

Design and Development of an Immersive Game-Based Mandarin Language Learning Medium to Enhance Student Learning Motivation

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ARTICLE INFO

Article History:

Received : 29-10-2025
Revised : 12-12-2025
Accepted : 14-12-2025
Online : 15-12-2025

Keywords:

Research and Development (R&D);
ADDIE Model;
Immersive game;
Interactive learning media



ABSTRACT

The rapid advancement of technology in the Industrial Revolution 4.0 era has driven innovation in education, particularly through the use of interactive digital learning media. This study aims to develop an immersive game-based learning media for Mandarin language instruction using the Roblox Studio platform to enhance students' motivation and engagement in the learning process. The research employed a Research and Development (R&D) approach using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The analysis phase identified that Mandarin learning tends to be monotonous and less engaging for students. Validation results from content experts reached 83% and media experts 81%, both categorized as good. User testing yielded 84%, while small-group and large-group trials achieved 88% and 85%, respectively, categorized as very high. The developed learning game integrates coin hunt and leaderboard features that effectively create an interactive and competitive learning experience. Overall, the findings indicate that the game-based learning media is feasible, engaging, and effective in improving students' motivation and learning outcomes in Mandarin language courses within vocational higher education.



<https://doi.org/10.31764/justek.vXiY.ZZZ>



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A. BACKGROUND

The advancement of information technology in the 4th Industrial Revolution has driven substantial transformation in the education sector, compelling institutions to adapt their learning processes accordingly (Azzahra et al., 2025). The transition from conventional instruction to digital technology enhanced learning has become essential to ensure more interactive and effective teaching activities (Abdullah & Yuniarta, 2018). Despite these developments, subjects with high levels of complexity, such as Mandarin, continue to pose significant instructional challenges.

Mandarin features a logographic writing system and tonal pronunciation, which frequently hinder students, particularly those without prior linguistic training, from mastering foundational writing and pronunciation skills (Samosir & Rudiansyah, 2021). Similar challenges are observed among students in the Furniture Industry Business Management Study Program at the Politeknik Industri Furnitur dan Pengolahan Kayu, who receive only one semester of Mandarin instruction. Limited instructional time and

monotonous teaching methods have contributed to reduced motivation, engagement, and learning outcomes.

Prior research demonstrates that Game-Based Learning (GBL) effectively improves both motivation and academic performance. Winatha and Setiawan (2020) reported that game integration in instructional settings yields positive effects on student motivation and achievement. Other studies likewise show that game-based learning increases engagement and active participation across various learning contexts (Adrillian et al., 2024). Findings from more recent systematic reviews reinforce this trend. A literature review by Andika et al., (2025) reported that GBL consistently enhances learner motivation, engagement, and learning outcomes through its interactive and student-centered characteristics, highlighting its potential to reduce learning monotony and strengthen conceptual understanding.

A broader body of literature supports these findings. Hussein et al. (2019) synthesized research on digital game-based learning and reported strong evidence of improved content understanding, motivation, and behavioral engagement among elementary science. Similarly, Bakan and Bakan (2018) noted that GBL demonstrates significant efficacy in promoting cognitive engagement and improving retention across various educational domains, emphasizing its relevance for contemporary instructional approaches. Studies in the Indonesian context also corroborate the motivational benefits of GBL, Palupi and Suaedi (2025) found that GBL fosters an enjoyable, interactive learning atmosphere and enhances students' participation and motivation in literary studies. Furthermore, Fatima et al. (2020) reported that GBL methodologies substantially improved children's reading and writing skills for Javanese script, illustrating GBL's potential for language learning through active involvement and contextualized practice.

Beyond game-based learning, the integration of immersive and interactive technologies has broadened opportunities for enhancing learning effectiveness. Augmented Reality (AR) and immersive environments offer more engaging instructional experiences. Zuo et al. (2022) noted that the inclusion of fantasy-based narratives in AR learning environments significantly increases learner engagement and demonstrates the importance of pedagogically aligned design features. AI integration has likewise shown promise, Aulia et al. (2024) found that AI-supported immersive games promote adaptive feedback, personalization, and improved cognitive development. Parallel findings were presented in Virtual Reality (VR)-based work, Rahman et al. (2024) demonstrated that VR classrooms enhance understanding of abstract science concepts and bolster student motivation, while Arden et al. (2025) observed that VR educational games meaningfully increase conceptual comprehension in fields such as Internet of Things (IoT) and VR.

In addition to effectiveness studies, a meta-analysis by Zhang and Yu (2022) confirms that GBL provides stable and significant effects on academic performance compared to conventional instruction, whereas gamification tends to yield stronger effects on learning motivation. Omarov et al. (2024) further demonstrated that AR game-based learning significantly boosts participation and motivation in physical education, underscoring the broad applicability of immersive technologies, including in language learning contexts.

Another important development concerns assessment frameworks for immersive learning. Udeozor et al. (2023) introduced a comprehensive Game-Based Assessment Framework for VR, AR, and digital games, emphasizing the need for authentic assessment mechanisms capable of measuring higher-order thinking skills in immersive environments. Dyulicheva and Glazieva (2021) this perspective by highlighting AI-

supported features such as emotion recognition and adaptive difficulty, reinforcing the pedagogical potential of intelligent and responsive game environments.

Although the application of GBL, AR/VR, and immersive learning technologies is well-documented across STEM fields, their integration into Mandarin language instruction remains limited, particularly for vocational students with brief learning exposure and no prior linguistic background. Many immersive learning studies focus on visualizing abstract scientific concepts rather than linguistic competencies, which require mastering symbolic representations, phonological distinctions, and culturally embedded meanings. Research on metaverse-based immersive language learning is still developing and has yet to be tailored to vocational contexts.

Given these gaps, the development of a metaverse-based immersive learning game for Mandarin is both relevant and necessary. To address this need, the present study aims to design and implement an immersive game-based learning medium that leverages metaverse technology to enhance interactivity and student engagement. Additionally, the study seeks to evaluate the effectiveness of this learning medium in improving Mandarin learning outcomes, particularly foundational skills such as Hanzi characters recognition and mastery simple vocabulary.

B. RESEARCH METHOD

This study employed a Research and Development approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The ADDIE model is a systematic instructional design framework consisting of five core stages, as illustrated in Fig. 1, and is widely used in the development of technology-based learning media (Adrillian et al., 2024). The stages conducted in this study are as follows:

1. *Analysis*

The analysis stage aims to identify learning issues and gather initial data to determine the needs for developing an appropriate learning media.

2. *Design*

The design stage focuses on planning the learning media and preparing the structure and framework of the product. To address the challenges identified in the Mandarin course, the researchers began developing a game-based learning concept, including selecting appropriate software. The immersive learning game was developed using the Roblox platform, with Roblox Studio employed for the game's construction.

3. *Development*

In this stage, the initial design is transformed into a functional learning medium. The development process also includes expert validation of both content and media. Revisions were made based on feedback from validators.

Suggestions and recommendations from subject-matter and media experts were incorporated to refine and improve the game so that it becomes more feasible and suitable for instructional use.

4. *Implementation*

The implementation stage involves testing the learning medium in an authentic learning environment. In this study, the intended users participated in testing and data collection. The product testing consisted of three phases: (1) small-group testing with 10 students, and (2) large-group testing with 30 students.

5. *Evaluation*

The evaluation stage is the final phase of the ADDIE model. Its purpose is to determine whether the objectives of the immersive game-based learning video have

been achieved. This is done by analyzing questionnaire data obtained from experts and students. The results enable the researchers to assess the overall effectiveness of the developed immersive game-based learning medium.

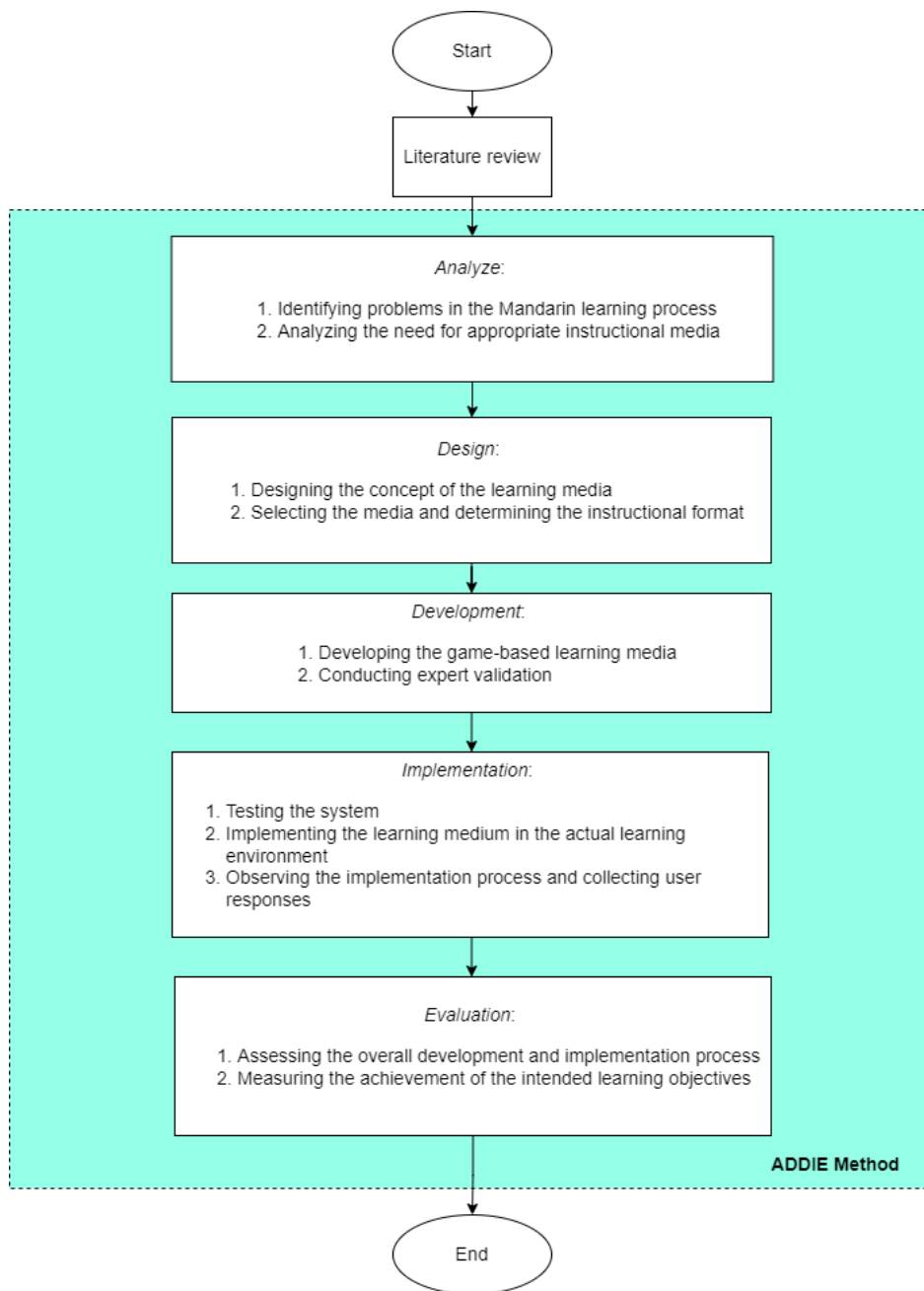


Figure 1. Research flowchart using the ADDIE method

C. RESULT AND DISCUSSION

The immersive game-based learning medium developed through the Roblox platform was designed to support Mandarin language instruction by presenting thematic quizzes that function as evaluation tools for assessing learners’ understanding of vocabulary and grammar. Using a Research and Development approach based on the ADDIE model, the results at each stage are described as follows.

1. Analysis Results

Observations of third-semester students in the Furniture Industry Business Management Study Program indicated that learning outcomes in the first month of the Mandarin course were relatively low. Based on quiz and assignment results, 15% of the 51 students did not pass, while 85% passed with an average score of 71.37. Students experienced significant difficulties in recognizing Hanzi characters and in mastering basic vocabulary.

The instructional process relied predominantly on textbooks, producing a monotonous learning environment that contributed to low motivation. Students expressed a preference for learning media integrating video, audio, and interactive quizzes. These findings demonstrate a clear need for an engaging, interactive instructional medium capable of increasing student motivation and supporting the acquisition of foundational Mandarin competencies.

2. Design Results

Based on the identified learning challenges, the design stage focused on developing a structured plan for an immersive instructional medium. The chosen development platform was Roblox, selected for its interactive 3D environment, accessibility, and capacity to support game-based learning features.

The design specifications included: (1) development of thematic quiz modules for vocabulary; (2) incorporation of game mechanics such as exploration zones, challenges, and feedback loops; (3) arrangement of content flow to align with basic Mandarin learning objectives.

This stage ensured that the instructional framework aligned with learner needs while maintaining pedagogical coherence.

3. Development Results

The immersive game-based learning medium developed on the Roblox platform was designed to support Mandarin language learning through thematic quizzes that function as evaluation tools for assessing learners' understanding of vocabulary and grammar. Through this game-based approach, the learning process is expected to become more appealing while enhancing students' cognitive and affective abilities in mastering Mandarin.

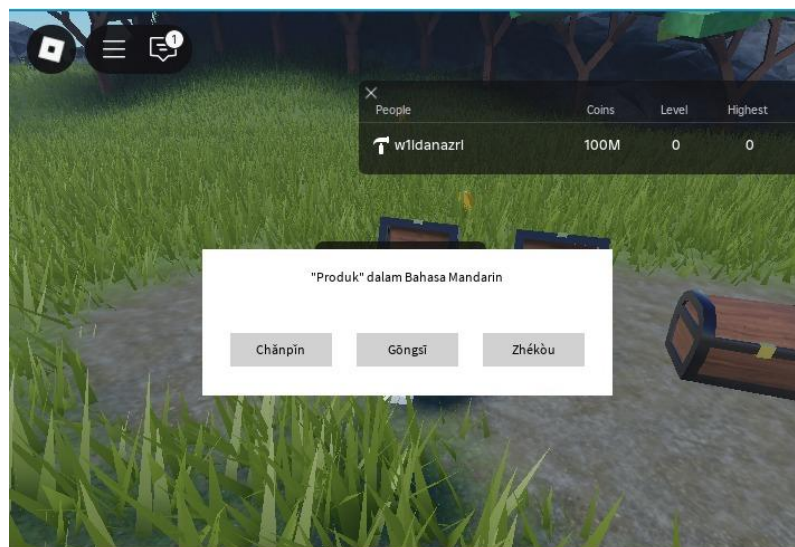


Figure 2. Immersive gaming experience

To increase student engagement, the game incorporated a coin hunt feature, providing additional challenges that help sustain student motivation and prevent learning fatigue. The coins collected by players can be used to unlock new features, obtain additional items, or boost their score, establishing a reward system that strengthens intrinsic motivation.

In addition, the game is equipped with a leaderboard that displays the highest coin achievements among all players. This mechanism serves to cultivate a healthy competitive atmosphere and to encourage students to continuously improve their academic performance. Through this competitive element, the game functions not only as an interactive learning medium but also as an edutainment platform that integrates gameplay and instruction in a balanced manner. To ensure that these features genuinely support the intended learning objectives, the developed medium must undergo a validation process prior to being tested with students.

Data validation was conducted after the immersive learning game had been fully developed and before it was administered to students. The validation process involved one content experts and one media expert to assess the feasibility of the learning game using a questionnaire. The results were analyzed using the formula (Agustien et al., 2018):

$$\text{Result} = \frac{\text{Obtained score}}{\text{Maximum score}} \times 100\% \quad (1)$$

The results of these calculations were then classified into feasibility categories based on the criteria presented in Table 1.

Table 1. Feasibility Categories for Learning Media

Achievement Level	Category	Description
85% - 100%	Very good	No revision needed
75% - 84%	Good	No revision needed
65% - 74%	Fair	Revision needed
55% - 64%	Poor	Revision needed
0 - 54%	Very Poor	Revision needed

a. Content Expert Validation

The content expert validation was conducted by the lecturer responsible for the Mandarin course, and the results are presented in Table 2. Analysis using Equation (1) showed that the feasibility score reached 83%. According to the criteria in Table 1, this score falls within the *Good* category, indicating that the developed learning media is suitable for instructional use. The expert recommended expanding the material coverage, particularly vocabulary commonly used in daily communication, to improve content relevance and applicability for students. Overall, the product meets the required content feasibility standards and does not require further revision.

Table 2. Content Expert Validation Results

Assessment Components	Indicators	Score (1-5)
Material suitability	Suitability with CPMK	4
Material depth	Accuracy of complexity level	4
Conceptual accuracy	Accuracy of Mandarin terminology and language structure	4
Relevance	Alignment with student needs	5
Presentation	Presentation flow in accordance	4

Assessment Components	Indicators	Score (1-5)
Coherence	with sequencing principle	
Integration with Games	Alignment of missions with learning objectives	4
Total Score (Maximum Score 30)		25
Feasibility Result		83,3%

b. Learning Media Expert Validation

The validation of the learning media was carried out by a lecturer with a background in information systems, and the results are presented in Table 3. Analysis using Equation (1) yielded a feasibility score of 81%, which is categorized as Good based on the criteria in Table 1. This outcome indicates that the media and instructional design components meet the expected standards. Nevertheless, the expert recommended incorporating a map feature that displays the full route of the coin-hunting activity to enhance interactivity and improve user navigation.

Table 3. Learning Media Validation Results

Assessment Components	Indicators	Score (1-5)
Visual display	Color and typography consistency	4
Navigation	Ease of moving between menu	4
Interactivity	Game responsiveness to user input	4
Clarity of instructions	Clarity of usage instructions	4
Audio & animation quality	Synchronization and comfort	4
Design suitability	Integration with the learning process	4
Total Score (Maximum Score 30)		24
Feasibility Result		80%

4. Implementation Results

The implementation stage was conducted to measure the attractiveness, usefulness, and feasibility of the immersive game-based learning medium within an authentic instructional context. The testing process consisted of two phases, small-group testing and large-group testing, which aimed to obtain a comprehensive understanding of the media's effectiveness from multiple user perspectives. From the test results, the appeal percentage was obtained using the following formula (Agustien et al., 2018):

$$F = \frac{\text{Percentage of indicators}}{\text{Number of indicators}} \times 100\% \quad (2)$$

Where F denotes the percentage of attractiveness. The resulting F value was subsequently compared with the attractiveness level categories listed in Table 4.

Table 4. Percentage of Attractiveness of Learning Media

Achievement	Category
85% - 100%	Very High
75% - 84%	High
65% - 74%	Moderate
55% - 64%	Low
0 - 54%	Very Low

The small-group test evaluated user engagement and learner responses in a controlled setting. This phase involved 10 third-semester students from the Furniture Industry Business Management Study Program. The results of the small group user trials are shown in Table 5.

Table 5. Small Group Test Results (n=10)

Indicator	Sample Statements	Mean Score (1-5)
User engagement	S1: "The learning game is engaging and encourages continuous participation." S2: "The game maintains my attention throughout the learning activities." S3: "The challenges provided in the game feel stimulating and enjoyable." S4: "I feel immersed in the game environment during the learning process." S5: "The interactive elements motivate me to complete all tasks within the game."	4.6
Usability	S1: "Navigation and instructions are easy to understand." S2: "The user interface layout is intuitive and organized." S3: "I can operate the game without requiring additional guidance." S4: "The buttons and menus respond accurately to my actions." S5: "Instructions for each mission are clear and straightforward."	4.4
Learning relevance	S1: "The game content aligns with my learning needs." S2: "The vocabulary and expressions presented are relevant to my coursework." S3: "The activities support the development of skills required in Mandarin classes." S4: "The game missions reflect real learning objectives." S5: "The difficulty level of the content is appropriate for my proficiency."	4.5
Learning motivation	S1: "The game increases my motivation to learn Mandarin." S2: "I feel encouraged to practice more after using the game." S3: "The rewards and feedback systems motivate me to achieve better results." S4: "The game makes Mandarin learning more enjoyable." S5: "I am more confident in my learning progress after using the game."	4.7
Total score (maximum score 200)		176
Feasibility percentage		88%

Based on data analysis, the learning media obtained an average feasibility percentage of 88%. Referring to the Percentage of Learning Media Attractiveness in Table 4, this falls into the very high category. These results indicate that the learning medium was perceived as engaging, easy to use, and relevant to students' learning needs during the preliminary testing phase.

The large-group test was conducted with 30 students from the third and fourth semesters of the same study program to assess the consistency of the medium's performance under real classroom conditions. The results of the large-group user trials are shown in Table 6.

Table 6. Large Group Test Results (n=30)

Indicator	Sample Statements	Mean Score (1-5)
User engagement	S1: "The learning game is engaging and encourages continuous participation." S2: "The game maintains my attention throughout the learning activities." S3: "The challenges provided in the game feel stimulating and enjoyable." S4: "I feel immersed in the game environment during the learning process." S5: "The interactive elements motivate me to complete all tasks within the game."	4.5
Usability	S1: "Navigation and instructions are easy to understand." S2: "The user interface layout is intuitive and organized." S3: "I can operate the game without requiring additional guidance." S4: "The buttons and menus respond accurately to my actions." S5: "Instructions for each mission are clear and straightforward."	4.3
Learning relevance	S1: "The game content aligns with my learning needs." S2: "The vocabulary and expressions presented are relevant to my coursework." S3: "The activities support the development of skills required in Mandarin classes." S4: "The game missions reflect real learning objectives." S5: "The difficulty level of the content is appropriate for my proficiency."	4.4
Learning motivation	S1: "The game increases my motivation to learn Mandarin." S2: "I feel encouraged to practice more after using the game." S3: "The rewards and feedback systems motivate me to achieve better results." S4: "The game makes Mandarin learning more enjoyable." S5: "I am more confident in my learning progress after using the game."	4.6
Total score (maximum score 600)		510
Feasibility percentage		85%

The analysis showed a feasibility score of 85%, also categorized as *very high*. This finding reinforces the results of the previous phase, demonstrating that the immersive game-based Mandarin learning medium meets the criteria of effectiveness and feasibility for broader application in higher-education settings.

Across all phases of implementation, the data indicate that the medium successfully supports learner engagement and provides a positive user experience. The consistent feasibility ratings across both small- and large-scale testing confirm

the robustness of the medium and its readiness for integration into formal instructional environments.

5. Evaluation Results

The evaluation stage examined whether the learning objectives were achieved. Questionnaire responses from both experts and students indicated strong positive perceptions regarding interactivity, clarity of content, and overall usability of the medium. Students reported higher motivation and interest in learning Mandarin, particularly in mastering vocabulary.

The results suggest that the immersive game-based learning medium effectively supports Mandarin language learning and addresses the motivational challenges identified during the analysis stage. The successful outcomes across all ADDIE stages confirm that the development process produced a feasible and engaging instructional solution.

D. DISCUSSION

Based on the results of small-group and large-group trial, it can be concluded that the immersive game-based learning medium received highly positive evaluations from all participating stakeholders. Overall, these findings indicate that the developed learning medium meets the criteria of content appropriateness, design quality, and effectiveness in supporting Mandarin language instruction within vocational education settings.

The subsequent small-group trial involving ten students yielded a feasibility score of 88%, categorized as very high. This score indicates that the medium is technically and pedagogically accessible, engaging, and capable of increasing student involvement in the learning process. These findings correspond with Sadiman et al. (2010) in Darojat et al., (2022), who state that effective learning media must stimulate motivation and facilitate active learner interaction.

Meanwhile, the large-group trial involving thirty students from two different semester levels produced an average score of 85%, also within the very high category. This result demonstrates that the medium can be implemented on a broader scale while maintaining consistent quality. The positive responses from the large group confirm that the immersive game-based Mandarin learning medium is able to support collaborative learning needs while providing an interactive and enjoyable learning experience. These outcomes further show that the medium exhibits strong validity in terms of content and design, and is regarded by learners as both appealing and easy to use. The testing process constitutes a form of real implementation, reinforcing the readiness of the medium for adoption in formal instructional settings (Dalimunthe & Rahmaini, 2023).

Collectively, the findings indicate that incorporating gamification elements into Mandarin language learning can effectively enhance student motivation and engagement. This aligns with the game-based learning theory proposed by Prensky (2001) in Risa Palupi and Suaedi (2025), which posits that well-designed educational games can improve focus, emotional involvement, and knowledge retention. Thus, the learning medium is not only feasible from a technical standpoint but also possesses significant pedagogical potential to support foreign language learning in vocational higher education. Furthermore, the use of game-based media has been shown to shift learners' mindsets and enhance creativity (Hasanah, 2023). Such media can stimulate learning interest through interactive and enjoyable experiences, thereby contributing to more optimal learning outcomes.

E. CONCLUSION AND RECOMMENDATIONS

This study employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) as a systematic framework for developing an immersive game-based learning medium on the Roblox platform for Mandarin language instruction. Through the five stages of ADDIE, the medium was developed in a structured manner: beginning with an analysis of student needs, followed by the design of the educational game framework, the development of a prototype validated by experts, field implementation through user testing, and finally, an evaluation of the medium's effectiveness. The validation results demonstrate that the learning medium achieved a high level of feasibility, with scores of 83% from content experts and 81% from media experts. The small and large-group trials produced scores of 88% and 85%, respectively all categorized as very good. These results indicate that the medium is suitable for use without major revisions and is effective in enhancing student motivation and engagement. The integration of gamification elements, such as coin hunts and leaderboards, successfully fosters a competitive, interactive, and enjoyable learning environment.

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