

## *Retraction*

# **Retracted: The Construction of Immersive Learning System Based on Virtual Testing Technology of Virtual Reality**

### **Wireless Communications and Mobile Computing**

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### **References**

- [1] S. Li and D. Zhou, "The Construction of Immersive Learning System Based on Virtual Testing Technology of Virtual Reality," *Wireless Communications and Mobile Computing*, vol. 2021, Article ID 9656578, 6 pages, 2021.

## Research Article

# The Construction of Immersive Learning System Based on Virtual Testing Technology of Virtual Reality

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**Objective.** To explore the construction of immersive learning system based on virtual reality (VR) and test its learning effect. **Methods.** 20 qualified subjects were divided into two groups, each tending to agree, each with 5 boys and 5 girls. Experimental group 1 is in the real operating environment, and experimental group 2 is in the VR virtual disassembly experimental environment. The task process errors, knowledge questionnaire scores and user subjective satisfaction were analyzed statistically. **Results.** The significance probability  $P$  of knowledge questionnaire in the Levene test was 0.777, greater than 0.05, and the variance homogeneous, so the final  $P$  of independent sample  $t$ -test was subject to “assumed variance equal”; the significance probability was 0.613, greater than 0.05; the questionnaire scores of two groups showed no significant difference, so VR virtual environment can achieve the learning effect of the real environment. The number of errors in a VR virtual situation is significantly lower than the number of errors in the real environment, the VR virtual environment can achieve the learning effect of the real environment, and the VR virtual environment can achieve more interaction, with good interaction. **Conclusion.** The immersive learning system based on VR detection technology can realize the cognition of three-dimensional model structure and has a certain learning effect.

## 1. Introduction

At present, in the field of education, more and more scholars have seen the importance of VR technology in classroom learning environment. For example, one of the characteristics of intelligent learning environment proposed by Professor Huang Ronghuai is that intelligent learning environment should realize the integration of physical environment and virtual environment; in the intelligent environment, the perception, monitoring, and adjustment functions of the physical environment are further enhanced; and the application of augmented reality technology makes the virtual environment and the physical environment seamlessly integrated [1]. VR virtual learning environment provides a large number of construction tool systems and performance areas, which can improve the subjective initiative of learners, which is consistent with Piaget’s conception and practice of “mov-

ing the laboratory into the classroom” and his constructivist view of “learning is the experience of a real situation” [2].

The biggest difference between “VR-based virtual testing technology” and the virtual instrument-based virtual testing technology that has been widely used at present lies in the introduction of VR technology into the testing field and the realization of the simulation of the testing process and visualization of the test results by the virtual testing system including operators [3]. Virtual testing technology based on VR has the following characteristics.

Nakayama et al. [4] proposed a simulated environment learning support system, based on Kinect sensor, systematic animation, and student action synchronous display on ancient biological animals and its habitat, soaking learners in real life, through record. The real-time measurement of the learner’s movement is evaluated system and controls the animation based on the sensor output, followed by an

interview to assess their immersion. The learner feels immersive and experiences an enhanced interest.

Fang [5] Focusing on the design of the teaching quality evaluation model based on machine learning theory, an in-depth study is conducted on the pretreatment and support vector machine teaching quality assessment model of assessment indicators. In addition, the study uses improved main component analysis to reduce the dimension of evaluation indicators, thereby avoiding the impact of too complex network model on prediction effects.

This paper mainly studied the immersive learning system based on VR virtual testing technology. We conducted experimental research on the construction of VR immersive learning system and concluded that the questionnaire scores of the two groups of experimenters generally did not differ significantly, which shows that the VR virtual environment can achieve the learning effect of the real environment. The number of errors in a VR virtual situation is significantly lower than the number of errors in the real environment, the VR virtual environment can achieve the learning effect of real environment, and the VR virtual environment can achieve more interaction, with good interaction. Therefore, the immersive learning system based on VR virtual detection technology can realize the cognition of 3D model structure and has a certain learning effect.

## 2. Method of Constructing Immersive Learning System for VR

Virtual reality technology combines multimedia and network technology, so multimedia design principle design virtual reality also has a great reference value; we should not only pay attention to the external form of teaching media but also pay attention to the value of education. Only according to the correct design principles the multimedia teaching software can fundamentally promote the students' meaningful learning [6, 7].

Virtual test is conducted through 3D human-computer interaction, realistic image generation, 3D sound positioning technology, and simulation information acquisition. The development path of virtual testing technology based on VR is shown in Figure 1.

## 3. Research Methods

**3.1. Experimental Arrangement.** A total of 20 qualified subjects were selected and divided into two groups. The ratio of males to females in each group tended to be the same, with 5 males and 5 females in each group. The experimental group 1 was in the real operating environment, and the experimental group 2 was in the VR virtual disassembly and assembly environment. The experimental task was to complete the disassembly and assembly tasks of the reducer assembly model with the help of the data and tools given by the team and to complete the knowledge investigation and test after the experiment according to the knowledge acquired in the disassembly and assembly learning process [8, 9]. In addition to different operating environments, the other conditions between the two experimental groups are consistent, as

shown in Table 1; that is, there is an equal corresponding relationship between experimental operating objects, experimental equipment, and experimental text data. For example, the solid model of the gearbox corresponds to the virtual model in the three-dimensional environment, actual model disassembly video animation corresponds to 3D model disassembly animation display in VR environment, and actual 2D text data corresponds to interface UI display in VR environment.

The specific description of the behavioral data to be recorded during the experiment and the mapping meaning of the results of the behavioral data are as follows:

*Error times E1:* the error times in the disassembly process whether the parts are placed correctly or not and the error times in the assembly process whether the parts are matched successfully or not. The error times are too high, indicating that the recognition of the parts at the disassembly position is insufficient [10, 11].

*Knowledge questionnaire score:* knowledge questionnaire mainly involves the structure cognition and working principle of the model and is used to judge whether learners understand the structure of the model in the process of model disassembly and assembly. The lower the score of the question test, the less helpful the learning system is to learners, and the lower the evaluation in the effectiveness index.

*Subjective satisfaction score:* obtains users' subjective evaluation of the design of the two operational learning environments.

**3.2. Statistical Analysis.** This experiment is a set of comparative experiments of learning styles, consisting of two groups, namely, physical disassembly environment (group 1) and VR virtual disassembly environment (group 2). Independent sample *t*-test is adopted to analyze all data, which is completed in SPSS software. If the *P* value of significance probability (i.e., Sig. in the table) is greater than 0.05 in Levene's test of the equation's variance, it indicates homogeneity of variance, and the final *P* value of independent sample *t*-test is subject to "assuming equal variance." On the contrary, we should deal with the *P* value when the strain variance is different. When the *P* value of *t*-test (i.e., Sig. (double tail) in the table) is less than the significance level of 0.05, it is considered that there is a significant difference between the two groups of data; otherwise, it is considered that there is no significant difference between the two groups of data.

## 4. Experimental Results

**4.1. Error Times in Task Process.** In the process of experimental tasks, task errors are mainly defined as the following three situations: one error and one record. Specifically, in the disassembly process, the parts should be placed in the specified parts tray, and the placement error is recorded as a task error. In the assembly process, the wrong parts are grabbed for assembly, which is recorded as a task error. The assembly position and direction of the parts are wrong, which is recorded as a task error. As shown in Table 2, in the process of task completion, the number of errors in the VR virtual situation was significantly lower than that in the real

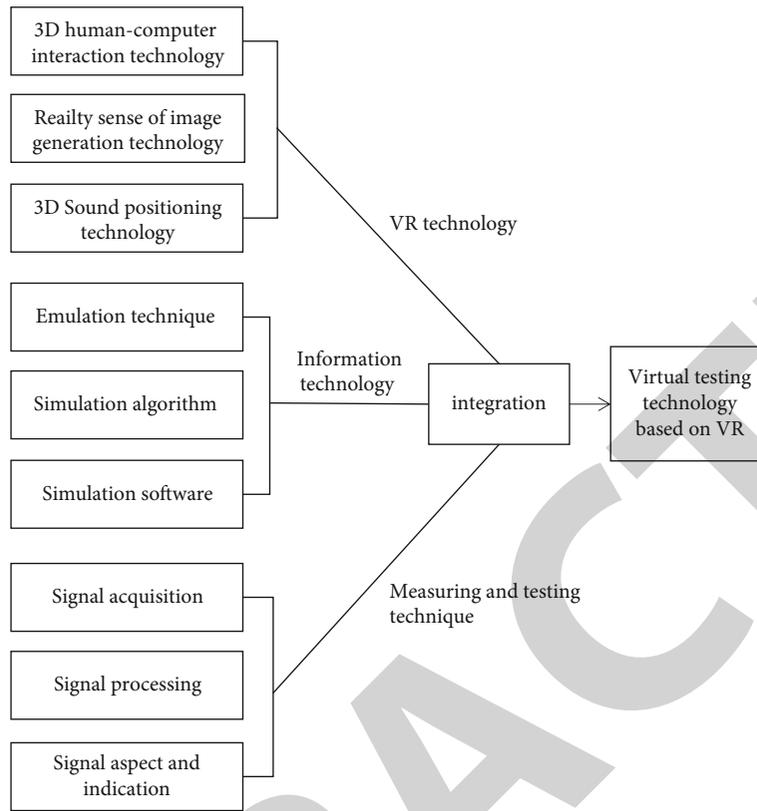


FIGURE 1: Development path of virtual testing technology based on VR. Virtual test is conducted through 3D human-computer interaction, realistic image generation, 3D sound positioning technology, and simulation information acquisition.

TABLE 1: Corresponding relation of each factor in the two groups of experiments.

	Physical disassembly group	VR disassembling group
Experimental environment	Real work drawing model laboratory operating environment	VR virtual disassembly and assembly experiment ring
The experiment task	Model disassembly and test	Model disassembly and test
Laboratory equipment	Wrenches and other commonly used tools, desks, part placement plates, etc.	VR headsets, leap motion, etc.
The subjects	Physical model	3D virtual model
Experimental data	Two-dimensional pictures, teaching materials Video animation of model disassembly	Virtual UI interaction, interface display 3D model disassembly animation demonstration

TABLE 2: Number of errors in the task process.

Experimenter code	1	2	3	4	5	6	7	8	9	10	The average
1_real environment	5	3	5	5	8	6	2	3	4	7	4.8
2_vr environment	2	1	1	1	2	3	3	2	4	3	2.2

environment. In the process of physical assembly, especially in the assembly process of shafting part group 1 and shafting part group 2, it is easy to make mistakes, and the most common mistake is the wrong assembly position of parts. In a VR virtual operation environment, the main reason for user operation error is that there are more than one bearing and adjustment ring in a shafting part group, but the matching

of the designed parts of the system is one to one; that is, the bearing located on the left side of the shaft must be assembled on the left side before the system can identify the assembly as successful. Due to the visual feedback of color highlighting after the successful matching of the system design, most users did not see visual feedback during the assembly process and would try repeatedly. The feedback information from the experimenters can provide guidance for the subsequent design and optimization of the learning system.

4.2. Score of Knowledge Questionnaire. As shown in Table 3, the average score of knowledge questionnaire in the VR virtual environment ( $M = 84$ ) was slightly lower than that in the real operating environment ( $M = 85.5$ ). The two sets of questionnaire score data are independent sample  $t$ -test, as

TABLE 3: Knowledge questionnaire scores.

Experimenter code	1	2	3	4	5	6	7	8	9	10	The average
1_ real environment	80	75	95	85	90	85	85	80	95	85	85.5
2 _vr environment	85	90	75	80	80	90	75	85	85	95	84

TABLE 4: Independent sample  $t$ -test of questionnaire scores.

	Levene's test of equation variance		$t$ -test of mean value equation		
	$F$	Sig.	$T$ value	Df (degrees of freedom)	Sig. (double tail)
Assumed equivariance	0.083	0.777	0.515	18	0.163

shown in Table 4; the analysis results show that two kinds of learning environment knowledge questionnaire score data in Levene's test in significant probability  $P$  value are 0.777, which is greater than the significance level of 0.05, homogeneous variance, so in the independent sample  $t$ -test, the final  $P$  values will be subject to "assume equal variance." The  $P$  value of significance probability of the  $t$ -test is 0.613, which is greater than 0.05. There is no significant difference in the overall scores of the two groups of experimenter, indicating that the VR virtual environment can achieve the learning effect of real environment. Knowledge questionnaire topic fills up the following topic: multiple choice, find the wrong topic, question of these four questions, fills up the topic focuses on the user of cognition, the basic structure of reducer model essay question inspects the knowledge for the user to the reducer between various parts of the assembly position and role of understanding, true or false user's understanding of the relation of the part assembly, and examine the user's learning degree of the assembly drawing of the reducer by finding the wrong questions. As for the drawing method of part assembly drawing, in VR headset, due to the influence of the resolution of the headset equipment, the presentation of VR virtual visual effect is not as clear as the two-dimensional paper data in the real world, leading to a large difference in the score of error finding in assembly drawing between the two groups. As VR virtual environment presents diversified and multisensory information, the learning effect of users on the working principle of gearbox model is better than that of the real environment. Users can quickly understand and enhance the cognition of this knowledge point in the three-dimensional dynamic environment. Therefore, the average score of students in group 2 in the question part is higher than that of students in group 1.

**4.3. User Subjective Satisfaction.** After sorting out and analyzing the scoring data of the user subjective satisfaction scale of the two groups of experiments, the mean value of the score is shown in Figure 2. The independent sample  $t$ -test is conducted on the subjective satisfaction score data of users, and the specific data description is shown in Table 5.

It can be seen from Table 5 that there are significant differences between the two operating environments in the evaluation indicators of user satisfaction such as Q1, Q3, Q6, Q8, Q9, Q10, and Q12. Among them, the user satisfaction score of the VR virtual learning environment is significantly higher

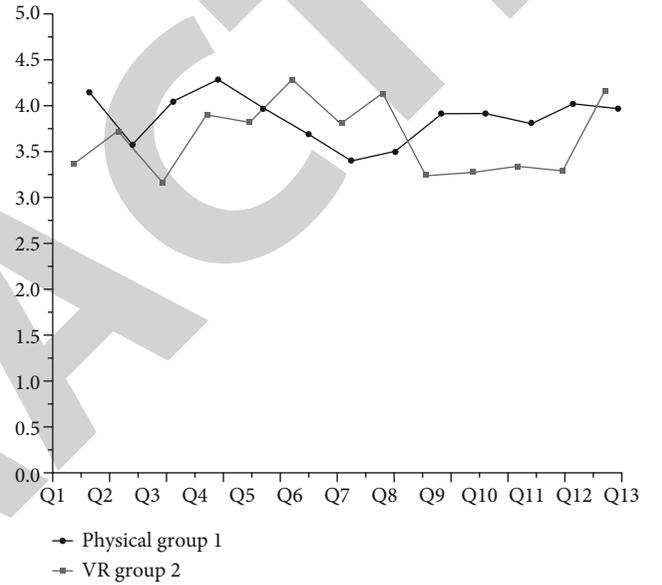


FIGURE 2: Average score graph. The scoring data of the user subjective satisfaction scale of the two groups of experimenters were sorted out and analyzed, and the mean map of the score was obtained.

than that of the real operating environment in Q1 immersion, Q3 fun, Q9 information guidance (reducing mistakes by providing feedback), Q10 help from visual feedback, and Q12 diversification of resource information presentation. In the two evaluations of Q6 realism and Q8 operating comfort, the user satisfaction of the VR virtual learning environment is significantly lower than that of the real operating environment.

Through interviews with experimental users, the specific reasons were obtained, which can be summarized as follows:

**Q1 immersion:** virtual environment can provide a closed learning environment for the operator to avoid external interference from other factors. The real environment is easily disturbed by other factors. Therefore, the immersive experience of the experimenters in the VR virtual learning environment is more obvious.

**Q3 interesting:** scenes in the virtual environment are of a relatively simple cartoon element style. Comfortable background music alleviates learning pressure. Interesting ways

TABLE 5: User satisfaction score in the VR environment.

Qid		Group 1	Group 2	Levene's test of equation variance		The <i>t</i> -test for the mean value equation	
		The average M1	The average M2	<i>F</i> value	Sig.	<i>t</i>	Sig. (double tail)
Q1	Immersive	3.700	4.500	0.336	0.569	-2.954	0.008
Q2	3D cognitive	4.000	3.900	2.903	0.106	0.361	0.722
Q3	Interesting	3.500	4.400	1.301	0.269	-3.250	0.004
Q4	Interactive	4.200	4.600	0.000	1.000	-1.549	0.139
Q5	Integrity	4.200	4.300	2.396	0.139	-2.777	0.785
Q6	Sense of reality	4.600	4.000	0.231	0.637	2.250	0.037
Q7	Ease of use	4.100	3.700	1.011	0.328	1.052	0.307
Q8	Comfort	4.400	3.800	0.000	1.000	2.324	0.032
Q9	Information to guide	3.500	4.200	5.063	0.037	-3.280	0.004
Q10	Visual feedback	3.500	4.200	0.590	0.452	-2.333	0.031
Q11	Auditory feedback	3.600	4.100	0.945	0.344	-1.301	0.210
Q12	Diversification of information	3.500	4.300	1.714	0.207	-3.539	0.002
Q13	Overall satisfaction	4.400	4.300	0.543	0.471	0.372	0.714

of interaction, especially gesture interaction, enhance learners' interest in learning and spirit of exploration. The real disassembly and assembly environment has a low evaluation of fun. Like the traditional learning method, there is not too much interactive operation, and the learners have no freshness.

*Q6 sense of reality:* users have a low score on the sense of reality of the VR virtual learning environment, in which there are only feedback and perception of visual and auditory channels. In the process of physical disassembly and assembly, there is not only the feedback of the two channels but also the multichannel information such as touch, which can truly grasp and move the model, which is very real.

*Q8 operational comfort:* user feedback that the VR environment is not suitable for long-term learning. Due to screen delay in HTC helmets, some users may experience discomfort such as visual motion sickness during learning, resulting in a low evaluation of the comfort level of the virtual learning system.

*Q9 information guidance, by providing feedback to reduce mistakes:* in the VR virtual environment, clear visual feedback is provided during the assembly process of the model, and the matching color of the parts becomes highlighted, effectively reducing mistakes.

*Q10 visual feedback help:* users believe that visual feedback information is more abundant in the virtual environment, which not only displays the structure of parts but also realizes the interaction that cannot be realized in the real environment, such as the prompts of virtual UI.

*Q12 diversification of resource information presentation:* the resource information in the virtual context is relatively rich, which can effectively help users to have a deeper understanding of the model structure. In addition to the physical model, the resource information of the real operating environment is mostly two-dimensional drawing data and video data. There is a lot of information, but the display way is single.

In addition, in terms of Q7 ease of use, although there was no significant difference in the score data between the

two groups, there was a significant difference in the mean value. The reason is that in the learning process of VR virtual situation, since users need to use gesture recognition devices for interactive operation, they need to learn the gestures and relevant operation instructions of the system in advance. In the physical disassembly environment, the user does not need additional operation training and can quickly grasp the basic operation methods of the operating environment. The definition of gesture in the VR environment needs to be familiar with in advance, and the experimenter who is familiar with gesture quickly has a higher evaluation on the usability of virtual environment.

*Q2 3D cognition, Q4 interactivity, Q5 integrity, Q11 auditory feedback, and Q13 overall satisfaction:* there is no significant difference between the two groups in these evaluations, indicating that the virtual learning environment can achieve the same learning effect as the real model learning under these several indicators. That is, under the virtual learning system, users can intuitively learn the three-dimensional structure of the body and observe the details of the model from multiple angles.

## 5. Conclusions

In general, the immersive learning system based on VR virtual detection technology can realize the cognition of the three-dimensional model structure and has a certain learning effect. Compared with traditional disassembly learning of physical model, VR disassembly learning is not as good as physical model learning in terms of realistic sense and assembly drawing learning, but VR virtual learning system has obvious advantages in terms of immersion, fun, and visual feedback, which can better stimulate learners' interest in learning. With the development of modern information technology, the display of large-scale data information has demand for virtual reality technology, and the development of virtual reality equipment provides a broad space and industrial background. The immersive learning system based

on VR virtual testing technology is of great significance to the research of this topic in teaching. However, due to the limitation of experimental conditions, there are still deficiencies in the research of some problems. Due to the constraints of practical conditions and obtaining the required hardware equipment, some technologies of this design can only make analysis and prediction in theory. We will further improve in our future study and research.

### Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

### Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Acknowledgments

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### References

- [1] C. Xia, "Innovative research on the construction of china's youth physical health promotion service system based on sensor technology1," *Journal of Intelligent and Fuzzy Systems*, vol. 37, no. 5, pp. 6063–6069, 2019.
- [2] T. Jantakoon, P. Wannapiroon, and P. Nilsook, "Synthesis of framework of virtual immersive learning environments (VILEs) based on digital storytelling to enhance deeper learning for undergraduate students," *International Education Studies*, vol. 12, no. 4, pp. 198–207, 2019.
- [3] L. Ping, "Construction and simulation on intelligent medical equipment system based on virtual reality technology and human-computer interaction model," *International Journal of Biomedical Engineering and Technology*, vol. 23, no. 2/3/4, p. 261, 2017.
- [4] T. Nakayama, R. Yoshida, T. Nakadai et al., "Immersive learning support system based on Kinect sensor for children to learn about paleontological environments," *International Journal on Smart Sensing and Intelligent Systems*, vol. 8, no. 2, pp. 1050–1062, 2015.
- [5] C. Fang, "Intelligent online English teaching system based on SVM algorithm and complex network," *Journal of Intelligent and Fuzzy Systems*, vol. 40, no. 2, pp. 2709–2719, 2021.
- [6] Y. Zhang, "Ideas and approaches on "construction of high level simulation experimental teaching center of virtual chemical laboratory", " *IOP Conference Series: Earth and Environmental Science*, vol. 94, no. 1, article 012070, 2017.
- [7] S. Zhou, Z. Yang, Z. Dong, M. Zhou, and D. Zeng, "Construction of virtual simulation system of gas chromatograph based on unity 3D," *Chinese Journal of Chromatography*, vol. 34, no. 6, pp. 621–624, 2016.
- [8] Z. Qin and Z. Tao, "Construction of SOA based VR technology in animation teaching," *International Journal of Emerging Technologies in Learning*, vol. 13, no. 5, p. 153, 2018.
- [9] H. Li, "Design of multimedia teaching platform for Chinese folk art performance based on virtual reality technology," *International Journal of Emerging Technologies in Learning*, vol. 12, no. 9, pp. 28–40, 2017.
- [10] L. Zeming, "Design and implementation of a Korean language teaching system based on virtual reality technology," *Agro Food Industry Hi Tech*, vol. 28, no. 1, pp. 2156–2159, 2017.
- [11] S. Maghool, S. Moeini, and Y. Arefazar, "An educational application based on virtual reality technology for learning architectural details: challenges and benefits," *International Journal of Architectural Research*, vol. 12, no. 3, p. 246, 2018.