

## The Effect of Virtual Reality Game Teaching on Students' Immersion

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**Abstract**—VR (Virtual Reality) technology as the current cutting-edge technology, is widely used in the field of education, and plays a huge advantage. VR game teaching creates an immersive learning environment so that learners can have a clearer and more intuitive understanding of professional knowledge of various disciplines, enhance their learning enthusiasm and interest in learning, and give full play to subjective initiative of learners. VR technology gradually blurs the boundary between realities and virtual, and experiential have a certain emotional investment in excessively real virtual space, to create a sense of immersion and to effectively cultivate students' spatial thinking and higher-order thinking ability. A questionnaire on the effect of VR game teaching technology on college students' immersion was designed, and the effects of four aspects of VR game teaching technology, namely publication rules, role description, game control, and game review on learners' immersion were explored. Results show that publication rules, role descriptions, and game control in VR game teaching have significant positive effects on college students' immersion. All samples of different game platforms show a significant degree of immersion ( $P < 0.05$ ), and two VR game platforms, namely wearable VR interaction and VR all-in-one, improve learners' immersion more significantly. Results of this study have important reference value for integrating VR technology into three-dimensional composition teaching, stimulating students' sense of participation in game learning, improving VR game teaching effect and improving learning efficiency.

**Keywords**—VR game teaching, immersion, questionnaire survey, VR platform, game teaching technology

### 1 Introduction

VR technology is formed by the continuous development of comprehensive information technology, which needs comprehensive support of graphics technology, multimedia technology, network communication technology, and other technologies. VR technology can bring different teaching mode reform to education because of its high simulation. With the comprehensive application of VR technology in ubiquitous learning and classroom teaching, especially VR technology game teaching, learners can play certain roles and identities, and their learning motivation is significantly enhanced.

More and more learners are willing to accept VR games for learning. The essence of VR game teaching is to complete learning tasks and to achieve learning goals by means of learners' group cooperation and group discussion. VR games provide a good platform for learners to learn independently, which can cultivate students' innovation ability and enable students to experience more knowledge transfer of game learning in process of game learning. VR games can make man-machine interaction more intense and learners can control it more easily. Therefore, VR educational games have great application prospects for reform and innovation of modern education and teaching mode.

VR game teaching is a teaching method that integrates VR technology and game mode. It uses high-precision digital simulation technology to put vision, hearing, touch and so on into virtual space and then integrates with traditional electronic media. Immersion is a positive mental state that is beneficial and pleasurable. By using VR game teaching mode, learners can be immersed in learning state for a longer time, and learners will feel that their learning behaviors are more meaningful. VR game teaching can enhance sense of immersion of experiencers through reasonable layout of space scenes. Highly free human-computer interaction mechanism endows learners with stronger and deeper emotional expression, and learners can participate in VR games more fully. In VR learning games, learners maintain a high degree of participation enthusiasm, and always hold a positive attitude towards the game, which helps them to solve learning problems through VR situational learning, and to build the knowledge system. VR game teaching enables mobile learners to experience science learning content in a more realistic teaching environment. In VR game teaching, learners can play different game roles, and their self-learning ability and higher-order thinking ability will be continuously improved, effectively supporting collaborative problem-solving. VR game teaching method enables learners to receive personalized push information about the role, which makes learners feel more immersed.

## **2 Theoretical basis and hypothesis development**

### **2.1 Theoretical basis**

Whitebread et al. [1] argued that “learn through play” mean that a student must adopt traditional learning and education method of integrating learning and games before continuously carrying out new learning. Online referred to games where learners could interact with each other through a virtual medium without facing each other. Learning of knowledge was facilitated by some manually designed and developed educational software, or the use of games with educational functions. As a new type of information technology and a form of cultural expression, educational games had a great impact on young people's life and study. Application value of games in education, with the virtual nature of the game in current traditional education, was difficult to achieve. Virtual scenes and fictional game plots could make learning fun.

Immersion theory was put forward by Nakamura et al. [2]. They believed that learning participants would attach great importance to the scene and automatically prevent irrelevant content in the scene from entering into a state of selfless immersion. With the advent of the era of big data, immersion theory had entered an important field of human-computer interaction. If the game was too difficult, players would give up

quickly, and if it was too easy, they would lose interest. Therefore, teachers needed to set appropriate difficulty for teaching method of the game. Therefore, educational games should control the difficulty of the game, so that player engagement would be high. One of the characteristics of VR technology was immersion, and this multi-sensory immersion was a good way to engage players in the game. VR game education technology learners could recall knowledge points in the process of playing games, to stabilize students' long-term retention of knowledge points learning.

## **2.2 Hypothesis development**

VR technology is a kind of computer virtual simulation in that the user wants to create a three-dimensional virtual environment. Through the simulation of virtual environment to create a new, multi-information fusion interactive experiment, users can be immersed in three-dimensional virtual environment. VR technology puts students in a virtual environment, and learners should actively construct knowledge. Learners rely on their accumulated experience to actively select and process all kinds of effective learning information, to organically integrate new knowledge with old knowledge and to construct a richer knowledge system. In terms of how VR game teaching can improve learners' immersion and academic performance, Philippe et al. [3] mainly believed that virtual reality environment could help students to become active learners through conscious attention, reflection and criticism, and use reflexivity and novel meaning.

Padgett et al. [4] showed that all children achieved 100% accuracy in computer-intervention after learning VR games for a week, and could take actions that should be taken in a home fire. Butt et al. [5] suggested that VR could enable nurse educators to find innovative teaching methods to help nursing students develop and remember basic skills while ensuring patient safety. Subjects who used VR system spent more time practicing than students who practiced traditionally. Graeske et al. [6] suggested TPACK capabilities and design principles for game field learning using VR technology. Results showed that VR game teaching could improve students' motivation by co-creating, co-designing and customizing their learning, solving problems, thinking and reflecting on their learning. Alfadil [7] analyzed the impact of VR language playhouse on middle school students' English vocabulary acquisition. Results of the quasi-experimental design showed that students who used VR language game houses had higher scores in vocabulary acquisition than students who used traditional vocabulary acquisition methods. VR technology could improve vocabulary acquisition and classroom performance. Hernandez-pozas et al. [8] believed that VR, as an innovative, cheap and effective alternative solution, could allow students to practice negotiation and cross-cultural communication, which helped to exercise students' digital abilities.

Souza et al. [9] believed that VR game teaching mode could improve learners' learning efficiency and make learning engagement more obvious. Lai et al. [10] showed that in the posttest of lexical translation delay, average score of VR group was significantly higher. Hui et al. [11] designed two teaching modes, "VR environment teaching" and "traditional teaching", and conducted a series of teaching comparative practices between two groups in a primary school. Research had found that it was easier to enter flow in VR, the introduction of VR technology was positively correlated with learning engagement, and VR technology could help individuals give full play to

their creativity. Tibaldi et al. [12] used immersive VR to enable users to virtually map, remotely measure, and collect data for research and teaching.

Sykes [13] believed that digital games were developing rapidly in the field of education, and the use of digital games in language learning environments could be promoted by increasing use of community games, meaningfully integrating virtual reality, and increasing use of commercial games. Segura et al. [14] adopted VR systems for teaching programming. Results showed that application of virtual reality in programming teaching could improve attractiveness and potential of learners, and enhance spatial orientation and autonomy of users. Virvou et al. [15] believed that VR software games aimed to improve students' learning motivation and participation. Results showed that this game could maximize educational benefits for all kinds of students. Lu et al. [16] believed that virtual reality technology game learning could help autistic children learn, and enable them to learn direction following, psychomotor skills and hand-eye coordination.

Ferrell et al. [17] believed that virtual reality was an emerging interactive tool for chemistry education. Research results showed that the use of VR technology in chemistry experimental teaching could improve students' learning motivation and measurable learning outcomes. McGovern et al. [18] believed that the use of VR in education could positively affect learning experience of students. Studies found that educational virtual reality games improved academic performance and maintained students' engagement with math. Buentello-Montoya et al. [19] showed that VR could improve learners' learning motivation. Ferguson et al. [20] thought VR games provided a rich, high-fidelity environment that gave a fully immersive and interactive storytelling experience for teaching. A controlled experimental study of 42 adolescents showed that allowing players to navigate freely in a game had a positive effect on cognitive interest and presence.

To improve motivation of children to learn VR fire safety training methods, Smith et al. [21] used game-like interface interaction technology and encouraged students to explore the virtual world. Results suggested that students were more interested in a new game like learning environments, with prospect of using game-based virtual environments to train children in important but cumbersome fire safety skills. Zheng [22] found that 3D games had been recognized by teachers and students and good effects had been achieved in implementation of the case, stimulating students' interest in learning. Akman et al. [23] developed an educational VR game, and the results showed that educational virtual reality game could provide learners with good learning experiences and make learners more clear about their learning objectives. Ke et al. [24] showed that learning environment based on VR cultivated interactive teaching and demonstration teaching performance of the participants.

Juh et al. [25] argued that VR technology was embedded in the teaching process, and systematic teaching process design of game teaching should be considered. VR technology, as an emerging science and technology, was itself a stimulus for students. VR game teaching mode could be established by establishing learning environment, supporting skill training, meeting special learning requirements and so on. VR-based teaching could make up for defects with technology and bring new experiences to teaching, especially those that could emphasize spatial observation, field experience, and practical operation. Through VR technology, game teaching mode could effectively solve many problems caused by realistic factors in teaching process, reproduce

teaching scenes in virtual space, and create immersive learning experiences for students, which was not available in traditional teaching. At the same time, VR technology could greatly stimulate students' learning motivation, give play to students' subjective initiative, and enhance students' understanding and perception of what they had learned. Therefore, this study puts forward the following four hypotheses.

*H1: Publication rules in VR game teaching can significantly improve learners' immersion.*

*H2: Role description in VR game teaching can significantly improve learners' immersion.*

*H3: Game control in VR game teaching can significantly improve learners' immersion.*

*H4: Game review in VR game teaching can significantly improve learners' immersion.*

### **3 Research design**

#### **3.1 Questionnaire design**

This study designed a questionnaire on the impact of VR game teaching technology on college students' immersion, which mainly includes three aspects. The first aspect is the basic information of the respondents, including name, grade, major, and type of VR game teaching platform. The second aspect is to measure four component aspects of VR game teaching technology, including four teaching links such as publication rules, role description, game control, and game review, which are measured with 5, 4, 6, and 4 questions respectively. The third aspect is to measure learners' immersion. The idea of Georgiou et al. [26] is used in this study to research six measurement problems. All questions are tested on a five-level Likert-type scale, with 5 points for each item (strongly agree=5, agree=4, neutral=3, disagree=2, strongly disagree=1).

#### **3.2 Research objects**

Jiangxi Province in China is one of the provinces in the central region, and Nanchang, the capital city, is the national VR Education Application Demonstration Base in China. At present, Jiangxi Province pays great attention to VR curriculum development and carries out VR teaching training for teachers, so that the proportion of VR virtual teaching increases year by year. To update teaching environment with VR education, many colleges and universities in Jiangxi Province have promoted extensive application of invasive education model in daily teaching, built cutting-edge and practical VR training rooms and experience centers, and increased construction of VR LABS and VR education resource libraries. An online questionnaire survey was conducted among students majoring in electronic information from six universities in Nanchang University, East China Jiaotong University, Nanchang Hangkong University, Jiangxi Agricultural University, Jiangxi Normal University of Science and Technology, and Nanchang Institute of Engineering in Nanchang, Jiangxi Province. Through online

questionnaire generation and two-dimensional code issuance, 243 questionnaires are recovered. After removing invalid questionnaires, 186 valid questionnaires are retained, with an effective recovery rate of 76.54%.

**Table 1.** Variable definition

Name	Measurement Options	Measurement Option Coding	Frequency	Percentage (%)
Gender	Female	0	65	34.95
	Male	1	121	65.05
Game platform	VR all-in-one	1	71	38.17
	Regular VR eyewear box	2	20	10.75
	3D interactive	3	36	19.35
	Wearable VR interaction	4	59	31.72
Major	Electronic information engineering	1	9	4.84
	Electronic science and technology	2	57	30.65
	Communication engineering	3	42	22.58
	Microelectronics science and engineering	4	34	18.28
	Information engineering	5	44	23.66
Grade	Freshman	1	32	17.2
	Sophomore	2	74	39.78
	Junior	3	39	20.97
	Senior	4	41	22.04

## 4 Results analysis

### 4.1 Reliability and validity analysis

This study uses Spss26.0 software to analyze the reliability and validity of the questionnaire. The commonly used Cronbach's  $\alpha$  coefficient method is used. If Cronbach's  $\alpha$  coefficient does not exceed 0.7, the reliability is generally considered insufficient. When the questionnaire reaches 0.7–0.8, it indicates that the questionnaire has considerable reliability, and when it reaches 0.8–0.9, it indicates that the questionnaire has very good reliability.

**Table 2.** Reliability results

Variable	Number of Measurement Problems	Cronbach's $\alpha$ Coefficient	Cronbach's $\alpha$ Coefficient
Publication rules	5	0.842	0.845
Role description	4	0.756	
Game control	6	0.715	
Game review	4	0.864	
Immersion	6	0.798	

As it can be seen from Table 2, Cronbach’s  $\alpha$  coefficient of this questionnaire is 0.845, indicating that this questionnaire has good credibility. Validity analysis generally adopts Kaiser’s commonly used KMO metric. In general, a KMO value above 0.9 indicates a good fit; 0.8–0.9 indicates suitable.

**Table 3.** The KMO value and Bartlett sphericity test

The KMO Value		0.839
Bartlett sphericity test	Approximate chi-square	3973.815
	df	300
	<i>P</i> value	0

As it’s shown in Table 3, the KMO value is 0.938, and the corresponding *P* value of Bartlett sphericity test is 0.00, indicating that the questionnaire has certain validity and can be investigated.

#### 4.2 Linear regressions

**Table 4.** Linear regression results

Variable	Standardization Coefficient	t	<i>p</i>	VIF	Adjust R <sup>2</sup>	F
Constant	–	4.855	0.000**	–	0.839	F(4,181)=241.177, <i>p</i> =0.000
Publication rules	0.728	9.277	0.000**	1.635		
Role description	0.064	2.125	0.035*	1.048		
Game control	0.247	6.543	0.000**	1.638		
Game review	0.015	0.512	0.609	1.022		

Note: The D-W value is 1.939. \* means  $p < 0.05$ , and \*\* means  $p < 0.01$ .

As can be seen from Table 4, the adjusted R<sup>2</sup> of the model is 0.839, which means that four independent variables can explain 83.9% of variation of the dependent variable. F-test of the model shows that the model passes the F-test ( $F=241.177, P=0.000 < 0.05$ ). In addition, according to the multicollinearity test of the model, VIF values in the model are all less than 5, which mean that there is no collinearity problem. Moreover, D-W value is near the number 2, which indicates that there is no autocorrelation in the model, and there is no correlation between sample data, and the model is good.

- (1) Hypothesis H1 is valid. Publication rules in VR game teaching can significantly improve learners’ immersion. The rules are to make learners fully know the significance of VR games teaching and to tell learners that teachers in teaching reasonably designing appropriate game components or modules, such as incentive element likely rankings, resource acquisition to mobilize students’ cooperation and competition, can promote enthusiasm of students to learn knowledge, strengthen students’ intrinsic motivation, and get a better VR game learning experience. In particular, teachers set up game situations to improve students’ activity, attract students’ attention, and lay a good foundation for the following learning. Before the start of



teaching, each game is designed according to the teaching objectives. When students play the game, they can master the knowledge and skills of the unit. To meet the cognitive characteristics and initial ability of college students, all the games are designed by teachers themselves, and difficulty is controlled within the range that college students can understand.

- (2) Hypothesis H2 is valid. Role description in VR game teaching can significantly improve learners' immersion. It creates role descriptions in teaching lead-in links. The purpose of role description is to fully mobilize enthusiasm of students to learn, for smooth future of learning to lay a good foundation. According to the theory of situational cognition, teachers should choose games suitable for college students according to cognitive characteristics of college students, and create a good introduction link to comprehensively explain operation of different roles played, to enhance students' attention, enhance students' thirst for knowledge, and to make them actively accept new knowledge.
- (3) Hypothesis H3 is valid. Game control in VR game teaching can significantly improve learners' immersion. Game control is the most important part of VR game teaching and the core of improving learners' immersion. Game control is to conduct repeated practice through games and continuous operation in daily classes, to guide students to find and solve problems in the process of doing, to better improve operation skills, to cultivate students' interest and to strengthen skills. According to situational cognition theory, students' learning runs through the whole game situation. After adapting game works, it means that students have fully mastered knowledge content and achieved specific teaching objectives. Game control elements include challenges, competition, cooperation and other forms. It is necessary to clarify the responsibilities and obligations of each learner in game control, to enhance sense of cooperation, team spirit and personal responsibility of the group. Group members need to actively think about solutions to problems, brainstorm ideas, complete tasks, and enhance learners' immersion.
- (4) Hypothesis H4 is not valid. Game review in VR game teaching does not significantly improve learners' immersion. Game review is the evaluation made by teachers to judge learning effect of VR games. It can be carried out through combination of students' self-evaluation, classmates' mutual evaluation and teachers' evaluation. Summative evaluation is generally carried out at the end of the semester, which is the link between classroom communication and evaluation on the final effect of the activity. Important reason for the failure of hypothesis H4 is that each group should be praised and encouraged after presentation, and the best group should be selected for reward. However, as time goes by, learners tend to get more involved in the game, do not attach great importance to mutual evaluation of students and teachers, and do not provide effective feedback on the results of game reviews, which leads to more perfunctory behaviors of learners in game reviews. This result also inspires VR game teaching teachers to think more about how to drive students to make effective VR game teaching comments. For example, they can adopt the following strategies. By setting group learning, which team spends the least time, and has the highest accuracy in finishing your homework then it gets the higher grade. For a certain period (such as half a month, or one month), after the top team members in the group are awarded a pen, a notepad and other small prizes, it may improve learners' VR games comment on motivation.



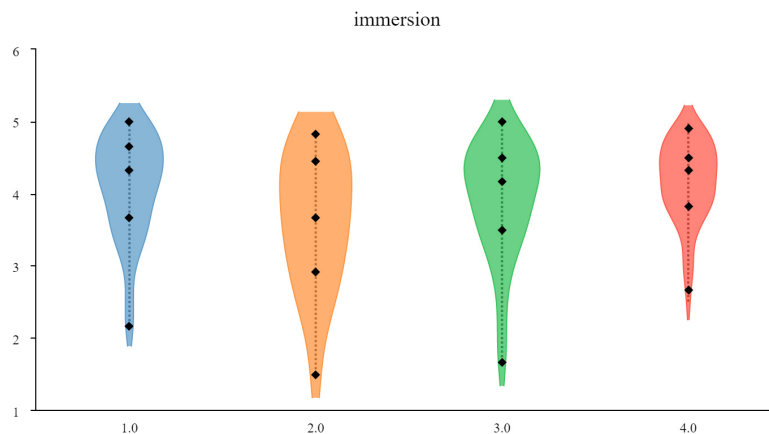
### 4.3 Difference of immersion in different VR platforms

**Table 5.** Difference of immersion of different VR platforms (variance test)

Immersion	Game Platform (Average ± SD)				F Value	P Value
	1.0(n=71)	2.0(n=20)	3.0(n=36)	4.0(n=59)		
	4.12±0.70	3.66±0.92	3.94±0.79	4.16±0.56	3.045	0.030*

Note: \* means  $p < 0.05$ .

As can be seen from Table 5 and Figure 1, samples from different game platforms all present significant values for immersion ( $P < 0.05$ ), which means that they have different values for immersion. Comparison results of average scores of the groups with relatively obvious differences show that two ways of wearable VR interaction and VR all-in-one machine would make learners' immersion more obvious. The main reason is that game education is a relatively new way of learning. In particular, wearable VR interaction is a high-tech integration of multimedia, game design, virtual human design, information geography and artificial intelligence, so that learners can easily master interactive game interaction skills. Under command of teachers, learners enter into game teaching through VR and wearable devices to experience real interactive learning knowledge. In particular, with wearable VR interaction, learners can feel pain of physical attack through body-sensing clothes. Through fully automatic tactile chair, you can experience a variety of equal body sensations in the game. Through collection of learner information and real-time output feedback information to the player through several devices, mapping feeling in the virtual space is more real, to obtain an immersive experience. VR all-in-one teaching can make man-machine interaction more perfect, produce a very strong three-dimensional depth in the game, and completely create real feeling of immersive so that learners are more fully involved in the game teaching. This also inspires colleges and universities should build more VR teaching platforms suitable for contemporary college students under the background of relatively perfect VR technology. Under the full guarantee of funding and other conditions, virtual training teaching platforms or teaching classrooms with wearable VR interaction should be built.



**Fig. 1.** Difference of immersion in different VR platforms

#### 4.4 Discussion

Reform of learning mode in which learners' passive acceptance learning is transformed into active learning has become the key content of educational model reform by improving their interest in learning and making students willing to join in learning. VR game teaching can make learners increase their sense of immersion in game learning. In VR game teaching, learners are divided into different groups, and learners in the groups take the initiative to meet challenges of complex knowledge by working together and relying on collective wisdom. VR game teaching needs to be focused on. In the process of game learning, learners need to be very clear about established process and operation rules of VR game teaching, and fully acquire and efficiently understand the key game information. In VR game teaching design, teachers should also reduce cognitive load of learners and irrelevant reading information in the game as much as possible. Game operation design makes people move more easily by adopting menu navigation operation, role scene playing and other ways. In VR game teaching, to achieve better academic performance, learners will generally take the initiative to challenge higher-level games, to generate a stronger sense of immersion and desire to participate. Instructor in VR games teaching, use of two-dimensional code, story clew, improving operation can enhance overall game operating immersive. In a story-driven scientific inquiry type of game, VR gaming technology can be the closest to natural form of interaction, to build an independent exploration of space and potential space of free play. For more abstract teaching content, VR game teaching mode is very enlightening for college teachers to design more teaching process, objectives, performance evaluation and other content.

#### 5 Conclusion

With the development of mobile Internet technology, effective integration of virtual technology into classroom and subject teaching has become an inevitable trend in development of educational informatization. VR game teaching can break through limitations of traditional teaching and optimize potential of existing teaching situations. VR games can provide students with personalized learning environment, bring innovation to traditional teaching classes, stimulate students' interest in learning, all of which can further enhance immersion and exercise students' abstract ability. This study designs a questionnaire on impact of VR game teaching technology on college students' immersion, and measures impact of four aspects of VR game teaching technology (publication rules, role description, game control, and game review) on learners' immersion. Results show that publication rules, role description and game control in VR game teaching have significant positive effects on college students' immersion. All samples of different game platforms showed significant effects on immersion ( $P < 0.05$ ). Wearable VR interaction ( $4.16 \pm 0.56$ ) and VR all-in-one ( $4.12 \pm 0.70$ ) VR game platforms improved learners' immersion more significantly. It is suggested that further research should be conducted on relationship between immersive VR and classroom teaching design, relationship between spatial layout of VR equipment in the classroom and learners' experience, and duration of VR technology-assisted teaching.

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