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Research on the Implementation Effectiveness of Virtual Simulation Technology in Language Education under Intercultural Interaction Mode

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Abstract The increase of globalization level puts forward higher requirements for cross-cultural language interaction ability. Based on the hierarchical teaching method, this paper designs a virtual simulation experimental platform with three layers: basic experiment, comprehensive application and research and development, and realizes the adaptation of educational resources according to the ability. Using the histogram equalization method and Adaboost algorithm, we optimize the gesture recognition to improve the real-time feedback effect of the platform in cross-cultural interaction. Relying on Raspberry Pi hardware and Scratch graphical programming and other technologies, build an intelligent language teaching system in the platform to visualize language feedback. The application value of the virtual simulation platform is judged through language education practice. The results show that the resource occupation of the virtual simulation platform system is basically not more than 100% and occupies less resources. After utilizing the platform for assisted teaching experiments, the classroom interaction activity, students' cross-cultural language communication ability, and the level of operating skills of the experimental platform were increased to the highest 96.01%, 72.23%, and 60%, respectively. The average score of the evaluation of the platform's functional diversity and the effectiveness of feedback and communication was over 4.5 at the highest.

Index Terms cross-cultural interaction, virtual simulation platform, histogram equalization, Adaboost algorithm, language teaching

I. Introduction

With the increasing ability of information technology, the cross-cultural interaction mode is gradually gaining attention in language education. Virtual simulation technology has become a very important means of teaching and is widely used in education to improve the quality of teaching, to promote the development of the learning atmosphere and to improve the teaching method, in order to help students better master knowledge [1]-[4].

Virtual simulation is a kind of technology that uses computer to generate a three-dimensional dynamic scene to imitate another real system, with the continuous development of modern computer technology, virtual simulation technology is gradually emphasized and applied on a large scale in many industries [5]-[8]. Virtual simulation technology for language teaching can build a virtual environment, the scene is to show all the experiments that can not be widely replicated because of the need for a very long period of time, high cost, and high risk in the form of three-dimensional models [9]-[11]. In virtual language learning, students can enter the virtual language learning environment through virtual simulation technology, communicate with virtual characters and participate in various language activities [12], [13]. This contextual learning approach can enhance students' cross-linguistic communication skills, deepen their understanding of language and culture, and improve the efficiency of language learning [14], [15]. Virtual simulation technology also provides new possibilities for cross-cultural communication [16], [17]. With the help of virtual simulation scenarios, people from different cultural backgrounds can simulate various cross-cultural communication situations and experience the challenges and joys of cross-cultural communication in a near-real way, which can help to promote understanding and respect between cultures and reduce misunderstandings and barriers in cultural communication [18]-[21]. However, the application of virtual simulation technology also faces some challenges, such as technical limitations and cost issues as well as the verification of long-term effects [22], [23]. With the further development of technology and the deepening of research, it is believed that virtual simulation technology will bring more new breakthroughs and progress for language learning and cross-cultural communication [24], [25].

In this paper, students are categorized according to their current level, and a virtual simulation experimental platform containing multiple levels is constructed to provide students with targeted resource allocation. The original gesture image contrast is enhanced using histogram equalization method, etc., and the image feature classification ability is improved by combining with Adaboost algorithm to improve the efficiency of gesture recognition. Complete the design of the language recognition system from the overall and functional aspects to improve the virtual interaction effect of the platform. Analyze the user requirements and test the platform system in modules to optimize the design process and improve the teaching assistance ability of the virtual assistance platform. Through specific teaching experiments, compare the classroom dynamic characteristics and students' skill levels before and after using the platform, and verify the quality of the constructed virtual simulation platform by combining the evaluation of platform use.

II. Analysis of Virtual Simulation Technology in Language Education

This chapter analyzes the specific application mode of virtual simulation technology in language education. Through designing the virtual simulation experiment platform, optimizing gesture movement recognition, teaching system construction and other steps, the feasibility of the application of virtual simulation technology in cross-cultural mode is systematically studied.

II. A. Virtual simulation experiment platform design

II. A. 1) Virtual simulation experiment platform construction

Colleges and universities aim to cultivate “language application talents under the mode of cross-cultural interaction” and provide talents and intellectual support for the economic and social development of the country and the region. Combined with the actual situation of our college, the College of English Language and Culture covers a number of specialties, with many specialties, great difficulty and high requirements for experimental equipment. The construction of laboratory should meet the actual situation of our institute, and the construction of virtual simulation experiment platform provides us with a good solution. This project explores how to build a virtual simulation experimental platform for applied undergraduate talents under the model of language cross-cultural interaction, which is based on the construction methods of “hierarchical teaching, course modularization, multi-course integration, school-enterprise cooperation, and sharing of teaching resources” to build a virtual simulation experimental platform for applied undergraduate talents under the model of language cross-cultural interaction. Figure 1 shows the virtual simulation experiment platform. Figure 1 shows the construction framework of the virtual simulation experiment platform.

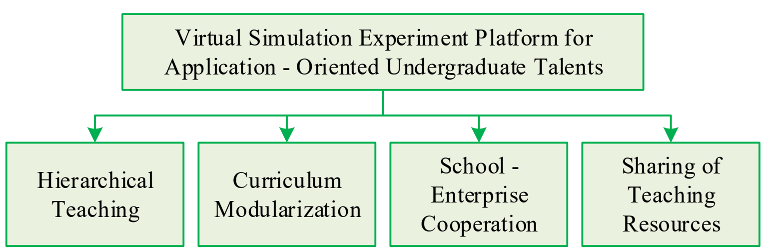


Figure 1: Construction framework of the virtual simulation experiment platform

II. A. 2) Analysis of hierarchical teaching and learning

Compared with the traditional physical laboratory, the virtual simulation laboratory has significant advantages, but can not completely replace the former, which requires the two complement each other, mutual coordination, the “virtual” and “physical” organic integration. How to integrate in order to maximize the use of resources, in order to better cultivate language cross-cultural interaction model under the application of talent, to provide support for regional development, for national cultural exchanges to provide talent services? We propose to adopt hierarchical teaching, dividing the course into three layers: the basic experimental layer, the comprehensive application layer and the research and development layer. Figure 2 shows the structure of hierarchical teaching.

Basic experimental layer: for lower-level students, the course is positioned as the basic experimental layer. The courses at this level are mainly validation experiments, suitable for students who have mastered basic knowledge. The traditional laboratory provides a good place for language experimentation for students at this level, where students can better recognize and understand the language basics of different cultures, laying a good foundation for subsequent application.

Integrated Application Tier: For senior students, the courses are positioned at the Integrated Application Tier. Courses at this level are mainly designed experimental programs for students who have mastered basic knowledge and can apply it flexibly. For juniors and seniors, they already have relevant professional knowledge and can synthesize and apply the knowledge points. Students design the program according to the mission statement, carry out cross-cultural interactive communication, and finally complete the language application task.

Research and Development Tier: The course is positioned as a research and development tier for final year students or students participating in language application competitions. Senior students or students participating in competitions have the ability to complete cross-cultural language application projects independently, have mastered the basic theoretical knowledge, can flexibly apply the theoretical knowledge to practice, and have strong comprehensive ability. Students at this stage need a larger platform to complete their projects. The virtual simulation experimental platform provides a multi-functional and highly scalable development platform to meet the needs of virtual simulation experimental teaching of language application in cross-cultural interaction mode.

Through this kind of hierarchical teaching, students of different grades and levels can master different theoretical knowledge of language and exercise various language application skills under the environment of cross-cultural interaction.

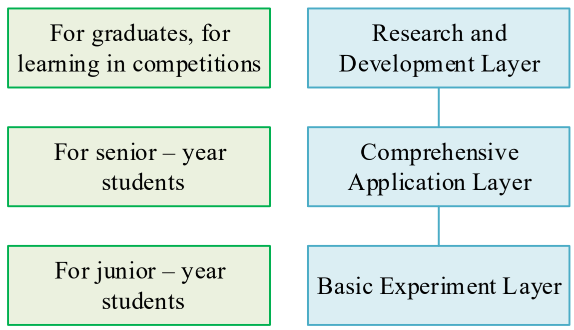


Figure 2: Hierarchical teaching structure

II. B.Principles of virtual simulation action recognition

II. B. 1) Gesture Image Preprocessing

Affected by the shooting distance, ambient light and the camera components themselves, the recorded gesture images may have the problems of underexposure, overexposure, and insufficiently obvious contrast. In view of the above problems, in this paper, image enhancement techniques are used to pre-process the raw data for operation, which in turn improves the clarity and light/dark contrast of the image.

Among the many image enhancement techniques, the histogram equalization method is particularly suitable for processing images with low contrast, so in this paper we will use the histogram equalization method to enhance the original gesture image sequence. The process of enhancement of custom gesture images using histogram equalization method is as follows.

Assuming that the gray level of the gesture data grayscale image is L, the probability of occurrence of k levels of gray is shown in Equation (1):

$$P\left(r_k\right)=\frac{n_k}{n},k=0,\cdots,L-1 \tag{1}$$

where n is the number of pixels and with n_k denotes the number of pixels with gray level r_k.

The histogram equalization method is denoted by T. The original gesture grayscale image is passed in, and the converted grayscale level is denoted by s_k. The histogram conversion method is shown in Equation (2).

$$s_k=T(r_k)=\sum_{j=0}^{k}\frac{n_j}{n},k=0,\cdots,L-1 \tag{2}$$

Mapping the gray scale range of the gesture image from $[0,255]$ to $[0,1]$ intervals, i.e., doing normalization on the original gesture image leads to Equation (3):

$$s_k=T(r_k)=\frac{255}{n}\sum_{j=0}^{k}n_j,k=0,\cdots,L-1 \tag{3}$$

The edges of the gesture image after the histogram equalization process are smoother and the contrast of the image is more pronounced. This is more conducive to the subsequent training and analysis of the gesture data.

II. B. 2) Dynamic gesture training based on VGB and Adaboost algorithm

This experimental custom gesture data training uses the Adaboost algorithm, the basic idea of which is to combine multiple weak classifiers, each of which handles a portion of the image features. The method is an iterative process, each time to optimize the last unoptimized features, and finally obtain the weighted sum of all weak classifiers. Take "sliding gesture" as an example, assume that the gesture has three features F1, F2, F3, when these features meet the requirements of multiple classifiers at the same time, it is a sliding gesture. Figure 3 shows the decision tree structure.

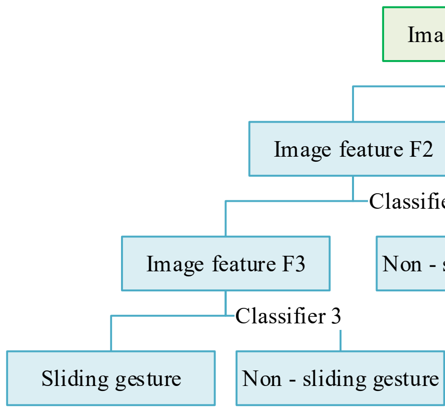


Figure 3: Decision Tree Structure

Since the input format of the action data received by VGB is xef and the format of the recording file generated by KS is xrf, it is necessary to convert the raw recording data. In this experiment, the KSConvert tool is used to convert the xrf files into xef format files and send them to the VGB platform for labeling, training and analysis.

The training process of customized gesture data requires creating a project solution file in VGB, setting the type of gesture to be trained, choosing whether or not to turn on the mirroring mode, and setting information such as bone parameters. In order to ensure the generality of the training results, this paper divides the preprocessed gesture data into training data and analysis data, the training data is used to generate the gesture training model, and the analysis data is used to check the accuracy of the custom gesture model. Figure 4 shows the process of custom gesture training.

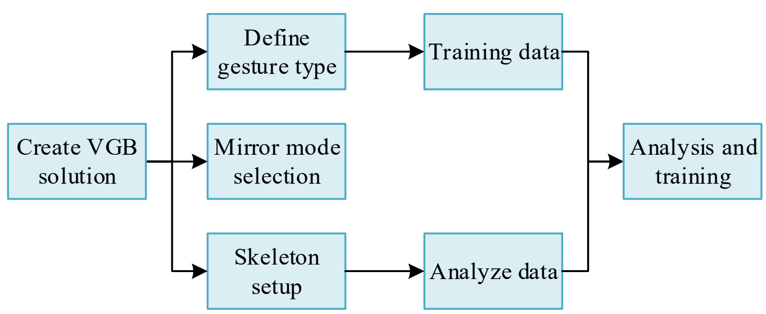


Figure 4: Custom gesture training process

II. C.System architecture and functional analysis

II. C. 1) Overall system structure

In order to realize energy-efficient virtual simulation language teaching, it is proposed to build an intelligent language teaching system based on the Scratch platform and Raspberry Pi with English teaching in colleges and universities as the research object. Figure 5 shows the overall structure of the system.

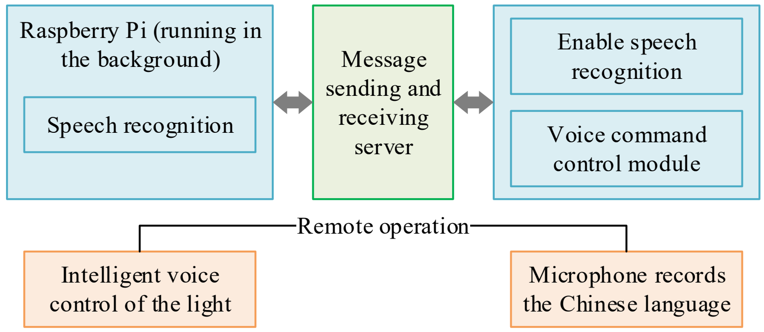


Figure 5: Overall Structure of the system

As can be seen from Fig. 5, the system is mainly divided into the front-end control module and the Raspberry Pi 3b+ module. Among them, the front-end control module, which can also be called the Scratch programming module, consists of the language recognition module. The workflow of the system is as follows: first, the constructed model is deployed in the Raspberry Pi; then the Scratch platform is used for the system graphic programming in order to visualize the language recognition results; after that, the bi-terminal communication connection is carried out in order to achieve the goal of remote operation, and thus realize the system intelligent language teaching.

II. C. 2) Hardware Module Design

The main control hardware of the system is the Raspberry Pi 3b+ microcomputer, whose CPU processor model is 2.8Hz 64-bit 8-core ARMCortex-A53, which is equipped with strong computational ability, and carries a number of external interfaces and Gigabit Ethernet itself, which can realize stable and fast wireless transmission. In order to meet the actual needs of language teaching, the overall design of the system hardware is based on Raspberry Pi 3b+ microcomputer. Figure 6 shows its hardware structure.

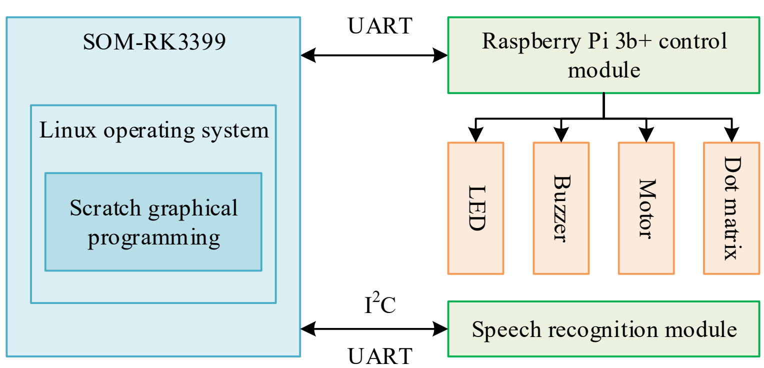


Figure 6: Design of System Hardware Structure

The system hardware mainly includes the Raspberry Pi 3b+ control module, the SOM-RJ3399 core board, the speech recognition module and each peripheral module. Among them, the SOM-RJ3399 core board is equipped with Scratch graphical programming software and Linux operating system, which can support I2 protocol or UART protocol to realize data communication and control of other modules. The Raspberry Pi 3b+ control module is responsible for executing the commands of the master control unit and controlling external devices.

II. C. 3) Software module design

The software part is developed using Scratch software, which is a graphical programming software version divided into 1.4, 2.0 and 3.0 types, which can also be subdivided into web and stand-alone versions. According to the system design requirements, the bottom layer is written in HTML5, which is compatible with all web browsers.The programming logic of Scratch 3.0 software programming is to form any code block of program requirements by dragging and dropping the blocks to set up the data types and data processing functions, etc., which can quickly obtain the logic rules of the programming language and realize the visualization of the image programming interface.

III. Language Education Practices Based on Virtual Simulation Platforms

This chapter optimizes the functions of the virtual simulation platform through user requirements analysis and performance testing and so on. After that, it is applied in actual language interactive teaching to analyze the platform's auxiliary teaching effect.

III. A. User needs analysis

Before formally establishing the virtual simulation platform, it is necessary to understand the language teaching and learning needs of teachers and students in the cross-cultural interaction mode and prioritize the platform development functions. Therefore, in this paper, a forward and reverse questionnaire was distributed to 300 freshmen and 50 teachers in the School of English Language and Culture to investigate their expectations of the platform's features. The results of the questionnaires were cross-analyzed, the collected data were visualized, and the Kano model of user requirements for virtual simulation experiments was constructed to obtain the analysis results. Table 1 shows the evaluation of virtual simulation user demand attributes. It includes the Kano positioning results of the platform functions, according to which it is beneficial to prioritize the platform development functions and help to classify the requirements, prioritize the importance, and classify the functions as well as the product requirement modules. From Table 1, it can be seen that among the 12 platform functional requirements, 3 are desired attributes, namely, interface recognition, UI design, and problem solving; 3 are required attributes, namely, gesture recognition speed, interactive reproducibility, repeatability, and security; 4 are charismatic attributes, namely, the quality of exercises, the length of experiments, ease of operation, and fun; and 2 are non-differentiated attributes, namely, online communication and knowledge expansion.

Table 1: Evaluation Situation of virtual simulation user requirement attributes

Platform functions	Proportion (%)				Kano Positioning	Better Coefficient (%)	Worse Coefficient (%)
	Charm attribute(A)	Expected attribute(O)	Essential attribute(M)	Undifferentiated attribute(I)			
Interface recognition degree	20.39%	68.35%	8.19%	3.07%	O	88.80	-76.51
UI Design	18.34%	63.25%	8.17%	10.24%	O	82.49	-71.12
Gesture recognition speed	4.01%	23.51%	55.17%	17.31%	M	29.15	-81.27
Quality of exercises	72.01%	8.00%	2.95%	17.04%	A	81.03	-9.48
Experiment duration	62.22%	13.23%	2.06%	22.49%	A	73.99	-13.55
Online communication	8.19%	6.12%	4.05%	81.64%	I	11.73	-8.50
Interactive fidelity	7.12%	5.12%	86.71%	1.05%	M	12.26	-91.85
Ease of operation	12.22%	14.27%	61.22%	12.29%	A	25.01%	-76.06
Repeatability and safety	3.04%	19.37%	75.54%	2.05%	M	20.65	-95.87
Interest	81.61%	7.12%	2.08%	9.19%	A	87.62	-9.23
Knowledge expansion	7.13%	1.03%	4.05%	87.79%	I	8.41	-1.01
Problem solving	17.36%	57.15%	9.17%	16.32%	O	75.50	-65.94

Substitute the results of user questionnaire research into the analysis table, calculate the absolute value of Better coefficient and Worse coefficient, get the percentage of functional attributes of each user requirement, based on the value, make quadrant diagram and Kano model, and visualize and show the requirement priority. The data is analyzed and processed, and Figure 7 shows the Better-Worse matrix analysis results of each requirement. According to the matrix analysis results in Figure 7, the one located in the first quadrant is the expectation-type requirement, including three requirements of interface recognition, UI design, and problem solving, which indicates that teachers and students are most concerned about the platform's clear arrangement of the operating interface recognition when they utilize the virtual simulation platform for cross-cultural interaction of languages, so that they can obtain scientific guidance on learning problems. When constructing the virtual simulation platform, it is necessary to follow the design idea of user demand-centered orientation, analyze the virtual simulation experiment use scenarios, and transform the demand into design interaction prototypes according to the user demand and function priority ranking situation of teachers and students.

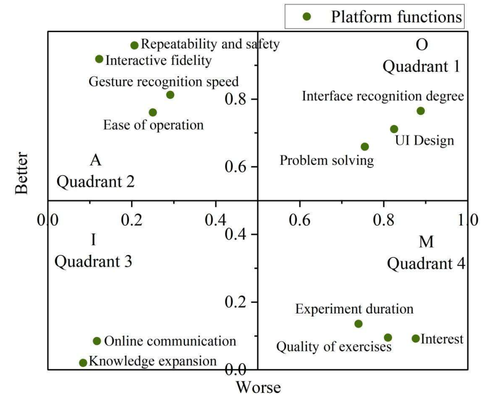
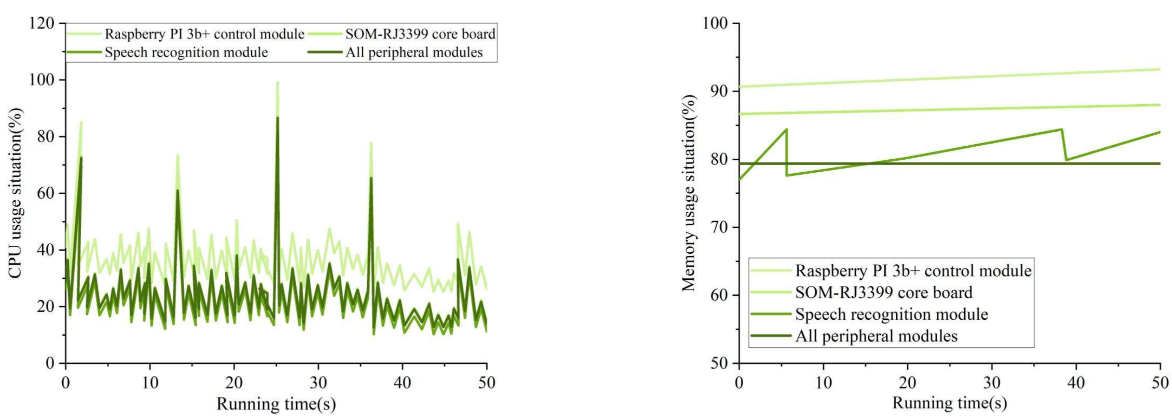


Figure 7: Analysis of the Better-Worse matrix of requirements

III. B. Performance Testing and Optimization

After building the virtual simulation platform, the system developed in the platform is further tested and optimized to ensure system usability. The performance of the system, such as smoothness, operability, and scene lighting, will affect the user's experience of the system, and may even lead to excessive hardware requirements due to the large consumption of processor and memory resources. Using this powerful performance analysis tool, developers can visually view the CPU, memory, and other resources occupied by the system while running, and quickly find the threads and functions that affect the system performance, which can be optimized according to the performance parameters provided by the tool.

In this paper, we click Windows→Analysis→Profiler in Unity3D in order to open the Profiler window, run the designed system, and then click the Play button in the Profiler window to display the resource consumption in the current running state. Fig. 8 shows the resource consumption of each module of the system at runtime, Fig. 8(a) shows the CPU resource consumption and Fig. 8(b) shows the memory consumption. Combining the resource consumption in Fig. 8, it can be found that the Raspberry Pi 3b+ control module in the system has the highest resource consumption both in terms of CPU consumption and memory consumption. The CPU usage of the Raspberry Pi 3b+ control module reaches a maximum of 99.17% when running up to 25ms, and the memory usage reaches a maximum of 93.24% when running up to 50ms. It is worth noting that the memory occupation of the speech recognition module shows different fluctuations from other modules, which is guessed to be that the module is greatly affected by the amount of language input by teachers and students, language pronunciation, etc., and it needs to be coded and modified accordingly in Unity3D to improve the stability of the module's operation. Overall, the system designed in this paper has less resource consumption, does not require high platform configuration, the resource consumption is basically no more than 100%, and can run smoothly without lagging and other phenomena.



(a) CPU usage situation (b) Memory usage situation

Figure 8: Resource occupation of the system during operation

III. C. Comparison before and after the application of virtual simulation technology

The constructed and optimized virtual simulation platform was put into the English teaching of freshmen in the College of English Language and Culture for a semester-long experiment. Three indicators, namely, the activity of classroom interaction, students' cross-cultural language communication ability, and the level of operating skills of the experimental platform, were used as a measure of the level of language education under the cross-cultural interaction mode. Through the test to collect students' index data in the classroom before and after the experiment, comparing the change of students' related skills before and after the application of the virtual simulation platform, so as to judge the value of the application of the virtual simulation platform.

Figure 9 shows the change of classroom dynamic characteristics in the same classroom before and after the experiment. Among them, C, S and O represent three indicators of classroom interaction activity, students' cross-cultural language communication ability, and the level of operating skills on the experimental platform, respectively. According to the comparison curve of the same class time before and after the experiment in Fig. 9, the highest classroom interactive activity before the experiment was at 72.15%, and the lowest was 19.93%; while the highest after the experiment was close to 96.01%, and the lowest was also by 47.85%. After utilizing the virtual simulation platform for interactive teaching, the classroom interactive activity remains above 50% most of the time, indicating that utilizing the virtual simulation platform for auxiliary teaching can improve students' enthusiasm for learning English. Then we analyze the change of students' intercultural language communication competence. Before the experiment, the highest is 67.13%, the lowest is only 0.81%; after the experiment, the highest reaches 72.23%, the lowest is 20.56%. Creating cross-cultural interactive scenes with the help of virtual simulation platform can effectively improve students' cross-cultural language communication ability. In the index of operating skill level of the experimental platform, the highest skill level of students before the experiment is 28.21%, while the highest level after the experiment reaches 60%. Utilizing the virtual simulation platform for assisted teaching also helps students improve the level of hardware and software operation. On the whole, comparing the specific changes in the classroom dynamic characteristics of the same lesson before and after the experiment, it is found that the virtual simulation platform can assist students in improving the relevant language skills and operational skills, while making the classroom more dynamic.

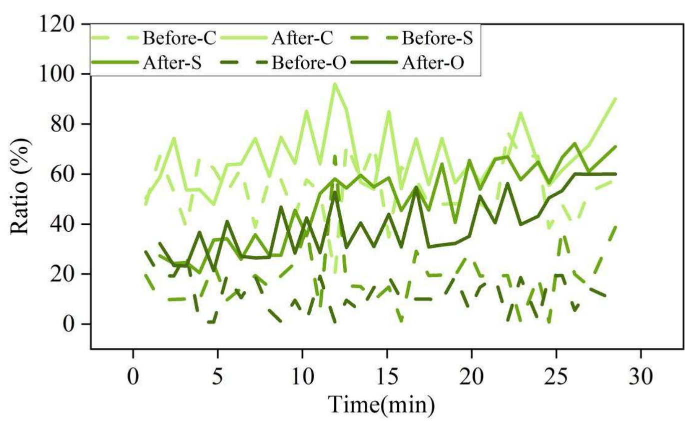


Figure 9: Comparison of dynamic characteristics before and after the experiment

III. D. Evaluation and analysis of the use of virtual simulation platforms

Through the distribution of questionnaires, the evaluation of teachers and students on the use of the virtual simulation platform was collected from the aspects of “functional diversity” and “feedback and communication”, and the results of the evaluation were used as a reference for the subsequent upgrading of the platform. The questionnaire has two dimensions: functional diversity (Q1-Q12); feedback and communication (Q13-Q24), using the assignment method to assign 1-5 points (very dissatisfied - very satisfied) to each question. A total of 350 questionnaires were distributed and 350 questionnaires were recovered with 100% validity.

Table 2 shows the statistical results of functional diversity. In terms of functional diversity, Q7 had the highest average score among the questions with a weight of 4, and the corresponding problem was "high degree of interactive restoration of the platform", with an average score of 4.50, and Q4 with the highest average score of 4.66 among the questions with a weight of 3. This also reflects that in the development of platform functions, the cross-cultural interaction needs of students are taken into account more comprehensively, and a large number of mutual exercises are provided, which has a good role in promoting students' language interaction experience, and students' satisfaction is also high.

Table 2: Statistical Results of Functional Diversity

Classification	Question Number	Average value	Weight
Functional Diversity	Q1	4.48	3
	Q2	3.79	4
	Q3	4.45	3
	Q4	4.66	3
	Q5	3.57	3
	Q6	3.53	3
	Q7	4.50	4
	Q8	4.01	4
	Q9	4.43	4
	Q10	3.56	4
	Q11	3.07	3
	Q12	4.44	3

Table 3 shows the statistical results of feedback and communication. In terms of feedback and communication, among the questions with a weight of 4, Q14 had the highest average score, and the corresponding question was "timely and fast interactive feedback from the platform", with an average score of 4.97. Among the questions with a weight of 3, the highest average score was Q20, and the corresponding question was "the platform has a good communication and interaction mechanism", with an average score of 4.54. Among the questions with a weight of 5, Q16 has the highest average score, and the corresponding question is "the platform can give reasonable language interaction analysis results", with an average score of 4.51. This shows that the virtual simulation platform has paid attention to the interactive feedback and real-time communication problems that students need when building, and provides reasonable feedback to students, which helps students understand their performance in the language cross-cultural interaction mode and make corresponding corrections. Holistic analysis, using a virtual simulation platform to meet the cross-cultural language teaching and learning needs of teachers and students.

Table 3: Statistical Results of Feedback and Communication

Classification	Question Number	Average value	Weight
Feedback and Communication	Q13	4.03	4
	Q14	4.97	4
	Q15	3.52	4
	Q16	4.51	5
	Q17	4.37	5
	Q18	3.35	5
	Q19	3.24	3
	Q20	4.54	3
	Q21	4.46	3
	Q22	4.43	4
	Q23	4.32	4
	Q24	4.37	4

IV. Conclusion

This paper builds a virtual simulation platform to realize the auxiliary enhancement of teachers' language teaching and students' language learning under the cross-cultural interaction mode. Comparing the changes in the classroom before and after using the virtual simulation platform for interactive learning, it is found that the activity of classroom interaction increases from the highest 72.15% before the experiment to 96.01% after the experiment. Students' cross-cultural language communication skills increased from a maximum of 67.13% before the experiment to 72.23% after the experiment. The skill level of operating the experimental platform improved from the highest 28.21% before the experiment to 60% after the experiment. The highest average scores of the platform evaluation indexes of “functional diversity” and “feedback and communication” are both greater than 4.5, and the utilization of the virtual simulation platform can improve students' engagement in the classroom and their communicative competence in interactive language learning. In the future, the recognition speed of gestures and movements can be further enhanced to improve real-time interaction and immersion.

References

[1] Wu, J. (2018). A Space Design Teaching Model Using Virtual Simulation Technology. International Journal of Emerging Technologies in Learning, 13(6).
[2] Li, Z., Cao, Y., & Luo, J. (2021). Application of virtual simulation technology in chemistry teaching. In E3S Web of Conferences (Vol. 267, p. 02067). EDP Sciences.
[3] Yu, W., & Chen, Z. (2022). Application of VR virtual simulation technology in teaching and learning. In The 2021 International Conference on Machine Learning and Big Data Analytics for IoT Security and Privacy: SPIoT-2021 Volume 2 (pp. 339-345). Springer International Publishing.
[4] Wang, P., Wu, S., Gao, L., Ning, Y., Zhang, C., Pan, S., & Zhao, C. (2024). The effect of virtual simulation technology applied to undergraduate teaching of periodontal probing. European Journal of Dental Education, 28(2), 461-470.
[5] Foronda, C. L. (2021). What is virtual simulation?. Clinical simulation in Nursing, 52, 8
[6] Liu, L., Li, W., & Chen, X. (2023). Exploration and realization about teaching experimental of CNC machine tool based on virtual simulation technology. Manufacturing Technology, 23(4), 485-494.
[7] Cant, R., Cooper, S., Sussex, R., & Bogossian, F. (2019). What's in a name? Clarifying the nomenclature of virtual simulation. Clinical Simulation in Nursing, 27, 26-30.
[8] Lingling, L. (2024). Research on the Application of the New Blended Teaching Model Based on Virtual Simulation Technology in Foreign Language Teaching. Journal of Critical Studies in Language and Literature, 5(2), 22-31.
[9] Zhang, M. (2020). Virtual situated learning of spoken English based on computer simulation technology. International Journal of Emerging Technologies in Learning (Online), 15(4), 206.
[10] Han, L. (2022). Students' daily English situational teaching based on virtual reality technology. Mobile Information Systems, 2022(1), 1222501.
[11] Chen, L. (2025). A virtual simulation-based perspective on intercultural communication in language learning. J. COMBIN. MATH. COMBIN. COMPUT, 124(333), 349.
[12] Du, J. (2025). Investigating Virtual Simulation Experimental Teaching (VSET) Potential as a Virtual Platform for Chinese EFL Learners to Enhance English Language Competency. Journal of Humanities, Arts and Social Science, 9(1).
[13] Lin, T. J., & Lan, Y. J. (2015). Language learning in virtual reality environments: Past, present, and future. Journal of Educational Technology & Society, 18(4), 486-497.
[14] Ali Mohsen, M. (2016). The use of computer-based simulation to aid comprehension and incidental vocabulary learning. Journal of educational computing research, 54(6), 863-884.
[15] Kazemanzadeh, S. (2022). Distributed System Integrating Virtual Reality Technology in English Teaching. Distributed Processing System, 3(1), 62-70.
[16] Li, M., Li, Y., & Guo, H. (2020). Research and application of situated teaching design for NC machining course based on virtual simulation technology. Computer Applications in Engineering Education, 28(3), 658-674.
[17] He, X., Hua, X., Montillet, J. P., Yu, K., Zou, J., Xiang, D., ... & Zhao, B. (2019). An innovative virtual simulation teaching platform on digital mapping with unmanned aerial vehicle for remote sensing education. Remote Sensing, 11(24), 2993.
[18] Bai, L., & Brown, M. (2022). The improvement of interactive learning efficiency based on virtual simulation technology. International Journal of Continuing Engineering Education and Life Long Learning, 32(2), 240-254.
[19] Zheng, P., Yang, J., Lou, J., & Wang, B. (2024). Design and application of virtual simulation teaching platform for intelligent manufacturing. Scientific Reports, 14(1), 12895.
[20] Chen, D., Kong, X., & Wei, Q. (2021). Design and development of psychological virtual simulation experiment teaching system. Computer Applications in Engineering Education, 29(2), 481-490.
[21] Li, M., Zhou, D., Liu, X., & Zan, H. (2025). Simulation of E-learning virtual interaction in Chinese language and literature multimedia teaching system based on video object tracking algorithm. Entertainment Computing, 52, 100764.
[22] Löllgen, R. M., Berger-Estilita, J., Rössler, L. A., & Mileder, L. P. (2022). Avatar and distance simulation as a learning tool–virtual simulation technology as a facilitator or barrier? A questionnaire-based study on behalf of Netzwerk Kindersimulation eV. Frontiers in Pediatrics, 10, 853243.
[23] Lim, A. S., & Lee, S. W. H. (2022). Is technology enhanced learning cost-effective to improve skills?: the monash objective structured clinical examination virtual experience. Simulation in Healthcare, 17(2), 131-135.
[24] Shadiev, R., Wang, X., & Huang, Y. M. (2021). Cross-cultural learning in virtual reality environment: facilitating cross-cultural understanding, trait emotional intelligence, and sense of presence. Educational Technology Research and Development, 69(5), 2917-2936.
[25] Zhang, G. (2019). Virtual Simulation Based Intercultural Learning. In Cross-Cultural Design. Culture and Society: 11th International Conference, CCD 2019, Held as Part of the 21st HCI International Conference, HCII 2019, Orlando, FL, USA, July 26–31, 2019, Proceedings, Part II 21 (pp. 492-504). Springer International Publishing.