

# *Exploration on Teaching Reform of Environmental Engineering Microbiology*

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**Abstract:** There are four major pain points existing in the teaching of the "Environmental Engineering Microbiology" course in our school, namely, the solidification of teaching content, the singularity of teaching methods, the singularity of teaching evaluation, and the lack of ideological and political education elements. Therefore, we proposed a four-step teaching innovation model, the first is to reconstruct the teaching content, the second is to enrich teaching methods, the third is diversified teaching evaluation and the fourth is to integrate ideological and political education into the curriculum. The effect of teaching reform shows that it has fully stimulated students' initiative in learning, promoted the cultivation of students' innovation ability, and achieved better teaching results.

## **1. Introduction**

"Environmental Engineering Microbiology" is one of the core compulsory courses for Environmental Engineering Major, which is a theoretical, practical and applied cross-penetration course. Through the study of environmental engineering microbiology theory, students can master the microbiological principles and methods required in biological treatment technologies, and be able to analyze and solve the mechanism problems in environmental engineering. In addition, it lays a solid foundation for the subsequent study of professional courses such as "Water Pollution Control Engineering", "Air Pollution Control Engineering", "Solid Waste Resource Utilization Engineering", and "Environmental Monitoring", which enabling students to systematically understand and master the basic knowledge of environmental engineering microorganisms necessary for the biological treatment of sewage, waste gas, solid waste, and environmental biological monitoring. With the rapid development of society and economy, environmental issues have become increasingly prominent, and the society urgently needs environmental engineering professionals with high comprehensive qualities and strong practical abilities[1]. Therefore, under the background of "ecological civilization construction", the core of the teaching reform and innovation for the "Environmental Engineering Microbiology" course is to reinforce students' foundational theoretical knowledge, which enabling students to master the ability to solve various ecological environment governance problems, possess strong knowledge application ability, practical innovation ability, good moral quality and strong international vision, so as to

comprehensively improve students' comprehensive quality[2]. Based on this, the course teaching team has carried out corresponding teaching reform and innovation in response to the teaching pain points existing in the "Environmental Engineering Microbiology" course and made a summary, with the expectation of having certain reference value for the teaching of the "Environmental Engineering Microbiology" course in colleges and universities.

## **2. The problem of “pain points” in teaching and learning**

### **2.1 Solidification of teaching content**

The textbook selected for the "Environmental Engineering Microbiology" course in our school is "Environmental Engineering Microbiology" (Fourth Edition) edited by Qunying Zhou, et al. The teaching content includes the first part "Fundamentals of Microbiology" and the second part "Microbial Ecology and the Role of Microorganisms in Environmental Ecological Engineering", totaling 12 chapters. The teaching content includes the basic knowledge of microbiology, microbial ecology, the role of microorganisms in the environmental material cycle, as well as the application and principles of microbiology technology in environmental engineering, etc. The rich teaching content and the progressive structure level satisfy the cognitive process of students from shallow to deep knowledge[3]. However, within the limited teaching hours, if the teaching strictly follows the content and sequence of the textbook, it is prone to problems such as unclear key and difficult points of the teaching content, and fragmented and redundant knowledge points. When Students are likely to experience the phenomenon of "monkeys moving corn" when they are confronted with a large amount of knowledge, they are likely to experience the phenomenon of "monkeys moving corn", meaning that they have difficulty remembering all the knowledge. Secondly, there are relatively few actual engineering cases, making it difficult to achieve an effective connection between classic theoretical knowledge and practical engineering applications. Therefore, students have a generally poor learning experience in class and are prone to feeling tired, and their desire to learn and their initiative in studying are difficult to stimulate and satisfy. Furthermore, the rapid and continuous advancement of various emerging technologies has driven the ongoing evolution and swift progress of control and treatment methods for water, air, and solid waste pollution, particularly through the application of microbiological techniques. However, the relatively slow update of the textbook content, as well as the limited teaching hours, prevent the supplementation and reinforcement of new knowledge and theories. Therefore, it is difficult to fully cultivate students' research and innovation abilities as well as their engineering practical skills.

### **2.2 A single teaching methodology**

Due to the characteristics of this discipline, currently in the teaching of the "Environmental Microbiology" course at universities, the traditional teaching method that mainly relies on teachers' lectures is the most widely used teaching approach. This teaching method is beneficial for imparting large amounts of basic theoretical knowledge and plays an irreplaceable role in university teaching. However, this teaching model usually places the teacher in a dominant position while students merely passively receive knowledge. On the one hand, the teacher imparted the textbook content in a self-amusing manner, while on the other hand students are in a passive learning role and lack enthusiasm. The classroom is faced with a situation of high attendance rate, low headcount rate, and low participation level, and it has seemingly become a silent study room. The actual teaching effect of this teaching model remains to be questioned. Students often resort to staying up all night before exams and rote memorization to cope with the tests. They lack a thorough understanding of abstract theoretical knowledge and do not possess the ability to apply knowledge flexibly[4]. Furthermore,

teachers can only cover the key points of the course within the limited class hours. Taking our school as an example, this course consists of 48 hours of theoretical classes and 12 hours of laboratory classes. During the sixteen-week theoretical class period, only the classic microbial theory knowledge can be taught, and there was no extra time available to supplement and reinforce the new knowledge and theories of environmental microbiology. It also failed to guide students to pay attention to and analyze the professional hot issues such as current affairs, engineering and technology. So it is not conducive to cultivating students' scientific research innovation ability and engineering practical ability.

## **2.3 A single evaluation method**

Course quality evaluation serves as an important basis for teachers to conduct teaching diagnoses on students, and it is one of the indispensable steps in the teaching process. The aim is to encourage students to conduct autonomous learning in multiple aspects, and it is also an important basis for teaching information feedback. The assessment method for the "Environmental Engineering Microbiology" course in our school is based on a combination of regular performance, mid-term results, and final exam scores. Among them, the final exam score accounts for 60%. Traditional teaching mainly relies on the final exam paper score to evaluate students' mastery of knowledge, but this method has the drawback that students tend to forget the knowledge soon after the exam. Under the new era development conditions, the single evaluation model no longer meets the society's demand for "all-round developed talents". Therefore, the construction of a diversified teaching evaluation system is the inevitable path to achieve the reform and innovation of teaching evaluation.

## **2.4 Lack of ideological and political elements**

Our school has incorporated ideological and political education into the "Environmental Engineering Microbiology" course since 2023. Although certain achievements have been made, the previous course teaching has not yet achieved an organic integration of ideological and political education with the knowledge of the course system. Although the students have mastered the professional knowledge of environmental engineering microbiology, they have not deeply understood the profound value contained within this knowledge. Furthermore, with the development of the new era, the instructors have failed to incorporate the major national ecological environmental strategic requirements in the context of ecological civilization construction (such as "integration of water resources, water environment and water ecology", "integrated protection and systematic governance of mountains, waters, forests, fields, lakes, grasslands and sands", "carbon peak and carbon neutrality" etc.) into the content of the "Environmental Engineering Microbiology" course. This leads to the students' lack of understanding of high-level ideological values, as well as their lack of professional confidence, political identity, cultural confidence and global perspective.

## **3. Innovations in teaching reform**

### **3.1 Innovation in teaching content**

The primary purpose of teaching content innovation is to enable students to apply theoretical knowledge to real-life situations, allowing them to more flexibly grasp theoretical knowledge and "apply it in practice" effectively. Secondly, the teaching content is integrated with the latest scientific advancements to stimulate students' interest in seeking knowledge and exploring the world of science. This course is in line with the training goals and graduation requirements for ecological environment talents, and combines core knowledge with the needs of ecological

civilization construction. It breaks the original knowledge system of the textbooks, deeply explores the logical relationships among the knowledge, organically integrates ideological and political elements, cutting-edge disciplines, immersive practice, etc., and forms three knowledge modules: Microbiology Basics, Built-in Relationship and Principles of Microorganisms and Ecological Environment, and Application of Microorganisms in Ecological Environment Engineering. The aforementioned measures have addressed the issues of limited class hours, the lack of systematic and logical teaching content, and the absence of cutting-edge innovative elements. Through the above innovative reforms, continuous innovation in teaching content has been achieved, and restructure the knowledge content based on the intrinsic connections among knowledge, ensuring that the knowledge system is advanced and challenging, thus laying a solid foundation for the achievement of teaching goals and graduation requirements.

### 3.2 Innovations in teaching methods

By adopting the "pre-class heuristic learning---classroom Q&A and difficult point explanation---classroom flipped feedback teaching" mixed teaching model, the teaching methods have been reformed and innovated.

1) Pre-class heuristic learning: one week before the class, the PPTs and related materials of the course content will be sent to "XueXi Tong Learning Platform". Students will preview the content by combining the online materials sent by the teacher and the textbook. The teacher assesses the students' self-study effectiveness in class by asking questions.

2) Classroom Q&A and Difficult Point Explanation: one day before the class, the teacher will send the questions related to the content of this course to "XueXi Tong Learning Platform". Based on the test results, the difficult points of the course will be summarized. In class, the main focus is on explaining the difficult points of the course and answering students' questions. This not only effectively addresses the issue of insufficient class hours for the "Environmental Engineering Microbiology" theoretical course at our school, but also enhances students' learning efficiency, allowing them to acquire more knowledge within the limited time.

3) Classroom flipped feedback-based teaching: in the first class of "Environmental Engineering Microbiology", it was clearly stated that a group-based classroom discussion would be organized after the completion of each chapter's content study. Students would be temporarily grouped, with each group consisting of 5-6 students. After the discussion, each group would write down on the blackboard an important knowledge point they believe is covered in this chapter, and explain the reason in 2 minutes. They must not repeat what other groups have said. Additionally, the twelfth chapter "Application of Microbiology Technology in Environmental Engineering" would be combined with the latest frontier research on the application of microorganisms in the ecological environment for flipped classroom integration. Students would independently research the latest studies on microorganisms in the environment and summarize them. In each class, one group would be selected for a classroom presentation.

### 3.3 Innovative teaching evaluation methods

The method of course evaluation will have a significant impact on students' learning attitudes. Therefore, it is extremely important to effectively address the drawback of the single evaluation method in traditional teaching processes. The original assessment model of the final exam has been changed to a new one that combines process-based assessment with the final exam assessment. The specific assessment model is detailed in Figure 1. This evaluation model enhances the evaluation of students' learning attitudes, learning abilities and learning outcomes throughout their entire learning process. It also facilitates teachers in reflecting on problems in the teaching process, formulating

countermeasures and improvement plans. The aim is to achieve the goal of promoting learning and teaching through evaluation, in order to comprehensively and effectively enhance the learning and teaching outcome.

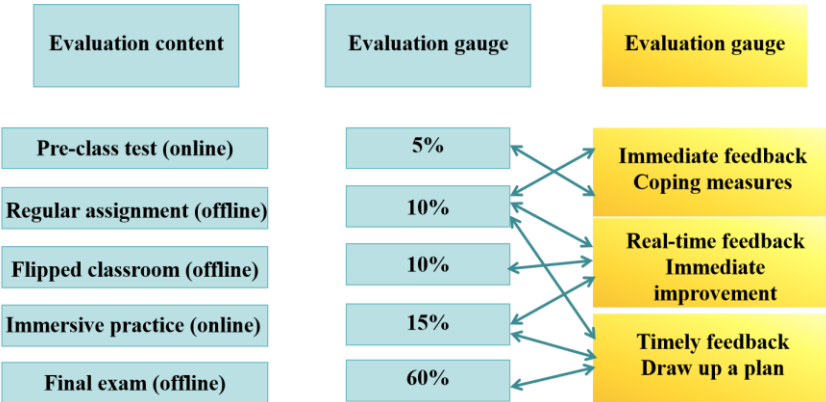


Figure 1 Design of evalation method for Environmental Engineering Microbiology.

### 3.4 Integrating ideological and political education into innovation

Ideological and political education is an essential path to cultivating environmental protection professionals under the background of new engineering discipline construction. In the course teaching, the team of teachers thoroughly reviewed the teaching content, deeply explored the ideological elements, and achieved the organic integration of knowledge points and ideological elements. They established a three-in-one course teaching goal of "value shaping, knowledge imparting, and ability cultivation", and formed a collaborative educational effect between "knowledge points and ideological elements". At the same time, based on current domestic and international hot issues, we continuously supplement, enrich and update teaching cases, and integrate the ideological and political content into the teaching process of knowledge in a subtle and imperceptible way. The aim is to enable students not only to master the professional knowledge of environmental engineering microbiology well, but also to deeply understand the profound value contained within this knowledge.

### 4. Conclusion

In response to the existing pain points in the teaching of "Environmental Engineering Microbiology" at our school, we have carried out innovative practices in aspects such as the integration of ideological and political elements, the curriculum system, teaching methods, and evaluation system. As a result, the satisfaction and recognition of students towards this teaching course have significantly improved.

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