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Research and Application of Smart Classroom in Surgical Practice Teaching

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Abstract: With the advancement of science and technology as well as the rapid development of next generation information technologies, such as big data and artificial intelligence, smart classrooms have emerged as the times have demanded. Adopting innovative teaching modes in smart classrooms allows the realization of various teaching techniques that cannot be achieved in traditional classrooms. Especially for some courses in medical schools, due to changes in the medical environment and the improvement of patients' awareness of medical rights and interests, the traditional teaching methods are becoming more restricted. For example, in clinical surgery, due to the increasing number of medical students in recent years and requirements for strict aseptic principle adherence in operating rooms, practical teaching has encountered great restrictions, thus preventing it from meeting the needs of students. In order to solve this problem, this research constructs a smart classroom teaching model for surgical practice teaching based on hardware equipment, such as smart classrooms, interconnected surgical mobile broadcast equipment, and intelligent medical simulators. Through this teaching model, the teaching effect and quality are further analyzed, laying a foundation for smart teaching in future medical courses.

Keywords: Smart classroom; Surgery; Practical teaching

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1. Introduction

Most of the courses in medical schools deal with human ethics, especially surgery, which not only calls for medical students to perform surgical procedures and engage in hands-on interaction with patients, but also to treat patients with utmost respect, while protecting their medical rights and interests. There are several limitations on classes [1]. In recent years, with the changes in the medical environment, the increased awareness of medical rights and interests among patients, as well as the concerns about medical risks in clinical departments, the surgical practice teaching is often a mere formality, thus resulting in poor teaching effect [2]. In addition, many medical colleges in China have increased the number of clinical students being enrolled, and these colleges are seeing a significant growth in the number of medical students, which exceeds the capacity of clinical departments to undertake practical teaching. In the traditional mode of teaching based on educational equity [3], there is still a dearth of autonomous learning and practice, along with poor teaching interaction effect, all of which have negative influences on the teaching effect of foreign science [4].

With the rapid development of next generation information technologies, such as cloud computing, artificial intelligence, and big data, the deep integration of information technology into education and teaching has led to the emergence of the smart classroom teaching model [5]. Innovative teaching in smart classrooms, the scientific use of surgical mobile broadcast equipment, and medical simulation simulators,

can effectively solve the shortcomings of the traditional mode of teaching in surgery, including medical ethics and clinical scenarios. Switching teaching from the side or operating room to smart classrooms heightens the opportunity for students to operate, stimulates their enthusiasm for learning, as well as enables practical teaching to be more personalized, precise, and modern, all of which are conducive to improving the quality of teaching and students' learning efficiency [6].

Based on the aforementioned reasons and objectives, this study places students at the heart of its design, constructs a smart classroom model for surgical practice teaching, and applies it in practice.

2. Smarter classroom and smarter teaching mode

Smart classroom is a product of the times. It is integrated with cutting-edge technologies, such as mobile internet, big data, cloud computing, artificial intelligence, and smart teaching aids, to create multi-dimensional interactive teachings with accurate evaluation, data-based decision-making, and innovative features [7]. Through the integration of virtual and reality, the connection between online and offline teaching stimulates students' interest and potential in learning, cultivate their creativity and problem-solving skills, as well as promotes their growth via personalized teaching [8].

In smart classrooms, innovative teaching is adopted. Relying on various teaching resources and technologies provides students a guarantee for achieving in-depth learning [9]. The "matching wisdom teaching mode" is particularly important, especially in practical teaching of surgical procedures, which focuses on cultivating students' practical and professional technical skills, as well as strengthening their application of theoretical knowledge. Students are expected to use their subjective initiative in classroom and participate in teaching scenarios that are comparable to actual settings, thus putting forward higher requirements for the innovation of smart teaching modes [10].

3. Analysis of the current situation of smart classroom in colleges and universities

With the advancement of the construction of smart classrooms by the Ministry of Education, the development of smart classrooms in colleges and universities across the country has reached a certain scale. However, some colleges and universities are still in the process of construction, and there are problems in the implementation process [11], such as the formalization of smart classroom construction, the lack of classroom intelligence, the single classroom teaching method, as well as the varying degree of acceptance and recognition of smart classrooms by both, teachers and students. These are the main reasons of which smart classrooms cannot be implemented effectively [12].

3.1. Formalization of smart classroom construction

The smart classroom is a new concept born under the development of the times. It requires constant development and improvement. There are obvious differences in concepts and technologies between the initial smart classroom and its later construction. Hence, it can be said that it is still in its infancy [13]. With the advancement of national policies and the interest of colleges and universities in smart classroom, it has been on the rise. However, in its application and implementation, some colleges and universities have formalized and superficialized the construction of smart classrooms, focusing primarily on the numerous lessons being taught in the classroom. The research on whether the technology and teaching resources are advanced and convenient enough, whether the smart classroom teaching mode can effectively improve the teaching quality, and whether it can solve the issues in the traditional teaching model has not been thoroughly explored [14]. When colleges and universities implement smart classrooms, they blindly integrate the characteristics of the courses with this new concept, adopting methods similar to those of other courses, resulting in blatant imitation, poor teaching effect, and the loss of enthusiasm over time; thus, smart classroom teaching becomes a mere formality [15]. For example, in the teaching of practical courses, teachers

tend to list out the resources, without integrating the corresponding hardware and software equipment; hence, the focus is on theoretical teaching rather than practical application, which deviates from the original intention of cultivating practical skills through practical courses. This not only brings about failure in achieving efficient classroom teaching effect, but also wastes time and energy.

3.2. The lack of intelligence in classroom

In many colleges and universities, due to the amount of capital investment for the construction of smart classrooms, the difference in cognitive concepts, and the current development of information technology, the level of intelligence of smart classrooms varies. Hence, it is impossible to maximize the application of big data and artificial intelligence, resulting in poor human-computer interaction and unfriendly hardware configuration, all of which affect the teaching work [16]. For example, in clinical reasoning training, where case resources stored in smart classrooms are used for teaching, it is necessary to set a single notion based on the program. The original intentions of the class differ from one another, thus failing to reflect the wisdom embodied in smart classrooms.

3.3. Single teaching method

In the early implementation stage of smart classrooms, teachers need to be trained. An overly complex system will inevitably engender more workload on teachers. In addition, traditional teaching habits may result in low recognition or acceptance of smarter classroom teaching. The single and modeled teaching method, which is deprived of innovation, causes the classroom to lose its vitality and intelligence, resulting in a decline in students' initiative and enthusiasm for learning, as well as teachers' enthusiasm for teaching [17].

4. The construction of a smart classroom teaching model for surgical practice teaching

Surgical practice teaching focuses on cultivating students' hands-on skills, including critical reasoning, tissue and organ identification, as well as basic procedures, such as cutting and suturing [18]. In terms of surgical practice, among the professors, they can be divided into two groups: one group practices on medical molds, whereas the other practices on real patients. Therefore, practical teaching should pay more attention the characteristics of the specific discipline, the capacities that smart classrooms are equipped with, and the ideas of matching resources, fostering strengths, avoiding weaknesses, innovating classrooms, giving full play to the advantages of smart classrooms, as well as overcoming the flaws in non-clinical learning [19]. In this way, the construction of a smart classroom teaching model for surgical practice teaching is particularly important.

This research relies on smart classrooms, grafts surgical mobile broadcast equipment and medical simulation simulators, transfers operating room scenarios into classrooms, and uses existing teaching resources to construct a "three-stage six-step" smart classroom model. "Three-stage" here refers to pre-class, mid-class, and after-class; "six-step" here refers to pre-class knowledge point review, learning situation analysis, in-class surgical demonstration, practical operation training, after-class video review, and online assessment.

4.1. Pre-class stage: Basing on knowledge points

First of all, the teaching goal of the practical course is determined by the teacher; following that, a detailed analysis is conducted based on the content of relevant theoretical courses and the specific requirements of the syllabus; materials are then produced and distributed to the students for independent learning before classes (courseware, video, pre-class assessment, and other materials); students can then review and raise doubts or questions via their terminal devices.

According to the students' learning situation fed back by the platform, an intelligent learning analysis is then conducted to identify the common and individual problems faced by students in learning and grasp the characteristics of students, so as to help students better understand the theoretical knowledge learned and grasp certain knowledge points. Through this process, the teacher can reorganize, focus on solving common problems and individual problems separately, as well as carefully prepare the teaching design.

In the teaching design of the course, the purpose is to improve students' clinical reasoning and hands-on skills by focusing on practical teaching. Therefore, the pre-class stage self-review is very important. Teachers need to simplify the knowledge points and select high-quality teaching resources, while avoiding resource piling and increasing the learning time.

4.2. Mid-course stage: Focusing on practical training

In this stage, medical records are introduced into the classroom, and questions pertaining to diagnoses, their bases, differential diagnoses, treatment plans, and surgical methods are raised; students are also guided to intervene in the diagnosis and management of patients as clinicians, so as to cultivate their passion as doctors. When applying what they have learned to solve problems in class, the teacher can intersperse and explain the common problems faced by students during pre-class learning as well as briefly review the knowledge points, without over-explaining them, but rather allowing the students to maximize their learning initiatives.

After arriving at the diagnosis and coming up with a management plan, students can observe the surgery more intuitively and vividly from the perspective of the surgeon through the broadcast or recording of the patient by using the mobile broadcasting equipment. During the surgery, a concise explanation that highlights the key points will be provided by the teacher. This facilitates a full sensory experience and the formation of knowledge point imprints.

At the end of the demonstration, the students are encouraged to perform practical operations on the medical simulator, including basic surgical operations, separation of tissues and organs, and the reconstruction of structures. If the students make mistakes during the operation, the medical simulator will sound alerts and error correction prompts. The teacher will also give a tour and address any personality issues that have been previously identified prior to class.

At the end of the operation, the teacher will provide feedback to the students, remind them of matters needing attention and their deficiencies, provide accurate explanations on error-prone and difficult points to improve the students' knowledge system, promote the integration of theory and practice, as well as improve the students' clinical reasoning.

4.3. After-school stage: Emphasizing on online assessment

After the end of the course, the smart classroom platform will share the teacher's feedback, the knowledge points, and the students' surgical operation videos to students' terminal learning devices in a point-to-point manner, so that the knowledge points can be better reviewed, and the mistakes made during the operation can be reflected and corrected.

Finally, based on the intelligent analysis of students' learning, the smart classroom platform extracts five to ten questions from its database to form online assessment questions. After-class online assessments are completed to check and fill in the gaps, consolidate their knowledge, and form constructive feedback, all of which will assist in enhancing the intelligent learning mode.

The teacher will then analyze the results of the assessment step-by-step, make an evaluation, and give the usual grades. In accordance with students' varying learning abilities, imparting targeted and personalized knowledge to students, including the latest knowledge and cutting-edge technologies in this field, would help broaden students' knowledge and promote deep learning.

5. Evaluating the effect of smart classroom implementation

5.1. Students' achievement

In this research, the 18th grade clinical medicine major undergraduates in Xi'an Medical University were randomly divided into four classes, with a total of 90 students in every two classes, which were considered as the experimental group and the control group. The smart classroom teaching mode was implemented in the experimental group, whereas the traditional bedside teaching mode was implemented in the control group for a whole semester of surgical practice teaching. In order to reflect the fairness of education, compensatory smart classroom teaching was implemented in the control group for the next semester following this study.

A general level test was conducted to determine the students' knowledge level in surgery before the implementation of the smart classroom teaching mode. According to the statistical analysis of the test scores, there was no significant difference between the experimental group and the control group.

After the experiment, a closed-book final examination of the same test paper was conducted based on the unified arrangement of the school. The final exam accounted for 70% of the total score, while the usual grades accounted for 30%. According to the statistical analysis of the total scores, the average value of the experimental group was higher than that of the control group, and the scores of the two groups were significantly different, indicating that the smart classroom teaching mode is better than the traditional teaching mode. It helps improve students' understanding and mastery of knowledge as well as cultivate their clinical reasoning.

5.2. Students' evaluation of smart classroom

Questionnaires were distributed to the 90 students in the experimental group to gather their evaluation on the smart classroom model. The results can be seen in **Figure 1**.

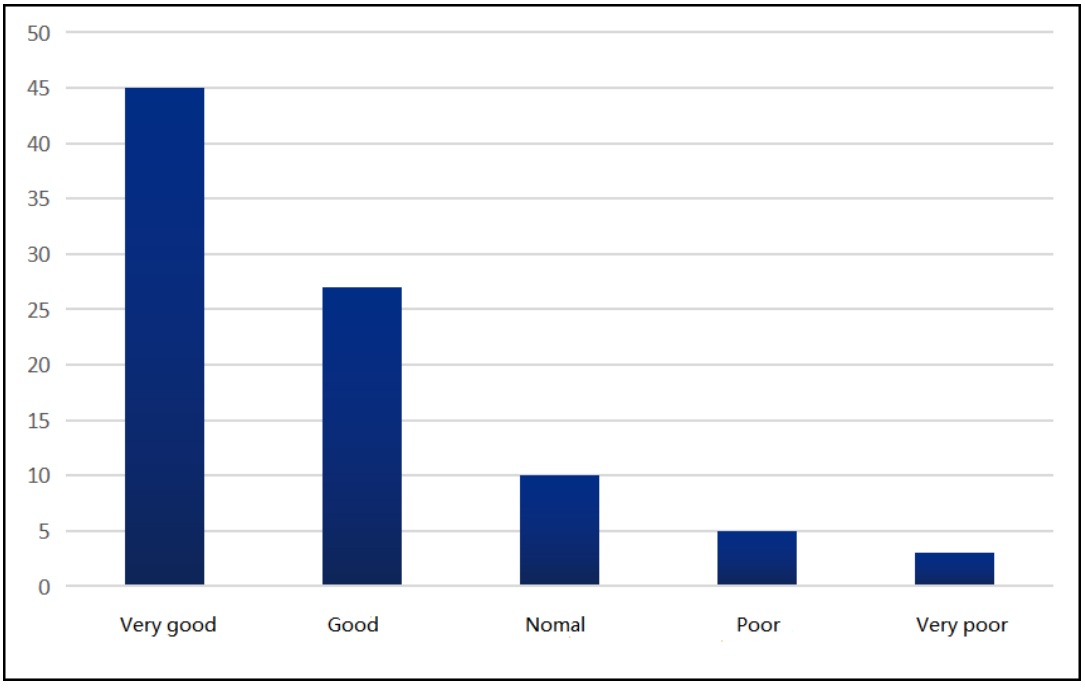

Figure 1. Students' evaluation of the smart classroom model

The study found that the students were more inclined to smart classroom teaching. They contended that the implementation of smart classroom prevents the waste of time going in and out of the operating room as well as resolve patient distrust and opposition toward practical teaching. Teaching from the side

or in the operating room, or even observing operations from the first surgeon's perspective, has a more positive educational impact than simply observing in the operating room because it helps students develop their practical operation skills, their clinical reasoning, and their enthusiasm for learning. However, 3.3% of the students rated the smart classroom teaching mode very poorly. They contended that rather than focusing on smart classroom teaching, bedside and operating room teaching with the involvement of real patients should be the primary focus for medical students, so as to truly learn clinical knowledge and improve their surgical practice level. This is an issue that the research group needs to further consider. The focus of future research should be on how to reasonably allocate the teaching hours of clinical teaching and smart classroom teaching, reflect the fairness in education, as well as further innovate and improve the smart classroom teaching model.

6. Conclusion

In this study, the smart classroom teaching mode was implemented in surgical practice teaching. The results suggest that by making full use of the advanced technology of smart classrooms in line with the characteristics of the discipline, it is possible to improve the teaching quality. Traditional surgery practical courses should consider implementing the smart classroom teaching mode. Due to the limitation of the number of observers, the high requirements for the aseptic principle, and the demands of patients' medical rights and interests, medical students are given more opportunities to exert greater subjective initiative in smart classrooms, participate in hands-on trainings, and improve their surgical skills. Hence, this model is worth promoting. However, there are certain problems with smart classrooms. The cultivation of psychological quality, doctor-patient communication skills, and humanistic care among students may be an issue due to the lack of exposure to actual settings.

With the continuous progress and rapid development of modern technologies, such as big data and artificial intelligence, the future will certainly be an "intelligent" future, and the future classroom will also be a "smarter" classroom [20]. With smart classrooms, the innumerable teaching methods that cannot be achieved in traditional classrooms can be realized, along with many more efficient teaching methods. However, it is important to continuously innovate and develop the smart teaching model, combining it with the course's characteristics, improve the efficiency and quality of practical teaching [21], as well as conduct in-depth research and exploration of the value of smart classrooms, so as to lay the foundation for future smart classrooms. When developing smart classrooms, it is necessary to take into account of the actual situation and certain scientific issues, such as how to balance virtual and real practical and theoretical teaching of practical courses, so that students can improve their medical skills, psychological quality, and humanistic care, thus ensuring that all aspects are well-cultivated.

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Disclosure statement

The authors declare no conflict of interest.

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