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Short Commentary

Application Analysis of VR Technology in Practical Teaching of Medicinal Plant

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Abstract

The restrictions of the class time, location, and phenology are the difficulties in the traditional practice teaching of medicinal plants. The advantages of virtual reality (VR) technology can enrich and improve the practice teaching of medicinal plants. After analysing the limitations of the traditional ways of the practice teaching of medicinal plants and the advantages of VR technology, it is suggested that VR technology contributes positively to the students' self-learning process in the entire knowledge system, visualise and concretise the abstract knowledge in the practice teaching of medicinal plant, and strengthen the ecological protection around the practice based on medicinal plant. Through the analysis of the application ideas of VR technology in the experiment and practice of medicinal plants, it can be concluded that VR technology can address various issues in the traditional practice teaching process of medicinal plants.

Keywords: medicinal plant, practice teaching, VR technology, application

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1 INTRODUCTION

Medicinal plant is an important professional basic course for traditional Chinese medicine (TCM), resources and development of Chinese medicine, cultivation and identification of Chinese medicine, pharmacy and other related majors. Its teaching content includes microscopic structure, morphology, classification, and identification of medicinal plants[1]. To provide new theories, knowledge, and technology for solving the new problems in TCM resources, the "14th Five-Year Plan" textbook for Higher Education of Chinese Medicine Profession, edited in chief by Professor Chunsheng Liu from Beijing University of Chinese Medicine and Professor Wei Gu of Nanjing University of Chinese Medicine, added the content of growth and development quality formation of medicinal plants and new resources of medicinal plants[1]. In addition to the theoretical teaching of medicinal botany, experimental courses and practical courses related to medicinal plants are also offered.

The main purpose of the practice course on medicinal plants is to help students consolidate their knowledge of the microscopic structure and characteristics of the organs of medicinal plants and the taxonomy of medicinal plants

taught in the theoretical course, master the general methods of collecting, preparing, and identifying plant specimens, and understand the characteristics of medicinal parts and the formation of medicinal properties[2]. Practice courses can consolidate and expand the classroom teaching content, and improve students' practice ability in field conditions and students' overall quality[3]. However, the traditional practice of medicinal botany faces numerous difficulties, such as the unavailability of long experiments in laboratory classes, and the vulnerability of the implementation and effectiveness of herb harvesting practice to factors such as phenology, weather, teachers, funds, and class hours[4,5]. The above adverse factors all compromise the practice effect of medicinal botany at varying degrees.

The emergence of virtual reality (VR) technology can provide a new solution for the practical teaching of medicinal plants. Introducing VR-related technology and equipment into the practical teaching of medicinal plants has great significance to solve problems and improve the effectiveness of the practical teaching of medicinal plants.

2 PROBLEMS EXISTING IN THE PRACTICE TEACHING OF MEDICINAL PLANTS

2.1 Time-consuming Techniques are Difficult to Practice and Consolidate in the Medical Plant Experiment Class

The experimental course of medicinal plants mainly includes training and mastering the knowledge and related technologies of microscopic structure characteristics, morphological characteristics, classification, and identification of medicinal plants. Temporary section, frozen section, and paraffin section techniques are important in the microscopic structure of medicinal plants. The temporary section and frozen section can be done in the lab class. However, paraffin sectioning involves multiple steps, such as material selection, fixation, immersion, dehydration, transparency, and embedding, which may require days of experiments. Therefore, video demonstration is the most available method for students to learn about paraffin sectioning in most colleges and universities.

2.2 The Time and Place of Practice in Collecting Medicinal Plants Limit the Effect and Quality of Practice

The practice of medicinal botany in most colleges lasts for two weeks. The internship site is also limited to areas around the school where medicinal plants are abundant. Due to the concentrated internship in a certain period, students cannot see the flowers and fruits of many plants in many cases.

Although our teaching team has summarised the rules and methods for classifying and identifying local plants in non-flower and fruit periods[6], limitations still exist due to the availability of flowers and fruits of the plants. Furthermore, financial and site constraints prevent students from observing the characteristics of medicinal plants outside their local area and experiencing the formation of medicinal properties of Chinese material madica[3], for which the quality of the practice of picking medicinal plants is also compromised.

2.3 The Practice of Medicinal Plants Has Affected the Local Ecological Environment to Different Degrees

Collection and preparation of plant specimens are essential in the practice teaching of medicinal botany[7]. It also includes the collection, identification, and specimen making of medicinal parts. To protect the locally rare plant resources and the local ecological environment, the concept of protecting both plants and the ecological environment is carried out throughout the practice. However, these restrictions adversely undermine the effect and quality of practice in medicinal botany and affect the local ecological environment to different degrees.

3 VR TECHNOLOGY AND ITS ADVANTAGES IN THE PRACTICAL TEACHING OF MEDICINAL BOTANY

VR technology is a computer technology that uses graphical resources and operating system to reconstruct a virtual environment and integrates relevant feedback information into the simulated environment to interact with users and operating system[8]. Immersion and interactivity are the most prominent features of VR technology. These features enable VR technology to break through the limitations of time and space in the teaching process, realise on-site experience, and enable participants to acquire knowledge and skills through their interaction with the system[9].

VR technology can be used to construct the growth environment, growth and development process, and microscopic structure characteristics of medicinal plants that are difficult to realize in reality. Hence, students can obtain real and complex knowledge and skills and understand the relationship between the growth environment and the formation of medicinal properties of medicinal plants. At present, many subjects have established online VR labs or hands-on training scenarios[10-13]. These provide a reference for the establishment of a VR system for the practical teaching of medicinal plants.

3.1 VR Technology Can Strengthen the "Student-Oriented" Practical Teaching of Medicinal Plants

Traditional practical courses in medicinal botany are generally divided into three steps. The first step is to arouse students' memory of theoretical knowledge by following the summary of the theoretical knowledge with teachers. Students are required to conduct practical courses based on the theoretical knowledge. The second step is the demonstration. The instructor demonstrates the operation process and precautions during the operation, and explains

the characteristics and classification basis of medicinal plants. The third step is practical operation. Students learn the knowledge and technology of microscopic structure and classification characteristics of different tissues and organs of medicinal plants, classification, and identification of the medicinal plants. However, due to the short duration and large content of practical teaching of medicinal plants, students are stressed in learning and have poor knowledge mastery[14]. The introduction of VR technology can combine theoretical knowledge and experimental skills of medicinal plants with teaching practice, allowing students to explore the entire knowledge acquisition process on their own, thereby establishing a "student-oriented" model of independent practice[15].

3.2 VR Technology Can Visualize the Abstract Knowledge of Medicinal Botany

Theoretical knowledge of medicinal botany is abstract, such as the types and characteristics of primary and secondary structures of roots and stems, and the formation and structure of fruits of medicinal plants. Structural characteristics of medicinal plants' roots and stems can be observed in experimental classes through temporary or permanent sections. However, due to the reasons of experimental time, most schools only offer observation under characteristic conditions, and the development process is taught through theoretical explanation. VR technology can present the development process of different organs of medicinal plants by introducing virtual simulation or animation, which reduces the difficulty of teaching and helps students understand the development and characteristics of organs.

3.3 VR Technology Can Increase the Protection Condition of Ecological Environment in the Process of the Medical Plant Practice

The main purpose of medicinal botany practice is to enable students to master the knowledge and skills of medicinal plant classification and the characteristics of medicinal plant organs and understand the relationship between the formation of medicinal herbs properties and the growth environment. In those processes, the collection of medicinal plant specimens is important. In practice, students may not be able to identify plants in the protected list due to weak knowledge of plant classification, resulting in the destruction of protected plants during practice[13]. VR technology combines virtual and real situations to enable students to conduct simulation training for the knowledge and technology of specimen making and identification in the process of medicine picking practice and the characteristics of protected plant species around the medicine picking practice base and understand the ecological environment features around the medicinal plant, without destroying protected species. On the premise of reducing the interference to the local ecological environment, the practical training purpose of medicinal plant harvesting practice can be achieved through the VR system.

4 IMPLEMENTATION IDEA OF VR TECHNOLOGY IN PRACTICAL TEACHING OF MEDICINAL BOTANY

According to the characteristics of VR technology, the VR practical teaching platform for medicinal plants can be composed of three parts, including a three-dimensional immersive display system, a simulation interactive system, and VR development system. The three systems of the VR practical teaching system of medicinal plants can provide students with an immersive and interactive virtual learning environment and simulation learning experience.

4.1 Case Analysis on the Application of VR Technology in Medicinal Plant Experiment Course

The main objective of the experimental course on medicinal plants is to teach the use of morphological features, microstructure and cytological characteristics of medicinal plants to identify the botanical origin of herbal medicines. Paraffin sectioning is one of the main techniques for observing the microscopic characteristics of medicinal plants. Its advantages include sufficiently thin and continuous sections with high clarity and accuracy for long-term preservation, while its disadvantages include the long duration of the experiment and the complexity of the operation, resulting in difficulties in implementing the technique in the experimental teaching process. Therefore, VR technology is most needed to simulate the operation in the experimental course of medicinal plants.

4.1.1 Design of VR System for Paraffin Section Technology

The paraffin section experiment consists of 13 operation steps, including sampling, infiltration, fixation, air exhaust, dehydration, transparency, wax-dipping, embedding, sectioning, gluing, dewaxing, staining, and sealing. Infiltration needs to be determined by students according to the material conditions. Dry materials need to be infiltrated, while fresh materials are omitted from infiltration. The other 12 items are mandatory in reverse order.

4.1.2 Parameter Selection of VR System in Paraffin Section

Before the operation, students should be familiar with the operation process and the experimental principle of paraffin section. After the preparation of the experimental program, the specific parameter setting operation can be started. The sampling module mainly includes fresh and dry materials, which are shown with pictures. Dry materials need to be infiltrated, while fresh materials are omitted from infiltration. There are two sub-modules for setting parameters of the fixation module, sampling reagent, and processing time. There is no other sub-module under the air extraction module. The dehydration module and

transparency module are more complex, including the reagent sub-module, reagent concentration sub-module, and duration sub-module, and need to be carried out in order during operation. The wax immersion module consists of three sub-modules: reagent, temperature, and time, while the embedding module mainly includes two sub-modules: temperature and duration. The section module includes the section thickness and the section angle of the slicer. The adhesive module consists of three sub-modules, experimental supplies, reagent selection and operating temperature. Dewaxing includes three sub-modules: reagent, duration and treatment times. The dyeing module includes three sub-modules: reagent, concentration and processing time. The selection order cannot be changed. The last module is encapsulation, which mainly includes two sub-modules, which are reagent selection and label sub-modules.

4.1.3 Paraffin Section's VR System Operation

After the experimental parameters are set, the experiment is started according to the system prompts. The corresponding modules are placed on the left side of the interface, and the name of the required materials and reagents are located on the right side of the interface. After each operation is completed, the reagents, concentration and processing time required for the next step are selected according to the system instruction, text prompts, or the color changes of items. Only the correct operation is done, the next module or sub-module can be started. After all experimental operations are completed, the system will prompt whether to submit or not, and the evaluation results will be displayed after submission.

4.2 Application Case Analysis of VR Technology in Practice Teaching of Medicinal Plants

The classification and identification of medicinal plants and specimen-making are the main knowledge and skills that students need to master during practice. However, due to phenology, ecology, and species protection, it is difficult to collect or observe the reproductive organs or medicinal parts of the plants. VR technology enables students to complete the train of picking herbs and improve the knowledge and skills of classification and identification of medicinal plants under simulation through the combination of three systems, namely a three-dimensional immersive display system, a simulation interactive system, and VR development. According to the purpose and requirements of practice teaching, VR system of virtual herbs picking can be constructed, and it includes two modes, virtual simulation learning, and examination of medicinal plants.

4.2.1 Design of VR Learning System for Medicinal Plant Practice

The learning mode of medicinal plant practice includes common medicinal plants in the practice base and the basic plant species system of bulk and valuable plant drugs that are not suitable for growth in the local area. The learning content includes the Chinese name, alias, scientific name, morphological distinguishing features, medicinal site, habitat distribution of each kind of plant, as well as related knowledge links. Pictures can be used to show the identification characteristics of the roots, stems, leaves, flowers, and fruit seeds of medicinal plants. The pictures reflect the characteristics of medicinal parts. The animation can be used to embody the growth and development of medicinal plants. By simulation, the growing environment of medicinal plants and the collection process of medicinal materials can be shown. Thus, the VR learning system for medicinal plant practice can provide conditions for students to experience the relationship between the formation of medicinal materials and their growing environment. In the knowledge link section, the classification status, artificial cultivation and processing, identification characteristics, functional indications and main chemical components of the medicinal plants can be found.

4.2.2 Design of VR Examination Mode for Medicinal Plant Practice

Based on the practice base, the mode of the medicinal botany picking test builds a virtual field environment of different picking routes, and students can enter the scene by the handle or mouse and identify the medicinal plants in the habitat according to the simulation model of medicinal plants, morphological characteristics, and growth environment provided by the system. The Chinese name and family name and the medicinal parts of the discovered medicinal plants should be given judged within the allotted time. The maximum score is 100 based on the number and accuracy of medicinal plants completed by the student, and students scoring less than 80 are advised to retake the course in the field or in the VR system.

4.3 Feedback on the Application of VR System for Practical Teaching of Medicinal Plants

The VR system for practical teaching of medicinal plants is established, followed by the pre-operation, which mainly examines the fluency, stability and load capacity of the system. Feedback is obtained from the students and instructors after each stage of application, and the VR system of practical teaching of medicinal plants should be upgraded and optimized according to the feedback.

The results of VR system of practical teaching of medicinal plants were investigated by questionnaire. The survey results showed that the respondents believed that the establishment of VR system for practical teaching of medicinal plants could overcome the difficulties encountered in the teaching process and help students to improve their understanding of relevant knowledge of medicinal plants and mastery of techniques. In particular, the addition of the species of medicinal plants that were unsuitable for growth in the practice base increase students' interest in learning.

Thus, the introduction of VR technology can address the difficulties faced by the traditional practical teaching of medicinal plants and improve the effectiveness of practical teaching.

5 CONCLUSION

VR technology has shown great application potential in experiments and practice teaching of various disciplines[10-13]. Therefore, integrating VR technology into the experiment and practice courses of medicinal plants can tackle the barriers in traditional experiments and practice teaching methods of medicinal botany in terms of time, space, phenology, and instrument conditions. It allows students to master the knowledge and technology related to the microstructure and the classification of medicinal plants. The VR system also helps the students to better understand the characteristics of medicinal parts and the medicinal properties formation of medicinal plants.

Using the VR system, we can achieve the teaching objectives of the practice course of medicinal botany efficiently and lay the foundation for cultivating high-quality modern talents for TCM.

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Not applicable.

Conflicts of Interest

The authors declared no conflict of interest.

Author Contribution

Ren G wrote the manuscript; Ren G and Liu C designed the work; Ren G, Bai Z and Xiao Y summarized the advantages of the VR system; Ren G, Xiao T and Ci R analysed the limitation of the traditional practice teaching of medicinal plant.

Abbreviation List

TCM, Traditional Chinese medicine

VR, Virtual reality

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