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The Innovation of the Curriculum System of Environmental Engineering at Anhui Jianzhu University

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Abstract

The curriculum systems of environmental engineering majors at well-known universities both domestically and internationally were overviewed. The paper also provides a detailed introduction to the development history and unique features of the environmental engineering major at Anhui Jianzhu University. A continuous improvement model for the environmental engineering curriculum system was proposed further. The continuous improvement model was based on the idea of "classified supervision, multiple assessments, problem orientation, and continuous improvement" to enhance the continuous improvement effectiveness of the major, which has passed engineering education certification.

Keywords: Continuous improvement, Development, Environmental Engineering, Course objectives.

Introduction

Environmental engineering is a branch of environmental science, which mainly studies how to protect and rationally use natural resources, solve increasingly serious environmental problems by scientific means, improve environmental quality, and promote environmental protection and social development (JG Henry, GW Heinke, and I Burton. 1996).

The environmental engineering specialty trains high-level engineering and technical talents who can be engaged in the control and treatment of wastewater, waste gas, solid waste, soil and other pollution of regions, cities and enterprise (L Faba , E Díaz. 2020), as well as senior

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environmental management talents who can be engaged in environmental remediation, environmental planning and sustainable management.

There are four specific objectives of environmental engineering.

(1) Graduates can solve global environmental problems by integrating engineering, science and management knowledge, and become outstanding backbone talents in the field of environmental industry;

(2) Graduates can enter world-class scientific research institutions for further study and can learn for life;

(3) Graduates can start their own businesses independently and promote environmental technological innovation and sustainable development;

(4) Graduates can eventually become well-known experts and leaders of academic institutions, international organizations, governments, professional associations, engineering design or consulting companies.

The curriculum system is an indispensable part of professional development and is an important link for the establishment and execution of training plans (Astutik I and Widiaty I, 2018). Establishing and improving a curriculum evaluation system in universities can detect students' learning outcomes and situations, promote their learning development, and test teachers' teaching levels, improving their teaching quality. Assessing whether it is scientific and reasonable is a key factor affecting the quality of teaching. A scientific and reasonable curriculum evaluation system in universities can promote the improvement and improvement of teaching quality, and promote the high-quality development of talent cultivation in universities (Levine T, 2002).

However, the current curriculum system for environmental engineering majors in universities still has the following problems:

- Unitary course subject affects the effectiveness of professional execution.
- The emphasis on result-oriented courses has led to a neglect of the teaching process.

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- Emphasizing the execution process guided by theoretical teaching, thus neglecting the teaching of practical activities.
- Interaction and communication between courses have been restricted.

To address these issues mentioned above, the aims of the paper are the exploration of the breakthrough of the environmental engineering curriculum system and the development of the reform plan for the curriculum system on the basis of the consideration of the environmental engineering major at Anhui Jianzhu University.

Current State of the Curriculum

The curriculum system of environmental engineering could be divided into the modules as follow:

- The first module is the basic principle, which consists of environmental chemistry, environmental engineering principles, environmental monitoring, instrument analysis and other courses.
- The second module is the pollution control module, which consists of water pollution control engineering, air pollution control engineering, solid waste disposal engineering and other courses. The content mainly involves water treatment methods and processes, air pollution process analysis and waste gas treatment processes, solid waste treatment and disposal processes and processes.
- The third module is environmental protection engineering design, which consists of hydraulics, water pump, environmental engineering design and other courses. The content mainly involves the selection of equipment required in the three wastes treatment process, the design of structures and the drawing of engineering CAD drawings, the selection of pumps and fans and parameter calculation.
- The fourth module consists of comprehensive practical training, and the course system consists of comprehensive design experiments, project-oriented practical training (for each course project), and ability-oriented practical training (for innovation ability cultivation). The aim is to cultivate students' ability to analyze and design environmental engineering processes, structures, equipment, and other aspects through comprehensive practical training.

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A sample representation of the curriculum system of environmental engineering in several universities worldwide was described herein. Tsinghua University, as one of the top 985, 211, and double first-class universities in China, is a leader in Chinese universities and a benchmark for the development of Chinese universities. The courses in environmental engineering at Tsinghua University include environment and development, introduction to sustainable development, lectures on eco-civilization, introduction to cleaner production, industrial ecology, introduction to science and engineering in water supply and drainage, global persistent organic pollutants, fundamental geology, biosensor for quick detection of contaminants in water, the mechanisms and control for haze, system thinking and big data for environment, energy and climate change, water science and water safety, environmental safety and organisms, environment and health, soil and environmental safety, environment and chemistry, solid waste: problem and solution, environmental crisis and ecological restoration, environmental internet of things and big data, special topics in energy and environmental catalysis, drinking water safety and security, introduction to environmental and earth science, environmental monitoring, environmental microbiology, principle of environmental engineering, ecology, environmental chemistry, environmental soil science, and so on.

The basic courses of the environmental engineering specialty of Harbin Institute of Technology include environmental engineering principles, pollution control microbiology, environmental science, environmental analytical chemistry, physical chemistry, and environmental fluid mechanics, and the core courses of the specialty include water pollution control engineering, air pollution control engineering, solid waste treatment and recycling, urban water supply and drainage system engineering, environmental monitoring, and environmental impact assessment.

Environmental Engineering at Tongji University is one of the pioneers in this major in China. Its curriculum objectives include mathematical knowledge, natural science knowledge, humanities knowledge, frontier progress knowledge, lifelong learning ability, logical thinking ability, laboratory workability, expression communication ability, and organizational, leadership, and management abilities. Therefore, the main professional courses include engineering mechanics, chemical engineering, environmental pollution monitoring and assessment, pollution control theory and technology, engineering economy and budget, as well as pollution control

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engineering, water and wastewater physicochemical treatment, wastewater pollution prevention, solid waste treatment and resource utilization, air pollution control engineering, physical pollution control, environmental impact assessment, environmental planning and management, and practical teaching courses such as professional practice curriculum design, innovative experiments, etc.

The mission, program educational objectives, and student outcomes of Bucknell university could be founded on the website of https://coursecatalog.bucknell.edu/collegeofengineeringcurricula/areasofstudy/environmentalengineeringeveg/#text. The university offers a five-year comprehensive humanities/engineering course, where students can choose elective courses to pursue their interests in specific fields of environmental engineering, thereby integrating their learning outcomes. The interdisciplinary nature of these courses allows students from multiple disciplines to participate in existing courses.

The curriculum of the Colorado School of Mines requires 135.4 semester credit hours (44 credit hours of mathematics and basic sciences, 48 credit hours of engineering topics, and 42.5 credit hours of general education requirements, such as economics, design, and the humanities). In this course, students collect environmental samples in the field, such as soil and water. These samples are then analyzed in the laboratory as a component of real-world environmental engineering projects. The curriculum referred to the fields of hydrology and water resources engineering, water and wastewater treatment processes, site remediation, chemical fate and transport in the environment, sustainable engineering design, pollution, prevention, and ecology.

Among numerous educational and teaching concepts, ability-oriented education, goal-oriented education, outcome-based education, and project-driven education was the most prominent in guiding the cultivation of applied talents. The outcome-based education concept aims to emphasize the effectiveness of the education process and the practicality of students' abilities. Herein, how to reform the curriculum system of environmental engineering under the premise of outcome-based education philosophy was a technical issue worth in-depth exploration.

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Development of environmental engineering at Anhui Jianzhu University

Orientation

The professional development of environmental engineering relies on the industrial background of "large civil engineering", defines the development orientation of environmental protection cause "based on Anhui and serving urbanization", and highlights the characteristics of regional urbanization water environment protection. With the "new engineering" education and teaching concept as the kernel, and the outcome-based education model as the approach, combine the education of outstanding engineers, professional certification and the education of the registered engineer qualification system, and on the basis of the basic requirements of the national environmental engineering professional training, cultivate the talents who meet the needs of the economic and social development of our province, with good ideological and moral character, solid basic theory, strong professional skills, good teamwork, innovative thinking Senior application-oriented engineering and technical talents with broad international vision. Build the environmental engineering specialty into a provincial first-class specialty with wide field coverage, strong professional characteristics and high talent quality.

History

In 1984, the water supply and drainage engineering was established in the Department of Urban Construction, laying the foundation for the development of Environmental Engineering. In 1996, the school underwent departmental adjustments and established the Department of Environmental Engineering and Electronics, which initially formed the Environmental Engineering; In 2000, the Environmental Engineering major was established, and the first enrollment was held in 2001; The National Teaching Demonstration Center for Water Pollution Control and Wastewater Resource Utilization was authorized for construction in 2009 and passed the construction acceptance in 2012. The Environmental Engineering discipline was approved as a key discipline in Anhui Province, and the Water Pollution Control and Wastewater Resource Utilization Laboratory was approved as a key laboratory in Anhui Province in 2012. Environmental Engineering obtained permission to confer a master's degree in 2014. Environmental Science and Engineering was awarded the first-level discipline master's degree

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authorization in 2017. It passed the professional evaluation of environmental engineering in Anhui Province and was approved as the Anhui Provincial Key Laboratory for Environmental Pollution Control and Solid Waste Recycling in the same year in 2019. This major passed the China Engineering Education Certification in 2022, indicating a new milestone in major development.

Curriculum System and Characteristics of Major

The first module is the basic principle, which consists of environmental chemistry, environmental engineering principles, environmental monitoring, instrument analysis and other courses.

The second module is the pollution control module, which consists of water pollution control engineering, air pollution control engineering, solid waste disposal engineering and other courses (Feng X D, Ma Y F, and Liu J D, 2011). The content mainly involves water treatment methods and processes, air pollution process analysis and waste gas treatment processes, solid waste treatment and disposal processes and processes;

The third module is environmental protection engineering design, which consists of hydraulics, water pump, environmental engineering design and other courses. The content mainly involves the selection of equipment required in the three wastes treatment process, the design of structures and the drawing of engineering CAD drawings, the selection of pumps and fans and parameter calculation;

The fourth module consists of comprehensive practical training, and the course system consists of comprehensive design experiments, project-oriented practical training (for each course project), and ability-oriented practical training (for innovation ability cultivation). The aim is to cultivate student's ability to analyze and design environmental engineering processes, structures, equipment, and other aspects through comprehensive practical training. The course study sequence diagram of environmental engineering at Anhui Jianzhu University was shown in Figure 1.

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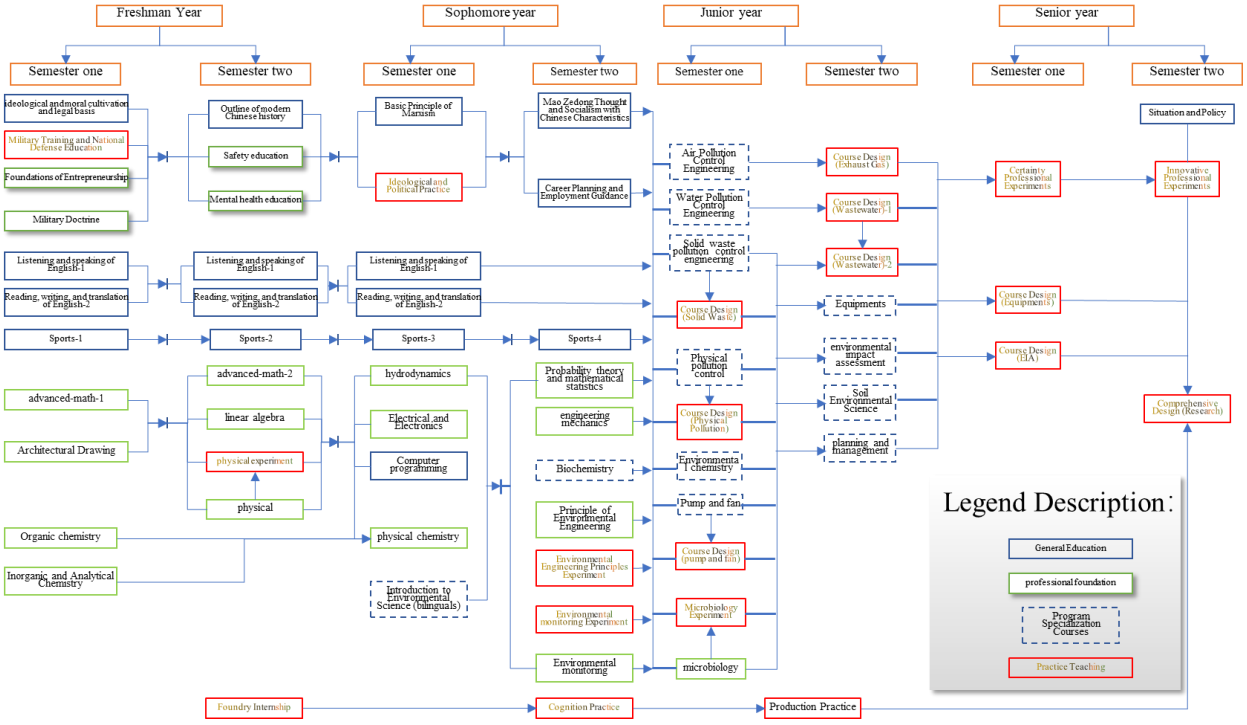

Figure 1. The Courses Executing Sequence

Exploration of Curriculum System

The courses in mathematics, science, and mechanics in the first two years cover basic concepts, which were commonly used in engineering practice. Students usually view these courses as " general education" courses rather than the foundation of future course content. In addition, as part of the general education requirements, several core humanities, arts, or social science courses are arranged, but these courses may not improve the development of relevant social and economic skills. Therefore, professional courses have been added in the third or fourth stages of college. Students first experience environmental engineering issues and then participate in the study of the themes in the subject. Finally, we added a top-level course in order to integrate previous knowledge to solve complex engineering problems.

Students rarely have the opportunity to practice combining skills and courses from different disciplines, which limits their ability to establish connections, integrate knowledge, and engage

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in intentional practice required for professional skill development. In order to improve students' abilities and better adapt to work needs, we have carried out reforms in the curriculum system.

(1) To cultivate students in this major, it is necessary to highlight the characteristics of the school's industry development and invest more energy in cultivating hands-on practical skills. Efforts should be focused on improving the training plan, updating teaching content, and innovating teaching methods.

(2) Improvement will be made in the content and execution of engineering practical courses in the course design, which will increase the category of engineering practice, such as the practical content of soil pollution remediation and treatment engineering courses that are in line with the current development of the environmental protection industry, environmental stewardship engineering internship practice, and pollution discharge permit environmental protection work practice.

(3) Expand the field of environmental protection engineering involved in the three major internships (understanding, production, and graduation internships), and increase relevant internship bases and points, such as adding ecological restoration engineering internship bases. And guide students on campus to adjust their internship content purposefully and in a planned manner during the internship process.

(4) We will continue to strengthen the scientific and technological innovation training of students, and cultivate the innovation ability of college students and the adaptive ability of students to meet the needs of industry development by virtue of college students' innovation and entrepreneurship project, Internet plus competition project, Anhui Provincial College Students' Ecological Environment Innovation and Entrepreneurship Competition held by Anhui Provincial Environmental Professional Cooperation Committee and other activities.

Conclusion

Through the reform of the environmental engineering curriculum system, students' interest in innovative research and experiments has been increased, and their ability to work

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independently and learn independently has been cultivated. In the future, we will further optimize and improve the curriculum system, and continue to practice and adjust the existing curriculum content and teaching methods. Continue to strengthen measures to cultivate practical abilities and improve the basic, comprehensive, and innovative practical abilities of students majoring in environmental engineering; Submit excellent, qualified, and innovative high-quality engineering talents to society.

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