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Design and Development of Virtual Simulation Comprehensive Experiment Project of Traditional Chinese Medicine

Li WANG*
College of Educational Science and Technology, Shanxi Datong University, Datong 037009, China
*Corresponding Author.

Abstract:

There are some problems in the experiment of traditional Chinese medicine, such as large loss of medicinal materials, limited or missing number of precious medicinal materials, lack of living medicinal materials, and long observation cycle in each stage caused by the growth cycle of medicinal materials. These problems not only affect the effect of the experiment of traditional Chinese medicine, but also are not conducive to the understanding and mastery of theoretical knowledge. In order to solve the above problems, the virtual simulation technology was applied to the experiment of Traditional Chinese medicine, and the virtual simulation experiment platform of traditional Chinese medicine was constructed to improve the understanding of relevant theoretical knowledge, the identification ability of traditional Chinese medicine and the ability of clinical application.

Keywords*: Traditional Chinese medicine; Virtual simulation; Experiment; Design; Development.*

I. INTRODUCTION

Traditional Chinese medicine is a compulsory basic course for Chinese medicine undergraduates. It is an important part of traditional Chinese medicine and plays a connecting role between the basic theory of traditional Chinese medicine and clinical practice. It is an experimental subject with rich theoretical content and strong practicality, which studies the basic theory of TCM and the knowledge of the source, extraction, performance, efficacy and clinical application of various TCM [1-3]. However, at present, there are many problems in the experiment of Traditional Chinese medicine, and the experimental effect is not good, which is manifested in the following aspect:

(1) Insufficient experimental materials

In terms of time and space, there are insufficient sources of observation materials due to the differences of geographical distribution and phenological period of medicinal plants[4]; Due to the limitation and disintegration of Traditional Chinese medicine, the teaching cannot meet a large number of students' experience of traditional Chinese medicine resources, especially rare and precious medicinal materials,

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such as Cordyceps sinensis, antelope horn, bezoar, etc; Due to the growth cycle of medicinal plants, it is impossible to provide samples or living bodies of medicinal plants in various periods.

(2) Special medicinal materials cannot be dissected and observed

Because some drugs have toxicity, they are not suitable for laboratory dissection and observation.

(3) Few practice opportunities and insufficient clinical application ability

Due to the lack of training venues, time constraints and other reasons, students cannot meet the full understanding of TCM decoction pieces, resulting in the lack of identification ability of TCM decoction pieces, thus affecting students' clinical application of TCM decoction pieces；Students lack of scene application and practical practice opportunities for Chinese medicine prescription；Due to the influence of experimental tools, instruments and safety risks, the processing experiments of medicinal materials cannot be carried out, so students' cognition of the processing process of medicinal materials is limited to books.

These problems directly affect and restrict students' understanding and application of the learning content, and affect the development and improvement of students' ability to identify Chinese medicinal materials and TCM decoction pieces as well as their clinical application ability. In order to solve these problems, the "College of educational science and technology" and the "College of traditional Chinese medicine health service" of our University jointly designed and developed the virtual simulation experiment platform of traditional Chinese medicine. The platform mainly relies on virtual reality, multimedia, database, network and other technologies to build high simulation virtual experiment links and experimental objects. Students can carry out experiments in the virtual environment to achieve the learning effect that the real experimental conditions do not have or are difficult to achieve [5]. The specific performance is as follows:

(1) Break through the limitation of time and space, effectively solve the problem of experimental number and time, and provide more practice opportunities

The platform uses the network environment to break through the limitation of time and space [6], shorten the experiment cycle, and build a highly simulated virtual experiment environment, enabling students to carry out experimental activities in the virtual environment anytime and anywhere [4]. It is convenient for students to preview before class and review after class, which is conducive to students' independent learning. With the help of three-dimensional technology, the built virtual simulation experiment reproduces the environment of traditional Chinese medicine resources, so that students can span time and space, quickly reach the region where traditional Chinese medicine resources are located, immersively roam in the virtual simulation environment, and feel the distribution of traditional Chinese medicine resources in different regions and different natural conditions [4].

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(2) Stereoscopic display of medicinal materials at different stages to promote students' cognition

Through this platform, students can comprehensively observe the three-dimensional morphology of medicinal plants and the growth and change of different stages, comprehensively grasp their characteristics and improve the identification ability of Chinese medicinal materials.

(3) Environmental protection, comprehensive grasp of Chinese pharmacy professional knowledge

Through this platform, students can easily realize the understanding of valuable and toxic medicinal materials and comprehensively master their characteristics [4].

(4) Reduce experimental costs and risks

The platform constructs the medicinal materials and facilities required by 3d modeling technology, which can save experimental instruments and equipment, avoid the loss of medicinal materials, reduce the experimental cost, and avoid the practical training risks caused by the unfamiliar operation of students in the practical training environment such as the processing of medicinal materials.

(5) Gamification mode, edutainment

The platform adopts the forms of game entry, game roaming and bonus points to carry out virtual experiments, which combine teaching with fun and effectively improve students' ability of identification and practical application of Chinese medicinal materials in a pleasant atmosphere.

II. DESIGN OF VIRTUAL SIMULATION EXPERIMENT TEACHING PLATFORM

2.1 Design of Platform Functional Framework

Starting with the problems existing in the experiment of traditional Chinese medicine, based on the syllabus of traditional Chinese medicine, constructivist learning theory, cognitive learning theory, situational learning theory and autonomous learning theory, and comprehensively considering the learning and psychological characteristics of college students, the function of the platform was planned and designed scientifically and reasonably. The platform is mainly divided into four modules, namely, “understanding of medicinal materials”, “identification of medicinal materials”, “virtual experiment” and “exercise test”. The overall framework of the platform is shown in Fig 1.

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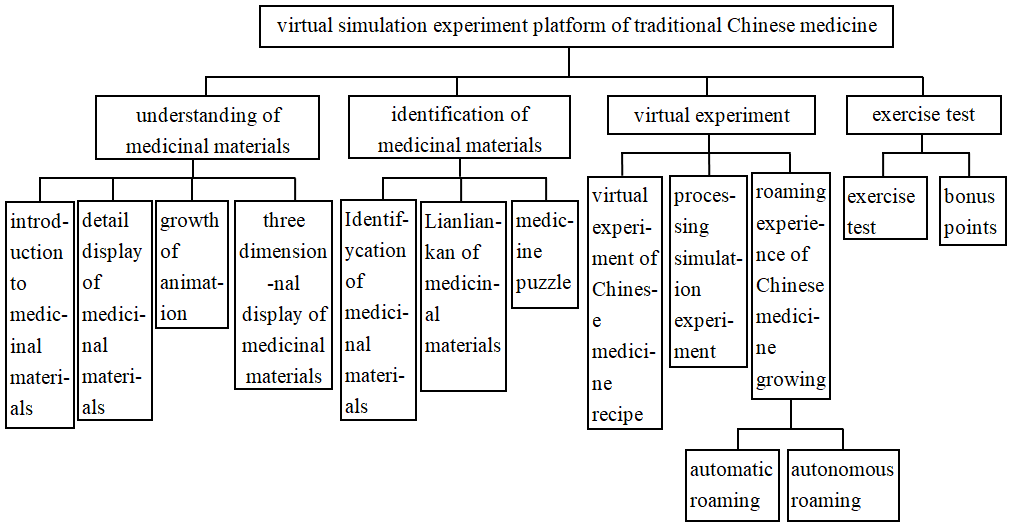

Fig 1: Overall scheme framework of the platform

2.2 Main Function Modules of the Platform

2.2.1 "Understanding medicinal materials" module

This module provides students with relevant knowledge of medicinal materials [2], including detailed introduction of medicinal materials, 3d models of living medicinal materials and animation of their growth process, as well as model display of dried medicinal materials. Voice and text explanations are set up to allow users to zoom in or rotate the model to observe medicinal materials in detail. Through the learning of this module, students can comprehensively observe the three-dimensional morphology of medicinal plants and their growth and changes at different stages, comprehensively grasp the characteristics of medicinal materials, and thus improve their ability to identify medicinal materials. The effect of understanding medicinal materials module is shown in Fig 2.

2.2.2 "Identification of medicinal materials" module

The module of "identifying medicinal materials" mainly uses three-dimensional modeling and animation technology to subdivide the medicinal material models with similar efficacy or shape, so that students can make clear the differences between them and master the identification methods. The module of "identification of medicinal materials" can be divided into three sub-modules: "identification of medicinal materials", " Medicine puzzle" and "lianliankan of medicinal materials ". Among them, the "identification of medicinal materials" sub-module lists the medicinal materials with very similar appearance and characteristics, and distinguishes them for students to identify. The module rendering is shown in Fig 3. The module of "Medicine puzzle" is a small puzzle game, which divides the medicine into nine pieces and randomly displaces the order. Students can click to move the picture and restore the medicine within the specified time to pass the test. "lianliankan of medicinal materials " module is a

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lianliankan small game, when the same medicine to move together, click them can be eliminated. These two modules strengthen students' memory of medicinal materials and improve their ability to identify medicinal materials through fun games.

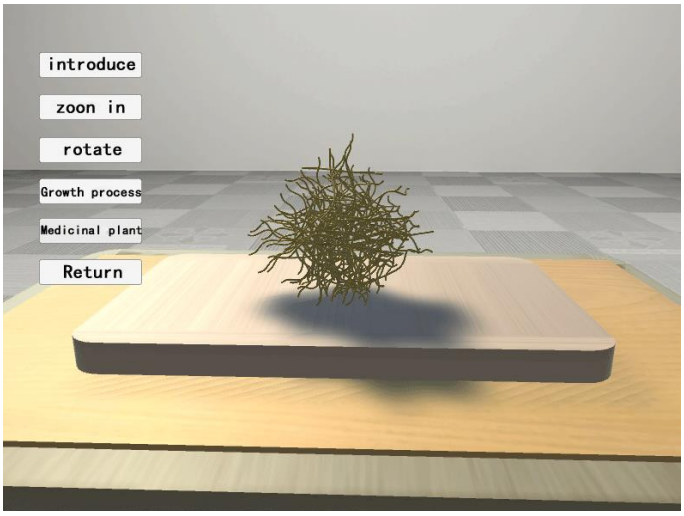

Fig 2: Effect diagram of "Understanding Medicinal Materials" module

Fig 3: Effect diagram of "Identification of Medicinal Materials" sub-module

2.2.3 “virtual experiment” module

This module includes three sub-modules: "Virtual experiment of Chinese medicine recipe", "simulation experiment of Chinese medicine processing process" and "roaming experience of Chinese medicine growing environment". "Virtual experiment of Chinese medicine recipe" is divided into eight difficulty gradients. Experiments at lower levels of difficulty can challenge experiments at higher levels of difficulty,

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as shown in Fig 4. The platform provides scenario simulation of TCM prescription formulation. After entering the formula formulation experiment, students can feel the situation of dispensing medicine in the TCM clinic.

Students choose the role (doctor or patient), and the virtual doctor starts to fill in the medicine and measurement after asking the virtual patient's symptoms. When filling in the medicine correctly, the link of "drug dispensing" will be entered. If you fill in the wrong information, the platform will prompt you and give feedback, and students can re-challenge or quit the challenge and re-learn the basic knowledge. After the prescription is filled in correctly and the required medicinal materials are selected from the similar medicinal materials library provided by the system, the dispensing is successful. At this time, you can enter the next level. If the wrong medicine is selected, the platform will give feedback, prompting to challenge again or exit the virtual experiment. The roaming scene of TCM clinic is shown in Fig 5, the simulation of doctor-patient conversation is shown in Fig 6, the procedure of filling prescriptions is shown in Fig 7, the feedback interface of the platform is shown in Fig 8, and the procedure of "drug dispensing" is shown in Fig 9.

Fig 4: Interface of "Virtual experiment of Chinese medicine recipe"

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Fig 5: Roaming scene of TCM clinic

Fig 6: Conversation situation

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Fig 7: Interface of filling prescription

Fig 8: Interface of Platform feedback

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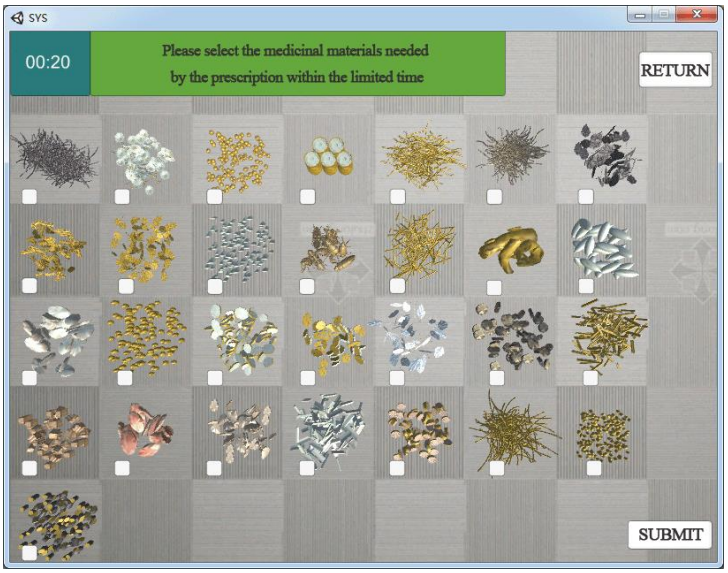

Fig 9: Dispensing scenario

During the virtual processing experiment of traditional Chinese medicine, students can use the mouse to move the experimental object for interactive operation according to the voice and text step prompts. The experimental interface of medicinal material processing is shown in Fig 10.

Fig 10: Interface of virtual experiment of Chinese medicinal materials processing

In "roaming experience of Chinese medicine growing environment ", the medicinal materials that are easy to be confused and have special growth environment are restored to its growth environment, so that students can clearly feel the medicinal materials through intuitive audio-visual channels. The platform provides students with two roaming modes, namely "automatic roaming" and "autonomous roaming". The feature of "automatic roaming" is that the user does not need manual operation, and the camera will move automatically to lead the user to roam in the three-dimensional scene. "Autonomous roaming" allows users to move the scene through the mouse and use the W, s, a and D keys in the keyboard to roam the scene in front, back, left and right. The roaming interface is shown in Fig 11.

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Fig 11: Roaming interface

2.2.4 “Exercise test” module

This module helps students consolidate their knowledge through typical exercises and sets up integral rewards, which can be used to increase the duration of interesting games. The exercise test interface is shown in Fig 12, and the feedback interface after the exercise is completed is shown in Fig 13.

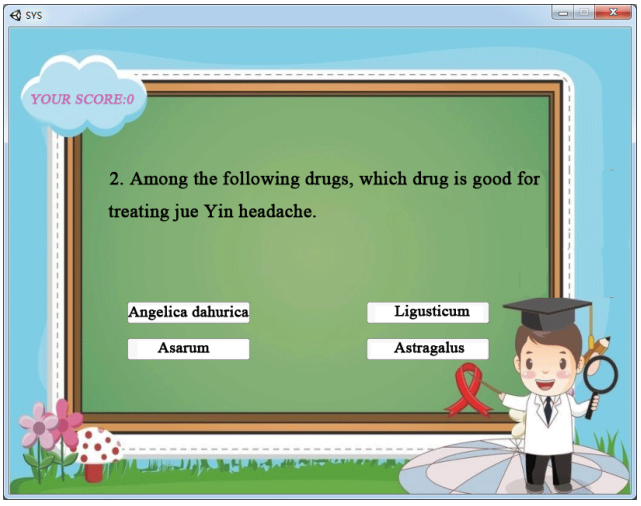

Fig 12: Exercise test interface

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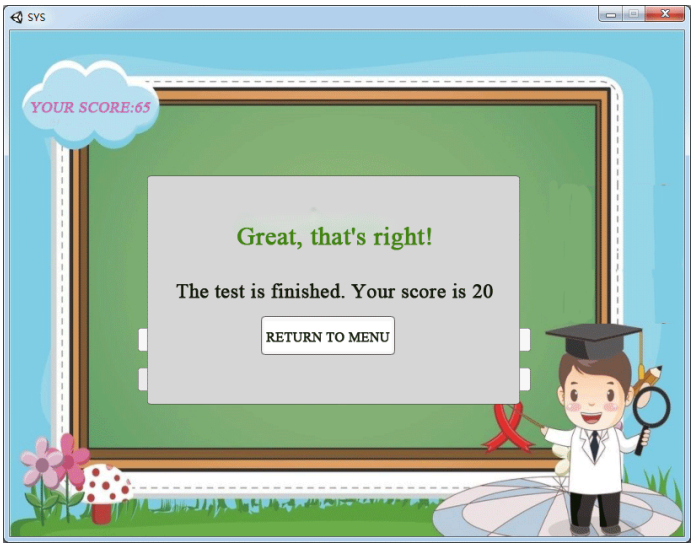

Fig 13: Feedback interface after exercise completion

III. DEVELOPMENT AND IMPLEMENTATION OF VIRTUAL SIMULATION EXPERIMENT TEACHING PLATFORM

3.1 Platform Development Tools

The platform is developed based on B / S architecture, and users use the browser to open the experiment. The server side of the platform is developed using java language and spring boot related framework. MySQL database is used for data storage. Using 3ds Max and C4D to realize the creation of traditional Chinese medicine model and three-dimensional animation on the platform. Photoshop is used to process the relevant pictures and generate the relevant map of the medicinal material model. The animation is synthesized with Premiere software. Unity3d is used as the development platform and c# as the development language to realize the interactive function of the platform [7,8].

3.2 Platform Development Process

Firstly, the functional modules of the platform were planned and designed according to the needs of TCM experimental teaching. Then, the model and scene of medicinal materials were established by 3ds Max. Then Photoshop was used to process the relevant pictures and 3ds Max material editor was used to generate the relevant materials of the medicinal materials model. Then, 3ds Max and C4D were used to generate the growth and 3d animation of medicinal materials. Use Premiere software for animation synthesis and editing, text, voice and other information into the animation; Import the produced model and animation into Unity3D for UI interface design, and use C# as the development language to realize the functions of each module; Design and connect database, configure network; Finally, the platform was tested, optimized and released. The specific development process is shown in Figure 14.

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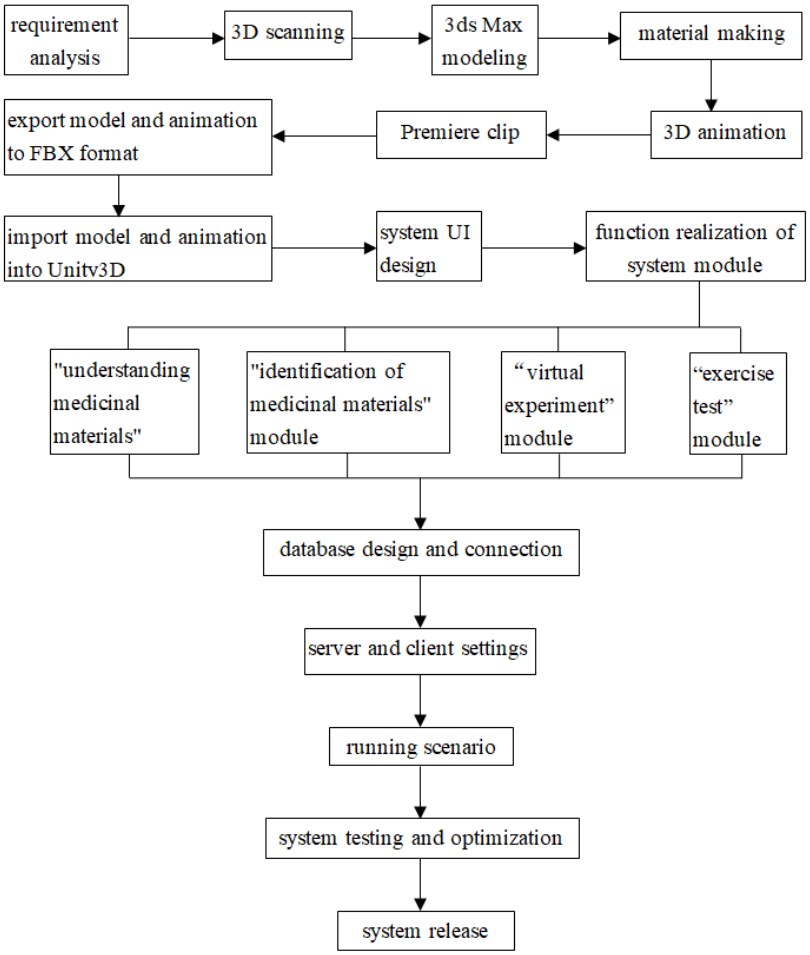

Fig 14: Platform development flow chart

3.3 Implementation of Main Functions of the Platform

3.3.1 Model making

The medicinal material model and the model in the virtual traditional Chinese medicine clinic are mainly realized through the basic modeling, two-dimensional modeling, composite object modeling and polygon modeling methods in 3ds Max [9]. Materials are mainly done through the material editor in 3ds max. The character model in the virtual traditional Chinese medicine clinic is mainly realized by the polygon modeling method in 3ds max. The modeling of character clothing is based on the body of a character, choosing parts of the body, making basic models of clothing and shoes through zoom and extrusion operations, and then adjusting the shape to make the outline more natural. Character actions mainly use the biped bones in 3ds Max to align with the model, and add the skin command to the model for skin operation. The movement posture of human body is made by moving and rotating. Figure mapping mainly uses Bodypaint 3D software and digital board. Draw the map of the person's skin, hair and clothing on the three-dimensional model or UV map, and draw the three-dimensional feeling of the map with bright

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and dark colors.

3.3.2 Animation production

The display animation of medicinal material model is mainly realized by the method of key frame animation in 3ds max. The animation of medicinal material processing is realized by C4D, which mainly involves displacement rotation animation, fluid animation, flame combustion animation, liquid adhesion animation and ripple animation. Displacement rotation animation is achieved by keyframing. The flame burning animation is realized through particle and melting ball effects. Liquid adhesion animation is realized by melting the ball effect. Ripple animation is realized by displacement effector. In the animation of pouring water from a water cup, the effect of running water is realized by three tools: particle, melting ball and spline constraint.

3.3.3 Scene construction

Import the required models into Unity, and arrange these models in the new unity scene according to the level and specified location.

3.3.4 UI interface construction

The interface design of the platform uses the NGUI system provided in Unity. This provides many powerful UI interface display elements. The platform uses canvas, button, rawimage, text and panel in UI interface layout.

3.3.5 Platform interaction function

Scene jump is implemented using the method of the SceneManager class. The mouse click event is implemented by OnClick function. Rotate the model using the Rotate method. Encapsulated exercises are implemented using the data dictionary IDictionary class. The interactive animation of medicinal material processing is realized by the method of animation class. The timer function is implemented by Mytimer custom timer class. Dragging objects is implemented using the DragItemScript class.

IV. THE CHARACTERISTICS OF THIS VIRTUAL SIMULATION EXPERIMENT TEACHING PLATFORM

4.1 Providing an Experiential Learning Environment

The platform makes full use of 3D animation, 3D roaming, 3D interaction and other technical means to build a high simulation three-dimensional shape of traditional Chinese medicine decoction pieces, virtual experimental environment, traditional Chinese medicine resource growth environment, three-dimensional shape of medicinal plants and their growth changes in different stages. With the help of the platform,

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students can comprehensively observe the characteristics of medicinal materials and improve the identification ability of Chinese medicinal materials. The platform presents the environment of TCM resources in different regions and natural conditions in an immersive way. It not only helps students to master knowledge deeply, but also increases their emotional identity. It is beneficial to cultivate students' moral sentiments and professional feelings to love the motherland and the cause of TCM.

4.2 Experimental Content Integrating Knowledge, Comprehensiveness, Challenge and Interest

The experimental content is closely related to the teaching material and outline of Traditional Chinese medicine, and the relevant knowledge and application of medicinal materials are designed in the form of three-dimensional, which helps students to solve the cognitive blind spot caused by the lack of materials in the experimental class and improve the ability of TCM identification. The virtual simulation experiment of Chinese medicine recipe shows the comprehensive, challenging and interesting experimental content. The experiment set up a formula experiment with increasing difficulty. By simulating clinical situations and providing patients with symptoms, let students practice situational prescription formation in the form of games. In the experiment, "medicine puzzle", "Medicine lianliankan", "scene roaming" in the way of game, and exercise test in the form of integral were added to increase the interest and challenge, improve students' interest in learning, and make students fall in love with learning.

4.3 Highlighting the Cultivation of Clinical Ability of Traditional Chinese Medicine

The platform improves students' clinical application ability of traditional Chinese medicine through comprehensive prescription virtual experiment and processing experiment.

4.4 Diversified Evaluation System

The platform adopts the value orientation of paying equal attention to goal and process, and comprehensively evaluates students' learning process, effect and non-intellectual factors closely related to learning in an internal and external combination and open evaluation method. In the experiment, the platform reviews and judges the students' operations, gives feedback and tips, and comprehensively evaluates their learning process, effect and thinking ability. The experimental steps are linked and interact with each other, so that the experimental results are diverse and reflect the open assessment and evaluation method. Integrating assessment into learning not only increases the difficulty of learning, but also mobilizes students' learning initiative, reflecting the spiral learning process.

III. CONCLUSION

The platform has been used for three years by all the freshmen majoring in Traditional Chinese medicine in Shanxi Datong University. In the process of teaching and experimental application, we have adopted the forms of students' group study, answer questions and game competition, situation simulation, dialectical group, discussion and so on, and achieved good results. With the help of this platform, it not

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only effectively solves the problems existing in the practice teaching of Traditional Chinese medicine, such as the shortage of materials of traditional Chinese medicine, the difficulty of obtaining precious specimens, and the inability to provide specimens or living bodies of medicinal plants in various periods, but also improves the enthusiasm of students and arouses their interest in learning. In this way, students can acquire a comprehensive understanding of Chinese medicine in an immersive environment and improve their clinical application ability of Chinese medicine. The comprehensive virtual simulation experiment of Traditional Chinese medicine has been identified as a provincial virtual simulation experiment teaching project in 2021.

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REFERENCES

[1] Zhao Chunli, ZHOU Yongqiang, ZHOU Tao. Open experiment teaching promotes the cultivation of professional ability of Chinese pharmacy undergraduates: A case study of quality control of Gastrodia elata before production. Chinese traditional medicine modern distance education, 2019,17(04): 143-145.

[2] Yan Xuehua, Liu Hongbing, Hu Hao. Research on experimental teaching of Traditional Chinese Medicine. Chinese ethnic and folk medicine.2013,22(14).

[3] CAI Yu, YUAN Yueling. A preliminary study on the training mode of innovative TCM talents. Chinese ethnic folk medicine, 2017,26(21): 123-125.

[4] Yao Weifeng, Bao Beihua, Zhang Li. Construction and practice of virtual simulation experiment teaching system of Chinese pharmacy. Pharmaceutical education, 2015,31(06): 39-43.

[5] Ma Liya, ZHANG Dawei. Based on virtual simulation teaching platform, TCM simulation practice teaching center is constructed. Journal of traditional Chinese medicine, 2016,22(21): 123-125.

[6] Wang Jing, DING Fei, Qiu Xiaohang. Application of virtual simulation technology in ICP-OES experiment teaching. Experimental Technology and Management, 201,38(05): 145-148.

[7] Wang Li. Design and implementation of 3d virtual campus roaming simulation system based on Unity3D. China Education Informatization.2016, (09) : 60-63.

[8] WANG L. Design and Implementation of 3D Virtual Campus Online Interaction Based on Untiy3D// 2019 IEEE 3rd Information Technology, Networking, Electronic and Automation Control Conference (ITNEC 2019). IEEE,2019:2066-2070.

[9] WANG L. Design and Realization of Scenes of 3D Virtual Digital Library//IOP Conf. Series: Journal of Physics: Conf. Series 1187 (2019) 052060. doi:10.1088/1742-6596/1187/5/052060