Application and exploration of virtual simulation experimental platform in the experimental teaching of clinical testing instruments and techniques

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Abstract. Clinical laboratory instrumentation and technology is a multidisciplinary, multi-technology, multi-disciplinary cross-discipline, with strong application, theoretical and experimental teaching methods are single and boring, and it is difficult for students to master and understand the abstract content. The laboratory has cooperated with a company to complete the experimental teaching for undergraduate students, and analyzed the advantages of this teaching method and the problems that need to be solved through the questionnaire and formative evaluation, and analyzed and summarized them, so as to provide relevant experience for this kind of courses to adopt the virtual simulation experimental platform and provide directional guidance for the construction and development of the virtual simulation experimental platform.

Clinical laboratory instrumentation and technology is a multidisciplinary, multi-technology, multi-disciplinary course, which is highly applied, rapidly developing, and has a short update cycle, and is one of the main professional courses in medical laboratory technology. Since the epidemic in 2020, universities across the country have been actively responding to the call of the Ministry of Education to "suspend classes without stopping school" and adopting various teaching methods such as online teaching, catechism teaching, virtual simulation teaching, etc. As a new applied subject course with a high degree of knowledge and technology intensity and a unique application goal, Clinical Laboratory Instruments and Technology has undergone After nearly three years of continuous integration and exploration, our teaching and research department is currently using Shandong Zezhong virtual simulation platform to conduct laboratory classes, replacing the online teaching method adopted by most institutions, and improving teaching quality and implementing teaching reform by continuously developing the teaching

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mode of this course. In accordance with the spirit of document [2001] No. 4 of the Ministry of Education, combined with the teaching requirements of this course and the construction standards of the national high-quality courses, constantly adhere to the development and practice of the teaching methods of the course, the reform and innovation of teaching methods, so that it can adapt to the teaching needs of the current situation is the focus of this paper.

1 Current problems faced by the traditional teaching methods of clinical laboratory instrumentation technology in the faculty

The current situation of teaching mode: This course takes the basic instruments and advanced professional instruments commonly used in clinical medicine laboratories as the learning content, reflecting the current situation of the rapidly developing laboratory medicine instruments, which plays an important role in the cultivation of the practice induction ability, clinical application ability and professional expansion ability of laboratory medicine students[1]. The course is composed of multidisciplinary intersection, with more knowledge points and more boring learning content, which brings certain challenges to students' learning. The traditional teaching mode and the common online teaching mode easily lead to low motivation of students and unsatisfactory teaching effect, coupled with the change of the teaching environment and mode by the epidemic, it is urgent to perfect and improve the teaching mode of this course.

Necessity of teaching reform: Since the beginning of 2020, the sudden epidemic has brought an unprecedented impact on Chinese higher education. In a very short period of time, the teaching in universities nationwide changed from "offline teaching" to "online teaching". This comprehensive online teaching is a big review of the achievements of "Internet+education" reform in China's higher education, and it also lays a rich practical foundation and ideological foundation for the future online teaching reform to continue to lead to more important status. The "Clinical Laboratory Instruments and Techniques" laboratory course contains five parts: blood, urine, coagulation, biochemistry, chemiluminescence, covering most of the instruments that students need to master in their internship and future work, the traditional teaching method uses PPT lectures in the laboratory, and then takes students to visit the medical testing center according to the conditions of the undertaking college; this teaching method faces several disadvantages, such as the influx of large numbers of students into the department at the same time It will affect the daily work of the staff, the medical laboratory center in a wide range of instruments, valuable, strict requirements of the laboratory environment, students in the department to visit will bring an increase in uncertainty may be infected with the normal operation of the instrument accident; and students in batches will bring the extension of the teaching time and different teachers to lead the teaching can not ensure homogeneous teaching and other issues; at the same time, students can only be in the laboratory class to observe and listen to the teaching The teacher's explanation loses the meaning of "laboratory class" and brings problems such as boring, single, abstract and incomprehensible content. Therefore, the teaching and research department is currently cooperating with Shandong ZeZhong virtual simulation platform to make the necessary teaching reform attempts.
2 Feasibility of building a virtual simulation platform

2.1 From the perspective of historical evolution

The development of educational technology has roughly gone through four different stages of development: the traditional 1.0 era based on oral and oral transmission; the 2.0 era of electrification education based on slides; the 3.0 era dominated by multimedia teaching; and the 4.0 era which is currently in between moving from the 3.0 era to digital teaching. Looking at this historical evolution, we can find that each breakthrough in education technology has brought about changes in teaching mode, which will drive the deepening development of university teaching theory and in turn guide the teaching reform practice. In the old days of traditional oral teaching, university lectures were conducted in the form of traditional fixed classes, and students needed to adapt to the needs of lecture-based classroom teaching, and the typical characteristics of the university learning space were fixed seats, fixed lecterns and fixed blackboards. With the development of education technology, multimedia learning and computer-assisted learning have emerged, and the space for students to learn has also changed. Classroom seating has changed from fixed to mobile, the teacher's podium has become changeable from front and center, the classroom blackboard has changed from fixed on the wall to a movable whiteboard, and multimedia equipment has been installed.

From a global perspective, computer-assisted education, marked by digitalization since the 1970s, has greatly promoted the change of university teaching mode and the continuous iteration of university students' learning style. One typical example is the promotion and application of the "active learning" teaching model. According to this theory, learning is a process in which the cognitive subject interacts with the learning environment and gradually constructs a cognition about the external world, thus developing its own cognitive structure. Based on this theory, the introduction of virtual simulation platform in our teaching department can reflect the emphasis on student-centered, problem-oriented, and teacher-student interaction and student-student interaction.

2.2 Guidance of national policy

The spirit of the document "Several Opinions of the Ministry of Education on Comprehensively Improving the Quality of Higher Education" (Education High [2012] No. 4), based on the "Ten-Year Development Plan for Education Informatization (2011-2020)" (Education Technology [2012] No. 5), the Ministry of Education issued the "Notice on the Construction of National Virtual Simulation Experimental Teaching Center (No. 94 [2013]) and launched the first batch of national virtual simulation experimental teaching centers in August 2013, up to now there are 300 national virtual simulation experimental teaching centers in China. The construction of national-level virtual simulation experimental teaching center is the key point of university education informatization and the extension of the construction of experimental teaching demonstration center [2].

2.3 Service undergraduate teaching

Whether it is experimental teaching demonstration center, or virtual simulation experimental teaching center, are for undergraduate services, so the landing point must fall on undergraduate teaching. Whether it is the acquisition or development of virtual simulation projects, there must be a broader application prospect, especially for medical undergraduate applications, the best can be applied in a number of medical-related
professional undergraduate students. Only such a project can really serve undergraduate teaching well.

2.4 Consistent with school-school sharing

The Ministry of Education advocates that experimental teaching resources should be shared between schools to improve the utilization rate of instruments and equipment. The nature of the virtual simulation project is especially in line with the requirement of school-school sharing \cite{3}. The amount of investment in virtual simulation projects is generally large, if each university independently invests funds in research and development, and the research and development is only used by students in their own schools, there will be repeated investment and waste of resources. Therefore, universities should not only cooperate with relevant virtual simulation development enterprises, but also establish inter-school sharing mechanism with other universities, so that virtual simulation resources can be promoted and applied efficiently.

3 Virtual simulation platform combined with course development

3.1 Integrating the virtual simulation platform into traditional experimental lectures Traditional offline teaching is teacher-led face-to-face lectures

Online teaching we follow the principle of student-centered teaching, and cultivate the ability of students to learn independently. Using virtual simulation experiments to explore the teaching model, the teaching and research department in the traditional physical experiments based on virtual simulation experiments into the virtual reality teaching model, for example, in the clinical laboratory instrumentation experiments, physical operations are currently being used or will be used in medical testing centers more advanced instruments, purely theoretical lectures on the principles of medical students is relatively boring, the content is also more abstract is not easy for students to understand, so the teaching department in the experimental lectures on the principle of boring, abstract content is not easy for students to understand. Therefore, the laboratory must focus on the actual operation in order to help students understand the key points, and the virtual simulation platform can not be limited by time and space, so that students can use it flexibly through pre-course pre-study, interspersed in class, and after class consolidation. The instructor completes the instrument explanation in the classroom, and the teacher assists the students to learn the corresponding virtual simulation integrated experiments and connects the corresponding principles, sources and extensions of the instrument experiments. For example, the principle of routine blood testing inside the clinical hematology instruments, the development and iteration of the instruments and the improvement of the testing principles and methods are taught one by one in the classroom as the main line. The traditional laboratory class can only give students a tour and demonstration, while the virtual simulation platform can show all the relevant testing principles of the machine and the methodological iteration of the operation process of the relevant instrument to students, through the timely guidance of the teacher, students operate on the virtual platform to practice or view the operation video in the system at any time, especially you can view the whole process of instrument development, it is easier to grasp the focus and difficulties of the experiment, more can continue to watch after class, if it is too late to extend the learning. By interspersing the virtual simulation platform with traditional laboratory operations, students can deepen their understanding of concepts, develop systematic thinking, and appreciate the practical role of the latest testing technologies and methods in clinical
practice. In this mode, students can make full use of classroom and classroom time to strengthen their memory and achieve "virtual" and "real" complementarity.

3.2 Transformation of student-directed learning

The virtual simulation platform of my teaching department is open and shared to undergraduate students, breaking the time and space restrictions. Students can enjoy the high-quality online resources at any time through cell phones and computer networks, and experience the experimental process by clicking on the required experimental supplies and instruments with the mouse and following the steps\(^4\). In addition, in order to improve the students' participation, the teaching and research department assisted the company to optimize the platform management functions, adding self-test questions, online Q&A interactive communication forum, learning statistics and other functions; some experimental steps are also set up in the middle of the question, only the correct answer can continue the experimental process, the wrong answer needs to find the reason, like a breakthrough game, this mode can increase the fun, but also to carry out formative evaluation of students.

Laboratory instrumentation and technology is a relatively boring course, but through the faculty lecturers to issue discussions, to inspire students' active thinking and innovation, as well as in the class session in addition to online question and answer, and interspersed with a combination of various forms of teaching, such as flipped classroom, group discussion, etc.. Depending on the characteristics of the content students are learning, undergraduate teaching should focus on the people. All in all, there is a method for teaching, but there is no definite method, and it is important to get the right method.

4 Implementation effect and problems

4.1 Virtual simulation platform implementation effect

Based on the actual lecture of the laboratory class, the teaching and research department relies on the virtual simulation teaching platform, in order to meet the characteristics of the course experimental content of strong theory, abstract content is not easy to understand, for example, the experiments related to "automatic biochemical analyzer" in just three hours of time, only using traditional lectures can not guarantee the quality of students' listening, and at the same time, because the experiment The content of the experiment is many, involving electrolytes, proteins, enzymes and other important and difficult knowledge covering all the theoretical content of "Clinical Biochemistry Laboratory Technology", which also brings great pressure to the laboratory teachers, and it is also a great challenge for students to recall the relevant knowledge points and master the new content in a short time. Therefore, in this experimental teaching, a combination of "virtual" and "real" teaching mode is implemented, in which students are allowed to log into the virtual simulation platform before class to practice the operation of the instrument and recall and review the testing principles and meanings of the relevant items; during the class, the teacher takes the form of micro-lessons and demonstration lectures in the virtual simulation platform to help students deepen their impression and master the important and difficult points; after the class, students then check and fill in the gaps through the experimental operation of the virtual simulation platform, and interact with the teacher online to improve learning efficiency. After 2 years of teaching practice in the undergraduate and post-secondary classes undertaken by the faculty, especially the large-scale online teaching at the time of the new crown epidemic, students in the classes undertaken by the faculty participated in
the whole experimental process by using the virtual simulation platform\textsuperscript{[2]} to make up for the limitation of long experimental materials and experimental cycles.

The teaching and research department surveyed a total of 169 students in Medical Laboratory Technology (College Preparatory) 2021-1, Medical Laboratory Technology 2019-1 and Medical Laboratory Technology 2019-2 by questionnaire star, and came to the conclusion that 90\% of the students think that the effect of adopting virtual simulation platform is better than traditional laboratory teaching, more than 88\% of the students think that the mode can increase learning interest, enrich learning resources and broaden their horizons, more than 83\% of the students think that virtual simulation teaching is beneficial to the cultivation of independent learning ability and the formation of scientific thinking, and 87\% of the students think that the form of virtual simulation is convenient for review and pre-reading after class, which can help to understand and consolidate abstract theoretical knowledge. Meanwhile, through the analysis of the formative evaluation of 169 students in the class of 2021 and the undergraduate class of 2019, we can learn that the passing rate of the exams after adopting virtual simulation teaching reaches more than 95\%, and the percentage of students who scored 80 or above also reaches 38\%, which shows that the virtual simulation teaching has been well evaluated by most students, and also makes the teaching quality improve year by year.

At the same time, the teaching and research department and the universities in Kashgar region are cooperating with each other, planning to build our own virtual simulation platform that meets our own needs by relying on the resources of the existing virtual simulation platform and the policy advantages of the state and autonomous region, and combining the advantages of the resources between the cooperating clinical medical schools and universities, so as to expand the advantages and avoid the poor information caused by our own "closed door", communicate and cooperate with related institutions, make full use of the resources, build and use the virtual simulation platform more rationally, and carry out the teaching reform of the curriculum in a deeper way.

4.2 Existing problems

First of all, compared with traditional experiments, the opening of virtual simulation experiments brings new challenges to teachers and students, and requires good cooperation and dedication of teachers and students. The conceptualization, writing, production and teaching application of virtual simulation integrated experiments in every aspect is a careful process that requires repeated refinement and improvement, and the faculty team needs to carefully plan and continuously learn all aspects of knowledge in order to continuously optimize the experimental content and teaching methods\textsuperscript{[6]}. Secondly, when students run virtual experiments with cell phones, the font and items are smaller and inconvenient to select and operate; when the lab computer is running, there may also be difficult problems such as network lag, which is related to the stability of the platform and computer hardware support, more school policies are needed to support and maintain to ensure safe operation and management\textsuperscript{[7]}. Again, in order to fully mobilize students' motivation, it is also necessary to enhance the data management functions of the platform, such as the number of logins and browsing time of students, the interactive function between students and teachers, the online test area, etc. Teachers can accordingly give students suitable formative assessments\textsuperscript{[8]}, and increase the proportion of such formative assessments in the total grade of the subject, which can improve students' motivation for online learning, broaden their horizons and expand their thinking, and help improve their overall quality ability.
5 Conclusion

This teaching and research department assists traditional physical experimental teaching through the constructed virtual simulation experimental platform of laboratory instrumentation, through the deep integration of modern information technology and medical professional knowledge. The teaching mode of combining virtual and real, online and offline teaching is adopted to help students integrate the abstract and profound principles of test instrumentation, which has a profound impact on the composition of students' knowledge system. At the same time, the use of virtual simulation platform also helps students to increase the access to knowledge and facilitate the improvement of students' independent learning ability; the core requirement of higher quality education is to strengthen the cultivation of students' independent learning ability. At present, the virtual simulation experiment platform has gained some experience, but how to further improve the teaching effect and the quality of classroom teaching must be further explored. In the future, based on the enhanced physical experiments and the syllabus, the teaching and research department will design comprehensive experiments with independent characteristics that are more suitable for students, use information technology to constantly update the educational concept and reform the educational model, and cultivate high-quality medical talents who can keep up with the times.

Undergraduate Education Teaching Research and Reform Project of Xinjiang Autonomous Region (PT-2021021), Education Research and Teaching Reform Project of Xinjiang Medical University (YGS2021009) Education Reform Project of the Third Clinical Medical College of Xinjiang Medical University (No.SLC202004).

References