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Empowered by Mathematical Modeling: Integration Paths of AI and Mathematics Teaching for Vocational Undergraduates

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Abstract: In the intelligent era, mathematics teaching in vocational undergraduate colleges faces prominent problems, including disconnection between theory and practice, superficial integration of AI, and fragmented application of mathematical modeling teaching. Taking mathematical modeling as the core link, this paper constructs an integrated teaching mode of "mathematics-major-AI". Supported by school-enterprise training platforms, the study designs matched classroom teaching and after-class training for TCM pharmacy majors to carry out mathematical modeling, AI data analysis and practical verification. This mode eliminates the barriers among mathematical theories, professional skills and intelligent technologies, enhances students' practical ability to solve practical industrial problems, and offers feasible references for mathematics teaching reform in vocational undergraduate education.

Keywords: Intelligent era; Vocational undergraduate mathematics; Mathematical modeling; Integrated teaching; Collaborative education

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1. Introduction

Against the backdrop of the intelligent era, technologies such as artificial intelligence and big data have promoted the intelligent transformation of various industries, putting forward higher requirements for the comprehensive literacy of talents [1]. As a key link connecting higher vocational education and general undergraduate education, vocational undergraduate education focuses on cultivating high-quality technical and skilled undergraduate talents, which needs to balance the theoretical depth of undergraduate education and the application orientation of vocational education. As a core basic course for multiple majors in vocational undergraduate education, mathematics is an important support for students to master professional skills, apply artificial intelligence technology, and solve practical problems, and its teaching reform is directly related to the improvement of talent training quality [2].

At present, mathematics teaching in vocational undergraduate education faces prominent difficulties: the obvious disconnection between learning and application, with teaching focusing on theoretical lectures, abstract content and detachment from professional scenarios; the shallow integration of artificial intelligence technology and mathematics teaching, failing to realize in-depth empowerment with teaching and professional practice; the teaching of mathematical modeling is limited to competitions and not integrated into daily teaching; there is a lack of coordination among mathematics, majors and artificial intelligence technology, and the teaching content is fragmented, making it difficult to meet the talent demand of the intelligent era [3]. As a natural link connecting mathematical theory, professional application, and artificial intelligence technology, taking mathematical modeling as the starting point to construct an integrated teaching mode of “mathematics-major-artificial intelligence technology” is an inevitable choice to solve teaching pain points and realize in-depth coordination of the three.

The theoretical significance of this paper lies in enriching the theoretical system of mathematics teaching reform in vocational undergraduate education in the intelligent era, exploring the law of collaborative education of the three, and providing a new theoretical perspective; improving the application theory of mathematical modeling in vocational undergraduate education, making up for the deficiencies in relevant research, and providing a theoretical reference for similar colleges and universities. The practical significance lies in providing a feasible path for teaching reform to solve the problem of disconnection between learning and application; improving students’ comprehensive literacy to meet the demand for technical and skilled talents; providing teaching guidance for teachers and promoting the transformation of the teaching team; promoting the connotative development of vocational undergraduate education and improving the quality and competitiveness of talent training [4].

2. Research status

Foreign research on mathematical modeling teaching has a mature system, focusing on integration with practical and professional scenarios and emphasizing the cultivation of students’ practical abilities. In the intelligent era, foreign vocational education has promoted the integration of AI technology into mathematics teaching, using big data and machine learning to develop personalized modeling schemes and intelligent evaluation systems [5]. However, foreign studies are tailored to their own national education systems, which are not directly applicable to China, and there is a lack of systematic research on the integration of mathematics, majors, and AI technology.

In recent years, domestic research on mathematics teaching reform in vocational undergraduate education has gradually deepened, mainly focusing on three aspects: the application of mathematical modeling, AI-enabled teaching, and the integration of mathematics and majors [6]. However, there are obvious gaps in domestic research [7]: insufficient systematic research on the in-depth integration of the three, poor operability of existing teaching modes, and inadequate research on implementation paths and supporting measures.

Based on the actual situation of domestic vocational undergraduate education, this paper constructs a feasible integrated teaching mode to make up for the deficiencies in existing research and provide support for mathematics teaching reform.

3. Classroom links

In actual classroom teaching, teachers firstly clarify the professional application scenarios of mathematical knowledge in accordance with talent training programs and job requirements of relevant majors. Instead of simply instilling theoretical formulas, teachers introduce courses with practical professional problems, enabling students to fully recognize the practical value of mathematics in professional study and future careers. During lectures, cumbersome theoretical deductions are simplified, and emphasis is placed on practical mathematical methods for solving real-world problems. Combined with industry-oriented practical cases, teachers integrate mathematical modeling ideas into knowledge explanation, guiding students to convert professional practical problems into mathematical ones and establish basic mathematical models independently.

On this basis, artificial intelligence tools and technologies are introduced to instruct students to conduct data sorting, model calculation, and result simulation via intelligent software. This simplifies complex calculations, improves modeling efficiency, and realizes the simultaneous integration of mathematical problem-solving, professional application, and intelligent tool operation. After class, traditional written exercises are replaced with major-oriented miniature modeling assignments, which motivate students to explore solutions through group cooperation and consolidate classroom knowledge. Hierarchical learning resources are delivered via online intelligent teaching platforms to provide targeted tutoring and solve learning difficulties for students at different learning levels.

In the whole teaching process, mathematics teachers cooperate with professional teachers to jointly design teaching plans and offer practical guidance, so as to keep teaching content consistent with professional development demands. At the end of phased teaching, the traditional examination-oriented assessment is transformed into a diversified evaluation system covering classroom performance, modeling quality, AI tool application proficiency, and professional problem-solving competence. Such evaluation mechanism promotes the all-round development of students' comprehensive abilities, bridges the gap between mathematics learning, professional practice, and AI technology application, and reverses the tendency of emphasizing theories over practice. Consequently, mathematics courses can better serve the goal of cultivating high-quality technical and skilled talents in vocational undergraduate education.

4. After-class links: A case study of TCM pharmaceutical major

After integrated classroom teaching, colleges can launch phased comprehensive practical training courses on mathematical modeling relying on on-campus TCM pharmaceutical training centers and real production projects of cooperative pharmaceutical enterprises. Such courses integrate scattered mathematical knowledge, professional skills of TCM pharmacy, and artificial intelligence application, so as to strengthen students' practical competency and extend integrated teaching from classrooms to actual TCM production practice. Different from regular exercises, the practical training sets comprehensive practical themes based on actual production procedures, herbal processing, and pharmaceutical preparation demands. Guided jointly by mathematics and professional teachers, students carry out project-based learning with the whole-process application of AI technologies to improve their all-round practical abilities in line with the talent cultivation objectives of vocational undergraduate TCM pharmacy majors. The integrated teaching focuses on core professional contents including optimization of TCM extraction processes, determination of active ingredient content, dosage form proportion adjustment, and production energy consumption control, so as to bridge the gap between mathematical theories and professional practice. In teaching, teachers simplify complicated theoretical derivations and focus on practical mathematical methods widely used in production, such as functional operation, linear regression, probability statistics, and orthogonal experimental design, and clarify their practical application scenarios in TCM extraction and preparation production. Taking the water extraction of *Salvia miltiorrhiza* as a typical practical problem, students are required to optimize extraction parameters to raise the yield of salvianolic acid B while cutting down energy consumption and ensuring stable product quality. Students are guided to convert this practical production issue into mathematical problems. With the extraction rate as the dependent variable and extraction time, temperature, and solid-liquid ratio as independent variables, students establish mathematical models via linear regression and orthogonal design methods. In data analysis and model solving, students adopt AI data analysis tools instead of manual calculation to process historical production data, conduct data screening, fitting calculation, and parameter optimization, and obtain the optimal parameter combinations as well as corresponding energy consumption data, which conforms to the intelligent development trend of modern TCM production. Subsequently, students verify the optimized parameters through practical operation in training centers, test the content of active ingredients with professional testing instruments, and check whether the optimized parameters comply with GMP standards, so as to confirm the rationality and practicability of established mathematical models. Upon the completion of training, each group submits mathematical modeling reports, AI data analysis results, practical operation records, and process optimization schemes. Teachers conduct comprehensive evaluations from multiple dimensions including data accuracy, model rationality, proficiency of AI tool application, and standardization of practical operation, so as to promote the improvement of students' comprehensive capabilities. Practical case teaching closely linked to vocational posts enables students to master practical mathematical methods and AI data analysis skills, and effectively solves the disconnection between mathematical learning and vocational employment. With mathematical modeling as the core link, it realizes the in- depth integration of mathematical knowledge, professional skills, and AI technologies, and cultivates students' ability to solve practical problems in TCM pharmaceutical industry, which fully meets the requirements for cultivating high-quality technical talents majoring in TCM pharmacy in the intelligent era.

5. Conclusion

This section constructs systematic after-class practical training systems for students majoring in traditional Chinese medicine pharmacy. By taking full advantage of on-campus training bases and real production projects from cooperative enterprises, it takes the optimization of Chinese herbal medicine extraction technology as a typical practical carrier to organically integrate basic mathematical theories, professional pharmaceutical expertise, and artificial intelligence application technologies. In the practical training process, students are instructed to transform actual industrial production difficulties into mathematical research problems, establish scientific mathematical models by adopting multiple mathematical analysis methods, and utilize intelligent data analysis means to complete data mining, scheme optimization, and effect prediction. Meanwhile, combined with professional operation standards and industry GMP specifications, relevant practical verification is conducted to ensure that the research results are practical and operable in actual production. In addition, this study adopts a multi-dimensional comprehensive evaluation mechanism to objectively assess students' theoretical application ability, practical operation level, and intelligent technology application literacy. The design of such after-class teaching links effectively breaks the long-standing separation between mathematical teaching and professional practical teaching in vocational undergraduate education, fully gives play to the bridging role of mathematical modeling in interdisciplinary integration, and effectively improves students' comprehensive ability to solve complex practical problems in the field of traditional Chinese medicine pharmacy. It not only enriches the practical teaching form of vocational undergraduate mathematics courses, but also provides a complete and referable practical implementation path for promoting the in-depth integration of mathematics, majors, and artificial intelligence, and steadily realizes the high-quality cultivation goal of applied, compound, and intelligent technical talents in vocational undergraduate colleges under the background of the intelligent era.

Disclosure statement

The authors declare no conflict of interest.

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