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Research on the Experimental Course based on the Students of Cultivation in Scientific Research Ability—The Experiment of Environmental Engineering Microorganism

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Abstract: The experiment of Environmental Engineering Microbiology has the characteristics of strong practicality and application. The teaching mode of microbiology experiment with teachers as the leading role and confirmatory experiment, and the main content cannot meet the needs of students' study. Taking the environmental engineering microbiology experiment as an example, this paper analyzes the ideological education elements of the course from the aspects of course design, dialectical thinking, and environmental protection awareness. And the teaching content of course was updated, the teaching methods were optimized, and the process assessment methods were strengthened. At the same time, a practical teaching system was explored and constructed, which is in accordance with the cultivation of innovation and entrepreneurship abilities as well as practical skills. The aim is to provide ideas for the training of application-oriented talents with both high moral standards and high-quality skills.

1. Introduction

"Environmental Engineering Microbiology Experiment" is an experimental course based on the theory course of environmental engineering microbiology, and the setting of the experiment mainly focuses on understanding and cognizing the morphological structure of microorganisms, as well as mastering the growth pattern and derivation laws of microorganisms in air, water, soil and other media. There are many problems in the teacher-led teaching mode. (1) The experimental subjects mainly focus on verification rather than comprehensive exploration, and students lack the thinking ability for scientific research. (2) Students do not have a deep understanding and mastery of experimental technology, and their overall planning for the experimental projects is not meticulous enough. (3) Students tend to be overly dependent, lack an exploratory spirit, and are short of initiative and flexibility. Therefore, it is imperative to carry out the reform of the experimental courses to establish a teaching system with scientific research thinking based on the experience summary of microbiology experiment teaching practice. From the form, method, and means of teaching, students are the main body, and teachers are guided to participate in the whole process,

fully mobilize students' subjective initiative, cultivate students' scientific research ability and innovation ability, so that teaching and scientific research penetrate each other, so as to lay the foundation for students to have a deeper understanding of the theoretical knowledge of professional courses and cultivate competitive practical talents[1].

2. Enrich the teaching content and establish an "basic-comprehensive -innovative" experimental teaching system

Environmental engineering microbial experiments are usually arranged according to the teaching order of theoretical courses, and pay more attention to the mastery of experimental skills. In order to enhance students' interest and fully master experimental skills, on the basis of the existing experimental teaching system, the order of experimental classes is completely disrupted and reintegrated into three main bodies: the basic experimental section, the comprehensive experimental section, and the innovative experimental section. In the basic experiments, the teaching method is mainly carried out by the teachers. Under the guidance of their standardized operations, students can master the basic experimental principles and key operation steps, and at the same time, they can also receive more comprehensive safety training in the laboratory. For example, microscope observation, use of sterilization pot, operation of ultra-clean workbench, etc. mastery of basic skills such as sterilization, cultivation, domestication, and screening of microorganisms[2]. For example, the use of microscopes, sterilization ovens, and ultra-clean workstations. And the acquisition of basic skills such as sterilization, cultivation, domestication, and screening of microorganisms, also the determination methods for microbial properties such as Gram staining, microbial counting, and dissolved oxygen measurement, etc. For the comprehensive experiments, students are required to connect the learned content, and verify the reproducibility of the experiments on the basis of understanding and mastering the basic experiments. The experimental report with scientific research thinking should be completed independently in small groups, by the method of consulting literature, clarifying experimental ideas, analyzing experimental conditions, determining variables, analyzing data, etc[3]. For instance, in the experiment of identifying the physical and chemical properties of bacteria in the existing soil samples. Students should consult the literature, determine the pre-experiment method, collect and pre-treat the soil, dilute the sample, cultivate, observe, identify, and use the whole process of instruments and equipment, so that students can systematically master the comprehensiveness of the experiment. For innovative experiments, we will interact with students in a variety of forms, and showing the materials accumulated in scientific research or practical engineering problems to students through the laboratory openings and group discussions, etc. Encourage students to design interesting and easy-to-operate experiments. Based on their existing experimental skills, start from practical problems, identify the problems in practice, describe these problems, and analyze how to solve them.Teachers should encourage students to design interesting and easy-to-operate experiments. Based on their existing experimental skills, they should start from practical problems, identify the problems in practice, describe these problems, and analyze how to solve them[4]. For instance, a series of experimental discussions on the use of activated sludge for the secondary treatment of domestic sewage. Students make use of their spare time to consult a large number of documents and independently design experimental plan. Research topics such as the cultivation and observation of nitrifying bacteria, the morphological changes of sludge activity under different pH conditions, the mechanism of nitrogen and phosphorus removal by activated sludge process in domestic wastewater, and the utilization of residual sludge, etc., which are closely related to practical applications have been proposed.

Through the construction of the above experimental system, students' subjective initiative is mobilized, so that students have a sense of participation and gain. They also have enough time and

space to think about and verify the feasibility of the experiment, truly integrate into scientific research thinking, apply what they have learned, and cultivate students' ability and level to serve society and economic development, so as to make them talents with solid theory and innovation and hard work.

3. Construct an open classroom concept and form an online and offline interactive teaching mode

The environmental engineering microbiology experiment course is a course that requires effective communication between teachers and students as well as their close cooperation. The theoretical knowledge should be presented in diverse forms in order to stimulate students' interest.By integrating Internet resources, promoting the coordinated development of inside and outside the classroom, and adopting a combination of online and offline teaching mode, supplementing the lack of a single teaching method, and helping students to understand deeply in a targeted manner can we present satisfactory experimental results. Take the experimental project "Determination of Peroxidase Activity in Soil Rhizosphere Bacteria" as an example. Before class, the teacher sorts out the relevant teaching materials and uploads the experimental topics, experimental requirements, steps, and specific operation videos to the online platform for the students. And the teacher requires students to complete the online tasks during their spare time and to further study with the questions in mind. Students flexibly manage their time and space, conduct self-study, and expand their extracurricular knowledge. At the same time, teachers arrange Q&A online.

In the offline teaching session, group discussions are adopted. Other students take turns to provide comments, raise questions, and the teacher and students propose issues from different perspectives. They engage in brainstorming and explain common problems to form a research mindset, which is conducive to students' efficient thinking. The purpose of classroom teaching is to check the preview effect, improve the experimental plan, and complete the main content of the experiment. For example, in the determination of enzyme activity of soil microorganisms, the core issue discussed by students is the determination of enzyme activity conditions, but through pre-experiments, it is found that the influencing factors are complex, and a single experiment cannot optimize the experimental conditions[5]. For instance, when measuring the enzymatic activity of soil microorganisms, the core discussed issue was the determination of the enzyme activity conditions by the students. However, it was discovered that the influencing factors were complex through preliminary experiments, and a single experiment could not optimize the experimental conditions. Finally, through discussion, it was determined to use orthogonal tests to find the best experimental conditions.

The after-class summary session is still held online, and students are required to write an experiment report, analyze the problems existing in the experiment, and draw conclusions. Experiments are allowed to fail, but the reasons for failure should be analyzed and improvement measures should be proposed. For example, why is the stability of soil enzyme activity poor? Is it because the sampling method is incorrect, or does the method need improvement, or is there an error in the operation? Teachers and students interact online to solve common problems, present the final experimental report, and form a closed loop. Students have improved their learning and induction skills through the training of environmental engineering microbiology experimental courses, and they have been comprehensively improved from scientific research thinking to experimental skills at the same time.

4. Introduce process assessment standards and improve the comprehensive evaluation of experimental results

In experimental courses, students are usually evaluated based on the completion of their experimental reports. However, this method is insufficient in reflecting the actual learning situation of students. In order to objectively and comprehensively evaluate students' learning outcomes, a comprehensive assessment standard was introduced for the experimental results. The final grades are divided into three parts according to the experimental sections: 20% for basic experiments, 30% for comprehensive experiments, and 40% for innovative experiments. The remaining 10% is for classroom performance and attendance. Among the three experimental sections, based on the students' performance in completing the experiments, their contributions ratio in the experiments, online preview and interaction, and the analysis of experimental data were all incorporated into the overall assessment process.

5. Conclusion

The main goals of the reform of environmental engineering microbiology experiment course are to improve students' understanding of theoretical knowledge, cultivate students' independent and independent experimental operation skills, and cultivate students' independent innovation and independent ability in the mode of combining basic, comprehensive and innovative experiments. Under the background of "New Engineering", with an emphasis on interests, supported by teaching, and carried out through research projects, a teaching model combining online and offline methods is adopted. The experimental teaching methods are constantly optimized. The aim is to promote the comprehensive improvement of students' qualities, help cultivate applied talents, meet the social demand for environmental protection professionals, and achieve a positive interaction among industries, academia and research[6].

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