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Teaching Reform and Practice of Functional Experiment Based on the Cultivation of Excellent Medical Talents

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Abstract

In order to cultivate excellent clinical medical talents with a solid foundation, strong literacy, refined skills, excellent communication abilities, innovative thinking, and a strong focus on practicality, functional experiments have undergone a series of reforms in areas such as constructing new curriculum systems, improving teaching content, updating teaching equipment, introducing new teaching models, and enhancing teaching evaluation systems.

Keywords

Functional Experiment, Excellent Medical Talents, Reform and Practice

1. Introduction

With the continuous development of medical education, cultivating medical talents with outstanding abilities has become an important goal of higher education. The Department of Medical Functionality at Changjiang University actively responds to the Ministry of Education and the Ministry of Health's Excellent Doctor Education and Training Program, and has carried out in-depth teaching reform and practice for the course of functional experiments. The aim is to build a scientific and reasonable experimental teaching system, cultivate students' hands-on and innovative abilities, and adapt to the needs of clinical medical development [1].

Functional experiment takes the whole animal and isolated organs and tissues as the main experimental objects, studies the normal function of the organism, the mechanism of disease occurrence and the law of drug action, integrates the

experimental teaching content and means of physiology, pharmacology and pathophysiology and other functional disciplines, and it is an experimental discipline with strong specialization and practicability, and it is also an important part of the experimental science of medical science, and it is the foundation and cradle of training the students to do hands-on and innovation ability, and it is also the foundation and cradle of cultivating the students to have the ability to do hands-on and innovation. It is also an important part of medical experimental science, the foundation and cradle of cultivating students' hands-on and innovative ability, and also an important platform for cultivating students' scientific research ability [2]. As one of the beginnings of the reform of medical experimental teaching, the experiment of functional science is a hot spot of reform in colleges and universities. A number of domestic universities have successively set up functional science laboratories, and constructed a progressive, hierarchical experimental teaching mode consisting of basic, comprehensive, and design (or innovative) experiments, forming their own characteristics [3]. In recent years, the role of practical education has been increased, combined with animal experiments, learning the relevant principles of bioethics, advocating reverence for life, and enhancing the humanistic spirit of medicine. At the same time, due to the rapid development of information technology, virtual simulation experiments, as a supplement to real experiments, have intelligence, simulation, image and fun, fully mobilizing the enthusiasm of students to learn [4]. The reform of experimental teaching of functionalism is beneficial to the cultivation of excellent talents in clinical medicine.

2. Ease of Use

2.1. Reform of Curriculum System and Teaching Content

Adhere to the student-centered teaching philosophy, integrate ideological and political work education into the entire process of experimental teaching, and cultivate students' clinical thinking and innovative abilities by constructing a progressive and hierarchical experimental teaching model composed of basic, comprehensive, and design experiments.

2.1.1. Enhancing Ideological and Political Education in the Curriculum

The clinical medicine excellent talent training system proposes the educational philosophy of "educating people as the foundation, moral education as the priority, ability as the focus, and innovation as the soul." To implement the educational philosophy of "educating people as the foundation and moral education as the priority" in the teaching process, ideological and political education is integrated throughout the teaching of functional sciences experiments. A "monument" is erected to commemorate the animals that sacrificed themselves for the exploration of life science. On April 24th of each year, which is the "World Laboratory Animal Day," students are organized to visit the graves and lay flowers for the experimental animals. During the first class of functional sciences expe-

riments, students are organized to observe a moment of silence for the experimental animals, educating them to treat the animals kindly, learn to be grateful, cherish life, and strictly abide by the 3R principles of Animal Ethics. During the experimental process, such as when accidents occur during anesthesia or surgery of experimental animals, students are trained in emergency handling skills to cultivate their humanitarian spirit of saving lives and curing injuries [5].

2.1.2. Implementing the Student-Centered Teaching Philosophy and Returning the Initiative of Learning to Students

In the teaching process of functional sciences experiments, based on the existing basic, comprehensive, and design-oriented experimental teaching system, we introduce CBL, PBL + flipped classroom teaching. The teaching process always adheres to the principle of heuristic teaching, guiding and motivating students to engage in online autonomous learning of micro-lectures and practice using virtual simulation experiments before class. This helps them familiarize themselves with experimental methods, improve the success rate of experiments, and save experimental animals. While imparting skills to students in class, we also focus on cultivating their hands-on abilities and developing their innovative consciousness, fully mobilizing their enthusiasm and initiative in learning.

2.2. Innovation in Teaching Modes and Methods

Based on the training objectives of outstanding clinical medical talents, develop a reasonable teaching plan and outline, appropriately increase the proportion of comprehensive and design experiments, reduce the number of basic experiments, and combine case discussions to enhance students' understanding of disease mechanisms and drug use patterns.

2.2.1. Basic Experiments

The teaching method integrates "online + offline" teaching with a combination of virtual experiments and real experiments. Students' online learning includes an overview of functional science experiments, laboratory safety education, animal ethics, virtual simulation laboratories, RM6240 biosignal acquisition and processing system, and an introduction to the human physiology experimental system. Offline learning focuses on basic animal experimental techniques, such as: 1) Frog experiments: preparing sciatic nerve-gastrocnemius muscle specimens, exploring the effects of different stimulus intensities and frequencies on skeletal muscle contraction, guiding nerve trunk action potentials, measuring conduction velocity and refractoriness, and studying the impact of drugs, as well as premature contractions and compensatory pauses. 2) Rabbit, mouse, and rat experiments: mastering techniques for handling, weighing, and administering drugs to experimental animals, tracheal intubation, carotid intubation, ureter intubation, and observing animals with unilateral cerebellar removal.

Through this stage of learning, students master the basic theoretical knowledge and experimental skills of functional science experiments, cultivating their

hands-on abilities and laying a foundation for subsequent comprehensive and design-oriented experiments. However, there are certain limitations in cultivating students' comprehensive analytical and innovative abilities. Additionally, students receive education on laboratory safety, animal ethics, and humanities during this stage, encouraging them to cherish experimental animals, be grateful, and respect and cherish life.

2.2.2. Comprehensive Experiments + Case Discussions

The teaching content for this phase includes: 1) Regulation of respiratory movement and experimental pulmonary edema, with synchronized recording of diaphragmatic discharge, observation of intrathoracic negative pressure and pneumothorax + case discussions. 2) Tracing of animal electrocardiograms, regulation of animal blood pressure, and the effect of drugs on blood pressure, with synchronized recording of vagus nerve discharge; hemorrhagic shock in rabbits and its treatment + case analysis. 3) Factors influencing urine production, diuretic effects of drugs + case analysis; kidney failure induced by liquid paraffin. 4) Preparation of specimens of isolated small intestine smooth muscle, physiological characteristics of isolated intestinal tubes, and the effect of drugs on the intestine. 5) Impact of different dosages on drug effects, determination of salicylate sodium half-life + case analysis. 6) Effects of different routes of administration on magnesium sulfate, antagonism between calcium and magnesium, and determination of the median lethal dose (LD50) of drugs. 7) Biological factors influencing cardiac output, and the effect of lidocaine on arrhythmias induced by barium chloride in rats.

The teaching methodology combines "online + offline" instruction before, during, and after class. Before class: virtual simulation experiments (for preview) and case studies (for materials research). During class: case discussions combined with real experiments and virtual simulation experiments. After class: virtual simulation experiments (for review). In clinical case discussions, teachers guide students to obtain relevant information from the evolution of the condition, explain clinical phenomena using basic knowledge, explore the pathogenesis of diseases and the principles of drug action, cultivate students' clinical thinking, and enable them to have early exposure to clinical practice. This truly embodies the teaching philosophy of "early clinical exposure, more clinical practice, and repeated clinical experience" for cultivating excellent medical talents. Through this phase of learning, students can proficiently master and apply experimental methods and skills in functional science, learn to observe complex experiments, record and statistically analyze experimental data, improve their ability to comprehensively apply knowledge, analyze and solve complex problems, and write high-quality experimental reports. They also cultivate a rigorous work style and logical thinking methods. At the same time, students' interest in learning and innovative thinking abilities are also stimulated.

2.2.3. Design-Oriented Experiments

To achieve good results in design-oriented experiments, both students and su-

pervising teachers need to attach great importance to them and actively participate. The basic procedures for design-oriented experimental teaching are as follows: 1) Teachers teach the basic theories and methods of scientific research design in advance (through micro-video learning) and provide the research scope (such as heart failure, respiratory failure, acute renal failure, etc.) and general ideas for design-oriented experiments, in order to reduce blindness and facilitate the preparation of experimental animals. 2) Students search for relevant materials in groups (five people per group). 3) Based on the materials, students design the experiment and submit a written design report. 4) Conduct a feasibility demonstration for the experimental design. 5) Students prepare for the experiment (including pre-experimentation). 6) Implement the experiment, collect data, and conduct statistical analysis. 7) Write a research paper. 8) Conduct a paper defense (with the requirement of making a PowerPoint presentation). 9) Summarize the problems throughout the process for improvement in the next year. Design-oriented experiments involve students independently completing all aspects of the experiment, including topic selection, objectives and principles, procedures, and results. The aim is to help students understand the basic procedures of functional science experimental research, initially master the methods and knowledge of literature retrieval, experimental design, experimental data collection, statistical processing, and paper writing, train their scientific research and innovative thinking, and establish a sense of teamwork and collaboration. The drawback of this stage is that it can be challenging for five-year undergraduate students. Therefore, professional teachers need to guide students in topic selection and experimental design, which poses higher requirements on the breadth and depth of teachers' knowledge [6].

2.3. Introduction of New Teaching Models

Combining teaching methods such as CBL (Case Based Learning) and PBL (Problem Based Learning), introducing modern teaching methods such as flipped classrooms, guiding students to learn independently and explore collaboratively, and improving learning outcomes.

To further enhance the effectiveness of practical teaching, better guide students in autonomous learning, and adapt to the integration of modern information technology with education and teaching, we have adopted a teaching model that combines online and offline teaching, specifically the flipped classroom approach. Before class, teachers upload the experimental teaching outline, lesson plans, micro-videos, practice questions and answers, case discussions, supplementary materials, and PowerPoint presentations to a learning platform such as Yu Ketang. Students can access these resources anytime, anywhere using their phones or computers and ask questions online, which teachers can answer and discuss. Additionally, through virtual laboratories, students can preview experimental objectives, principles, procedures, phenomena, videos, virtual simulations, and test questions, and engage in virtual operations on a one-to-one basis for repeated practice.

3. Improvement of Teaching Evaluation System

3.1. Improve the Evaluation System

Establish a diversified teaching evaluation system, including multiple dimensions such as student self-evaluation, peer evaluation, and teacher evaluation, to comprehensively evaluate the learning effectiveness of students and the teaching quality of teacher [7].

3.2. Emphasis on Process Evaluation

Emphasize the performance of students in the experimental process, including experimental design, operational skills, team collaboration, innovation ability, etc., and promote the comprehensive development of students through process evaluation.

4. Conclusion

Through the teaching reform and practice of "Functional Experiments", the Department of Medical Functionality at the School of Medicine of Changjiang University has successfully constructed a scientific and reasonable experimental teaching system, effectively enhancing students' hands-on and innovative abilities, laying a solid foundation for cultivating outstanding clinical medical talents with "solid foundation, strong literacy, refined skills, good communication, innovation, and practicality". In the future, the department will continue to deepen teaching reform and explore experimental teaching models and methods that are more in line with the development needs of clinical medicine.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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