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Research on the Reform Path of Mathematical Modeling Teaching under the Background of Interdisciplinary Integration

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Abstract: Under the background of interdisciplinary integration, mathematical modelling teaching faces new challenges and opportunities. The traditional teaching mode is characterized by obvious disciplinary barriers, lagging content updating and insufficient teachers' interdisciplinary guidance ability, which makes it difficult to meet the demand for composite talents in modern society. This paper combines social needs and educational goals, and proposes reform paths such as optimizing teaching content, innovating teaching methods, and improving teachers' abilities, in order to realize the organic integration of interdisciplinary knowledge and the comprehensive enhancement of students' comprehensive abilities. The interdisciplinary integration of mathematical modelling teaching can effectively cultivate students' innovation ability, teamwork ability and social responsibility, which provides an important reference and practical guidance for the cultivation of talents in vocational universities.

1. Introduction

With the continuous advancement of social development and scientific and technological progress, the complexity and diversity of problems in various fields are becoming more and more prominent, which puts forward higher requirements for the talent cultivation mode of colleges and universities. As an important bridge between theory and practice, mathematical modelling plays an indispensable role in the cultivation of applied and innovative talents [1-3]. The current teaching mode of traditional mathematical modelling courses is relatively single, often limited to the teaching and application of mathematical knowledge, and insufficient attention is paid to the integration of knowledge of other disciplines and interdisciplinary collaboration, which makes it difficult to comprehensively cope with the complex problems in modern society.

Interdisciplinary integration is gradually becoming an important trend in solving complex problems. Through the integration and interaction of multidisciplinary knowledge, interdisciplinary collaboration can provide a comprehensive perspective, deeply analyse problems and propose optimized solutions [4-7]. In this context, the introduction of interdisciplinary concepts into

mathematical modelling teaching helps to cultivate students' comprehensive analytical ability and systematic thinking ability, and at the same time enhances their ability to solve practical problems and their sense of innovation.

This paper aims to explore the reform path of mathematical modelling teaching in the context of interdisciplinary integration. By analysing the shortcomings of the existing mathematical modelling courses and combining the actual needs of interdisciplinary integration, the article proposes specific reform paths such as optimization of teaching content, innovation of teaching methods, and improvement of teachers' ability, etc. Through this study, it provides a theoretical basis and practical references for the reform of mathematical modelling teaching in vocational undergraduate colleges and universities, and helps cultivate composite talents adapted to the needs of the new era.

2. The Current Status of Mathematical Modelling Teaching under the Background of Interdisciplinary Integration

2.1. Current Teaching Models in Mathematical Modelling Courses

Traditional mathematical modelling courses generally focus on mathematics as the core, emphasising the construction of mathematical models and the implementation of algorithms, and stressing practicality and the ability to solve practical problems. However, the existing teaching models rarely involve deep collaboration between different disciplines, and the course content mainly focuses on the application of mathematical theories and methods, lacking integration of knowledge from other disciplines [8]. Although this model is well suited to solving single subject problems, it is inadequate in the face of complex systems and interdisciplinary problems, and cannot comprehensively address the multidimensional challenges of practice. The teaching objectives of the course focus mostly on the practical application of mathematical knowledge, such as traditional mathematical methods like linear programming and differential equations, neglecting the global analysis of complex systems and the integration of multidisciplinary perspectives. Current assessment methods are too one-sided, often focusing on the accuracy of models and the rigour of mathematical reasoning, without reflecting the importance of interdisciplinary global skills and innovative solutions. This traditional teaching model still has significant limitations in cultivating students' thinking patterns and skills, especially in situations requiring cross-disciplinary collaboration, and lacks the cultivation of interdisciplinary collaboration.

2.2. Needs Analysis for Interdisciplinary Integration

2.2.1. Social Needs

With the increasing complexity of societal issues, many real-world challenges are no longer confined to a single disciplinary field, but involve the intersection and integration of multiple disciplines, such as health, environment, engineering, economics, and more. Effective solutions to these problems require not only in-depth analysis of a single discipline, but also comprehensive assessment from multiple disciplinary perspectives and multidimensional solution strategies. For example, in the field of public health, preventing and controlling infectious diseases or responding to disease outbreaks requires the collaborative efforts of multiple disciplines such as mathematical modelling, biology, epidemiology and sociology. In the field of intelligent manufacturing, the integration of mathematics and information technology has become an important way to promote innovation and improve production efficiency. The knowledge system of a single discipline often fails to meet the needs of these complex problems, making interdisciplinary and comprehensive skills particularly important.

2.2.2. Student Needs

The demand for versatile talents in today's society is increasing day by day. With the advancement of technology and changes in industries, many emerging industries require practitioners not only to have in-depth professional knowledge, but also to have interdisciplinary collaboration skills. Mastering interdisciplinary knowledge and being able to flexibly switch, apply and integrate it between different fields has become the key for students to enhance their employment competitiveness. During the academic learning process, students need to be exposed to content from different disciplines and to develop broad analytical and innovative skills in order to better cope with diverse challenges in society and the workplace. Therefore, interdisciplinary learning and practice not only enhances students' professional competence, but also strengthens their ability to think globally, helping them to better adapt to complex societal needs.

2.2.3. Educational Needs

The current higher education focuses not only on imparting professional knowledge, but also on cultivating students' comprehensive qualities to meet the rapidly developing social needs. The ultimate goal of education is to achieve moral education and serve society by cultivating composite talents with innovative ability and sense of social responsibility. To achieve this goal, curriculum design should break down barriers between disciplines and integrate interdisciplinary knowledge systems, especially in mathematical modelling courses. Through the interdisciplinary integration of mathematical modelling courses, students can not only improve their professional skills, but also help them better understand and solve practical problems, and promote the formation of innovative consciousness. This educational model can effectively combine knowledge teaching, ability cultivation and value guidance, and thus better meet the current educational goals and cultivate talents with comprehensive qualities.

2.3. Current Issues in Teaching

2.3.1. Barriers Between Disciplines

Existing mathematical modelling courses focus mainly on the mathematical subject itself, with teaching content and methods mostly revolving around mathematical knowledge, and the integration of interdisciplinary knowledge is relatively low. Most courses do not fully integrate core knowledge from other disciplines, which limits students' comprehensive understanding and solution of complex, interdisciplinary problems. Mathematical modelling itself is an interdisciplinary field of application, involving problems that are often multi-dimensional and multi-dimensional. Therefore, the lack of interdisciplinary learning and practical opportunities makes it difficult for students to develop systematic, comprehensive analysis skills and innovative solutions. The barriers between disciplines not only prevent students from accessing a broader perspective of knowledge, but also reduce their ability to collaborate across disciplines on practical problems, limiting their overall development.

2.3.2. Slow Updating of Textbook Content

At present, the contents of many mathematical modelling textbooks are still limited to traditional mathematical modelling methods, such as linear programming, dynamic programming, regression analysis and other classical mathematical models and algorithms, which are mainly applied to abstract problems with a strong theoretical foundation. The contents of these textbooks have not been updated in a timely manner and do not reflect the hot topics in the latest disciplinary

development and actual social needs, such as the application of data science, artificial intelligence, Internet big data analysis and other fields. The lag of textbooks makes it difficult for students to access real and complex interdisciplinary problems in today's society, which limits their learning interest and innovation ability. Especially when faced with complex problems that require a combination of interdisciplinary knowledge, students often lack sufficient theoretical support and practical experience, which reduces their ability to solve problems.

2.3.3. Insufficient Interdisciplinary Guidance Ability of Teachers

Effective implementation of mathematical modelling courses not only depends on appropriate course content, but also requires teachers to have solid interdisciplinary knowledge reserves and teaching skills. However, many teachers have relatively single subject backgrounds and usually have strong professional skills in the field of mathematics, but relatively weak knowledge accumulation in other subjects such as computer science, economics, physics, etc. Due to the lack of in-depth understanding and application of other disciplines, teachers often face significant challenges in guiding students in interdisciplinary modelling. The lack of interdisciplinary guidance ability directly affects the depth and effectiveness of teaching mathematical modelling, and also limits the cultivation of students' diversified thinking and the improvement of their comprehensive abilities. Therefore, improving teachers' interdisciplinary ability has become an urgent task in the current reform of mathematical modelling teaching.

3. Reform Path of Mathematical Modelling Teaching under the Background of Interdisciplinary Integration

3.1. Optimization and Design of Teaching Content

3.1.1. Combining Actual Cases

In interdisciplinary integrated mathematical modelling courses, the teaching content should be closely linked to social reality and current issues. By introducing typical interdisciplinary problems such as medical data analysis, environmental management, and intelligent manufacturing, students can see the value and application of interdisciplinary modelling in solving practical problems. For example, in medical data analysis, students can combine knowledge of biology, data science and statistics to design optimised disease prediction models, thereby cultivating their ability to solve practical problems and stimulating their interest in interdisciplinary modelling. Through this approach, students can better understand the practical applications of mathematical modelling and enhance their ability to analyse and solve complex problems.

3.1.2. Expand Knowledge of Related Disciplines

Traditional mathematical modelling courses typically focus on mathematical knowledge, while interdisciplinary mathematical modelling requires students to have knowledge from multiple disciplines. Therefore, course content should incorporate knowledge from fields such as data science, artificial intelligence, and engineering management to help students build a multidisciplinary knowledge framework. For example, when studying environmental management issues, mathematical modelling courses can combine Geographic Information System (GIS) technology to use data analysis and model construction to solve problems such as environmental protection and resource optimisation. Through this interdisciplinary integration, students can not only master the core skills of mathematical modelling, but also learn how to combine mathematical tools with knowledge from other disciplines, thereby cultivating their interdisciplinary thinking and

comprehensive problem-solving skills.

3.1.3. Strengthen the Design of Comprehensive Problems

To improve students' comprehensive skills, mathematical modelling courses should include more comprehensive tasks to help students apply interdisciplinary knowledge to construct solutions. For example, in teaching medical resource allocation optimization, a comprehensive task involving mathematics, medicine, and economics can be designed. In solving such problems, students need not only to perform mathematical modelling, but also to analyse the factors influencing resource allocation in combination with medical knowledge, and to evaluate the cost-effectiveness of different strategies based on economic principles. This comprehensive design can help students develop systematic thinking skills, stimulate innovative thinking and encourage students to solve practical problems from a multidisciplinary perspective. Through this comprehensive task, students can enhance their interdisciplinary application skills through collaboration and interaction, and better address complex societal challenges.

3.2. Innovation of Teaching Methods

3.2.1. Project-Based Teaching

The project-based teaching model emphasises that students design and implement practical projects in group collaboration. In interdisciplinary mathematical modelling courses, students can not only enhance their ability to apply disciplinary knowledge, but also improve their teamwork and communication skills by working together to solve practical interdisciplinary problems. For example, organising students to participate in urban traffic optimisation projects requires students to use mathematical modelling skills to analyse traffic flow, road layout and spatio-temporal factors, and to propose optimisation proposals. By solving problems in a practical environment, students can better understand how to apply mathematical modelling methods to complex systems, and improve their problem-solving skills and innovative thinking in practical projects. In addition, project-based teaching can enhance students' ability to collaborate with different disciplines and further improve their ability to integrate interdisciplinary knowledge.

3.2.2. Case Teaching Method

The case teaching method helps students understand the practical application process of interdisciplinary modelling by analysing classic or cutting-edge interdisciplinary modelling cases. In mathematical modelling courses, teachers can select practical cases, such as global climate models and pandemic transmission models, to show students the whole process from problem definition, modelling assumptions, model construction, solution and result analysis. Through such teaching, students can gain a deeper understanding of the application of mathematics in areas such as environmental protection and public health, and understand the assumptions, constraints and implementation implications of the solutions behind the models. In addition, the case teaching method not only enhances students' modelling skills, but also stimulates their sense of responsibility and participation in global issues, cultivates their awareness of paying attention to social issues and applying disciplinary knowledge to solve problems.

3.2.3. Situational Teaching

Situational teaching immerses students in the complexity of problems and enhances their ability to solve interdisciplinary problems by constructing real or simulated application scenarios. For

example, when teaching urban traffic optimisation, teachers can simulate traffic conditions in different areas and set different real-life scenarios, such as traffic peaks, emergencies and traffic policy adjustments. Students are required to use interdisciplinary analysis combined with mathematical modelling, computer simulation and traffic engineering knowledge to propose appropriate solutions. Through this situational teaching approach, students can better understand the complexity and multi-dimensional characteristics of interdisciplinary problems, while also improving their adaptability and decision-making skills in practical work. Situational teaching can effectively enhance students' practical perception of problems and equip them with stronger abilities to cope with complex interdisciplinary challenges.

3.3. Improvement of Teacher Abilities

3.3.1. Interdisciplinary Knowledge Training

In order to effectively implement interdisciplinary teaching of mathematical modelling, teachers need to have a broad disciplinary background. Schools should regularly organise teachers to participate in interdisciplinary training in fields such as data science, artificial intelligence, environmental science, etc., in order to enhance teachers' knowledge reserves and strengthen their understanding and teaching ability of interdisciplinary issues. Through systematic training, teachers can better integrate multidisciplinary knowledge into mathematical modelling courses, thus promoting the improvement of teaching effectiveness. In addition, the training can also help teachers to develop stronger adaptability and interdisciplinary perspectives when dealing with interdisciplinary issues, enabling teachers to guide students to fully understand the integration and application of knowledge from different disciplines in the teaching process.

3.3.2. Participate in Multidisciplinary Research Projects

Encouraging teachers to actively participate in interdisciplinary research projects not only helps to improve their practical skills, but also provides richer experience for teaching. For example, teachers can collaborate with experts in fields such as health care, environmental protection and intelligent manufacturing to conduct research projects, gain experience in interdisciplinary collaboration, and translate this experience into teaching content to improve the quality of teaching. Participation in scientific research projects can not only enhance teachers' academic skills, but also help them to understand the challenges and needs at the forefront of industry, making teaching content more realistic and enhancing the practicality and applicability of the curriculum. In addition, teachers' participation in interdisciplinary research can provide students with more practical and cutting-edge academic resources, stimulating their academic interest and innovation ability.

3.3.3. Improvement of Teaching Skills

In addition to subject knowledge, teachers' teaching methods need to be constantly updated and improved. Regular teaching workshops and seminars should be organised to help teachers master innovative methods such as project-based teaching, case-based teaching and situational teaching, to stimulate their teaching creativity and to effectively apply these new methods to the teaching of mathematical modelling courses. By continuously improving their teaching skills, teachers can create a more interactive and practical learning environment in the classroom, which promotes the cultivation of students' interdisciplinary skills. For example, teachers can stimulate students' team spirit through project-based teaching, use case studies to help students understand application examples of interdisciplinary modelling, and use situational teaching to help students understand multidimensional solutions to complex problems. By continuously practising and optimising these

innovative teaching methods, teachers can continuously improve their teaching effectiveness and enable students to better grasp interdisciplinary knowledge and cultivate their ability to solve practical problems.

4. Conclusions

Through research on the reform of mathematical modelling teaching in the context of interdisciplinary integration, it can be found that this teaching model has significant effects on improving the overall quality of students and adapting to the needs of modern society. The optimised teaching content focuses on the combination of practical problems and interdisciplinary knowledge. The innovation of teaching methods effectively stimulates students' learning interest and innovation ability, and the improvement of teachers' skills provides a solid guarantee for teaching reform. This series of measures not only breaks through the limitations of traditional single-subject teaching, but also cultivates students' ability to comprehensively analyse and solve complex practical problems.

The reform of mathematical modelling teaching further strengthens the close connection with social and industrial needs, makes full use of modern technological means, optimises teaching methods and creates a more intuitive and dynamic teaching environment. In addition, the scientific teaching evaluation system will be improved, the reform effect will be evaluated from multiple perspectives, and a basis for continuous improvement will be established. Through deepening reform, mathematical modelling courses will play a more important role in cultivating students' innovation ability, practical ability and sense of social responsibility, and make greater contributions to social development and the cultivation of composite talents.

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