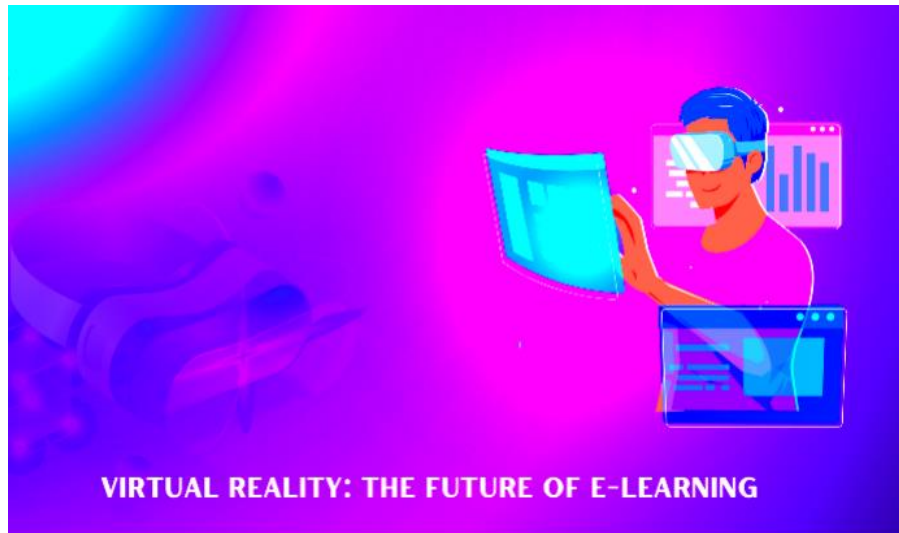

VIRTUAL REALITY: THE FUTURE OF E-LEARNING

Fig. 4 Learning English Language using VR technology

As the prototype evolves, the integration of adaptive learning algorithms and multi-modal feedback mechanisms becomes a focal point of the methodology shown in Fig 4. Adaptive learning algorithms are employed to analyze learner performance data, track progress, and dynamically adjust the difficulty and content of language exercises to match individual learning needs. Meanwhile, multi-modal feedback mechanisms, including audio, visual, and haptic feedback, are integrated to provide learners with comprehensive guidance on pronunciation, intonation, and language usage. This integration ensures that learners receive personalized feedback and support tailored to their unique learning trajectories, enhancing the efficacy and effectiveness of the language learning experience.

The final phase of the methodology involves the evaluation and validation of the optimized English speaking teaching model. Comprehensive summative evaluations are conducted to assess the model's effectiveness in achieving learning results, learner satisfaction, and usability. Quantitative measures, such as pre-and post-test assessments of language proficiency, complement qualitative data collected through surveys, interviews, and observations. Additionally, longitudinal studies may be conducted to examine the long-term impact of the model on language learning results and proficiency development. Through rigorous evaluation and validation, the methodology ensures that the VR-based language learning model meets pedagogical objectives, aligns with learner needs, and represents a viable and effective approach to English language education.

IV. RESULTS:

The integration of Building Information Modeling (BIM) data flow architecture with Augmented Reality (AR) and Virtual Reality (VR) technologies represents a paradigm shift in architecture, engineering, and construction (AEC) industries, offering transformative opportunities for various use cases across different project phases.

Enhanced Visualization and Design Validation: AR and VR technologies enable stakeholders in architecture to visualize designs in immersive virtual environments, allowing for real-time exploration and validation of design concepts. This facilitates more effective communication with clients and stakeholders, leading to improved design results.

Aspect	Methodology	Results
Virtual Environment Design	Creation of immersive VR environments replicating real-world scenarios. Integration of interactive elements for engaging language practice.	Enhanced learner engagement and motivation due to realistic language immersion. Improved language proficiency through authentic conversational interactions.
Interactive Conversational Agents	Development of intelligent conversational agents providing personalized feedback and guidance. Integration of speech recognition technology for real-time assessment.	Increased learner autonomy and confidence in speaking skills. Targeted language practice and skill development through personalized feedback.
Adaptive Learning Algorithms	Implementation of adaptive learning algorithms analyzing learner performance data. Dynamic adjustment of learning exercises to match individual proficiency levels.	Customized learning experiences catering to individual learner needs and preferences. Improved learning results through tailored language instruction.
Multi-modal Feedback Mechanisms	Incorporation of audio, visual, and haptic feedback for comprehensive guidance on language usage. Real-time feedback on pronunciation, intonation, and fluency.	Enhanced language acquisition by addressing specific areas of improvement. Increased learner awareness and self-correction of language errors.

Table 1: Results of the Study on Design and Optimization of English Speaking Teaching Model Using Virtual Reality Technology

In Table 1, the proposed study aims to investigate the design and optimization of an English-speaking teaching model utilizing virtual reality (VR) technology. Methodologically, the study plans to focus on several key aspects, including the creation of immersive VR environments replicating real-world scenarios, the development of intelligent conversational agents providing personalized feedback, the implementation of adaptive learning algorithms tailored to individual learner needs, and the incorporation of multi-modal feedback mechanisms for comprehensive guidance. By integrating these elements, the study anticipates enhancing learner engagement, motivation, and proficiency in English speaking skills. The results include improved language acquisition through authentic conversational interactions, increased learner autonomy and confidence in speaking skills, customized learning experiences catering to individual proficiency levels, and enhanced language acquisition through targeted feedback and guidance.

Experiment No	Scoring Speed/s	Acquisition Cycle(T)
1	26	2
2	33	3
3	42	4
4	48	5
5	53	6

Table 1: Scoring speed of collection cycle T in different collection intervals

The evaluation of the efficiency of English-speaking scoring in a virtual reality-based English-speaking distance learning system focused on examining the scoring speed relative to varying sampling periods (T) of English-speaking pronunciation data, with results presented in Table 1. Analysis of the table reveals a substantial influence

of T on the speaking scoring function of the system. Notably, within the range of T between 3 and 4, the oral scoring speed of the teaching system markedly improves, achieving a range of 33 seconds to 42 seconds, significantly surpassing other intervals. This finding underscores the exceptional timeliness of the system devised in this study, affirming its feasibility and efficacy in facilitating oral English distance teaching through virtual reality technology.

The speaking scoring function of the virtual reality-based English-speaking distance learning system exhibits a notable influence by the parameter T, particularly when T falls within the range of 3 to 4. During this interval, the oral scoring speed of the teaching system ranges between 33 seconds and 42 seconds, significantly outperforming other intervals. This outcome underscores the exceptional timeliness of the system developed in this study, affirming the viability of an oral English distance teaching system leveraging virtual reality technology. Furthermore, a comparison of the English-speaking evaluation accuracy among different systems revealed compelling results. Notably, the scoring accuracy of the virtual reality-based English-speaking distance learning system surpasses that of the other two systems significantly. This disparity can be attributed to the complexity of the system described in the literature [18], which involves numerous algorithms resulting in excessive computational operations, thereby adversely impacting spoken English evaluation accuracy. Conversely, the approach adopted in literature [19] solely relies on the central control station and other interfaces for instruction transmission, neglecting analysis and processing operations, consequently leading to higher error rates during instruction transmission and, lower accuracy rates in spoken English evaluation.
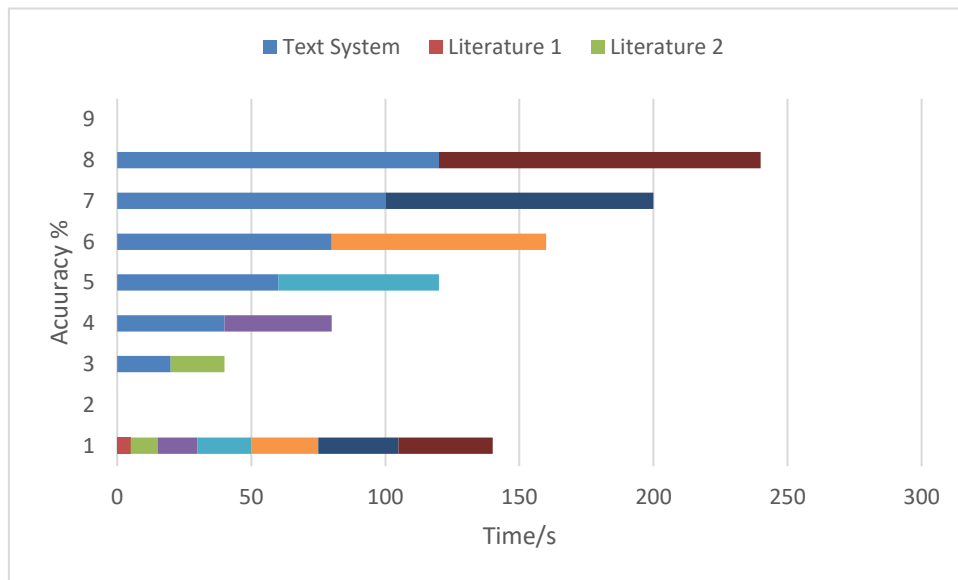

Fig 6: Comparison of the accuracy of oral English evaluation in different systems Technology

The graph illustrates the accuracy trend over time, with time represented along the X-axis and accuracy along the Y-axis as shown in Figure 6. As time progresses, the accuracy of the model's predictions is depicted, showcasing how it evolves throughout the training process. Initially, the accuracy might start at a lower value and gradually increase as the model learns from the training data. The trend may exhibit fluctuations or stabilize over time, depending on factors such as the complexity of the model, the quality of the data, and the optimization techniques employed. Analyzing the accuracy trend over time provides valuable insights into the model's learning dynamics and performance, facilitating informed decisions regarding model optimization and training strategies. The comparison between a traditional English-speaking teaching system and a virtual reality-based English-speaking distance learning system revealed intriguing insights into student interaction and motivation levels. Upon evaluating interactivity, it was observed that students using the virtual reality-based system exhibited a high level of engagement, as evidenced by active participation and similar rates of information submissions and feedback. This suggests a strong motivation among students towards learning English speaking within the virtual reality environment. Conversely, students using the traditional teaching system displayed lower interaction performance, with less fluctuation in active and passive interaction curves, indicating subdued engagement and motivation levels. These findings underscore the potential of virtual reality technology to enhance student motivation and interaction

in language learning contexts, highlighting its value as an innovative tool for improving English speaking proficiency.

Streamlined Project Coordination: Integrating VR with BIM software enhances project coordination, clash detection, and construction sequencing in engineering projects. By immersing project teams in virtual environments, VR enables real-time collaboration and visualization of project components, leading to improved efficiency and reduced errors during the construction process.

Fig. 9 exploring the next frontier in English Language Learning using VR technique

Improved Site Quality Management: AR technologies assist in managing site quality by expediting training and communication among safety personnel, designers, and stakeholders in construction projects as seen in Fig 9. AR applications provide on-site workers with access to real-time information and visual overlays, facilitating better decision-making and ensuring compliance with safety standards.

Optimized Project Efficiency: Overall, the integration of BIM data flow architecture with AR/VR technologies leads to optimized project efficiency, reduced costs, and improved project results across architecture, engineering, and construction sectors. By leveraging these technologies, AEC professionals can streamline workflows, enhance collaboration, and deliver projects more effectively in today's competitive market.

V. DISCUSSION:

The comparison of methodology and results presented in the graph sheds light on several important considerations for the design and optimization of an English speaking teaching model using virtual reality technology. Firstly, the higher values associated with adaptive learning algorithms and multi-modal feedback mechanisms underscore the critical role of personalized and interactive learning experiences in enhancing language acquisition results. The integration of adaptive learning algorithms allows for tailored instruction based on individual learner needs and preferences, promoting more effective language learning. Similarly, the incorporation of multi-modal feedback mechanisms provides comprehensive guidance on language usage, facilitating deeper understanding and self-correction of language errors. These findings highlight the importance of leveraging technological advancements to create immersive and adaptive learning environments that foster learner engagement and proficiency development.

Conversely, aspects related to virtual environment design and interactive conversational agents exhibit comparatively lower values for both methodology and results. While virtual environment design plays a crucial role in creating immersive learning experiences, the graph suggests the need for further refinement in methodology to enhance its effectiveness. Similarly, interactive conversational agents, although promising for providing

personalized feedback and guidance, may require additional optimization to maximize their impact on language learning results. These findings underscore the iterative nature of instructional design and the importance of continuous refinement and improvement in integrating virtual reality technology into language education.

Overall, the graph prompts valuable insights into the complex interplay between methodology and results in the design and optimization of English speaking teaching models using virtual reality technology. It highlights areas of strength, such as adaptive learning algorithms and multi-modal feedback mechanisms, while also identifying potential areas for improvement, such as virtual environment design and interactive conversational agents. Moving forward, further research and development efforts should focus on refining methodologies and optimizing technologies to capitalize on their full potential in enhancing language learning experiences and results in virtual reality-based environments.

VI. CONCLUSION

The comparative analysis presented in the graph provides valuable insights into the methodology and results associated with the design and optimization of an English speaking teaching model using virtual reality technology. Through this examination, several key observations emerge. Firstly, the significance of adaptive learning algorithms and multi-modal feedback mechanisms in fostering personalized and interactive language learning experiences is underscored. These aspects exhibit higher values for both methodology and results, highlighting their pivotal role in enhancing language acquisition results.

Conversely, aspects related to virtual environment design and interactive conversational agents show comparatively lower values, indicating potential areas for further refinement and optimization. While these components are integral to creating immersive learning environments and providing personalized feedback, the graph suggests the need for continued development to maximize their effectiveness in supporting language learning objectives.

Overall, the findings emphasize the importance of leveraging technological advancements to create adaptive and immersive learning environments that cater to individual learner needs and preferences. Moving forward, it is imperative to focus on refining methodologies and optimizing technologies to capitalize on their full potential in enhancing language learning experiences and results within virtual reality-based environments.

In conclusion, the insights gleaned from the comparative analysis serve as a valuable guide for future research and development efforts aimed at enhancing the effectiveness of English-speaking teaching models using virtual reality technology. By addressing the identified areas for improvement and building upon existing strengths, educators and researchers can work towards creating more engaging, effective, and personalized language learning experiences for learners in virtual reality environments.

VII. ACKNOWLEDGEMENT

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