The application of virtual reality technology in the efficiency optimisation of students' online interactive learning

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Abstract: In order to overcome the problems existing in the current research methods of students' learning efficiency, such as poor interactivity and insufficient authenticity, this paper proposes an online interactive learning efficiency optimisation method for students based on virtual reality technology. By testing the individual extremum in the learning system with variation factors, the depth zero trajectory information and feature space of students' online learning were obtained. Using virtual reality technology, divide the value of students' grades and track the corresponding learning content quickly. Combined with the principle of greedy search, the study efficiency is optimised through the normalisation process to update and feedback students' online interactive learning. The experimental results show that this method is a feasible method to improve students' learning ability and has significant advantages in terms of fluency, interaction and virtual reality of virtual learning.

Keywords: virtual reality technology; learning efficiency; optimisation; normalisation.

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1 Introduction

The whole education mode of our country is constantly changing and innovating, but it is still in the traditional teaching mode, which has a great influence on our education (Marques et al., 2018; Warner et al., 2016). The traditional teaching and learning mode is centred on teachers and aimed at imparting knowledge. This mode pays too much attention to knowledge teaching and ignores the cultivation of students' innovation ability, which leads to the teaching state of teachers' one-way output and students' passive acceptance. In this environment, the classroom atmosphere is dull, which restrains the subjectivity and efficiency of students' learning, and leads to college teaching unable to fundamentally meet the educational and teaching needs of all kinds of new talents (Davis et al., 2018; Karuza et al., 2016; Kitta and Tilya, 2018). To sum up, how to reform and innovate the teaching mode and students' learning style in a better and more comprehensive way, and how to cultivate all-round development talents with practical ability and innovation ability are the issues that need comprehensive consideration in the current and future college education.

Yang (2019) proposes to improve the efficiency of Chinese learning for ethnic minority students. Based on the overall research status of the second language acquisition of ethnic minorities in China, this paper describes the efficiency evaluation method to improve the second language acquisition, and gives a plan to improve the efficiency of learning Chinese for ethnic minorities. However, this method can not meet the learning needs of different types of students. Li and Luo (2018) point out that the innovation of the dynamic scheme and the grasp of the interactive mechanism are the reliable guarantee to improve the learning efficiency of students. The driving force of learning efficiency improvement comes from the internal driving force of subject cognition and the operation ability constructed by objective indicators; the driving mechanism of teaching mainly comes from the role cognition and logical confirmation of teachers; the linkage cultural driving force can effectively drive the cooperation and interaction between the internal driving force and the external driving force. Different motivation mechanisms can work together to improve students' learning efficiency. Although this scheme has certain effect on improving learning efficiency, the implementation process is complex and not universal. He et al. (2016) point out the advantages of flipped classroom, analyses the reverse process of teaching, and observes knowledge internalisation from the perspective of knowledge internalisation. Among them, the autonomous learning ability has a very important influence and role in the classroom. It focuses on how to improve the students' autonomous learning ability in the classroom from the level of knowledge internalvation, mainly including the construction of the overall structure of the school curriculum, the analysis of micro video and students' basic situation, and the selection of teaching programs. However, the research is less interactive and less flexible. Ye (2017) puts forward the optimisation method of cooperative learning teaching effect from the perspective of deep learning. Based on the theoretical and practical exploration of deep learning, this method optimises the learning effect from the aspects of learning intrinsic motivation, independent cooperative learning strategy, teacher training and optimising education management. To stimulate students' intrinsic motivation for cooperative learning and ensure that cooperative learning is full of vitality; To improve students' autonomy and cooperative learning strategies, to lay the foundation of cooperative learning ability, and to promote the effect of cooperation; Optimise teacher training and promote the improvement of teachers' cooperative learning concept and ability; To

promote the efficiency and effect of cooperative learning; Make full use of information technology to expand the ways and approaches of cooperative learning; Optimise the management of education, construct the learning community of teachers and students, and provide a guarantee for cooperative learning to go to deep learning. This method can optimise the teaching effect to a certain extent, but it has poor interactivity.

In order to better meet students' learning needs and improve students' learning initiative and efficiency, this paper proposes a virtual reality technology to improve students' learning efficiency. According to the principle of virtual teaching design, the teaching learning system is designed, and the individual extremum in the learning system is tested by variable factors to obtain the depth zero trajectory information and feature space of students' online learning. In order to optimise the efficiency of students' online interactive learning, virtual reality technology is used to quickly track the interval value of students' grades and corresponding learning content. Through normalisation process, update and feedback students' online interactive learning, optimise learning efficiency.

2 Content of virtual reality technology

2.1 Design principle

Based on the principle of virtual teaching and learning design, the teaching and learning system of virtual reality technology is designed to improve students' learning efficiency. Figure 1 is the principle of virtual teaching and learning design. The design principles of virtual teaching and learning are explained in detail as follows:

1 *Interactivity*: it is an interactive channel and means to communicate and answer questions on the Internet. At the same time, virtual teaching learning can give real-time feedback to students' operation, and provide interactive information to assist students and teachers to summarise experience and lessons to make up for the shortage (Ye, 2017).

2 *Openness*: the virtual way of teaching and learning is to take the network as the support, so it has the characteristics of openness. Students can log in to the system through any terminal for operation.

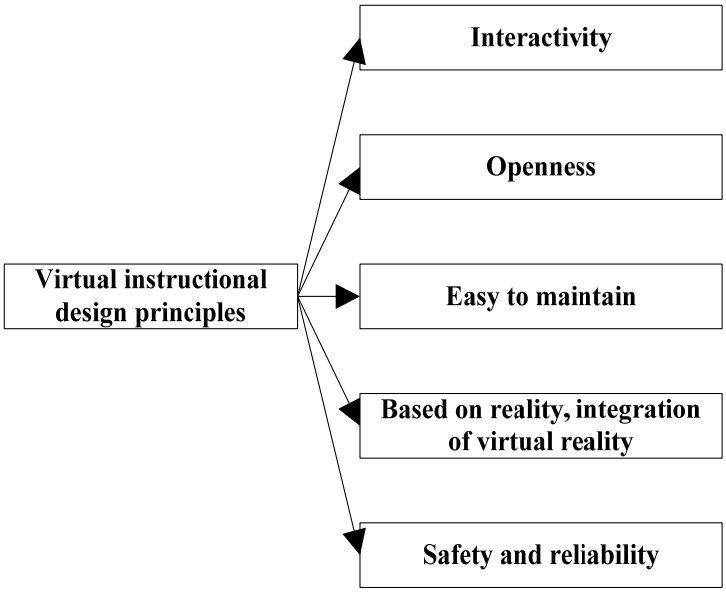
3 *Easy to maintain*: the teaching and learning system of virtual reality technology provides the interface of information release and teaching management for teaching and learning, realises remote maintenance by using the network teaching management mode, and maintains it through cross platform components on the basis of software.

4 *Based on reality, integrating virtual reality*: the actual virtual teaching and learning can not completely replace the actual operation, which is the auxiliary of teaching and learning. Distance students not only have fixed learning time and online teaching courses, but also regular practical operations.

5 *Security and reliability*: the management personnel shall regularly maintain the network and back up the database. The running environment of the whole server should be safe and reliable, and it can work continuously day and night to ensure that students can log in to the network at any time. The relevant management personnel

shall allocate the corresponding software and hardware management authority for students, teachers, school staff and educational administration office, so as to realise the normal and safe operation of the system.

Figure 1 Design principle of virtual teaching and learning system



The core of teaching and learning system of virtual reality technology is server. The software is the key component of virtual teaching and learning system. The main components of the software are conversion driver, I/O interface and advanced application.

2.2 Architecture

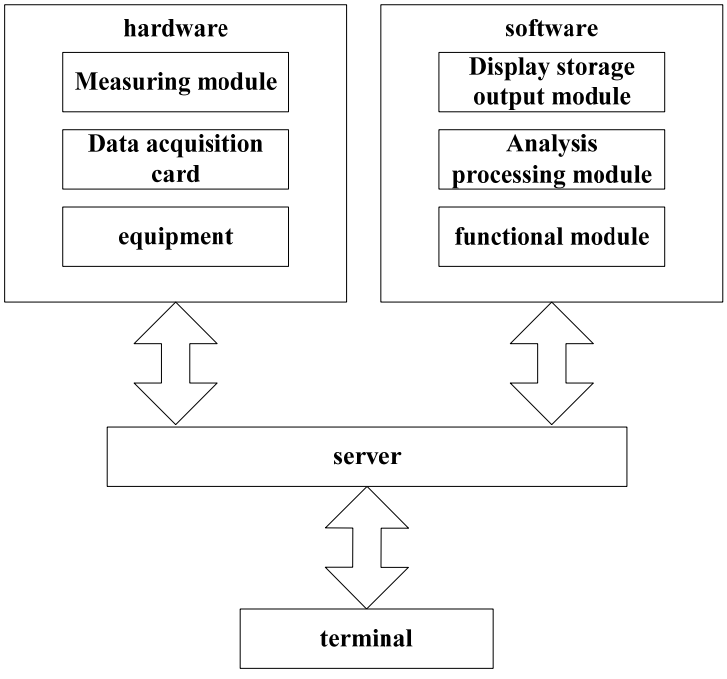
The hardware components of the teaching and learning system are instrument equipment, measurement module, data acquisition card, etc. The main function of the data acquisition card is to collect the data collected by the measurement module or instrument to the computer end, and cooperate with the hardware which can also feed back the command transmitted and output by the computer to the measured module or instrument, so as to realise the corresponding operation at the same time. Figure 2 shows the teaching and learning system of virtual reality technology.

2.3 Design and development of virtual reality courseware

Unity3D engine is used to realise the design and development of virtual reality courseware. The detailed process is shown in Figure 5. Firstly, the basic content of the training is determined, demand collection and analysis are carried out based on the content, understanding and learning business are carried out based on the demand for the corresponding, and then the detailed scheme is designed based on the business content and demand; corresponding art materials based on the training content are collected,

including model and material collection; art production is carried out. Through 3DMAX modelling, and using PS and other technologies, material map is made, then skeleton animation is made, and finally the format supported by Unity is exported; the built model is used to build the scene. Firstly, the scene is modelled, then the light based on the actual environment is built, and the model categories according to different platforms are designed. Combined with the optimisation of the scene environment, the best effect is to achieve, so as to handle the lens effect and show the actual effect; the teaching content is used to carry out the relevant design of interaction effect, and carry out SDK selection based on the display platform. The interaction involved in this process should be designed according to the actual action and specific content of the interaction, and finally connect with the training system (Lacave et al., 2017).

Figure 2 Teaching and learning system of virtual reality technology



After the completion of the production, the configuration of the whole content based on the detailed content of the required platform and interaction is optimised, then the corresponding platform version is output and tested according to the needs.

2.3.1 Basic control

The management and control framework of virtual reality courseware mainly includes the management of system functions, resources and training. Among them, training management combines training plans, classroom courses, processes and results, and carries out transparent processing. Resource management can unify the management of courseware content and courseware release, control the terminal of training and learning process, including the basic functions of downloading and playing curriculum resources.

The basic function module can carry out basic management for the personnel participating in learning and the personnel related to training management, at the same time, it can manage and analyse the training classroom, achievements, plans, etc.

2.3.2 Interactive and sharing learning model

Based on the basic theory of teaching learning interaction level, interaction can be divided into three levels: first, interaction between students and media interface operation; second, interaction between students and teaching elements information; third, interaction between students' original definition and new definition (Peteranetz et al., 2018). Among them, concept interaction is a variety of interactive high-rise buildings, which is the change of students' thinking. To sum up, in order to effectively promote the generation of students' concept interaction, it should adopt scientific and reasonable information interaction method and basic principles of interactive operation, and introduce efficient and timely feedback method to get the effect of students' concept interaction. The scheme can adjust and optimise the interaction between information and operation in real time by using several aspects of coordination and cooperation. Based on the specific needs and characteristics of virtual teaching and learning interaction, the interactive model of virtual teaching and learning is obtained.

Generally, the most critical tasks of the server are: to control and maintain the consistency of scenarios, monitor the connection application and response connection among listening clients, client registration and surrogate management. Among them, the client is mainly responsible for perception, scene display and update of other users' conditions. The communication end connects the client and the server, which plays a very important role in the whole system (Swart, 2016; Miller and Lang, 2016s). The main content includes: transferring the data controlled by the server and all avatar status data to the client, and transferring the client data and all avatar status data to the server (Lee et al., 2016).

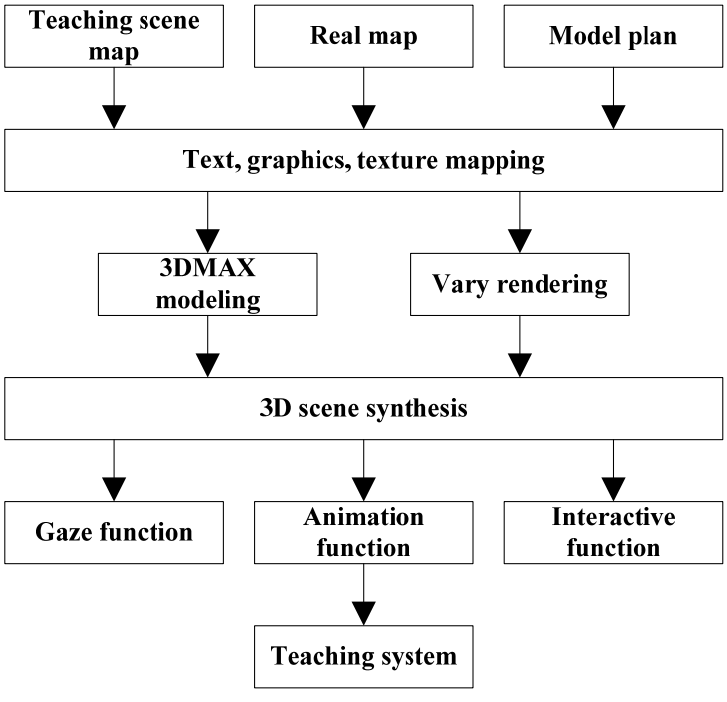
2.3.3 Other auxiliary function modules

In the method for improving students' learning efficiency of virtual reality technology, virtual teaching and learning system includes the following auxiliary function modules in addition to the above important technologies.

- *User authentication*: after the system is officially released, it needs to register to log in to the system. In the process of outputting the user name and password, the server calls the authentication program. When the user name and password match each other, the user can enter the system.
- *Roaming system*: after students log in to the system, they enter the course scene firstly, and then roam according to the prompts and options.
- *Hypermedia presentation*: the auxiliary function module is mainly responsible for the management of hypermedia teaching materials, and the format can be converted into static and dynamic web pages. When students enter the course classroom, they can see the current hypermedia course and watch it after clicking (Campbell et al., 2016).

- *Online conversation*: students can enter the teacher's office and ask professional tutors questions. The teacher can answer on the spot, make an appointment, or send the answer to the student email. Students can also enter the discussion room to discuss problems and strengthen learning effect, so as to improve students' learning efficiency.
- *Student history and statistical analysis*: after students enter the system, the virtual Academic Affairs Office will use the statistical analysis function module to sort out and analyse students' learning history, and present it in the form of charts. It is very important for students to understand and improve their learning situation.
- *Help subsystem*: is to realise online guidance on the use methods and skills in the help subsystem (Lee et al., 2018).

Figure 3 Implementation process of teaching and learning system based on virtual reality technology



2.4 Process of teaching and learning system

Virtual reality technology is a kind of computer simulation system that can create and experience virtual world. It has the characteristics of multi-sense, immersion, interaction and conception. The realisation process of the teaching and learning system of virtual reality technology is divided into three stages: the first stage is data collection and arrangement, in which the main purpose is to statistically sort out the scene models and interactive data involved in the VR teaching and learning system, and collect and make relevant effect drawings for the system development; the second stage is 3D modelling

and scene building. Through the data collected in the previous stage, the scene model building is realised, the relevant format data file in 3DMAX is formed, and Unity3D engine is imported to realise the scene model building; the third stage is human-computer interaction, in this stage, through Unity3D engine and C# language for human-computer interaction, the executable data file will be exported, thus the system is completed. The flow of teaching and learning system based on virtual reality technology is shown in Figure 3.

3 Optimisation method for students' online interactive learning efficiency based on virtual reality technology

In order to improve the efficiency of online interactive learning, it is better than the traditional learning efficiency optimisation method. Based on the design principles and architecture of virtual teaching and learning, this paper analyses the optimisation technology of students' online interactive learning efficiency under the virtual reality technology (Bai, 2018; He et al., 2017). The key parts of the teaching and learning system mainly include personnel, training environment, etc. First of all, the experience terminal control system of virtual reality technology is designed. The input layer is the number of online learning students, and the output layer is the student's learning score d, so the variance factor detection formula of students' online interactive learning efficiency is as follows:

$$E = \sum_{j=1}^{q} E_j / (q * k) \text{ where } E_j = \sum_{k} \varepsilon_k^2 = \sum \left(d_k - c_k\right)^2 \tag{1}$$

where q is the number of online learning students in the input layer, ε_k is the initial weight coefficient of the output layer, d_k is the ideal performance extreme value of the k^{th} student in the output layer, and c_k is the actual performance extreme value of the k^{th} student in the output layer.

Then the virtual reality technology is used to optimise the efficiency of students' online interactive learning. The specific contents are as follows: firstly, the individual extreme value $p(x_0)$ in the learning system is tested by the variation factor, and the zero point trajectory information of students' online learning is obtained.

$$\left\{x_0^i, i = 1, 2, ...N\right\} \tag{2}$$

According to the zero point trajectory information, the characteristic space of the depth zero point trajectory of students' online learning is obtained as follows:

$$X = \left\{x_1, x_2, \cdots, x_n\right\} \subset R^s \tag{3}$$

where R^s represents the trajectory information containing s samples.

The data set contains n samples, in which the eigenvector of sample x_i, i = 1, 2, …, n is:

$$x_i = \left(x_{i1}, x_{i2}, \cdots, x_{is}\right)^T \tag{4}$$

Based on the virtual reality technology, the interval value of students' performance is divided and the corresponding learning content is tracked quickly. The probability density function $q(x_k^i / x_{k-1}^i)$ of the steady-state excellent performance and the new student's online learning performance set $\{\tilde{x}_k^i\}_{i=1}^N$ (Wang et al., 2018) are obtained. The weights of all scores of the set are calculated by greedy search principle:

$$\tilde{w}_k^i = \tilde{w}_{k-1}^i \frac{p\left(z_k / \tilde{x}_k^i\right) p\left(\tilde{x}_k^i / x_{k-1}^i\right)}{q\left(\tilde{x}_k^i / x_{k-1}^i\right)} \tag{5}$$

where $\tilde{x}_k^i$ is the online learning performance of the k^{th} student, $\tilde{w}_{k-1}^i$ is the performance parameter, and the output optimal weight vector is $w_k^i = 1/N$.

In order to update and feedback the online learning situation of students in time, and then normalise it, the access output value is:

$$\hat{x}_k = \sum_{i=1}^{N} \tilde{w}_k^i \tilde{x}_k^i \tag{6}$$

In this paper, virtual reality technology is used to speed up the students' online learning performance optimisation and feedback ability, and realise the optimisation of students' online interactive learning efficiency, so as to improve students' learning efficiency (Zhong et al., 2016).

4 Experiment and discussion

In order to verify the effectiveness of virtual reality technology in improving the learning efficiency of students, correlation test is carried out. Considering that the method is mainly aimed at students, the open computer room of college students is used as the test site. The detailed configuration is: the CPU is Intel (R) core (TM) 2 Duo CPU, the memory is 2GB, the video card is NVIDIA geforee 8400 se, and the network is campus network. The subjects of the experiment are 130 students from computer, sports, music and foreign languages.

The main way of the experiment is to let students access the system by using the above methods, log in and independently carry out virtual operation. In this process, students know and understand the function of hardware equipment, and students' overall recognition of this learning method, whether they can really achieve the purpose of learning, learning situation, etc. are tested.

A total of 130 questionnaires are sent out in this test, of which 110 are valid. The questions are answered in the form of scoring. The details of the questionnaire are shown in Table 1.

In order to simplify the experiment, several items in Table 1 are used as indicators to verify the effectiveness of virtual reality technology in improving students' learning efficiency. The detailed results are as shown on Figure 4.

Table 1 Questionnaire

Coding	*Problem indicator*
1	VR technology
2	Virtual learning operation
3	Overall impression
4	Operational fluency
5	Whether to stimulate interest
6	Interactivity
7	Learning process
8	Virtual reality
9	Help with learning operations
10	Mastering the operation of the equipment
11	Learning phenomenon truth
12	Whether it improves learning efficiency
13	Is there an advantage

Figure 4 Effectiveness of virtual reality technology in improving students' learning efficiency, (a) average score of overall impression satisfaction (b) average score of virtual learning fluency (c) average score of interaction degree (d) average score of virtual reality (e) average score of mastering the truth of equipment operation (f) average score of improving learning efficiency (g) average score with advantages

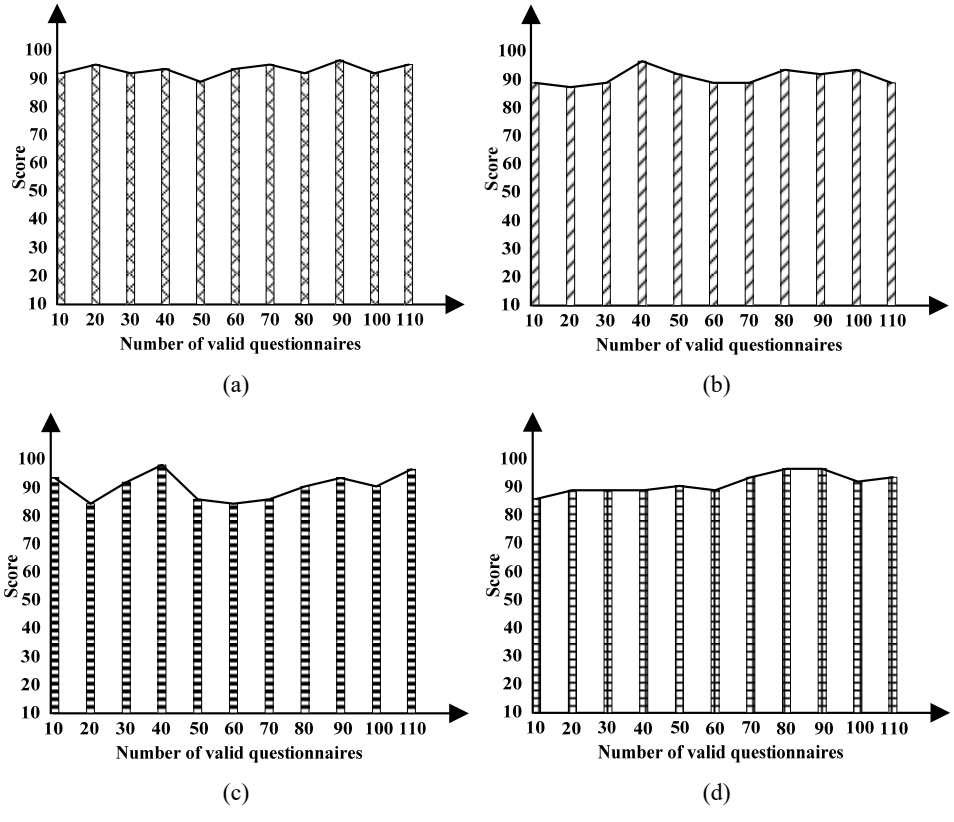
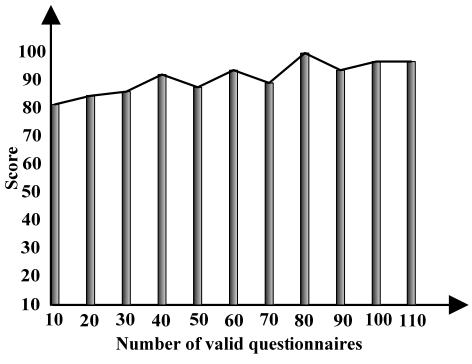
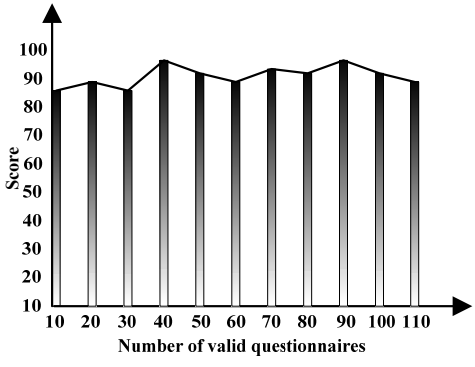


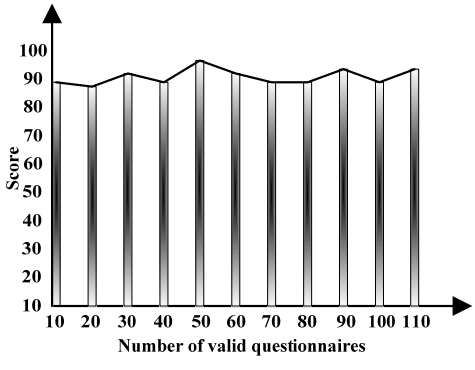
Figure 4 Effectiveness of virtual reality technology in improving students' learning efficiency, (a) average score of overall impression satisfaction (b) average score of virtual learning fluency (c) average score of interaction degree (d) average score of virtual reality (e) average score of mastering the truth of equipment operation (f) average score of improving learning efficiency (g) average score with advantages (continued)



(e)



(f)



(g)

According to the analysis of Figure 4, the improvement methods for students' learning efficiency of virtual reality technology are relatively reliable in terms of overall impression satisfaction, smooth operation of virtual learning, interaction degree, virtual reality degree, mastering the real degree of equipment operation, improving learning efficiency and having advantages, with high scores, which is a feasible method for improving students' learning ability. Because this method USES virtual reality technology to divide the interval value of students' scores and track the corresponding learning content quickly, it provides the basis for the optimisation of the efficiency of the following online learning. In the process of operation, the method can use the program to simulate weightlessness and rotation, enhance the interactive fidelity of the learning process, and effectively improve the learning efficiency of students. In the auxiliary function module, students can discuss various types of problems, strengthen the learning effect, so as to provide a reliable support for improving the learning efficiency of students.

5 Conclusions

Aiming at the optimisation of students' online interactive learning efficiency, this paper puts forward a method to improve students' learning efficiency based on virtual reality technology. Based on the overall structure, it is supplemented by key technologies, to achieve the improvement of students' learning ability. The experiment shows that the method presented in this paper has the advantages under various experimental indicators, can effectively meet the learning needs of different types of students, facilitate students' daily learning, and enhance interaction and flexibility. As far as the whole system is concerned, some aspects need to be optimised and improved, such as equipment sequence and operation in complex environment.

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