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Research on the Application of Virtual Simulation Technology in Stomatology

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Abstract: In view of the poor safety of traditional stomatology teaching experiments, large material loss and low teaching efficiency, it is proposed to apply virtual simulation technology to stomatology experiments. By building a digital virtual simulation dentist training system, using virtual simulation technology to help students enter the virtual simulation system environment, so that students can have an immersive, interactive and conceptual experience through this system. The specific method is to select experience courses, module clearance training models, comprehensive training and training plans for comprehensive evaluation of training effects, and conduct skill training for students in different stages of oral clinical practice. After the training is completed, subjective and objective evaluations will be made on the students being trained using the virtual simulation training system. The survey results show that the construction of a digital virtual simulation dentist training system and the development and application of targeted training plans for students at all stages can enhance students' professional interest in dental clinics and operational skills, and provide a safe, efficient and energy-saving approach for dentistry students. Training mode.

With the rapid development of big data and Internet information technology, virtual simulation technology has been widely used in medical simulation education, including the field of oral clinical experiment teaching. Traditional oral experiment teaching mostly uses a simulation head model system. Although this system has certain experimental effects, it still has many problems such as low safety, large material loss, and high experimental cost. In response to these problems. Kou Yurong proposed advanced mode training based on virtual simulation technology in oral teaching, summarized its development prospects and application status, and explained in detail its teaching effects and challenges, which is the application of virtual simulation technology in oral cavity[1]. Li Hongyi proposed the application of virtual simulation technology and 3D printing technology in the clinical teaching of oral and max illofacial surgery, starting with digital and solid three-dimensional models, and proposed the establishment of virtual simulation technology and 3D printing technology to assist teaching mode, which opened up the development of medical education a new path[2]. In order to make the training of the digital virtual simulation dentist training system more precise and personalized, combined with the above experience and research, it is proposed to apply the virtual simulation technology to the dentistry experiment, build a digital

virtual simulation dentist training system, and repeat the clinical skills of medical students. Training restores the effects of oral clinical experiments, helps students familiarize themselves with clinical operations, reduces experimental errors, thereby enhances students' professional interest and operational skills, and makes the training mode safer, more realistic and effective.

1. Virtual simulation technology

Virtual Reality (VR) is a technology that uses computer systems to create and experience a virtual world, and it can also be called simulation technology. It is the use of one system to simulate another real system, with the characteristics of immersion, interactivity and conception. The main principle is to reconstruct the two-dimensional slice image data based on the computer network and three-dimensional graphics, so as to obtain the three-dimensional model of the object. With the emergence of virtual simulation technology, medical students are more closely exposed to the actual medical environment and behaviors during clinical internships, breaking the limitations of time and space, and enabling virtual simulation technology to restore and reproduce the real in the digital virtual space. Medical scene. Using high-fidelity feedback to help operators obtain virtual 3D visual experimental effects. Through simulation and simulation technology, it is no longer necessary to build a physical model, thereby saving experimental materials and labor costs, simulating the real vision and touch in real life. So students can be integrated into the real training environment, so that the training effect is more effective and safe, and improve the students' basic hands-on ability[3-5].

2. Construct a virtual simulation training mode

2.1 Construction of a digital virtual simulation dentist training system

Construct the overall framework of virtual simulation dentist training system, as shown in Figure 1. Training system tools mainly include 3D glasses, tablet computers, 3D projectors, tactile multifunctional handles and virtual mouth mirrors under the projector screen. The working principle of the system is to use virtual reality technology to construct a virtual oral diagnosis and treatment environment and three-dimensional space model. After medical students enter the virtual environment through 3D glasses, they carefully observe the simulated teeth in the three-dimensional space model through virtual mouth mirrors, and operate dental handpieces or probes with force tactile feedback system through pedal control, thereby fully simulating and reproducing oral clinics. The operating environment (clinical dental chair) makes students fall into immersive experience learning. More importantly, the digital virtual simulation dentist training system can simulate the intensity difference of different tissues during the feedback operation process, and help students experience the difference of different tissues of the teeth, the "failure feeling" of pulp penetration and other real oral clinical touch. Among them, the system provides various oral professional experiments including dental, endodontic, gingival restoration, periodontal, etc., which are suitable for students at all stages, including virtual simple modules, virtual isolated teeth, virtual simulation head mold teeth, virtual patients Wait. This system can record the training data of the students during the experiment, make the system score more objective, and to a certain extent discover the students' mistakes in the virtual model training, and provide feedback, thereby achieving targeted and systematic training for the students[6-8].

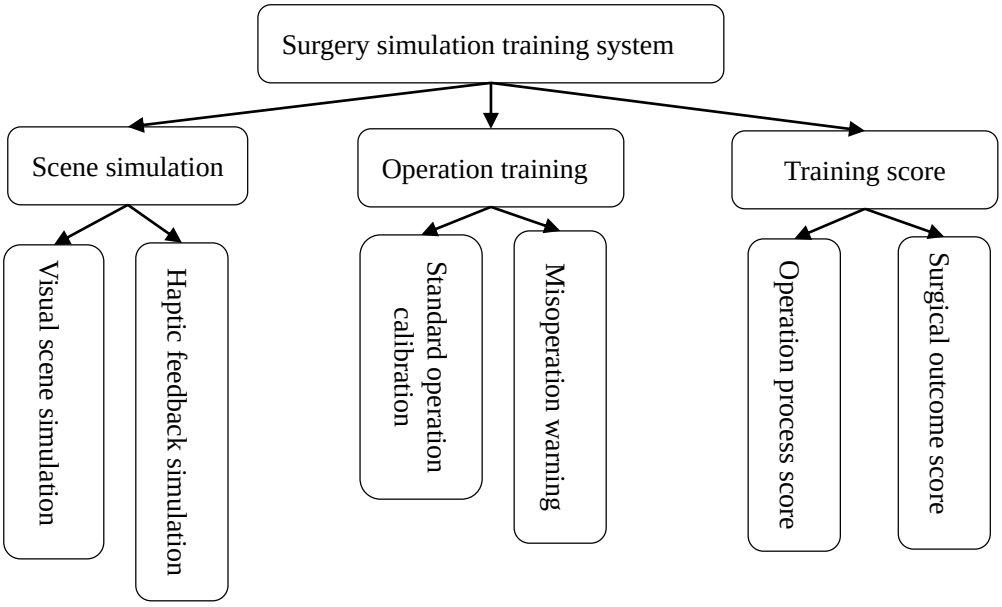

Figure 1: Digital virtual simulation dentist training system architecture

Among them, the calculation formula of the three-dimensional space model of the teeth in the oral cavity is shown in formula (1)(2)(3). The center of gravity of the triangular facet of the three-dimensional tooth model is weighted according to the area, and the average method is calculated to obtain the center of gravity coordinates. Set the three vertices of the tooth model triangle as A (x1, y1, z1), B (x2, y2, z2), C (x3, y3, z3), and point O (x, y, z) is represented as a tooth triangle The center of gravity of ABC, thereby obtaining the coordinates of point O:

$$X=(x_1+x_2+x_3)/3 \quad (1)$$

$$Y=(y_1+y_2+y_3)/3 \quad (2)$$

$$Z=(z_1+z_2+z_3)/3 \quad (3)$$

The area of ABC is calculated using Helen's formula as formula (4):

$$S_{ABC}=\sqrt{(p*(p-a)*(p-b)*(p-c))}$$

According to the above formula, set a, b, c to the corresponding side length of the triangle in the tooth model, and calculate p from the distance formula of the three-dimensional space point, as shown in formula (5)[9]:

$$p=(a+b+c)/2$$

Assuming that the surface of the three-dimensional model of the teeth in the oral cavity is composed of n triangular facets, then the center of gravity of the model is set to O1, O2,..., On, and the area of the three-dimensional model is set to S1, S2,..., Sn to obtain the oral cavity The coordinate O of the center of gravity of the three-dimensional tooth model is shown in formula (6)[10]:

$$O=S_1O_1+S_2O_2+...+S_nO_n/(S_1+S_2+...+S_n)$$

The architecture of the virtual simulation dentist training system and the calculation method of the three-dimensional model of teeth in stomatology are described in detail above. Due to the different levels of stomatology students at each stage of the mastery of stomatology knowledge, the following is mainly for medical students from freshman to senior medical students to conduct

phased training, using the construction of digital virtual simulation dentist training system in each class Training module, formulate targeted oral clinical laboratory skills training plan, adopt a combination of subjective and objective evaluation methods to evaluate students' training effects.

2.2 Skills training plan at different stages

2.2.1 Set up experience class

As shown in Figure 2, for the first-year students of stomatology, "Introduction to Stomatology" is mainly used as an experimental course. First, let students have a preliminary understanding of the virtual simulation system, and then have a full understanding of the virtual simulation system. The purpose is to help students truly understand the oral cavity. The skills of actual clinical operation can stimulate students' interest in learning in this area and improve their enthusiasm for learning.

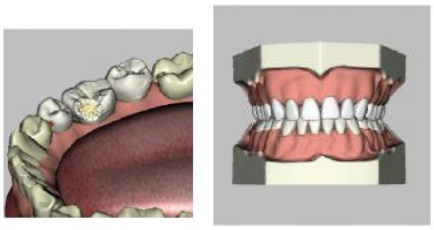

Figure 2: Experience class mode

2.2.2 Module clearance training

As shown in Figure 3, for students in the second and third grades of stomatology, "Stomatology Preclinical Skills Training" is used as an experimental course, and the primary and intermediate training modes of the virtual simulation system are used to deal with different hole types, depths and safety. The virtual modules in the range carry out corresponding hole preparation training, and design a training plan that simulates "customs clearance". The same teacher guides and teaches students, and the training plan includes the correct operating position and specific requirements for hole preparation. The development of simulated customs clearance training can help students familiarize themselves with basic clinical operation skills, such as patient position, device holding methods, fulcrum and other clinical operation habits to be more standardized.

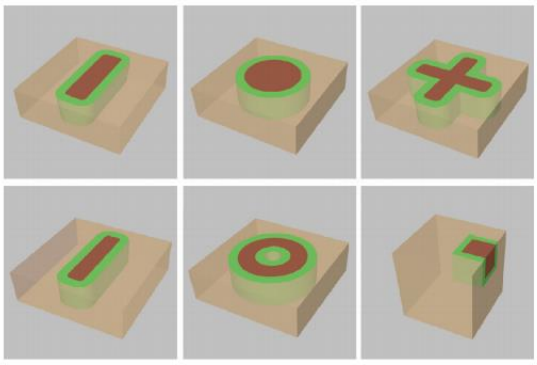

Figure 3: Clearance training mode

2.2.3 Comprehensive training

For students in the fourth grade of stomatology, the "Endodontics" will be taught in an open laboratory, and the advanced training mode of the virtual simulation system will be used to diagnose,

analyze and treat virtual oral disease cases, and simulate the real diagnosis and treatment process. At this stage, the focus is to provide supplementary exercises for professional laboratory courses to assist students in cultivating preliminary ideas for oral clinical diagnosis and treatment.

2.2.4 Effect evaluation

After the students have passed the virtual simulation system training at different stages, the system adopts subjective and objective evaluation methods to evaluate the training effects of the students. Among them, objective evaluation mainly adopts systematic scoring, which mainly includes the time required to complete the experiment operation, the degree of completion of the goal, the score of errors, the comprehensive score, etc. The evaluation method of subjective evaluation is that the same teaching teacher focuses on students during the operation process. The posture, holding method, fulcrum and preparation of the hole are evaluated. At the same time, a questionnaire is used to obtain the personal satisfaction of the trained medical students with this system.

3. Evaluation of the application effect of the virtual simulation training system

After formulating the above training plans for different stages, test the training situation of the digital virtual simulation training system, as shown in Table 1. The test selected a total of 827 medical students from 2014 to 2019 from freshman to senior year for digital virtual simulation dental system training. Judging from the experimental operation time of students at different stages in Table 1, all students have completed the relevant experimental operations within the specified time of the training test, and the system scores show that they are qualified.

Table 1: Digital virtual simulation dentist training for freshmen to senior students

Year	Grade	Number of Trainees	Theoretical Lessons	Training Method	Each Operation Time
2014	Senior year	23	Endodontics	Open Experimental Course	1h
2015	Senior year	37	Endodontics	Open Experimental Course	1h ×4
	First grade	120	Introduction to Stomatology	Understanding, primary experience	30min
	Senior year	36	Endodontics	Open Experimental Course	1 hx4
2016	First grade	114	Introduction to Stomatology	Understanding, primary experience	30 min
	First grade	105	Introduction to Stomatology	Understanding, primary experience	30 min
2017	First grade	96	Introduction to Stomatology	Understanding, primary experience	30 min
2018	First grade	87	Introduction to Stomatology	Understanding, primary experience	30 min
	Senior year	36	Endodontics	Open Experimental Course	1h ×2
2019	second grade	95	Pre-clinical skills training courses	Primary training	1h ×3
	Third grade	78	Intermediate training interest class	Intermediate training	1h ×3

It can be seen from Table 1 that the training system objectively obtains their training details. The following uses subjective evaluation to conduct a questionnaire survey on these students, asking students about the effect of using the virtual simulation system, and taking satisfaction, general, and

dissatisfaction as the selection criteria. The feedback results obtained are shown in Table 2.

Table 2: Questionnaire feedback data

Problem	Satisfied/%	Fair/%	Dissatisfied/%
1. The anatomical models, modules and instrument images provided by the virtual simulation system look very lifelike	97.00	3.00	0.00
2. The instructions of the virtual simulation system are very clear and the format is simple	96.82	3.18	0.00
3. The feedback information provided by the virtual simulation system can guide my training	95.65	4.35	0.00
4. After using the virtual simulation system training, more confident in clinical trial skills	91.31	8.50	0.19
5. In the dentistry test course of stomatology, the virtual simulation system can effectively improve my preclinical/clinical skills	100.00	0.00	0.00
6. Compared with traditional experiments, the virtual simulation system makes a real pre-clinical experience	100.00	0.00	0.00

It can be seen from the questionnaire survey results in Table 2 that 97% of the students think that the anatomical models, templates and device images provided by the virtual simulation system look very realistic. 96.82% of the students think that the system has clear instructions and simple format, and this system is evaluated Expressed satisfaction. 95.65% of students believe that the feedback provided by the virtual simulation system can guide their training. 91.31% of students believe that this system can enhance their self-confidence in technical internships. All students believe that the virtual simulation system can improve students' experience in professional class experiments. The clinical skills of this system are considered to be a real clinical experiment. In summary, applying the virtual simulation dentist training system to actual medical clinical training can increase students' interest in learning and sense of belonging in the stomatology specialty, help students master basic experimental skills more quickly and efficiently, and reduce professional experimental classes. The adaptation period, thereby increasing students' self-confidence.

4. Conclusion

The final result shows that by constructing a digital virtual simulation dentist training system, it can provide students with a very realistic virtual training environment and bring students a different clinical operation experience of stomatology. Realize the combination of virtual reality and stomatology clinical experiment, so that students are immersed in the simulation model to communicate and interact with the experimental model, which provides a new way for stomatology preclinical skills training. The digital virtual simulation dentist training system enhances students' professional interest and clinical operation skills, and also provides a safer, more efficient and energy-saving training mode for stomatology students.

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