Application Research of Virtual Reality System in Stomatology Practice Teaching

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Abstract. From September 2021 to December 2022, 246 stomatological students from Hunan University of Medicine were randomly divided into a virtual simulation experiment teaching group and a traditional simulation head form teaching group to explore the application effect of virtual simulation experiment teaching systems in stomatology practice teaching. While the traditional simulation head form teaching group adopted the traditional simulation head form training teaching, the virtual simulation experimental teaching group implemented oral training teaching based on 3D virtual simulation technology. The results of practical operation, theoretical examination, and teaching satisfaction contrasted between the two groups after the course was completed. The results indicated that the virtual simulation experiment teaching group outperformed the traditional simulation head form teaching group in both practical operation and theoretical examination ($P < 0.05$). Furthermore, the virtual simulation experimental teaching group scored better than the traditional simulation head model teaching group in terms of stimulating learning potential, encouraging learning interest, strengthening clinical thinking ability, enhancing practical ability, recognizing and understanding theoretical knowledge, and cultivating comprehensive quality ($P < 0.05$). It was clear that the oral virtual simulation experiment teaching system could boost students' learning potential and interest, develop their capacity for clinical thinking, enhance their practical skills, improve their cognition and comprehension of theoretical knowledge, and develop their comprehensive quality.

Keywords: application · virtual simulation experiment teaching system · stomatology practice teaching

1 Introduction

Stomatology is an extremely practical and operational science. Students primarily learn clinical practice skills and clinical thinking through oral practice teaching. Due to its abstract nature and temporal constraints, the traditional teaching method of a simulated head form is detrimental to developing students' clinical practice skills and clinical thinking. The oral digital virtual simulation experimental teaching system based on computer technology, simulation technology, and artificial intelligence technology has recently emerged as a significant component of educational informational digital resources owing

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to the ongoing development of educational informational construction. Virtual simulation practice teaching centers are being established in an increasing number of schools and virtual simulation technology is being applied to fundamental oral teaching, oral skill training, and oral experiment examination. It offers considerable technological benefits in areas such as 3D scenes in real-time realistic rendering, soft tissue deformation, surgical process simulation, real-time feedback, etc. To some extent, virtual simulation technology partially addresses the drawbacks of traditional simulation head form teaching by better creating a highly realistic training environment, saving time and money, increasing the safety of oral practice teaching, facilitating the examination form, and improving the teaching effect [1].

2 Application of Virtual Simulation Experiment Teaching

2.1 Data and Methods

1) **General Information**

Between September 2021 to December 2022, 246 stomatological students from Hunan University of Medicine were assigned randomly to the virtual simulation experiment teaching group and traditional simulation head form teaching group. The virtual simulation experiment teaching group consisted of 123 students, 70 males and 53 females, ranging in age from 19 to 26 years old with an average age of (23.6 $\pm$ 1.2) years old. Students' educational backgrounds included 74 junior college students and 49 undergraduates. The traditional simulation head form teaching group consisted of 123 students, 65 males and 58 females, ranging in age from 20 to 26 years old with an average age of (23.3 $\pm$ 1.1) years old. Their educational backgrounds included 72 junior college students and 51 undergraduates. The fundamental information about the two groups of students was equivalent and did not differ ($P > 0.05$).

2) **Method: Offline Traditional Simulation Head Mold Teaching was Used by the Traditional Simulation Head Model Teaching Group**

The virtual simulation experiment teaching group adopted a virtual simulation experiment teaching system that was available both online and offline. The most popular and efficient treatment for pulp disease and periodical illness in the world is root canal therapy, which is also a critical skill for clinical stomatologists. The reason is that the three-dimensional model in the virtual simulation experiment teaching system can accurately and easily present the anatomical structure of the tooth and pulp as well as the entire operation procedure of root canal therapy. By clicking and dragging the mouse, students can perform a series of operation processes, such as pulp extraction, root canal length measurement, root canal preparation, root canal washing, and root canal filling. They are also able to master the essential theory of tooth and pulp along with the key operating principles of root canal therapy. In order to thoroughly describe the operation of the oral virtual simulation experiment teaching system, we utilized the root canal preparation along with the filling virtual simulation training system as an example.

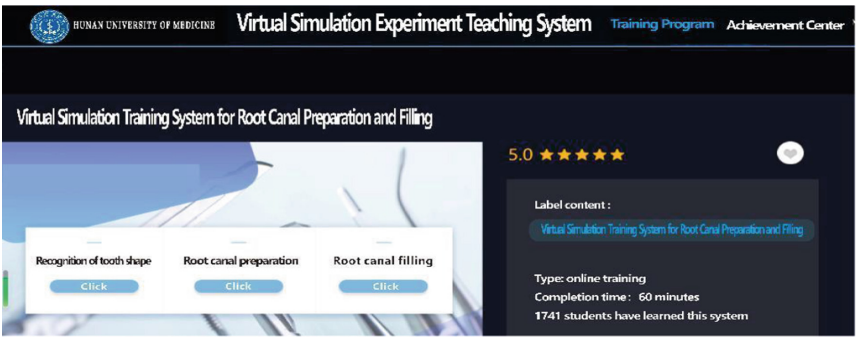

Fig. 1. Login System

Step 1: After logging in, students selected the virtual simulation training system for root canal preparation and filling from the virtual simulation experimental teaching system of stomatology of Hunan University of Medicine) (Fig. 1).

Step 2: Students initially accessed the Tooth Shape Recognition screen by clicking the All Kinds of Teeth button. Subsequently, they could click the zoom, rotate, and translate buttons to view the interior anatomical structure of all kinds of teeth in conjunction with Chinese analysis. After that, students clicked the white rectangular button on the right to carry out the recognition of the various sections, such as buccal and lingual sections, transverse sections, etc. (Fig. 2).

Step 3: Students practiced simulating root canal preparation with the help of the Protapaoer system. Specific procedures included pulpotomy, root canal probing and dredging, working length measurement, drying, test tip, temporary sealing of the cavity, and medical advice (Fig. 3).

Step 4: Root canal filling was carried out.

Firstly, students entered the interface by clicking the Root Canal Filling button. They were able to comprehend the knowledge and preparation needed before root canal filling,

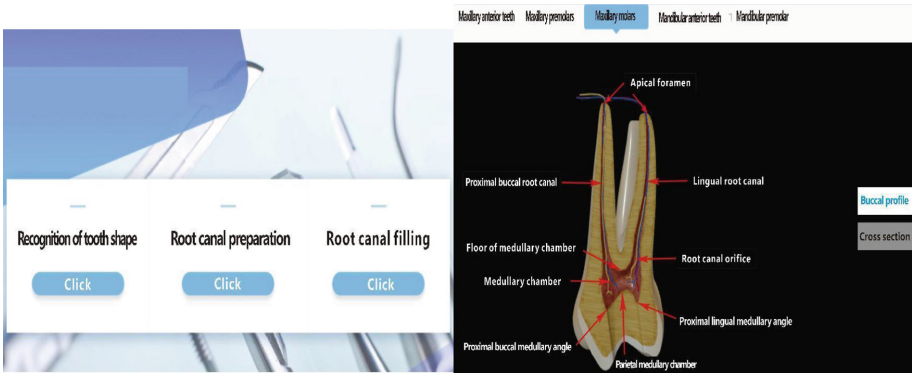

Fig. 2. Tooth Shape Recognition

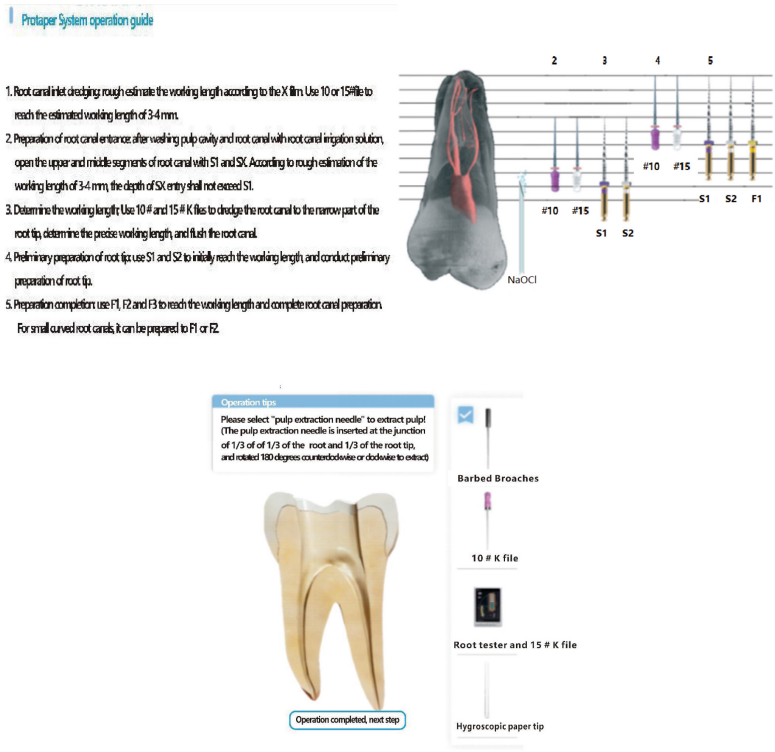

Fig. 3. Simulating Root Canal Preparation

remove temporary sealing and root canal sealing drugs, and choose a paper tip that was hygroscopic to dry the root canal.

The root canal filling was then conducted under the guidelines for cold lateral pressure filling. Students could enter the Main Tip Filling interface, select the main gum tip on the right side and slowly insert the marking length by dipping it into the root filling paste. Additionally, it needed to confirm that the marking point was consistent with the original reference point and put in the auxiliary tip. The root canal filling was ultimately completed.

Step 5: Teachers and students entered the performance evaluation center for root canal preparation and filled in the virtual simulation training system. Teachers provided feedback on the mistakes and students reflected and practiced until they had mastered all of the operational methods perfectly (Fig. 4).

3) **Assessment Indicators and Investigation**

Two groups of students were organized to conduct both practical operations and theoretical assessments at the course's conclusion. In the form of anonymity, they filled in a questionnaire about the teacher satisfaction survey that included topics like fostering

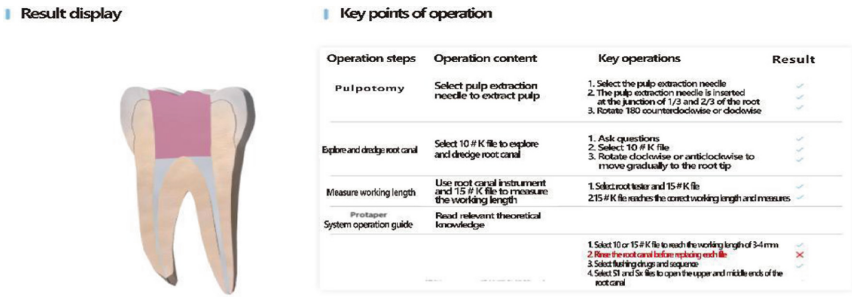

Fig. 4. Root Canal Therapy Evaluation

learning potential and interest, developing clinical thinking capacity, improving practical ability, understanding theoretical knowledge, and cultivating comprehensive quality. With a 100% recovery rate, the questionnaire was promptly returned after completion.

4) **Statistical Methods**

The statistical software SPSS 20.0 was used to analyze the data. The measurement data was expressed by $\bar{x} \pm s$, whereas frequency (percentage) represented the counting data. $P < 0.05$ was deemed statistically significant when a t-test was used to examine the difference between the two groups.

2.2 Results

1) **Comparison of Practical Operation and Theoretical Results Between the Two Groups**

Results from the virtual simulation experimental teaching group were superior to those from the traditional simulation head form teaching group in both practical operation and theoretical evaluation ($P < 0.05$) (Table 1).

Table 1. Comparison of Practical Operation and Theoretical Results between the two Groups (Score, $\bar{x} \pm s$)

Group	*Number*	*Practical operation results*	*Theoretical results*
Teaching group of virtual simulation experiment	123	88.21 ± 1.31	87.24 ± 2.15
Teaching group of traditional simulation avatar	123	73.15 ± 1.22	74.95 ± 3.31
t	–	54.0734	30.5729
P	–	0.0000	0.0000

Table 2. Comparison of Teaching Satisfaction between the Two Groups (Score, x ± s)

Group	*Number*	*Encouraging learning potential*	*Fostering learning interest*	*Cultivating clinical thinking ability*	*Improving practical ability*	*Boosting comprehension of theoretical knowledge*	*Facilitating comprehensive quality*
Teaching group of virtual simulation experiment	123	83.12 ± 1.21	84.34 ± 1.45	82.72 ± 1.11	84.43 ± 1.31	80.09 ± 1.64	83.33 ± 1.23
Teaching group of traditional simulation avatar	123	68.53 ± 1.32	73.67 ± 1.63	69.67 ± 1.21	71.45 ± 1.43	72.54 ± 1.76	70.37 ± 1.28
t	–	46.2879	25.2869	19.3675	35.2886	18.3672	44.4943
P	–	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

2) **Survey of Teaching Satisfaction**

The virtual simulation experimental teaching group outperformed the traditional simulation head form teaching group in terms of encouraging learning potential, fostering learning interest, cultivating clinical thinking ability, improving practical ability, boosting comprehension of theoretical knowledge, and facilitating comprehensive quality ($P < 0.05$) (Table 2).

3 Discussion

Experimental teaching is the foundation of stomatology education. The "on-looking" simulation head model was the primary teaching tool in the early stages. On the one hand, the majority of students could not perceive the operation details and demonstration process clearly throughout the teaching process because of the small oral space and body position restrictions of the simulation head model. On the other hand, the effective time for students to practice autonomous operation was rather brief because teachers devoted themselves to teaching the experimental class. Simultaneously, there were weaknesses in the objective evaluation, real-time feedback, operational skill requirements, and other aspects.

The three-dimensional virtual technology, teaching scoring system, interactive simulation mirror, spatial positioning, and other components make up the oral virtual simulation experiment teaching system. It may help students to learn about complicated and abstract oral three-dimensional anatomical structures, as well as the onset and progression of clinical diseases. It contributes to a variety of simulation operation items, including root canal therapy, supragingival scaling, gingivectomy, tooth preparation, oral implant, dental extraction, and block anesthesia for students to learn and practice autonomously [2–4]. In addition to having hardware capabilities like an oral dental model, mobile phone, and root canal motor, the oral virtual simulation experiment

teaching system also achieves the overall coordination and precise real-time tracking feedback of various instruments in the system at the software level. It can prevent the safety and ethical issues that arise when students operate on the living and human body, minimize unneeded doctor-patient conflicts, increase students' confidence, and better develop their clinical operation skills and passion for autonomous learning [5–7]. The oral cavity virtual simulation experiment teaching system breaks free from the traditional teaching mode's reliance on teachers and overcomes the time and space constraints. It can employ three-dimensional virtual space to execute remote online oral practice simulation operation teaching and offer innovative solutions for remote teaching, particularly in the context of the possible long-term life of COVID-19.

246 oral students from Hunan University of Medicine were randomly assigned to the teaching group of oral virtual simulation experiments and the teaching group to traditional simulation avatars. The practical operation and theoretical scores of the two groups were compared at the end of the course. It was discovered that students in the teaching group virtual simulation experiment scored higher on both the practical operation and theoretical exam than those in the teaching group of traditional simulation avatars ($P < 0.05$).

Through a questionnaire survey, it was observed that the oral virtual simulation teaching system was more effective at stimulating students' learning potential and interest, cultivating students' clinical thinking ability, enhancing their practical ability, strengthening their cognition and understanding of theoretical knowledge, and developing their comprehensive quality ($P < 0.05$). The bridge between the virtual and reality is the virtual simulation oral teaching system. The simulation environment allows students to carry out practical operations while being taught. For instance, the root canal treatment virtual simulation teaching system may assess the position and depth of the pulp opening and root canal preparation devices in real time. It can guarantee the direction of the students' pulp opening and immediately provide the results to students, which are conducive to students' prompt identification of operational defects and error rectification. Students can also improve their understanding and mastery of the details of the operation to mobilize their learning potential and interest, along with improving their awareness and ability to learn autonomously [8]. Moreover, the virtual simulation oral experiment teaching system can offer instances that are consistent with clinical practice in terms of obtaining medical history, performing physical exams, diagnosing an illness, and treatment. Students increase their cognition and comprehension of theoretical knowledge through a series of operations that also assist them in enhancing their clinical thinking and practical competence. It is beneficial to systematically grasp the fundamental idea of disease, the occurrence and development process of disease, pathogenesis, and treatment procedures, which truly cultivate students' comprehensive qualities [9, 10].

4 Conclusions

The virtual simulation teaching system is becoming an important part of modern stomatology education because of its advantages of intuitiveness, operability, security and freedom from time and space constraints. By exploring the application of the virtual simulation experiment teaching system in stomatology practice teaching, this paper

confirms that the virtual simulation experiment teaching system has obvious advantages over traditional practice teaching: it can not only strengthen students' understanding of theoretical knowledge, but also better cultivate students' clinical thinking ability and clinical practice ability, and greatly improve the effectiveness of practice teaching. With the continuous development of medical and computer information technology, virtual simulation technology will play a greater role in stomatology education.

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