

Application Research of Medical Imaging Practical Teaching Based on Virtual Simulation Teaching Platform

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Abstract: *Objective:* To explore the application effect of virtual simulation teaching platform in the practical teaching of medical imaging. *Methods:* A total of 97 students majoring in medical imaging technology of class 2022 were selected and divided into two groups according to the random number method: control group (n = 48) and observation group (n = 49). The observation group was under the practical teaching mode based on the virtual simulation teaching platform, while the control group was under the traditional multimedia teaching mode. Questionnaire survey and teaching assessment were carried out after the teaching period, and the application effects of the two teaching modes were compared. *Results:* The reading and theoretical scores of the students in the observation group were significantly higher than those of the students in the control group ($P < 0.01$); there were statistically significant differences in the results of the questionnaire survey (improved learning interest, improved language expression, improved ability to comprehensively analyze problems, and improved teamwork awareness) between the two groups of students ($P < 0.05$); the students in the observation group were markedly more satisfied with the teaching content, teaching methods, and teaching quality than the students in the control group ($P < 0.05$). *Conclusion:* The medical imaging practical teaching mode based on virtual simulation platform not only helps improve students' theoretical understanding and practical ability in medical imaging technology, but also improves students' learning interest, language expression ability, ability to comprehensively analyze problems, communication skills, teamwork awareness, and satisfaction with the teaching content, teaching methods, and teaching quality. Therefore, it has wide application value in medical specialty education.

Keywords: Medical imaging; Virtual simulation; Practical teaching; Problem-oriented

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1. Introduction

As one of the fastest-growing and most widely-involved disciplines in the field of modern medicine, medical imaging has become a discipline with strong practical requirements with the continuous development. In recent years, with the rapid development of medical imaging technology, the clinical demand for medical imaging talents is also increasing^[1]. However, due to the complexity involved in medical imaging technologies, such as computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET)-CT, many of the content requires learning through practice, and the speed at which new information is updated results in a shortage of clinical talents. However, there are some disadvantages in traditional medical imaging practical teaching methods, which have led to the failure

of trained medical imaging talents in meeting the skill requirements of clinical imaging diagnosis and treatment. For this reason, many colleges and universities have begun to make efforts to improve the traditional practical teaching mode through virtual simulation technology. The so-called virtual simulation technology is a technology that involves the use of computer technology to establish a virtual space to simulate various scenes and experimental objects [2]. At present, the virtual simulation technologies used in medical imaging include medical imaging virtual simulation platform, simulated surgery system, and virtual CT/MR. Among them, the medical imaging virtual simulation platform primarily functions to simulate various types of medical imaging images and functions through computers, allowing students to simulate clinical examination operations without being in contact with actual clinical situations, and thus helping students gain understanding of the components of medical imaging. At the same time, the virtual simulation teaching platform also enables students to realize automation and intelligence in pre-class preview, in-class learning, and after-class review, thus further assisting students in mastering medical imaging knowledge and improving students' learning efficiency. In the present study, we examined the application of the virtual simulation teaching platform in the practical teaching of medical imaging through a clinical trial.

2. Materials and methods

2.1. General information

A total of 97 students majoring in medical imaging technology of class 2022 were selected and divided into two groups according to the random number method: control group (48 cases), which adopted the traditional multimedia teaching method, and observation group (49 cases), which adopted the clinical case-oriented virtual simulation teaching platform practical teaching method. In the control group, there were 23 male and 25 female students, with a mean age of 22.65 ± 2.27 ; in the observation group, there were 25 male and 24 female students, with a mean age of 23.02 ± 1.95 . The differences in the enrollment scores, teachers, and baseline data of the students were not statistically significant ($P > 0.05$); thus, the two groups of students were comparable.

2.2. Methods

The control group adopted the traditional multimedia teaching method, and the teaching duration was 8 weeks. Traditional PowerPoint (PPT) teaching was implemented in all medical imaging theory courses, and the teaching plan was uniformly formulated by the teaching and research department, with the key and difficult points clearly indicated. After the theoretical course, practical observation teaching was carried out by placing a teaching film over a lighted screen for students to inspect; the teacher would explain it, and the students would then read the film in groups.

The observation group adopted the clinical case-oriented virtual simulation teaching platform practical teaching mode; similarly, the teaching duration was 8 weeks.

(1) Building a virtual simulation teaching platform for medical imaging. The Medical Imaging Training Center network resource sharing platform was developed in cooperation with Chongqing Huajiao Technology Co., Ltd. and participated in the use of simulation software. Three-dimensional (3D) simulation technology, multimedia, human-computer interaction technology, network technology, *etc.*, were used, and a virtual simulation practice project based on medical imaging diagnosis and treatment thinking and standard operating procedures was built to train imaging technology capabilities, as well as conduct teaching and training in 3D interactive ways and assessment. The platform mainly includes two modules: teaching resources and teaching management. The former includes teaching videos of imaging technology, summaries of important and difficult theoretical knowledge, *etc.*, while the latter focuses on the maintenance of the virtual simulation platform by teachers, the monitoring and management of data

statistics, and student feedback. See **Figure 1** for the structural diagram of the virtual simulation online platform.

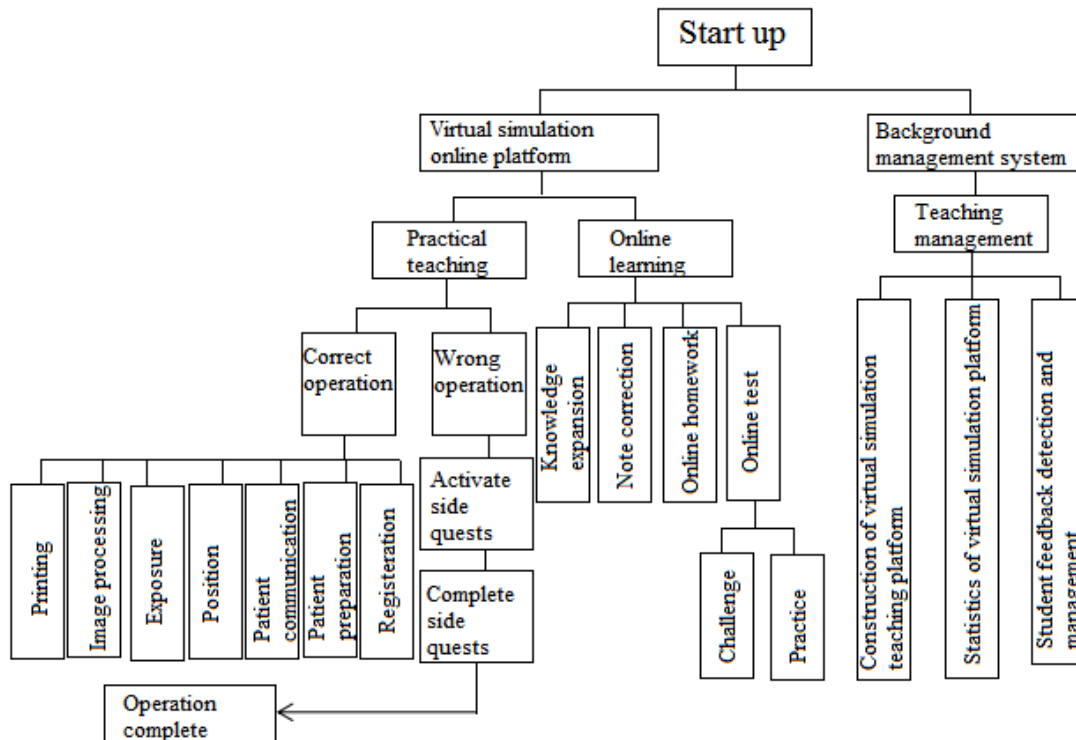


Figure 1. Structural diagram of the virtual simulation teaching platform

- (2) Creating a digital network image teaching mode. On the virtual simulation teaching platform, contents related to general radiology, as well as CT and MRI, are presented, including modules such as imaging case database, imaging picture database, new imaging technology frontier, student information database, *etc.*, creating a new digital network imaging teaching mode. Teachers can select appropriate clinical cases and integrate anatomy, pathology, diagnostics, and other content into the virtual simulation process, so that students would be able to link their knowledge of medical imaging with other disciplines, allow them to experience the process of disease development and diagnosis, gradually cultivate their clinical thinking, deepen their understanding of medical imaging, and improve their independent learning ability.
- (3) Online learning of medical imaging theory. Through the virtual simulation online platform, online teaching of medical imaging can help students deepen their understanding of key and difficult points. We used a large number of microscopic models and 3D animations to vividly demonstrate relevant knowledge points, such as MRI imaging principles, including magnetic and nonmagnetic nuclei, nuclear spin, precession, resonance, relaxation, and imaging cross-section analysis. Macro and micro demonstration animations, along with concrete and abstract intelligent voice explanations would help students understand the mathematical model behind the phenomenon and the significance of imaging; in addition, students can also click on the model to adjust the viewing angle, modify the experimental conditions, and obtain the corresponding feedback results. Through virtual practice, they can verify the principles, strengthen their understanding of knowledge points, achieve inferences from one instance, and establish a systematic knowledge framework of imaging. The students were also assigned homework and allowed to conduct self-inspection and error correction in the process of completing their homework online. This process deepens their understanding of knowledge points. On the virtual simulation education platform, the students could do exercises, challenges, *etc.* Upon understanding the most basic

imaging knowledge, students can carry out extended learning according to their own schedule. Through online tests, teachers will learn about students' weak points, thus giving them timely opportunity to adjust their teaching plans and optimize the teaching content.

- (4) Virtual simulation practice operation. After the students have mastered the basic theory of imaging technology, they can complete the corresponding X-ray/CT/MRI principle virtual simulation experimental learning through the online virtual simulation platform, complete the imaging inspection of the virtual patient, fully understand the content of each link (registration – patient preparation – patient communication – positioning – exposure – image processing – printing), and think deeply about the imaging principles and detection technology, thus realizing the teaching goal of combining theoretical knowledge and practice.

2.3. Observation indicators

- (1) After the 8-week teaching period, the two groups of students were tested on their learning outcomes. The theoretical knowledge assessment included knowledge of X-ray/CT/MRI principles, equipment performance, detection methods, inspection safety, and image characteristics, while the practical skill assessment included film reading, with a full score of 100 points.
- (2) Questionnaires were used to investigate students' cognition of the teaching mode, including the role in improving learning interest, improving language expression, improving the ability to comprehensively analyze problems, and improving teamwork awareness, as well as their satisfaction with the teaching content, teaching methods, and teaching quality of medical imaging.

2.4. Statistical analysis

Statistical software SPSS 22.0 was used for data analysis; measurement data were expressed as mean ± standard deviation, and *t*-test was performed for comparison between groups; count data were expressed as n (%), and chi-square (χ^2) test was performed; *P* < 0.05 indicates statistically significant difference.

3. Results

3.1. Final grades

The students in the observation group scored 83.3 ± 4.8 and 86.2 ± 3.6 points in film reading and imaging theory, respectively. Both of the scores were significantly higher than those of the control group (72.5 ± 3.2 and 73.6 ± 5.4 ; *P* < 0.01), as shown in **Table 1**.

Table 1. Comparison of final grades between the two groups of students

Group	Number of students	Score	
		Film reading	Imaging theory
Control group	48	72.5 ± 3.2	73.6 ± 5.4
Observation group	49	83.3 ± 4.8	86.2 ± 3.6
<i>t</i>		13.0108	13.5474
<i>P</i>		0.0000	0.0000

3.2. Questionnaire survey results

There were statistically significant differences in the results of the questionnaire survey (improved learning interest, improved language expression, improved ability to comprehensively analyze problems, improved communication skills, and improved teamwork awareness) between the two groups of students (*P* < 0.05). See **Table 2** for details.

Table 2. Analysis of questionnaire survey results

Group	Number of students	Improved interest in learning	Improved language expression	Improved ability to comprehensively analyze problems	Improved teamwork awareness
Control group	48	26 (54.16)	25 (52.08)	23 (47.92)	19 (39.58)
Observation group	49	45 (91.83)	43 (87.75)	42 (85.71)	44 (89.79)
χ^2		17.5376	14.7215	15.6702	26.8544
<i>P</i>		0.0000	0.0001	0.0001	0.0000

3.3. Teaching satisfaction

Comparing the satisfaction of students with the teaching content, teaching methods, and teaching quality between the two groups, the students in the observation group showed significantly higher satisfaction with all three indicators than those in the control group ($P < 0.05$). See **Table 3** for details.

Table 3. Comparison of teaching satisfaction between the two groups of students

Group	Number of students	Teaching content	Teaching method	Teaching quality
Control group	48	30 (62.50)	29 (60.42)	31 (64.58)
Observation group	49	46 (93.84)	45 (91.83)	45 (91.83)
χ^2		14.0739	13.2332	10.6174
<i>P</i>		0.0002	0.0003	0.0011

4. Discussion

With the advancements in modern medicine, imaging has become one of the important means of clinical diagnosis. In view of its low cost and reusability, it is widely used in clinical examination. However, due to its complexity and involvement of various types of equipment, the operators are required to have good hands-on skills^[3]. In the cultivation of imaging professionals, problems such as low teaching efficiency and poor teaching effect exist in the traditional teaching mode. These problems have become the key factors that restrict the improvement of medical imaging teaching quality. In order to solve the problems existing in the current teaching of medical imaging, researchers have put forward training plans and curriculum standards for medical imaging professionals as well as student-centered and problem-oriented virtual simulations of medical imaging practical teaching by using modern information technology platform. This platform integrates and optimizes the instruments and equipment involved in image inspection, adopts a modular management method, and realizes the basic operations of various instruments and equipment, typical images of typical diseases, and teaching interaction^[4]. This student-centered platform satisfies three learning methods: independent learning, cooperative learning, and inquiry learning. Along with a mixed teaching mode that combines online and offline teaching methods, the platform realizes the application of multimedia technology and virtual simulation technology to medical imaging. By carrying out the reform of the multi-disciplinary cross-integration compound talent training mode, the limitation of time and space is broken, and learning activities can be carried out anywhere that has a network. This greatly improves the enthusiasm of students to participate in learning activities, thereby achieving the goal of improving the practical and innovation skills of medical imaging students. In addition, the platform also includes imaging technology experiment course design, typical case reports, imaging technology assessment, medical imaging evaluation system, and other functions^[5]. By completing the above modules, students would be able to test and consolidate the knowledge and skills they have learned.

In this study, by comparing the learning effects of students in the control group under the traditional multimedia teaching mode and the observation group under the practical teaching mode based on the clinical case-oriented virtual simulation teaching platform, we found that the students in the observation group scored significantly higher in film reading and imaging theory than those in the control group ($P < 0.01$); in addition, the questionnaire survey results (improved learning interest, improved language expression, improved ability to comprehensively analyze problems, and improved teamwork awareness) were better in the observation group compared to the control group ($P < 0.05$); and the satisfaction of students with the teaching content, teaching methods, and teaching quality was significantly higher in the observation group than in the control group ($P < 0.05$).

5. Conclusion

The application of clinical case-oriented virtual simulation teaching platform practical teaching in the teaching practice of medical imaging professional courses can significantly improve students' ability to master the theoretical understanding and hands-on skills of medical imaging; in addition, it is beneficial to improving students' learning interest, language expression, ability to comprehensively analyze problems, and teamwork awareness. Given its positive role, this teaching mode is worthy of extensive application in medical specialty education.

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Disclosure statement

The authors declare no conflict of interest.

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