MWORKS Empowers Vocational Undergraduate Mathematics Teaching Innovation: The Path of Digital Reconstruction and Ideological-Political Integration

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Abstract: *In the era of Industry 4.0, the cultivation of high-quality talent is crucial, and mathematics courses serve as a fundamental pillar. Based on an analysis of the positioning and characteristics of vocational undergraduate mathematics education, this paper constructs a digital framework, including curriculum content restructuring, preparation of teaching materials and software, development of digital resources, compilation of textbooks, evaluation methods, and teaching methodologies. It also elaborates on the specific participation in the MWORKS domestic software verification project, taking a further step in exploring how MWORKS empowers innovation in vocational undergraduate mathematics teaching.*

Keywords: *Vocational Undergraduate Education; Mathematics; MWORKS; Ideological and Political Education in Curriculum; Digitalization*

1. Introduction

Interdisciplinary skilled talents are central to the Industry 4.0 era. Currently, China is vigorously advancing vocational undergraduate education, with a strong emphasis on cultivating high-skilled professionals. Within this educational framework, mathematics courses serve as fundamental general education curricula, whose broad applicability underscores their significant importance. To shift away from the traditional academically-oriented knowledge system, it is essential to strengthen the cultivation of applied and integrative competencies. However, vocational undergraduate mathematics teaching still faces multiple challenges: firstly, the disconnection between teaching content and engineering practice hinders the development of students' ability to solve real-world engineering problems; secondly, insufficient application of digital teaching tools means traditional instructional models fail to meet the demands of vocational education for practical operation and innovation capability; thirdly, the integration of ideological and political education into the curriculum remains fragmented, undermining the full realization of the educational value of mathematics courses.

Currently, the traditional mathematical software MATLAB is facing significant challenges, while the domestic substitution process is steadily accelerating. The domestic software MWORKS has now largely replaced MATLAB in most functionalities and is specifically equipped with the Syslab scientific computing environment for mathematical applications. Moreover, MWORKS offers free educational account applications, and universities have deployed free on-campus IP access, significantly reducing the barriers to usage. Therefore, integrating the domestic software MWORKS effectively into the curriculum to empower the reform and innovation of vocational undergraduate mathematics courses will be a crucial component.

2. Analysis of the Positioning and Characteristics of Vocational Undergraduate Mathematics Education

Vocational undergraduate education, as an independent educational type distinct from regular undergraduate and specialized education, possesses a distinct "high-level technical skills" attribute. Compared to the academic research-oriented talent cultivation model of regular undergraduate education, vocational undergraduate education places greater emphasis on the alignment of practical innovation capabilities with occupational positions; when compared to specialized education, its cultivation objectives further extend towards solving complex engineering problems, technological research and development, and innovation. This positioning requires that mathematics courses must break through the traditional theoretical teaching framework and shift towards a composite teaching model of "knowledge application, ability cultivation, and literacy enhancement." They must not only cover theoretical proof problems in undergraduate mathematics to cultivate students' logical thinking abilities but also address practical problems and software applications in specialized mathematics to develop students' practical application skills[1].

3. Construction of the Digital System

3.1 Software Preparation

The Symbolic Math Toolbox within the scientific computing module of the MWORKS software is primarily utilized. It enables users to perform symbolic mathematical computations, providing functions for solving, plotting, and manipulating symbolic mathematical equations. The toolbox offers functions covering common mathematical domains such as calculus, linear algebra, algebra, ordinary differential equations, equation simplification, and equation manipulation. The TySymbolicMath toolbox allows users to analytically perform differentiation, integration, simplification, transformation, and equation solving.

3.2 Updates to Curriculum Standards and Teaching Schedules

The curriculum system has been restructured by integrating MWORKS in accordance with the requirements of vocational undergraduate education, leading to the development of new curriculum standards. Regarding course content, practical training sections using MWORKS have been incorporated into each chapter. Corresponding adjustments have been made to the teaching schedule, with 2-3 practical training sessions arranged per semester. These sessions are scheduled after every 2-3 chapters of instruction, and specific curriculum standards for these practical training sessions have also been established.

3.3 Course Content

Chapter 1: Fundamentals of MWORKS and the Syslab Toolbox

Chapter 2: Functions, Limits, and Their Visualization in MWORKS

In the section on functions, the MWORKS software is introduced to perform basic numerical computations and function evaluations. Students will learn to utilize MWORKS for plotting function graphs, enabling a clear understanding of function properties and behavioral patterns.

In the limits section, after covering the calculation methods of limits, students will use MWORKS to compute limits, including handling more complex limit operations.

Chapter 3: Derivatives, Differentials, and Their Applications

After explaining the calculation of derivatives, students will employ MWORKS to compute derivatives, including solving more complex derivative problems[2].

Chapter 4: Integrals and Their Applications

Following instruction on integral computation, students will use MWORKS to calculate integrals, including handling more complex integral operations.

Chapter 5: Differential Equations and Practical Application of MWORKS

Students will utilize MWORKS to solve differential equations.

Chapter 6: Multivariable Calculus

MWORKS will be applied to solve problems involving partial differentiation and multiple integrals of multivariable functions.

Chapter 7: Fourier Series, Fourier Transform, and Practical Application of MWORKS

In the Fourier series section, MWORKS will be used to solve complex Fourier series computations.

For Fourier transforms, which involve signal processing and analysis, MWORKS will be introduced. Students will be guided to use MWORKS for performing Fourier transforms on signals, visually presenting spectral characteristics such as amplitude and phase information. This approach helps students develop a profound understanding of signal characteristics and variations in the frequency domain.

3.4 Resources (Code, etc.)

To support the corresponding teaching content, corresponding teaching resources need to be developed. First, lesson plans: in addition to traditional course content lesson plans, specialized MWORKS lesson plans must be created, primarily detailing the specific implementation of the 2-3 practical training sessions. Second, PowerPoint presentations required for teaching: these mainly cover MWORKS-related theoretical knowledge, specific operations, code principles, and code for specific example problems[3]. Third, an exercise bank and its corresponding code for in-class practical operations: the exercises include many applied case studies. Fourth, practical application projects related to specialized fields that can be implemented using MWORKS.

3.5 Digital Teaching Materials

To better support teaching, the team is actively preparing to compile supporting digital teaching materials. Currently, there are two textbooks awaiting publication.

In addition to conventional content such as advanced mathematics and calculus, the course materials include Fourier series and Fourier transforms, which are challenging yet crucial topics. This is particularly true for telecommunications students, as these concepts are indispensable prerequisites for signal processing. In past teaching practices, students have found the theoretical understanding and mastery of this content quite difficult. We aim to simplify these complex topics through software applications. During the textbook compilation process, we discovered that implementing Fourier series and Fourier transforms in MWORKS is also relatively complex, with particularly lengthy code required for Fourier series due to the intricate calculations involved in computing Fourier coefficients. Throughout this process, we have been continuously exploring methods to optimize the code, establish our own function libraries, and streamline this section of code to help students better understand and master these concepts.

Additionally, at the beginning of each chapter, an introduction to the history of mathematics is included, along with relevant examples corresponding to different chapter content that integrate cutting-edge technologies in China's development with mathematics. These cases include high-speed railways, the C919 large passenger aircraft, and the Hong Kong-Zhuhai-Macao Bridge, which not only incorporate ideological and political elements but also help students understand how mathematics is applied in practice. Each chapter concludes with corresponding extended reading materials, allowing students to broaden their knowledge while learning the subject matter.

3.6 Evaluation

For course assessment, we adopt a formative evaluation approach, comprehensively assessing students through regular performance and final examination results. Regular performance covers a broad range of components, including attendance, in-class exercises, and homework. Additionally, a dedicated MWORKS evaluation module has been incorporated, primarily focusing on students' performance in practical in-class operations, specifically their mastery of the code implementation process and results. All examinations at the vocational undergraduate level are conducted as closed-book tests, with the structure and difficulty of the examination papers designed with reference to the mathematics standards of postgraduate entrance examinations.

3.7 Methods

In addition to regular coursework, we have established a teaching assistant team selected from outstanding senior students. Teaching assistants are scheduled to attend classes one day per week, not during regular class hours but primarily utilizing evening self-study sessions. During these evening sessions, they explain exercises and provide tutoring to fellow students. This initiative not only addresses the limited communication between students and teachers during regular hours but also provides an additional mechanism to regulate students' mathematics learning and enhance its effectiveness. Simultaneously, it improves the teaching assistants' mathematical proficiency and instructional skills.

4. Application Validation of Course Implementation

4.1 Application of MWORKS Software in Course Teaching Reform, Teaching Resource Development, and Construction of Typical Teaching Application Cases

In terms of course teaching reform, first, the visualization function of MWORKS software is utilized to present abstract theoretical knowledge to students through intuitive graphics, curves, and other forms. These methods not only enhance student interest but also help students better understand the characteristics and variation patterns of functions, thereby improving the effectiveness and quality of classroom teaching. Second, a task-driven teaching model is introduced, incorporating practical exercises designed with MWORKS software. This approach allows students to learn through practice, transforming the traditional theory-focused instruction. It enables students to actively explore and learn through practical application, enhancing their practical abilities and innovative thinking.

Regarding the development of teaching resources, electronic courseware, teaching cases, and other materials related to MWORKS software are currently available. The software is also equipped with corresponding help documentation[4].

In the construction of typical teaching application cases, teaching cases have been developed for various topics, including function calculation, function graph plotting, limit calculation, derivative calculation, integral calculation, and solving differential equations. These cases are provided for use in classes and for student reference.

4.2 Application Validation Results

4.2.1 Advantages of the Software

High-Precision Computational Capability: When handling complex mathematical problems, the MWORKS software demonstrates exceptional computational accuracy. This capability helps cultivate students' rigorous scientific attitude and their ability to solve problems with precision.

Rich Visualization Effects: The software provides diverse visualization tools that can present abstract data and models through intuitive charts, animations, and other forms. This enhances students' learning interest and deepens their comprehension.

4.2.2 Disadvantages of the Software

Insufficiently Comprehensive Operation Documentation: The software's operation manual and help documentation lack detailed and clear explanations for certain complex functions. For beginners, it is difficult to quickly find effective solutions from official documentation when encountering problems. This situation forces students to rely more on teacher guidance and peer communication during the initial learning phase, which increases the teaching burden on instructors and, to some extent, limits students' autonomous learning capabilities.

Non-Open Source Software and Access Restrictions: The software is not open source and requires either a school email account or campus network access for use. These restrictions limit the user base and accessible locations, hindering the software's broader promotion.

Comparative Analysis with Similar Software:

Comparison with MATLAB:

In scientific computing, MATLAB boasts a broad user base and rich toolbox resources, with extensive and mature applications in traditional fields such as numerical computation and signal processing. In contrast, MWORKS software offers more specialized modules and targeted functionalities in specific engineering domains, where its computational efficiency and accuracy demonstrate outstanding performance.

Regarding visualization, MATLAB provides powerful and flexible plotting functions, allowing users to achieve highly customized graphical displays through programming. MWORKS, however, focuses on providing intuitive and user-friendly visualization interfaces. For students and teachers without programming expertise, it is easier to quickly generate high-quality visualization results with

MWORKS, though its capabilities for fine-grained graphical customization are relatively limited.

Student Feedback:

Positive Feedback: Most students indicated that MWORKS software enables them to closely integrate theoretical knowledge learned in class with practical applications. Through hands-on operation with the software, their practical abilities and problem-solving skills have been significantly enhanced.

Suggestions for Improvement: Students also proposed several improvement suggestions. These include providing more online tutorials and case demonstrations to help them master software usage techniques more quickly; optimizing the interface design to make it more concise and intuitive, thereby reducing operational complexity; and adding data interaction interfaces with other commonly used software to facilitate data sharing and collaborative work across different platforms, further improving learning and research efficiency.

4.3 Issues Identified During Application Validation

The teaching practice revealed several areas where the MWORKS software still has room for improvement. First, compared with MATLAB, there remain certain differences in code implementation, requiring users to familiarize themselves with the software rather than using it immediately. Additionally, the code implementation in MWORKS is relatively complex, indicating a need for further optimization and simplification in this aspect. Second, slight discrepancies between computational results and theoretical expectations were observed. For instance, in topics such as limits and series, results that should theoretically be zero sometimes appeared as very small decimal values in the software output. Third, the software cannot directly recognize the mathematical constant π, requiring users to handle it through floating-point number processing. Fourth, when solving differential equations requiring substitution or multiple integrations, the software fails to recognize arbitrary constants. Fifth, educational accounts cannot be used for activation authentication on school computers due to system conflicts[5].

Therefore, such teaching practices are highly meaningful. To some extent, they have promoted the optimization of the MWORKS software, helping this domestic software to progress more rapidly toward maturity, achieve comparability with traditional software, and become genuinely applicable in teaching and practical scenarios.

4.4 Participation in Application Validation Activities

To gain proficiency in MWORKS software and apply it effectively in teaching and research, active participation in multiple professional training activities was undertaken. Training sessions organized by Tongyuan were attended, covering in-depth analysis of the software's core functional modules. The curriculum ranged from explanations of fundamental mathematical computation engine principles to hands-on practice with complex multidisciplinary coupling simulation cases, comprehensively enhancing understanding of the software's capabilities. These sessions not only provided software usage skills but also exposed participants to cutting-edge application methodologies across different fields, offering inspiration for subsequent teaching reforms.

Based on accumulated experience in MWORKS software applications and practices in teaching and research, active involvement in textbook publication was pursued. Preparations are underway to compile and publish the book "Engineering Applied Mathematics (Based on MWORKS)", which systematically introduces the application of MWORKS software in engineering applied mathematics through practical cases[6].

Through the series of application validation activities described above, not only was personal professional competence and practical ability enhanced, but a solid foundation was also laid for the widespread application of MWORKS software in teaching, competitions, and scientific research, thereby promoting development and progress in related fields.

Conclusion

This study, grounded in the cultivation orientation of "high-level technical and skilled talents" in vocational undergraduate education, systematically explores teaching innovation pathways empowered by MWORKS, addressing key challenges such as the disconnection between theory and practice in mathematics teaching and the rigid integration of ideological-political education. Through digitally reconstructing curriculum content oriented toward professional needs, the research transforms abstract mathematical knowledge into operable practical application cases. Utilizing MWORKS, it builds a bridge connecting "mathematical principles — tool application — engineering practice," shifting mathematics instruction from "formula derivation" to "problem solving," thereby effectively enhancing students' mathematical application abilities and digital tool operation skills. Meanwhile, by excavating ideological-political elements within application cases, a trinity integration model of "knowledge imparting — ability cultivation — value guiding" is constructed. This allows qualities such as craftsmanship and national sentiment to naturally permeate through MWORKS practical operations, resolving the issue of disconnection between ideological-political education and specialized teaching.

Practice has demonstrated that MWORKS serves not only as a technological tool for optimizing the teaching process but also as a significant vehicle for promoting the conceptual innovation of vocational undergraduate mathematics teaching, providing replicable and scalable practical solutions for curriculum reform. Certainly, the study still has limitations, such as the need to expand the coverage of cross-disciplinary case libraries and further optimize the compatibility between ideological-political elements and different mathematical modules. In the future, sustained efforts can deepen the integrated application of MWORKS and AI technologies to develop personalized teaching resources; collaborate with industries and universities to build dynamic case libraries, strengthening the connection between teaching and industrial demands; and explore more targeted pathways for ideological-political integration. These initiatives will enable mathematics teaching, empowered by digitalization, to be both "practical and user-friendly" and "morally and mentally educative," injecting sustained momentum into the high-quality development of vocational undergraduate education.

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References

[1] Zhang Yongfei, Qu Yingbo, Zhang Li, et al. Teaching Case Design for Scientific Computing and Visualization Course Based on MWORKS: Taking Sudoku Image Recognition and Solving as an Example. Software Guide, 2025, 24(01): 176-182.

[2] Chang Xiaofei, Yang Tao, Fu Wenxing. Exploration on the Ideological and Political Construction in the Teaching of Domestic Independent Industrial Software MWORKS. Shaanxi Education (Higher Education), 2025, (09): 10-12.

[3] Shi Lu. Reform and Exploration of Higher Mathematics Practical Teaching in Vocational Undergraduate Institutions under the Background of the "Three Teachings" Reform. Modern Vocational Education, 2024, (01): 45-48.

[4] Xie Ying, Yao Kejian, Zhang Yazhuo. Research and Practice on the Innovation of Higher Mathematics Curriculum Model Oriented towards Adapting to Vocational Undergraduate Universities. Journal of Higher Education, 2023, 9(06): 73-76.

[5] Long Yiyu. Research on the Construction of Public Basic Course Textbooks in Vocational Undergraduate Education from the Perspective of Ideological and Political Education. Education Science Forum, 2022, (09): 18-21.

[6] Li Bowen, Lei Tianli. Blended Online and Offline Teaching Reform of "Economic Management Mathematics": Based on the Practice of the Chinese University MOOC Platform. Journal of Shenzhen Polytechnic, 2021, 20(05): 64-68. DOI: 10.13899/j.cnki.szptxb.2021.05.012.