International Journal for Housing Science and Its Applications
Publish August 10, 2025. Volume 46, Issue 4 Pages 2087-2099

https://doi.org/10.70517/ijhsa464179

Foreign Language Teaching Simulation and Scenario Construction Based on Virtual Reality Technology

Siyuan Zheng[1] and Jiaoyue Liu[1,*]
[1] School of International Culture and Communication, Beijing City University, Beijing, 100094, China
Corresponding authors: (e-mail: ljiaoyue@126.com).

Abstract This study utilizes VRML and ASP.NET technologies to model foreign language teaching scenarios, including the basic configuration of teaching scenarios, the creation of irregular shapes, and the addition of lighting effects. In addition, to make the foreign language teaching scenarios more realistic, the browser's change function is used to navigate the virtual classroom. At the same time, based on the interactive modules and virtual character models of the virtual scenario, the personalization and fun of foreign language teaching are enhanced. This scenario was applied to a foreign language teaching simulation at a university in City Y and compared with traditional teaching scenarios to analyze its impact on students' foreign language learning. The teaching scenario in this study received a relatively low score of 4.01 in terms of controllability, while all other indicators scored above 4.2, indicating good user experience. In this scenario, the foreign language proficiency of experimental class students significantly improved, with a difference of 5.25 points between pre- and post-test scores, and an increase of 0.83 to 1.04 points in scores for three indicators of syntactic ability. Additionally, experimental class students' satisfaction scores for foreign language learning interest, attitude, motivation, and learning outcomes exceeded 4.3 points in this scenario. Virtual teaching environments can enhance students' sense of presence during learning, enabling teaching activities to transcend time, space, and teacher constraints, thereby effectively improving teaching outcomes.

Index Terms VRML technology, ASP.NET technology, teaching scenario modeling, foreign language teaching simulation

I. Introduction

Traditionally, the concept of language learning has been viewed as a process of knowledge transmission, where abstract, decontextualized knowledge from textbooks is passed from one person to another [1], [2]. However, language is a highly social discipline that is created through actual communication [3]. Therefore, learning foreign language knowledge in an abstract manner, detached from specific application contexts, tends to lead to passive learning of materials and rote memorization methods. Moreover, language knowledge memorized in the short term is often ineffective because students cannot apply it in real communication settings to gain firsthand cultural experiences, resulting in low learning efficiency and an inability to convert it into genuine language proficiency [4]-[7]. Furthermore, foreign language learners must possess cultural sensitivity, which requires a deep understanding of their own culture. Learners with a strong foundation in their own culture are more likely to develop cultural sensitivity. Thus, how to enhance foreign language learners' cross-cultural communication abilities has become one of the challenges in foreign language education [8]-[11]. To address these issues, virtual reality (VR) technology has gradually been applied in foreign language education.

Virtual reality technology (VR) is a cutting-edge technology that has developed rapidly in recent years, integrating computer graphics technology, multimedia technology, sensor technology, parallel real-time computing technology, artificial intelligence, simulation technology, and other disciplines [12]-[15]. VR technology creates a three-dimensional image world for users that real-time reflects the changes and interactions of physical objects. Through realistic sensory experiences in vision, hearing, touch, and smell, participants can directly engage with and explore the roles and changes of virtual objects within their environment, as if they were immersed in a virtual world, thereby generating a sense of immersion [16]-[19]. Addressing current challenges in foreign language education, such as limited contextualized learning environments, weak cross-cultural communication skills, and low learning efficiency, VR technology offers immersive learning experiences and personalized learning opportunities for students through simulated teaching and scenario construction, while providing educators with innovative teaching tools [20]-[23].

In the current information age, an increasing number of emerging technologies and teaching methods are being applied to education. VR technology creates a better language environment for foreign language learners through more diverse and intuitive means, thereby promoting the development of foreign language education. Literature [24] emphasizes the importance of developing VR- and 3D-based foreign language learning environments, noting that VR is widely applied in educational institutions in the United States and China, and highlighting that VR is an ideal learning environment with significant application potential in foreign language education. Literature [25] highlights the significant impact of VR on education and identifies gaps related to language learning. Based on this, it examines VR technology in foreign language listening learning, with results indicating that the application of VR technology helps stimulate students' enthusiasm and enhance their foreign language listening abilities. Literature [26] discusses the application and evaluation of VR in foreign language learning, revealing through a literature review that VR's immersive, interactive, and imaginative characteristics enhance learners' interest in foreign language learning. Literature [27] investigates the application of immersive virtual reality (iVR) in the learning of Chinese as a foreign language. By analyzing individual differences in foreign language performance during the learning of 60 Chinese words across two learning stages, it reveals the primary influences in foreign language learning contexts and emphasizes the effectiveness of iVR in foreign language learning. Literature [28] introduced the uncertainty surrounding the effectiveness of VR in education and explored the feasibility of a VR-based learning tool, as well as the differences between VR methods and traditional audio methods in foreign language learning. The results emphasized the effectiveness and higher satisfaction of VR. Literature [29] reviews the characteristics, teaching methods, and technologies of iVR in foreign language education, conducting a systematic evaluation based on the PRISMA method. The results indicate that compared to traditional teaching methods, iVR is more effective in improving foreign language learning outcomes and can stimulate students' learning motivation. Literature [30] introduces a comprehensive theoretical framework for VR-based foreign language learning (VR-ccl) grounded in constructivism and cognitive load theory. Through a literature review, it analyzes existing work on VR applications in education and foreign language learning theory, and finally validates the effectiveness of VR-ccl through research. Literature [31] discusses the potential applications of VR technology in foreign language teaching, describing its advantages in language environments, such as immersive effects and interactivity, which are beneficial for enhancing foreign language communication skills and stimulating students' learning interest. It emphasizes the significant potential for using VR technology in foreign language teaching. Literature [32] investigates the potential application of VR headsets in campus environments and verifies their impact on foreign language teaching. The results indicate that VR activities can promote high levels of motivation and engagement among students and contribute to the development of language skills. Literature [33] explores the application potential of augmented reality (AR) and VR technology in foreign language teaching, particularly in the professional training of future teachers. It reveals that although both technologies have certain limitations, they still have the potential to become powerful teaching tools, and lists the applications of AR and VR technology in foreign language teaching. Literature [34] designed a quasi-experimental study to determine the impact of utilizing VR environments related to Chinese culture on students' intercultural communication competence (ICC) levels. The results indicated that VR can effectively enhance students' ICC levels. Literature [35] conducted a literature review using the PRISMA method to analyze the application of VR games in foreign language education, revealing that VR games provide an immersive learning environment that can enhance students' motivation to learn languages, while also highlighting challenges such as technical limitations and limited equipment availability. Literature [36] analyzed the effectiveness of VR in Chinese vocabulary learning from the perspective of international students. Through vocabulary tests and questionnaires, it validated that VR teaching methods provide students with positive learning experiences and promote vocabulary learning. Literature [37] aims to discuss the relationship between VR and foreign language learning, particularly English. By comparing traditional and VR teaching methods, it demonstrates that both methods can improve students' English vocabulary learning outcomes, but VR teaching methods are more engaging and yield more significant improvements in vocabulary learning outcomes. Literature [38] introduces the application of VR technology at various stages and its impact on foreign language education based on literature reviews and case analyses, revealing that the development of VR technology has increasingly highlighted its immersive, interactive, and personalized language learning experience characteristics.

This study is based on VRML technology and ASP.NET technology to develop a virtual teaching environment for foreign languages. The study conducts technical modeling of the virtual teaching environment from the aspects of overall scene configuration, teaching facility construction, and lighting rendering. Through continuous changes such as rotation and translation, students can navigate the virtual classroom, enhancing visual effects in the classroom. Complex interaction designs in the virtual scene are completed using the JSAI method, and the H-Anim component is used to construct virtual classroom characters, further improving the operability of foreign language learning in the virtual scene. Finally, based on foreign language teaching simulation experiments, the practical value of foreign language learning scenes based on virtual reality technology is evaluated.

II. Virtual teaching environment development technology

II. A.VRML Technology

(1) Modeling Techniques

Simple geometric shapes can be created using the basic shapes described above, but complex structures require more advanced modeling methods in VRML, which combine points, lines, and shapes [39]. Extruded shapes and elevation grid space modeling. In theory, any shape can be created using points, lines, and shapes. Points, lines, and shapes can create a virtual space, and any curved surface can be represented using points, lines, and planes, thereby enabling the creation of any desired spatial model. For certain terrain features, elevation grid nodes can be used.

(2) Appearance Control Technology

When creating a VRML scene, texture images are required to display various visual details, i.e., texture mapping. In VRML, texture mapping nodes primarily include image textures, pixel textures, and movie clips. The VRML language supports common image formats such as JPEG and PNG. The JPEG image format is widely used and offers excellent image quality. VRML provides LOD nodes to control modeling levels. LOD nodes represent different levels of detail and are divided into high, medium, and low tiers. Different versions display varying levels of detail to distinguish between users.

(3) Lighting and Fogging Control Techniques

The purpose of lighting is to adjust the display effect of the scene and highlight the theme. The light sources included in the VRML language are:

Point light, parallel light, and spotlight. Point light emits light radially to the surrounding area, similar to a light bulb emitting light from a single point. The application of point light requires parameters such as spatial position coordinates and point light brightness. Parallel light is an infinite light source where light rays are emitted in the same direction. In addition to being defined as parallel to the light source, parallel light also specifies the direction of light emission. In the VRML virtual world, parallel light can concentrate all emitted light rays into a cone along a specific direction. In VRML files, fog nodes are typically used to simulate atmospheric effects. Fog nodes have parameters such as shading and control of fog color.

To simulate the real world, various methods are needed to restrict user movement in VRML-based virtual environments, as certain user movements are difficult to achieve in the virtual world. The collision node provided by the VRML language addresses this issue, enabling the detection of virtual modeling methods to observe and prevent collisions with the observer's body.

II. B.ASP.NET Technology

ASP.NET, as a powerful development framework rooted in the .NET ecosystem, integrates HTML, CSS, JavaScript, and server-side scripting technologies to specifically enable the creation of modern, dynamic, and highly interactive web pages and websites [40]. This framework fully leverages the .NET platform's broad compatibility, allowing developers to use multiple .NET-supported languages to create applications, ensuring projects are both secure and highly scalable and stable. Systems built with ASP.NET stand out for their exceptional scalability, flexibility, broad compatibility, and ease of maintenance.

In the ASP.NET runtime process, HTTP requests initiated by the client are first received by IIS and assigned to the corresponding application pool. The request then passes through a carefully designed pipeline system, undergoing critical processing stages such as authentication and session management. For requests targeting .aspx pages, the ASP.NET engine intervenes, intelligently merging the front-end .aspx layout with the back-end .cs logic code to form a page class instance. This process then uses just-in-time compilation technology to convert the page class into an efficient assembly and directly generate the final static HTML content, which is quickly responded to the client browser for rendering and display. For repeated visits, ASP.NET intelligently reuses the compiled assembly, greatly reducing page loading time and improving the user experience.

III. VRML virtual teaching scenarios and interactive control design

The virtual teaching model is shown in Figure 1. The virtual teaching environment mainly includes a virtual reality environment and virtual characters. This section focuses on how to use VRML for virtual teaching environment modeling and interactive control design, and provides a detailed introduction to the implementation ideas, technical difficulties, programming techniques, and some of the implementation source code.

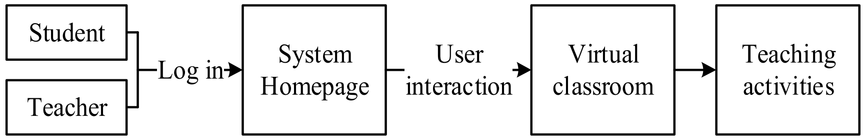

Figure 1: Virtual teaching model

III. A. Virtual Teaching Scenario Modeling

III. A. 1) Teaching scenario configuration

A virtual multimedia classroom is a realistic three-dimensional virtual teaching environment created using VRML language on a computer. The various objects within the classroom are primarily modeled using VRML's Shape nodes. A single Shape node can only create one shape, which can be a basic geometric shape (such as a box or cone) or a complex shape composed of points, lines, and surfaces. For shapes like computers, multiple Shape nodes can be combined using a Group node to create a more complex structure. By default, the geometric center of objects in VRML aligns with the origin of the VRML three-dimensional coordinate system. The spatial position and display scale of objects can be adjusted using a Transform node.

III. A. 2) Creating irregular shapes

For the creation of more complex objects such as multimedia podiums, modeling is first performed in 3DStudioMAX 8.0 using standard 3D modeling techniques. Then, using the interface provided by 3DStudioMAX for the VRML language, the model generated in 3DStudioMAX is "exported" as a "*.wrl" format file. During export, 3DStudioMAX automatically converts certain modeling nodes to VRML format, but it does not fully include all 54 nodes defined in VRML 2.0. After testing the exported WRL file using a VRML browser, you must use a VRML editor to modify the VRML source code and add nodes not supported by 3DStudioMAX.

III. A. 3) Adding lighting effects

Simulate the lighting effects of electric lights in foreign language teaching using the PointLight node in VRML. The PointLight node emits light rays in a radial pattern from the light source center point in all directions. The light intensity continuously decreases from the light source center and eventually reaches "0." Other spatial models outside the light source's illumination range will not be affected by this light source.

III. B. Virtual Teaching Scenario Tour

Through virtual roaming, the generated foreign language teaching scenarios are made "alive," allowing users to control the direction of roaming with a mouse or keyboard while roaming [41].

III. B. 1) Adding Viewpoints

In order to enable different users to have different viewing experiences when entering the virtual multimedia classroom, the Viewpoint node is used to pre-set viewing points. Users can select different viewing points and use the continuous change functions provided by the browser, such as rotation and translation, to navigate around the virtual classroom.

III. B. 2) Viewpoint Control

VRML provides multiple viewpoints, but only one is currently available. To facilitate users in automatically controlling viewpoints with the mouse, a virtual avatar can be generated through the NavigationInfo node. Users can observe the virtual world from the avatar's perspective and use the mouse as an interactive tool to control the avatar's movement within the scene. Collision specifies the distance at which the avatar collides with other objects, Terrain specifies the height of the avatar's viewpoint relative to the ground, and Stepheight specifies the height of the avatar's legs.

III. C. Virtual Scene Interaction Design

Basic interactions in VRML virtual scenes are achieved through sensor nodes, field-of-view nodes, and interpolation nodes. In VRML, the powerful network programming capabilities of the Java language can be utilized to dynamically control VRML scenes. There are two ways to use Java in VRML: the Script Programming Interface (JSAI) method and the External Authoring Interface (EAI) method. In the JSAI method, the url field of the Script node is used to call Java program code, enabling interaction between VRML and Java. The JSAI method is very convenient to use, as the Script node provides a connection to Java from within the VRML scene, allowing corresponding interactive actions to be performed directly through the browser [42]. In the EAI method, a Java Applet is integrated with the

VRML file on the same HTML page. This system adopts the JSAI method to achieve complex interactions, enhancing the functionality of the Script node. The JSAI call process is shown in Figure 2. Taking a classroom question exercise as an example, a question is posed with four options for selection, and clicking on an incorrect option turns it red.

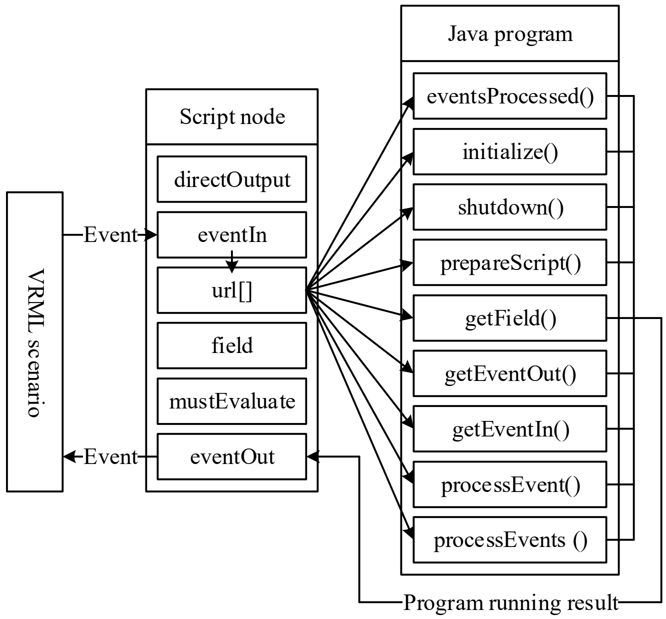

Figure 2: The script programming interface JSAI

III. D. Virtual Characters

This paper adopts the H-Anim virtual character construction standard, which is widely used in VRML, to describe virtual teachers. The H-Anim standard balances compatibility, adaptability, and simplicity, enabling the virtual characters created to be easily distributed and viewed on the web. The behavior of the virtual characters is controlled by system participants. The design points are as follows:

(1) Selecting the appropriate Levels of Articulation reference specifications

A complete H-Anim human model already covers most of the joints and limb-trunk correspondences of the real human body. However, in practical applications, not all joints are necessary. Depending on the application domain, the H-Anim standard provides four levels of Levels of Articulation reference specifications: LOA0, LOA1, LOA2, and LOA3. Based on the design requirements of this system, the LOA1 specification is selected for creating the human model. LOA1 includes the HumanoidRoot node and 17 Joint nodes, defining the basic limb joints, making it the most typical low-end real-time 3D skeletal hierarchy model.

(2) Set the spatial transformation of joint nodes

The joints described by Joint nodes are the direct manipulation objects for virtual human pose control. Human joints should have rotational degrees of freedom but no translational degrees of freedom. The displacement values of Joint nodes are always set to “000” to ensure that joint nodes have no translational transformations. Rotational transformations are the only valid spatial transformations for Joint nodes. The center value defines the center of the joint's rotational transformation, and the joints described by Joint nodes can only rotate around this center.

(3) Creating Viewpoints

Create different viewpoints for the virtual human model by adding Viewpoint nodes in the viewpoints domain of the Humanoid node. Define the front of the human model as the +Z direction, the top as the +Y direction, and the left side as the +X direction, corresponding to the creation of Front, Side, and Top viewpoints, respectively.

III. E. Coordinate Transformation and Scene Representation

This section primarily utilizes algorithms to implement scene coordinate transformations and the representation of three-dimensional scenes.

(1) Coordinate Transformation

Given a camera i, the transformation from the camera coordinate system to the world coordinate system can be expressed as $T_c^i = [R_c^i \mid t_c^i]$, where $R_c^i \in \mathbb{R}^{3\times3}$ and $t_c^i \in \mathbb{R}^3$ represent the rotation matrix and translation vector of camera i, respectively. The rotation matrix R_c^i forms the special orthogonal group $SO(3)$ in the Lie group, and t_c^i forms the Euclidean orthogonal group $SE(3)$.

After presetting the camera's external parameters, the internal parameter matrix of camera i is defined as $G_c^i \in \mathbb{R}^{3\times3}$, which is used to handle the coordinate transformation from the camera coordinate system to the pixel coordinate system.

Let the three-dimensional coordinates of a point in the space captured by camera i be $P_i \in \mathbb{R}^3$. Then, the corresponding pixel coordinates $r_i \in \mathbb{R}^2$ of P_i can be calculated as follows:

$$d_i r_i^+ = G_c^i \cdot [R_c^i \mid t_c^i] \cdot P_i^+ \tag{1}$$

where $r_i^+ \in \mathbb{R}^3, P_i^+ \in \mathbb{R}^4$ represent the homogeneous coordinate forms of r_i and P_i, respectively, i.e., an additional dimension is added to the original coordinate system, and the value in the added dimension is set to 1. The coefficient d_i of the homogeneous term r_i^+ is the depth value corresponding to that point in the perspective of camera i.

To simplify the expression, the operator φ is defined to describe this process. Based on the properties of the special orthogonal group $SO(3)$ and the Euclidean orthogonal group $SE(3)$ in Lie algebras, the coordinate transformation process in equation (1) is reversible, so the transformation relationship between r_i^+ and P_i^+ can be expressed as:

$$d_i r_i^+ = \varphi_i(P_i^+), P_i^+ = \varphi_i^{-1}(d_i r_i^+) \tag{2}$$

In the image mapping process, the most important consideration is the mapping relationship between the two views in the pixel coordinate system. After obtaining the mutual conversion relationship between the two-dimensional pixel coordinates and the three-dimensional space coordinates expressed in equation (2), the mapping of the point with pixel coordinates r_j on camera i to camera j can be expressed as:

$$d_{i\to j} r_{i\to j}^+ = \varphi_j(\varphi_i^{-1}(d_i r_i^+)) \tag{3}$$

For simplicity, define the operator ϕ to represent the transformation from r_i^+ to $r_i \to j^+$, expressed as follows:

$$d_{i\to j} r_{i\to j}^+ = \phi_{i,j}(d_i, r_i^+) \tag{4}$$

Among these, $\phi_{i,j}$ represents the combination of two affine transformations. Based on the rigid body transformation properties of the object, this expression is naturally differentiable. After calculating the mapping coordinates r_i to the mapping coordinates $r_{i\to j}$, we can use bicubic interpolation to sample the view $I_{j\to i}$ and calculate the view $I_j \to i$ mapped from the view I_j. This process:

$$I_{j\to i}(d_i) = \xi_{\Omega(r_{i\to j})}(I_j, r_{i\to j}^+) \tag{5}$$

Among them, the ξ operator represents the interpolation algorithm. Since $r_{i\to j}$ is calculated using a coordinate transformation method, the resulting values may not be integers. Therefore, the value of $r_{i\to j}$ is sampled within the neighborhood $\Omega(r_{i\to j})$ to obtain integer coordinates that conform to the pixel value type. In this chapter, we have selected a naturally differentiable bicubic interpolation algorithm to facilitate subsequent backpropagation calculations.

(2) Scene Representation

After generating a sequence of images mapped from the input view to the target view, the same operation is performed on all other input views to generate a sequence of images mapped from each input view. Since these image sequences form a set of depth planes based on known prior depth and filled depth, they are named Plane-Depth Fusion Scan Volume (PDFSV). This scan volume contains all scene information projected from the input view to the target position.

This section introduces prior depth values into the scene representation method and proposes the PDFSV method to address the scene representation problem under wide baselines. Depth estimation is performed in complex texture regions, and the estimated depth is used to directly map the region to the target view. Other regions with unknown depths are then mapped using a set of depth planes. Through this process, the goal of using known priors to assist network predictions is achieved. After calculating the PDFSV of the target view, to better extract the statistical features of the scene, the mean and variance of the PDFSV are further calculated and named the defocus tensor and correlation tensor, respectively.

In addition to the three-dimensional scene information provided by the defocus tensor and correlation tensor, the direction vector of the target camera is also incorporated, enabling the network to learn the correlation between scene features and the target camera's pose. The direction vector of the target camera is combined with the defocus tensor and variance tensor of the PDFSV to form the feature tensor. An encoding method is used to map the direction vector to a high-dimensional space, with the mapping function represented as:

$$\gamma(p)=(\sin(2^{0}\pi p),\cos(2^{0}\pi p),\cdots,\sin(2^{l-1}\pi p),\cos(2^{l-1}\pi p)) \tag{6}$$

In this context, p represents one of the coordinate components of a three-dimensional direction vector, and γ denotes the mapping function that maps p to a high-dimensional space of dimension $2l$. The encoded direction vector is combined with PDFSV to form a feature tensor, which serves as input for the subsequent neural network.

PDFSV enhances the expressive power of virtual scene features through its unique non-uniform depth filling method, which uses known coarse depth priors to fill the depth space and depth planes to fill missing depth positions.

IV. Simulation and Effect Analysis of Foreign Language Teaching Based on Virtual Reality Technology

IV. A. Teaching Implementation

IV. A. 1) Teaching Target Audience

The teaching location for this educational activity was a university in City Y, where 80 first-year foreign language students were randomly divided into two classes of roughly equal foreign language proficiency, with 40 students in each class. Prior to the foreign language teaching simulation experiment, the students took a pre-test to assess the foreign language proficiency of both classes. Additionally, since the students had been enrolled for two months, they had already gained a general understanding of how to use and learn with tablet computers. Their knowledge and skill foundations were both at a relatively good level.

IV. A. 2) Teaching Content

After discussions and exchanges with the supervising teacher, the content of this teaching activity was designed to focus on foreign language skills, professional knowledge, cross-cultural competence, and comprehensive qualities. The teaching design emphasizes the cultivation of students' comprehensive abilities in listening, speaking, reading, writing, viewing, and translation. Therefore, the selection of foreign language textbooks integrates multiple teaching tasks based on six abilities, which is of great significance for the development of students' foreign language abilities.

IV. A. 3) Instructional Design

The instructional objectives of this study are based on the core competencies of foreign language education. Through the design, development, and application of foreign language virtual teaching scenarios utilizing virtual reality technology, this study aims to create a realistic and engaging foreign language learning environment for students, meeting the needs of foreign language instruction centered on contextual teaching. This enables students to engage in interactive learning before, during, and after class. Through this part of the teaching, students can engage in independent thinking and enhance their foreign language listening, speaking, reading, writing, viewing, and translation skills.

Therefore, the two classes with consistent foreign language proficiency levels were divided into an experimental class and a control class. The experimental class utilized VR technology to create contextual scenarios, simulate oral dialogue scenarios, objects, and characters, and assist in text reading and comprehension, ensuring the orderly progression of all teaching components including listening, speaking, reading, and writing. The control class, on the other hand, uses conventional foreign language teaching scenarios and traditional multimedia technology for foreign language learning. A foreign language teaching simulation experiment was conducted in September 2024, and after 12 weeks, the impact of the teaching environment on students' foreign language proficiency and learning interest was analyzed.

IV. B. Analysis of foreign language teaching based on virtual teaching scenarios

IV. B. 1) Simulating foreign language teaching experiences

Validating the virtual reality foreign language simulation teaching course is a key process in this course design. The purpose of this questionnaire design is to collect students' evaluations of the user experience in virtual foreign language teaching scenarios. The questionnaire structure evaluates the course from five aspects: interaction methods, visual perception, teaching content, interface design, and technical support. The specific evaluation indicators include: multiple effective presentation methods, clear information hierarchy, consistency of design style, content relevance, interaction fluency, feedback effectiveness, perceived controllability, ease of operation, scenario adaptability, and scene aesthetics—a total of ten indicators. After completing the course user experience questionnaire design, 40 students from the experimental class were invited to score the design results of this virtual simulation course. After the students had fully experienced all the teaching scenarios, they scored the user experience of the foreign language course using a 5-point scale.

The students' user experience ratings for the course are shown in Figure 3. Based on the data in the figure, the average score for the user experience metrics of the foreign language simulation course is above 4, indicating that the innovative design strategies employed in this virtual simulation course have achieved preliminary success, and users generally evaluate the user experience of this virtual simulation course positively.

Among the specific user experience metrics, the course scored the lowest in perceived controllability, with only 4.01 points. Perceived controllability is strongly correlated with the design objectives of interactive operation guidance and interactive animation feedback design. Based on the actual situation of this design, since interactive animation feedback design is influenced by both visual and technical aspects, these two areas need to be strengthened in future course iterations. The score for “various effective presentation methods” was 4.30, which has a strong correlation with 3D model design. In this design practice, the number of 3D model operation methods was increased, indicating that students still have a certain adaptation period for this operation method. This operation form can be appropriately optimized in subsequent course iterations. Clear information layering has a strong correlation with page information layering design. In this course design practice, the traditional page information layering format was altered, with each operation page designed independently. This indicates that the current page information layering design still has significant room for improvement, and multi-dimensional page layering methods could be appropriately added. The scores for design style consistency and content relevance were 4.34 and 4.32, respectively. Both metrics have a strong correlation with multiple design objectives, making it difficult to clearly define all design objectives. The improvement of user experience in terms of interaction fluency and feedback effectiveness relies more on technical support. Therefore, in subsequent course designs, it is necessary to have in-depth communication with technical personnel to clarify the technical points that need to be upgraded. The user requirement of contextual adaptability is more focused on students' visual perceptions. In future course visual designs, it is necessary to align more closely with students' existing cognitive habits. The scores for ease of learning and aesthetic appeal are relatively high, so in future course designs, these two requirements can be prioritized after other requirements.

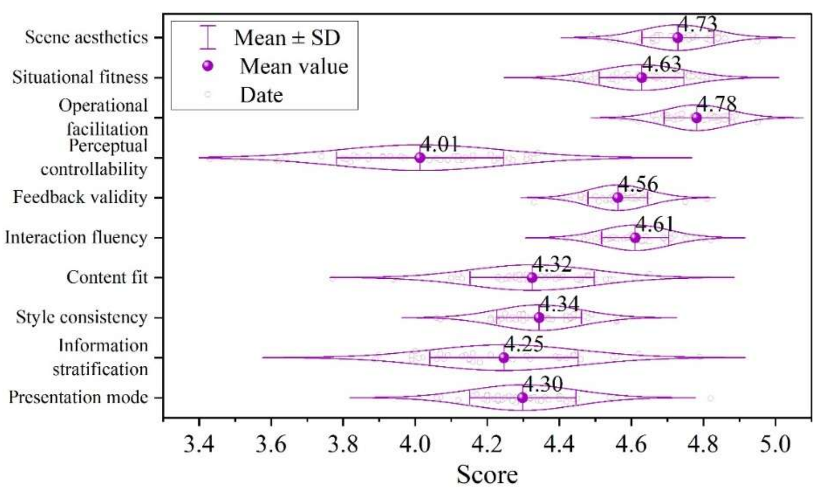

Figure 3: Foreign language course user experience scores

IV. B. 2) Changes in Students' Foreign Language Proficiency

The purpose of this section is to examine the impact of foreign language virtual reality teaching scenarios on participants' foreign language proficiency and students' attitudes toward this teaching model. In this study, foreign language proficiency was measured using test scores. SPSS software was used to perform paired sample tests on the pre-test and post-test scores of the experimental and control groups. The distribution of pre-test and post-test scores for the experimental and control groups is shown in Figure 4, and the results of the t-test for the scores are shown in Table 1.

Based on the analysis of the charts, with a total score of 30 points, the pre-test mean score for the experimental class was 19.18, and the post-test score was 24.43, with a difference of 5.25. It can be seen that after 12 weeks of virtual reality foreign language instruction, the foreign language proficiency of the experimental class improved significantly. Furthermore, for the pre-test and post-test scores of the experimental class, the F-value of the t-test was 14.954, and the paired probability sig value was 0.008, which is less than the significance level of 0.05, thus rejecting the hypothesis of equal variances. When variances are unequal, the t-test result is 0.522, and the sig. (two-tailed) value for pre- and post-test scores is 0.000 < 0.05, indicating a significant difference in foreign language proficiency scores between the pre- and post-test for the experimental class.

For the pre-test and post-test scores of the control class, the F-value is 8.318, and the paired probability sig. value is 0.194, which is greater than the significance level of 0.05, so we do not reject the hypothesis of equal variances. When variances are equal, the t-test result is 1.276. The mean pre-test score of the control class is 18.98, and the mean post-test score is 20.6, showing a slight increase. However, the Sig. value (two-tailed) for the independent samples t-test total score is 0.114 > 0.05, indicating that although the foreign language proficiency of the control class improved before and after teaching, the difference is not statistically significant.

Therefore, it can be concluded that after a period of learning under the new teaching model, the participants' foreign language proficiency has improved significantly.

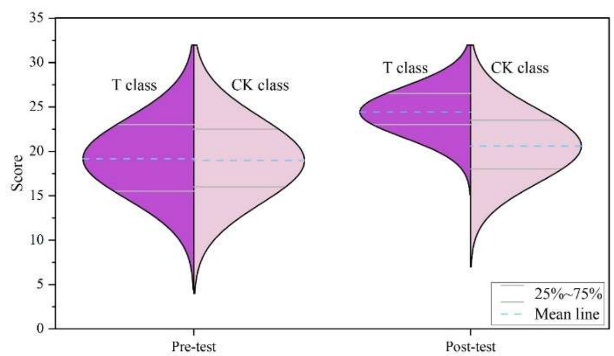

Figure 4: The distribution of the pre-test and post-test results

Table 1: T test results of grade date

Class	Stage	N	Mena	SD	F	Sig.	T	Sig. (Double side)
CK	Pre	40	18.98	1.423	8.318	0.194	1.276	0.114
	Post	40	20.6	1.176				
T	Pre	40	19.18	1.315	14.954	0.008	0.522	0.000
	Post	40	24.43	0.662				

Additionally, to examine the impact of the virtual reality teaching model on students' syntactic abilities—specifically fluency, accuracy, and complexity—a paired-sample test was conducted on the text analysis data from pre- and post-test essays of students in both classes. The results of the pre- and post-test scores for syntactic ability in the experimental and control groups are shown in Figures 5 and 6, respectively.

As shown in the figures, there was a significant increase in the three measures of syntactic ability in the experimental class before and after the experiment. The average scores for fluency, accuracy, and complexity increased from 3.16, 3.39, and 2.79 to 3.99, 4.43, and 3.76, respectively. Additionally, the results of the independent samples t-test showed that the Sig. (two-tailed) values for fluency, accuracy, and complexity in the experimental class were all 0.000 < 0.05, indicating a significant difference. Before and after the experiment, in the three measures of syntactic ability, the post-test mean scores of the control class students increased slightly compared to the pre-test mean scores, with the average scores for fluency, accuracy, and complexity increasing from 3.20, 3.41, and 2.74 to 3.34, 3.42, and 2.96, respectively. The control group showed no significant differences in any of the three measures, with Sig. (two-tailed) values all greater than 0.05. After the experiment, the experimental group demonstrated more significant improvements in syntactic fluency, accuracy, and complexity compared to the control group. This indicates that foreign language teaching scenarios based on virtual reality technology are more effective in enhancing students' syntactic abilities.

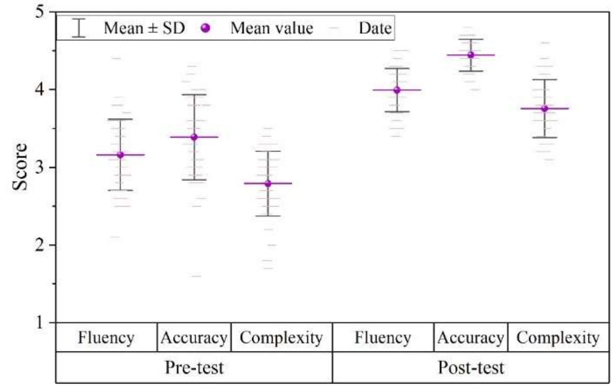

Figure 5: The distribution of the test and the post-test results of the T class

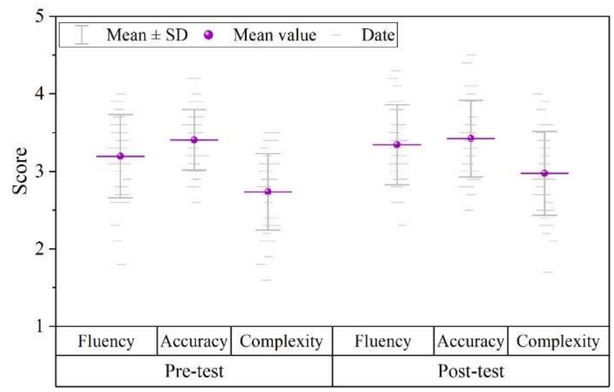

Figure 6: The distribution of the test and the post-test results of the CK class

IV. B. 3) Virtual teaching satisfaction

Following the conclusion of the foreign language virtual teaching simulation experiment, a satisfaction survey questionnaire regarding virtual teaching activities was distributed to the 40 students in the experimental class. The survey was conducted across four dimensions: interest in foreign language learning, learning attitude, learning motivation, and learning outcomes. The questionnaire was designed using a 5-point Likert scale, with 40 copies distributed and 40 returned, resulting in a 100% response rate. The collected data were organized and analyzed for reliability using SPSS. The specific reliability analysis results of the virtual teaching satisfaction survey questionnaire are shown in Table 2. As can be seen, the overall α coefficient of the questionnaire is 0.931, indicating high reliability and validity.

Table 2: The analysis of the reliability of virtual teaching satisfaction survey

Dimension	Cronbach's α	Term number	Sample size
Learning interest	0.927	4	40
Learning attitude	0.913	4	40
Learning motivation	0.906	4	40
Learning effect	0.933	6	40
Total	0.931	18	40

Figure 7 shows the distribution results of the virtual teaching satisfaction score questionnaire survey. Figure 8 shows the percentage of students in each satisfaction level for each question item. From the two figures, it can be seen that students have a high level of satisfaction with the foreign language virtual teaching scenario constructed in this paper. The satisfaction scores for learning interest, learning attitude, learning motivation, and learning outcomes are 4.75, 4.33, 4.47, and 4.61, respectively. Over 95% of students believe that the activity scenarios set up in virtual teaching are closely related to real life, rich, and vivid, effectively enhancing their interest in foreign language learning. Between 77.5% and 97.5% of students believe that the virtual teaching activities in this paper have enhanced their confidence in foreign language learning and improved their learning attitude. Between 85% and 92.5% of students believe that foreign language virtual teaching activities can further stimulate their internal learning motivation and increase their enthusiasm for learning foreign languages. In terms of learning outcomes, 90% to 100% of students reported that their participation in classroom interaction and communication had improved in the virtual teaching environment, and that they had gradually developed the ability to use various strategies to solve real-world problems during the thematic teaching activities.

In summary, the foreign language teaching scenarios constructed using virtual reality technology in this study can enhance students' interest, attitude, and motivation toward learning, enabling them to engage in foreign language learning with greater enthusiasm. Additionally, these scenarios have a significant positive impact on students' comprehensive foreign language expression abilities and outcomes.

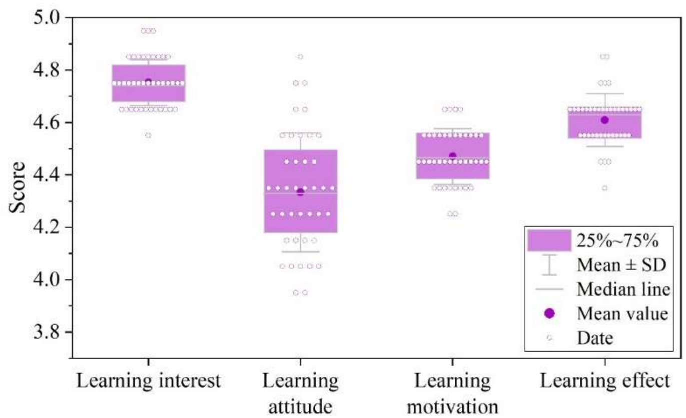

Figure 7: The results of the questionnaire survey of virtual teaching satisfaction score

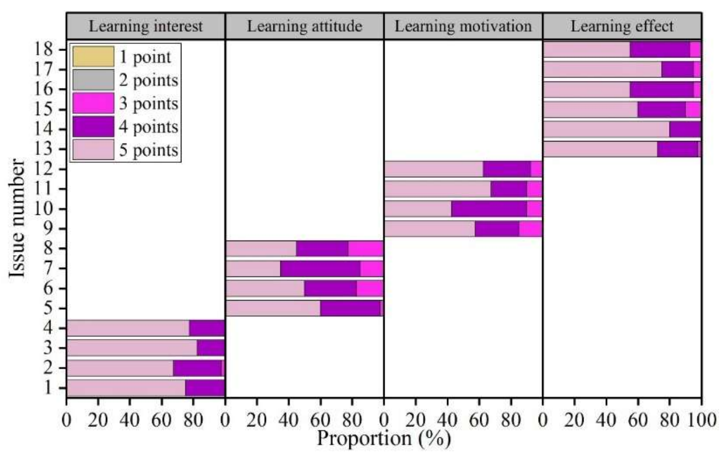

Figure 8: The proportion of the number of satisfaction levels

V. Conclusion

The article analyzes the feasibility of VRML and ASP.NET technologies in the development of virtual teaching scenarios and uses them to realize the virtual scenario and interactive control design for foreign language teaching. First, the teaching scenario is modeled and analyzed, including scenario configuration, irregular shape construction, and lighting effect addition. Then, the browser's change function is used to add and control the scene viewpoint, enabling students to navigate within the teaching scenario. Finally, JSAI is used to design the interactive functions of the teaching scenario, and virtual characters are created based on the H-Anim standard to simulate the interactivity of a real foreign language classroom. The results of the foreign language teaching simulation experiment indicate:

(1) The virtual teaching scenario constructed in this study received experience evaluation scores between 4.0 and 4.8 in terms of interaction methods, visual perception, teaching content, interface design, and technical support, providing students with a good foreign language learning experience.

(2) In this scenario, the foreign language proficiency of the experimental class students improved by 5.25 points, while that of the control class students improved by only 1.62 points. Additionally, the experimental group students demonstrated significant improvements in fluency, accuracy, and complexity, with average scores increasing from 3.16, 3.39, and 2.79 to 3.99, 4.43, and 3.76, respectively.

(3) In terms of satisfaction evaluation, students' satisfaction scores for learning interest, learning attitude, learning motivation, and learning outcomes were 4.75, 4.33, 4.47, and 4.61, respectively, indicating a high level of satisfaction.

The research results demonstrate the significant effectiveness of the virtual teaching scenario in foreign language instruction. However, this virtual scenario does not support external program language control. Therefore, voice-based interaction control is not feasible, and students can only interact with virtual characters through simple actions and voice commands using a keyboard and mouse.

As educational informatization continues to advance, it is anticipated that an increasing number of modern scientific and technological innovations will be integrated into foreign language classroom instruction, thereby enhancing the cultivation of students' comprehensive foreign language competencies. In future work and studies, the author will continue to closely monitor and explore related research in this field.

References

[1] Li, C. (2025). Foreign language learning boredom and enjoyment: The effects of learner variables and teacher variables. Language Teaching Research, 29(4), 1499-1524.

[2] Rubio, F. (Ed.). (2021). Self-esteem and foreign language learning. Cambridge Scholars Publishing.

[3] Wang, Y., Derakhshan, A., & Zhang, L. J. (2021). Researching and practicing positive psychology in second/foreign language learning and teaching: the past, current status and future directions. Frontiers in psychology, 12, 731721.

[4] Li, C., Zhang, L. J., & Jiang, G. (2024). Conceptualisation and measurement of foreign language learning burnout among Chinese EFL students. Journal of Multilingual and Multicultural Development, 45(4), 906-920.

[5] Dizon, G. (2023). Foreign Language Learning in the Digital Wilds. CALICO Journal, 40(2), 238-256.

[6] Sudina, E., & Plonsky, L. (2021). Academic perseverance in foreign language learning: An investigation of language-specific grit and its conceptual correlates. The Modern Language Journal, 105(4), 829-857.

[7] Golonka, E. M., Bowles, A. R., Frank, V. M., Richardson, D. L., & Freynik, S. (2014). Technologies for foreign language learning: A review of technology types and their effectiveness. Computer assisted language learning, 27(1), 70-105.

[8] Ginsburgh, V., Melitz, J., & Toubal, F. (2017). Foreign language learning and trade. Review of International Economics, 25(2), 320-361.

[9] Li, C., Dewaele, J. M., & Hu, Y. (2023). Foreign language learning boredom: Conceptualization and measurement. Applied Linguistics Review, 14(2), 223-249.

[10] Oga-Baldwin, W. Q. (2019). Acting, thinking, feeling, making, collaborating: The engagement process in foreign language learning. System, 86, 102128.

[11] Hou, Y. A. (2018). A study of the role of strategy in foreign language learning. Open Journal of Modern Linguistics, 8(5), 151-175.

[12] Scrivner, O., Madewell, J., Buckley, C., & Perez, N. (2019). Best practices in the use of augmented and virtual reality technologies for SLA: Design, implementation, and feedback. Teaching language and teaching literature in virtual environments, 55-72.

[13] Bamodu, O., & Ye, X. M. (2013). Virtual reality and virtual reality system components. Advanced materials research, 765, 1169-1172.

[14] Özçelik, N. P., Ekşi, G., & Baturay, M. H. (2022). Augmented reality (AR) in language learning: A principled review of 2017-2021. Participatory Educational Research, 9(4), 131-152.

[15] Christoforou, M., Xerou, E., & Papadima-Sophocleous, S. (2019). Integrating a virtual reality application to simulate situated learning experiences in a foreign language course. CALL and complexity–short papers from EUROCALL, 82-87.

[16] Andujar, A., & Buchner, J. (2019). The potential of 3D Virtual Reality (VR) for language learning: An overview. In Proceedings of the 15th international conference on mobile learning (pp. 153-156).

[17] Kaplan-Rakowski, R., & Gruber, A. (2023). The impact of high-immersion virtual reality on foreign language anxiety. Smart Learning Environments, 10(1), 46.

[18] Pataquiva, F. D. P. F., & Klimova, B. (2022). A systematic review of virtual reality in the acquisition of second language. International Journal of Emerging Technologies in Learning (iJET), 17(15), 43-53.

[19] Chen, Y. L. (2016). The effects of virtual reality learning environment on student cognitive and linguistic development. The Asia-Pacific Education Researcher, 25, 637-646.

[20] Pinto, R. D., Peixoto, B., Melo, M., Cabral, L., & Bessa, M. (2021). Foreign language learning gamification using virtual reality—a systematic review of empirical research. Education Sciences, 11(5), 222.

[21] Tafazoli, D. (2024). From virtual reality to cultural reality: integration of virtual reality into teaching culture in foreign language education. Journal for Multicultural Education, 18(1/2), 6-24.

[22] Solak, E., & Erdem, G. (2015). A content analysis of virtual reality studies in foreign language education. Participatory Educational Research, 2(5), 21-26.

[23] Alfadil, M. (2020). Effectiveness of virtual reality game in foreign language vocabulary acquisition. Computers & Education, 153, 103893.

[24] Dobrova, V., Trubitsin, K., Labzina, P., Ageenko, N., & Gorbunova, Y. (2017, November). Virtual reality in teaching of foreign languages. In 7th International Scientific and Practical Conference" Current issues of linguistics and didactics: The interdisciplinary approach in humanities"(CILDIAH 2017) (pp. 63-68). Atlantis Press.

[25] Peixoto, B., Pinto, D., Krassmann, A., Melo, M., Cabral, L., & Bessa, M. (2019). Using virtual reality tools for teaching foreign languages. In New Knowledge in Information Systems and Technologies: Volume 3 (pp. 581-588). Springer International Publishing.

[26] Li, M., Pan, Z., Sun, Y., & Yao, Z. (2021, May). Virtual reality in foreign language learning: A review of the literature. In 2021 IEEE 7th international conference on virtual reality (ICVR) (pp. 302-307). IEEE.

[27] Legault, J., Zhao, J., Chi, Y. A., Chen, W., Klippel, A., & Li, P. (2019). Immersive virtual reality as an effective tool for second language vocabulary learning. Languages, 4(1), 13.

[28] Pinto, D., Peixoto, B., Krassmann, A., Melo, M., Cabral, L., & Bessa, M. (2019). Virtual reality in education: Learning a foreign language. In New Knowledge in Information Systems and Technologies: Volume 3 (pp. 589-597). Springer International Publishing.

[29] Peixoto, B., Pinto, R., Melo, M., Cabral, L., & Bessa, M. (2021). Immersive virtual reality for foreign language education: A PRISMA systematic review. IEEE Access, 9, 48952-48962.
[30] Song, C., Shin, S. Y., & Shin, K. S. (2023). Optimizing foreign language learning in virtual reality: a comprehensive theoretical framework based on constructivism and cognitive load theory (VR-CCL). Applied Sciences, 13(23), 12557.
[31] Kolesnichenko, A. N. (2023). The possibilities of using virtual reality technology in teaching a foreign language. Samara Journal of Science, 12(2), 266-270.
[32] Nobrega, F. A., & Rozenfeld, C. C. D. F. (2019). Virtual reality in the teaching of FLE in a Brazilian public school. Languages, 4(2), 36.
[33] Rudnik, Y. (2023). The use of augmented reality and virtual reality technologies in teaching foreign languages. Educological discourse, (1 (40)), 165-183.
[34] DeWitt, D., Chan, S. F., & Loban, R. (2022). Virtual reality for developing intercultural communication competence in Mandarin as a Foreign language. Educational technology research and development, 70(2), 615-638.
[35] Çakır, N. (2024). Virtual reality games in foreign language education: A systematic review. Language Education and Technology, 4(1).
[36] Chen, C., & Yuan, Y. (2025). Effectiveness of virtual reality on Chinese as a second language vocabulary learning: Perceptions from international students. Computer Assisted Language Learning, 38(3), 397-425.
[37] Bisogni, F., Laccone, R. P., Esposito, C., Frolli, A., & Romano, M. (2023). Virtual reality and foreign language learning. In ICERI2023 Proceedings (pp. 9201-9207). IATED.
[38] Yan, W., & Lowell, V. L. (2025). The Evolution of Virtual Reality in Foreign Language Education: From Text-Based MUDs to AI-Enhanced Immersive Environments. TechTrends, 1-6.
[39] Lai ZhengWen,Zeng QingLiang & Zhou Shiyuan. (2022). Research on Online Virtual Energy-Saving and Environment-Friendly Building Design and Implementation Based on VRML. Wireless Communications and Mobile Computing,2022,
[40] S.Selvakani,K.Vasumathi & M.Harikaran. (2019). Web based Online Crime Reporting System using Asp.Net. International Journal of Innovative Technology and Exploring Engineering (IJITEE),8(10),1220-1224.
[41] Peter Kuna,Alena Hašková & Ľuboš Borza. (2024). Applicability of Virtual Excursions in Technical Subjects Teaching. Applied Sciences,14(19),9120-9120.
[42] Vineeth Kashyap,Kyle Dewey,Ethan A. Kuefner,John Wagner,Kevin Gibbons,John Sarracino... & Ben Hardekopf. (2014). JSAI: Designing a Sound, Configurable, and Efficient Static Analyzer for JavaScript.. CoRR,abs/1403.3996.