Research and Practice on the Teaching Reform of Integrating Mathematics Curriculum and Major in Vocational Colleges

Taking Environmental Engineering Technology Major as an Example

Lili Shi[1] Qibing Chen[2] Junxuan He[3] Chunhui Wang[4]

[1,2,3,4] *Chengdu Textile College, Chengdu, Sichuan, China*
[1] *Corresponding author.*

ABSTRACT

As a public basic course in higher vocational education, higher mathematics curriculum not only shoulders the responsibility of imparting mathematical knowledge and cultivating mathematical thinking, but also needs to carry out mathematical practice and expand innovation based on the professional background of the subject, and lay a solid learning foundation for "high-quality" talents. However, due to issues such as student quality, lack of close connection with majors and actual needs, and slow learning outcomes for students, there are still many problems in the teaching of higher vocational mathematics curriculum. Taking the chapter of ordinary differential equation in the higher mathematics curriculum of higher vocational colleges as an example, this paper, combined with the teaching practice of environmental engineering technology specialty, based on strengthening moral education and cultivating people, based on the position, combined with the learning situation, elaborated on the methods and processes of how to integrate the mathematics curriculum content with the specialty to design and implement teaching reform, and provided new ideas for the higher mathematics teaching reform of higher vocational colleges.

Keywords: *Vocational education, Advanced mathematics, Ordinary differential equation, Specialty integration.*

1. INTRODUCTION

President Xi Jinping has entrusted vocational education with the important task of "cultivating more high-quality technical and skilled talents, skilled craftsmen and great craftsmen". To help cultivate "high-quality" talents, higher mathematics teaching in higher education institutions should not only continue the responsibility of teaching mathematical knowledge and cultivating mathematical thinking, but also carry the important task of developing mathematical practice and innovation based on the discipline's professional background, and consolidate the learning foundation for "high quality" talents. As an important public basic course in higher vocational colleges, higher mathematics is a necessary learning content for engineering students in vocational colleges. It is closely related to the effectiveness of students' subsequent learning of professional knowledge and mastering professional skills in related majors and industries such as information industry, integrated circuit, mechanical engineering, electronics, and environmental engineering. In the new situation where China continues to strengthen the cultivation of highly skilled talents and comprehensively enhance the international competitiveness of "Made in China" and "Created in China", it is crucial to conduct research and practice on the teaching reform of higher mathematics curriculum in vocational colleges, in order to promote students' better mastery of knowledge and cultivate practical application abilities.

2. THE SHORTCOMINGS OF HIGHER MATHEMATICS REFORM IN VOCATIONAL COLLEGES

In recent years, the country has vigorously developed higher vocational education, promoting it to adapt to the development of the times and social needs, and improving the teaching quality of higher vocational education. The Ministry of Education has successively issued the "Opinions on Promoting the High Quality Development of Modern Vocational Education", "National Vocational Education Reform Implementation Plan", and "Vocational Education Quality Improvement and Excellence Action Plan (2020-2023)" to improve the quality of higher vocational education curriculum teaching. The reform of higher mathematics teaching in vocational colleges has achieved some results in recent years, but there are still the following problems, mainly concentrated in the following three aspects:

2.1 Mathematical Theory Is Relatively Difficult and Profound, and Students' Mathematical Foundation Is Relatively Weak and Difficult to Acquire

Strong theoretical foundation, multiple knowledge points, large capacity, and high requirements have always been the basic characteristics of higher mathematics teaching in Chinese colleges and universities. [1] After 2006, the scale of higher vocational education in China rapidly expanded and accounted for half of the total higher education, while the basic quality and learning ability of vocational students generally declined. [2] According to data on the development of national education in 2022, there are currently 1,521 higher vocational colleges (including vocational undergraduate programs) in China. In 2022, there were 5.4661 million students enrolled, surpassing the enrollment scale of regular undergraduate programs for four consecutive years. The source of students in higher vocational education is relatively wide, and they can be recruited through channels such as the college entrance examination and individual admission exams. The composition of students includes ordinary high school students, vocational high school students, etc. The complexity and diversity of student sources also pose challenges to the teaching reform and implementation of higher vocational mathematics curriculum.

2.2 The Teaching Content Is More Classic and Disconnected from the Actual Needs of the Current Industry and Majors

Professor Dai Shihong, a renowned vocational education expert, believes that "vocational college students are not here to receive and accumulate knowledge in general, but to learn practical employment skills. They need to be able to solve practical problems in future career positions." [4] Technical application talents are the basic positioning for cultivating talents in higher vocational colleges, which has been recognized by the theoretical and practical frontline vocational colleges and education administrative departments in China's vocational education industry; The level of higher vocational college students' development needs for higher mathematics should be the level of higher mathematics required for technical application talents to carry out technical application practice. [5] Due to the fact that the content of higher mathematics curriculum is based on classic mathematical theories and has strong theoretical attributes, many courses mainly focus on theoretical teaching in content design and teaching implementation, with insufficient practical teaching content, making it difficult to help students effectively improve their practical application abilities. Although many courses have invested a large amount of resources in producing online videos, demonstration animations, etc. to enhance the vividness and aesthetics of the courses, they have not effectively integrated mathematical modeling, Matlab mathematical experiments, simulation experiments, dynamic demonstrations, etc. into the courses, which cannot improve the interactivity, practicality, and innovation of online courses. By strengthening the connection with the profession and highlighting the application of mathematics, the abstraction of mathematical knowledge can be overcome to some extent, which not only serves the profession but also suits the learning characteristics of vocational college students. [6]

2.3 The Slow Manifestation of Learning Effectiveness Makes It Difficult for Students to Have a Sense of Achievement and Affects Their Learning Enthusiasm

D.B. Mumford, the winner of the Fields medal in mathematics and an American mathematician,

believes that mathematics education should make very serious efforts and attach importance to application ideologically. In his article "Reforming calculus - for millions of people", he said: "teachers teach calculus to hope that a small part of the students can follow their love for preciseness, or to enable most of the students to have the ability to apply calculus in their majors in the future?" [7] If students cannot see the connection between mathematics and contemporary human life in the process of learning mathematics and start learning to use mathematics, such mathematics education will be difficult to have vitality. [8] Vocational mathematics cannot simply focus on cultivating thinking ability and laying a foundation, but must strengthen the applied teaching of mathematics according to their respective professional goals and requirements. If the relationship between mathematical knowledge and professional application is not well handled in curriculum design and implementation, it cannot effectively guide students to enhance their interest in mathematical learning, thereby affecting the cultivation of mathematical application ability.

3. STRATEGIES OF HIGHER MATHEMATICS TEACHING REFORM IN HIGHER VOCATIONAL COLLEGES — TAKING ORDINARY DIFFERENTIAL EQUATION AS AN EXAMPLE

In view of the above problems, this paper takes the chapter of ordinary differential equation in higher mathematics as an example, develops relevant teaching strategies for environmental engineering technology specialty, and focuses on making improvements in such aspects as basing on professional standards, meeting job needs, reconstructing teaching content, accurately analyzing learning situation, integrating ideology and politics in courses, strengthening modeling training, building three-dimensional classrooms, and conducting dynamic assessment. Adopting a seven pronged strategy, the authors will carry out teaching reform in cultivating environmental engineering technical talents in the new era who are knowledgeable in theory, good at modeling, and dedicated to their work. The details are as follows:

3.1 Restructuring Teaching Content, and Developing a "Reality Teaching" Project Based on Job Requirements

Based on the professional ability and job demand, combined with the knowledge structure system and teaching rules of the ordinary differential equation chapter of higher vocational mathematics, it is necessary to deeply explore and expand the knowledge and ability connotation corresponding to relevant cases, and reconstruct the teaching content. By implementing national training policies and school talent training programs, targeting positions in industries such as environmental management and evaluation, sewage treatment, etc., and connecting with subsequent professional courses such as microbiology, environmental monitoring technology, and water pollution control technology, it has developed "What are the differential equations in environmental engineering?" "Why do blue algae break out?" "How do you predict the concentration of air pollution?" "Is sea level change related to species extinction?" "How do industrial CO_2 emissions affect the stock of greenhouse gases?" "How do you explore the law of changes in the degree of water pollution?" 6 "practical teaching" projects of ordinary differential equation.

3.2 Accurately Grasping the Learning Situation and Clarifying the "Four Dimensions and Four Waiting" Learning Situation Based on Multivariate Analysis

For students majoring in specific environmental engineering technology, through pre course module testing, platform data analysis, and course survey questionnaire analysis, teachers can complete learning situation analysis and accurately grasp the learning situation. Through analysis, it is clear that students' learning situation conforms to the characteristics of "four dimensions and four waiting": firstly, the systematization of knowledge structure needs to be improved. Students have completed the module of calculus of unary function and have basic knowledge of calculus of unary function. Through comprehensive evaluation, it is shown that students' mastery of individual knowledge points is superior to that of comprehensive knowledge points. It indicates that students' systematic understanding of knowledge structure still needs to be improved. Secondly, the cognitive ability of independent exploration needs

to be strengthened. Students are able to complete basic absorption of new knowledge they have learned, but their ability to apply and transfer knowledge is not strong, especially when facing practical problems under complex conditions. Their ability to independently explore, analyze, and solve problems still needs to be strengthened. Thirdly, the quality and ability of professional positions need to be improved. Students have a certain level of environmental awareness and professional environmental literacy. However, the innovative and practical abilities to flexibly apply the knowledge learned, team collaboration skills, and the enterprising spirit to overcome difficulties still need to be improved. Fourth, it is to stimulate the learning motivation of internal drive, which needs to be mobilized. Students are willing to learn through teamwork and exploration, and excel in practical operations and graphical analysis. However, due to the difficulty of the course itself, the sense of learning acquisition and initiative are not strong, so the learning motivation to stimulate internal drive needs to be mobilized.

3.3 Keeping Up with the Pace of the Career and Combining It with Academic Analysis to Determine the Goal of "Knowing Goodness, Loving Respect"

According to the curriculum standards, based on the relevant positions and technical ability requirements of the Environmental Engineering Technology major, the teachers can develop three-dimensional teaching objectives. It is necessary to integrate ideological and political elements, promote the sentiment of technology serving the country, align with the core competency requirements of environmental engineering technology positions and clarify teaching priorities, and determine teaching difficulties based on students' learning situation analysis. By organically integrating and understanding knowledge objectives such as ordinary differential equation and professional typical ordinary differential model, ability objectives such as analytical solution, mathematical modeling, analysis and interpretation of ordinary differential equation, as well as quality and curriculum ideological and political objectives such as mathematical literacy, professional literacy, family and country feelings, efforts are made to cultivate professional talents who know theory, are good at modeling, and love their jobs.

3.4 Following the Spirit of Craftsmanship, Persisting in Strengthening Moral Education and Cultivating People, and Building a "Green Water and Green Mountains" Pattern

It is necessary to adhere to strengthening moral education and cultivating people, and shape the values of "green ecology". Through the four dimensions of humanistic quality, scientific literacy, professional quality and craftsman quality, with the theme of ecological environmental issues that have been widely concerned in recent years, such as water resources protection, climate change, air pollution, etc., and by means of situational experience, case analysis, modeling practice, invisible infiltration, etc., there is a must to build a pattern of educating people, expand the elements of ideological and political education, and give play to the functions of ideological and political education. On the one hand, there is a necessity to focus on exploring unique educational elements that correspond to factors related to the profession, position, and professional background of environmental engineering. On the other hand, there is also a necessity to explore universal educational elements such as patriotism, scientific spirit, striving spirit, and excellent traditional culture. Through excavation, there is a necessity to integrate mathematical ideas, mathematical spirit, mathematical thoughts, history of mathematics and other mathematical cultural knowledge implied in ideological and political materials, improve students' thinking quality and cultivate their mathematical literacy.

Teachers and students can design the ideological and political theme of "science and technology change industrial development, make green water and green mountains become golden mountains and silver mountains". In view of the current environmental pollution, case method is conducted through cyanobacteria pollution, air pollution, greenhouse effect, industrial CO_2 emissions and reservoir water pollution control. There is also a necessity to shape the values of "green ecology", such as designing water pollution control cases for reservoirs, establishing and optimizing models to provide precise guidance for water pollution control, and reflecting the craftsmanship spirit of "pursuing excellence and seeking truth and practicality".

3.5 Implementing the Requirements of the Goals, Building an Inquiry Classroom, and Implementing the Strategy of "Integrating Innovation and Connectivity"

By constructing an exploratory classroom, the first to do is to integrate job examples, immerse ourselves in the environment, and inspire learning motivation. With the aim of meeting job requirements, students should extensively accumulate a case library of industrial development, apply technology, and social hotspots. Teachers can decompose and analyze job examples to create learning scenarios, set learning tasks, and cultivate knowledge application and practical abilities. By concretizing abstract mathematical knowledge, reducing the difficulty of understanding, and creating a surrounding learning atmosphere of "mathematics around", students can feel the charm of mathematics, strengthen their understanding of the importance and practicality of mathematics, and stimulate interest and motivation. The second is to create practical tasks, construct three sections and seven links, and establish exploratory classrooms. The course can be divided into three stages: "before class, during class, and after class". According to the modeling and learning process, seven teaching stages are set up, including "preview tasks, creating scenarios, knowledge exploration, knowledge condensation, practical exploration, knowledge summary, and expansion tasks". The traditional mathematics classroom teaching and learning that mainly focuses on imparting knowledge will be transformed into multi-dimensional interactive mathematics teaching and exploratory mathematics learning that mainly focuses on solving problems and completing tasks. Combining teaching priorities and difficulties, tasks are further divided and decomposed during the teaching implementation process, presented in various forms such as group experiments, group tasks, and challenge games. The emphasis is placed lightly and difficulty is reduced to ease, creating a progressive and proactive classroom atmosphere to guide students to actively improve their thinking and abilities. It is particularly important that the teaching throughout the entire stage involves the cultivation and practice of modeling thinking, modeling techniques, and modeling abilities. Modeling processes such as model analysis, solution, condensation, summary and expansion are used to solve practical problems in job realities and professional tasks, to cultivate modeling thinking and train modeling techniques, to help students build a bridge of thinking from mathematical theories and methods across to practical application scenarios, to improve the spirit of innovation and creative ability, and to enhance the awareness and ability to solve practical problems scientifically and mathematically.

3.6 Relying on Information Technology, Integrating Teaching Resources, and Promoting "Dual Line Parallel" Teaching

By combining courses on the online learning bank platform with offline smart classrooms and mathematics laboratories, a three-dimensional learning scenario is established to provide support for the blended online and offline teaching mode; students can utilize learning tools to collect, evaluate, and provide feedback on learning, activities, and other data, and efficiently carry out learning and interaction; Manim animation engine can be used to independently develop small videos explaining mathematical principles; the geometric drawing tool Geogebra can be used for graphic animation deduction; the interactive application Jupyter Notebook can be used to complete mathematical model calculations. The introduction of various information resources can enhance students' interest in learning and enhance learning effectiveness in a simple and intuitive manner.

3.7 Constructing an Evaluation Model, and Implementing a "Multi-dimensional" Evaluation Based on Tree-dimensional Evaluation

It is necessary to deeply implement the spirit of the "Overall Plan for Deepening the Reform of Education Evaluation in the New Era", adhere to the principle of morality-oriented, ability-oriented, and comprehensive development, establish an assessment and evaluation system by combining formative evaluation with summative evaluation, and integrate value-added evaluation with comprehensive evaluation. It is also necessary to integrate information technology with assessment and evaluation to establish a fuzzy comprehensive evaluation model based on data mining. Process evaluation needs to be implemented throughout the three stages of "pre class, during class, and after class". Assessment and process evaluation can be completed through four evaluation subjects: platform evaluation, teacher evaluation, student

self-evaluation, and student mutual evaluation; the evaluation index set can be divided into two levels, set up a comment set, determine the weight vector using Analytic Hierarchy Process, and combine the difficulty of the course task to determine the synthesis operator. Finally, a fuzzy comprehensive evaluation model should be established to solve the evaluation results. There is a must to objectively analyze the current situation of curriculum implementation, generate dynamic evaluation reports from three dimensions: curriculum evaluation, individual evaluation, and group evaluation, help teachers and students keep an eye on evaluation dynamics, understand learning situations in real time, and make timely adjustments.

4. TEACHING PRACTICE AND EFFECT OF HIGHER MATHEMATICS ORDINARY DIFFERENTIAL EQUATION IN HIGHER VOCATIONAL COLLEGES

In the process of reform implementation, specific teaching work is carried out through the implementation of the above teaching strategies, which are divided into three stages: "pre class, during class, and after class". According to the talent cultivation plan for environmental engineering majors, corresponding abilities for the corresponding positions should be benchmark, curriculum standards should be closely followed, and teaching emphasis and difficulties need to be set based on the analysis of the learning situation. With the mathematical analysis and solutions of environmental protection and governance issues as the main line, students' sense of professional mission and social responsibility will be cultivated, ideological and political elements will be permeated throughout the process, and students will be guided to learn independently in an orderly manner. Firstly, relying on the Xueyin online course platform and other publishing tasks before class, students are guided to engage in independent learning through various forms such as micro courses, animations, small videos, and survey tasks. At the same time, according to the content, some knowledge points will be moved to pre class learning to achieve a "flipped classroom". Secondly, in class, students are guided to divide and collaborate on knowledge exploration and learning according to the five steps of "creating situations, exploring knowledge, condensing knowledge, practicing exploration, and summarizing knowledge"; Finally, it is necessary to expand tasks and consolidate assignments after class, and rely on online course platforms to further consolidate and enhance knowledge and abilities.

Through the reform, students' learning effectiveness has been improved. Compared with the situation before and after the reform, the improvement is mainly reflected in the following three aspects: the first is to achieve teaching objectives and break through key and difficult points. Through the implementation of three stages before, during and after class, and seven teaching steps from knowledge preparation before class to expansion and consolidation after class, students have systematically understood and mastered the necessary theoretical knowledge and practical computing skills of ordinary differential equation, and have the ability to apply relevant mathematical theoretical knowledge and computing skills in the learning of environmental engineering technology courses; In a teaching environment with rich information technology scenarios, students have a strong interest in learning, good cognitive practice, good grasp of relevant key and difficult points, and a pass rate of 92.4% in project testing, effectively achieving the overall teaching objectives. The second is to strengthen mathematical modeling and enhance job capabilities. The course combines the actual needs of environmental engineering industry and specific positions, and sets up guiding, practical and enlightening problems for engineering practice to guide students to carry out modeling experiments, realizing the transformation from teacher-taught knowledge to student-initiated learning, from teacher-guided experiments to student-initiated exploration, effectively promoting the overall improvement of students' knowledge, ability and quality to match the specific needs of industry positions. In the past three years, students in this major have won two first prizes and six second prizes in the provincial college student mathematical modeling competition, and six second prizes in the national college student market and survey analysis competition. The third is the guidance of ideological and political education in the curriculum, and the improvement of comprehensive literacy. With the theme of "using technology to change industrial development, turning green waters and mountains into golden mountains and silver mountains" as the main line of ideological and political education in the curriculum, the cultivation of the four major qualities is practiced throughout the entire process of the project. By promoting the spirit of science,

cultivating patriotism, cultivating the spirit of struggle, establishing the concept of energy conservation and environmental protection, it is a necessity to improve students' professional ability and moral cultivation, achieve simultaneous cultivation of morality and technology, and resonance with the same frequency. After the implementation of the project, students' comprehensive literacy ability has been significantly improved.

5. CONCLUSION

By studying and reforming the knowledge structure and teaching methods of the ordinary differential equation chapter of higher mathematics in higher vocational colleges, this paper explores the in-depth excavation and expansion of the knowledge and ability connotation corresponding to relevant cases in a modular and project-based way according to the national standards and talent training plans of specific majors. In combination with the requirements of post ability and professional courses, this paper also explores and expands the knowledge and ability connotation corresponding to relevant cases in a modular and project-based way, and redesigned the teaching content of "Advanced Mathematics" (ordinary differential equation chapter), which has achieved good results in implementation. In the subsequent work, continuous research and improvement will continue to be carried out in areas such as individualized teaching of students, expanding the scope of mathematics teaching research and reform, and enhancing the closeness of mathematics teaching with majors.

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