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Teaching Model Exploration of Integrating Digital Literacy into Higher Vocational Mathematics Courses

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Abstract: Higher vocational mathematics education witnesses a historic transformation, driven by the development of information technology. Cultivating the digital literacy of vocational education normal students is a fundamental link in promoting the digital teaching reform of vocational education. This paper analyzes the necessity of integrating digital literacy into higher vocational mathematics courses under the current national strategies and employment market demands, and explores how digital literacy can facilitate students' learning. We primarily explores the teaching model of mathematics to enhance students' digital literacy, thereby generating a practical system. Through these changes, it will promote the cultivation of more high-quality technical and skilled talents in higher vocational colleges.

Keywords: Digital Literacy; Higher Vocational Education; Mathematics Education; Course Construction

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1.Introduction

The teaching reform of vocational colleges is the core thread of the development of vocational education in China, and its process deeply reflects the changes in the demand for technical and skilled talents in the economy and society[1].

Nowadays, technologies such as artificial intelligence, big data, and virtual reality are deeply integrated into the entire process of professional construction, curriculum teaching, practical training and evaluation, achieving personalized learning, intelligent management, and cultivating students' digital literacy to adapt to future intelligent production.

The reform of mathematics teaching in vocational colleges is a concrete and crucial microcosm of its overall teaching reform, and its evolution clearly reflects the value shift of vocational education from emphasizing skill imparting to emphasizing comprehensive literacy and sustainable development capabilities[2]. The core of the reform is the transformation of positioning: from an independent discipline to a tool based foundational course serving professional technical learning. Vocational colleges have begun to vigorously promote the reform of "modular teaching" and "application-oriented". The teaching content has been restructured into "basic modules" and "professional application modules". In terms of teaching methods, case-based teaching and project driven approaches have been introduced, attempting to help students appreciate the value of mathematics in solving practical problems. It fully demonstrates the current situation of deepening the integration of industry and education and embracing digital intelligence.

With the digitalization of industries, the teaching content of vocational mathematics will inevitably integrate more modern mathematical knowledge such as data analysis, statistical prediction, and optimization algorithms, cultivate students' data thinking and computational thinking, and lay a foundation for them to adapt to the smart industry. The ultimate goal of the reform will go beyond imparting specific knowledge and focus more on cultivating students' core competencies through mathematical training, including logical reasoning ability, quantitative analysis ability, critical thinking, and innovative ability to solve uncertain problems. These qualities are key for students to cope with future career changes and achieve sustainable development.

The cultivation of digital literacy in higher vocational education is upgrading from an auxiliary skill list to a fundamental empowerment that supports students' lifelong learning and career development. Its goal is to equip future craftsmen with core mental models and key abilities to cope with the digital world, making them not only users of technology, but also active participants and rational guides in digital transformation.

2.Perface

2.1 Political Motivation of Cultivating Digital Literacy

Driven by the new round of technological revolution, according to the "Digital China Development Report (2024)"[3], the scale of core industries in the digital economy has steadily expanded, accounting for about 10% of GDP. High-end industries like Internet Plus, embodied intelligence and AIGC are progressively integrating into our daily work routines and entertainment, driving social and economic development and transformation through digital technology.

In response to this development reality, in 2025, Opinions of the State Council on Deepening the Implementation of the "Artificial Intelligence+" Action[4] says that we shall promote the development of industrial all factor intelligence, intelligent linkage of all industrial factors and accelerate the application of artificial intelligence in the entire process of design, pilot testing, production, service, and operation. We shall focus on improving the artificial intelligence literacy and skills of all employees, and promote the formation of more reusable expert knowledge in various industries. Also the Ministry of Education, along with nine other departments, jointly issued the "Opinions on Accelerating the Digitalization of Education"[5], urging educators to expedite the development of large artificial intelligence education models, explore innovative paradigms for "AI + education" application scenarios, and facilitate the deep integration of these models into educational teaching practices. Promote the intelligent upgrading of the curriculum system, textbook system, and teaching system, and integrate artificial intelligence technology into all facets and stages of education and teaching. It underscores the pressing need for teachers and students to acquire the skills of the digital age, as recognized by society.

2.2 Practical Necessity of Curriculum Reform

Digital literacy is the ability of individuals to effectively use digital technologies, tools, and platforms to acquire, analyze, evaluate and create information[6]. It encompasses not only the operational proficiency in digital technology but also the comprehension of information processing and communication within the digital environment, serving as a crucial impetus for the advancement of digital technology[7]. Therefore, digital literacy has gradually been incorporated into the basic qualities of citizen learning in the digital society, and is also an important guarantee for the development of new quality productivity. It is a fundamental quality that every learner ought to prioritize and a key skill that universities should emphasize in their training. It helps the future career prospects of vocational students, necessitating in-depth research in this domain.

Currently, researchers' studies on integrating digital literacy into teaching primarily focus on enhancing teachers' digital literacy[8], with less exploration of specific courses and a lack of digital literacy practices centered around students. Also, as students newly enter university, their understanding of learning knowledge is mostly limited to paper-based and book-inherent knowledge. While, most knowledge can be acquired online nowadays. Therefore, it needs an effective method to lead them to practice digital literacy in the classroom.

Furthermore, higher vocational mathematics courses, particularly 'Advanced Mathematics', serve as a mandatory course for freshmen in polytechnic colleges, functioning as a gateway to university studies and future careers. Undoubtedly, they play a pivotal role in enhancing students' overall quality. These courses encompass rigorous mathematical thinking methodologies and pragmatic applications of mathematics, empowering students to enhance their computational thinking skills and actively assume digital social responsibilities.

3.Strategies for Enhancing Digital Literacy

3.1 Revising Teaching Objectives

After years of educational reform, evaluation system of students' overall qualities has been continuously improved. Building upon three-dimensional objectives, the inclusion of digital literacy considerations enriches the existing system, enabling lesson planners to align their efforts with specific goals.

At the level of knowledge and skills objectives, emphasis should be placed on mastering specific information skills. This involves learning to utilize digital tools for calculating results, verifying mathematical conjectures, or presenting outcomes. For instance, one can calculate characteristics like the average of a dataset using Excel and SPSS, illustrate the convergence rate of sequence limits and the significance of vector dot product calculations using geometric drawing tools and Geogebra, and perform numerical calculations and simulations such as fitting and iteration through MATLAB and Python programming.

At the level of process and steps objectives, students should pay attention to the occurrence and development process, understanding various approaches to solving problems. For example, when learning calculus, they should understand the significance and use of approximate calculation of calculus through definition, and learn to use the idea of approximation to simplify computation in financial or engineering calculations. When confronted with problems that are difficult for individuals to solve, they actively recognize and utilize trained database and various AI question-answering platforms.

At the level of emotional attitude and values objectives, while being stimulated by new technologies and gaining motivation, students should form appropriate opinions on new development, embody information ethics towards technology, use tools temperately and avoid mental illnesses such as AI psychosis. Students shall respect labor achievements of others, pay attention to citation norms and data privacy protection, and consciously maintain data security in case of potential leakage of personal or national information.

3.2 Refining Blended Teaching Strategy

Modern higher education has incorporated emerging information technology, new media technology, and Internet resources into various courses. The digital literacy embodied in these tools, such as digital awareness, digital innovation, and learning, subtly brings efficiency and scalability into limited classrooms.

For example, by utilizing the SPOC teaching method that combines online and offline approaches, we can achieve a flipped classroom. Before class, students can watch micro-lecture videos on online platforms such as MOOC, Rain Classroom, and Supernova to acquire basic knowledge. This allows classroom time to be devoted to higher-order tasks.

After class, AI-generated questions on the platform can help students independently test and consolidate their understanding. We can further integrate digital resources tailored for higher vocational mathematics, such as encompassing interactive exercise and case libraries (like dynamic simulations of infectious disease models), and open-source code libraries (like augmented reality displays showcasing the dynamic distributions of vector fields), and enhance the knowledge graph for review after class.

For another example, we employ task-driven approach and practice-oriented teaching, design interdisciplinary projects (like big data analysis in financial risk models), incorporate situational test questions into daily teaching, and require students to integrate mathematical knowledge with programming language such as Excel or R language to complete reports. Meanwhile, in their spare time, students can develop interest groups in mathematical modeling to consolidate their learning achievements in solving problems using mathematical thinking and technological means.

3.3 Project-Based Learning Process

Project-based learning (PBL) requires students to solve a complex, real-world problem through teamwork over a period of time. This mode introduces professional mathematical calculation software and tools into the classroom which is a direct means to enhance students' digital literacy. These tools not only visualize abstract mathematical concepts, but also enable students to tackle complex problems that are difficult to solve with traditional methods. Therefore, it provides a practical field for the cultivation of digital literacy. For example, a study developed a mathematical electronic module based on STEM collaborative project-based learning, aimed at enhancing the mathematical literacy of vocational students.

In mathematics PBL, students need to do at least following three things. First, it requires students to study their own way of information retrieval and evaluation to utilize online resources to search for industry data, technical standards, and background information related to the project. Second, data processing and analysis urges students to use spreadsheets, statistical software, and even programming languages to process and analyze collected data, and build mathematical models. Third, digital content creation and communication is also gained by students naturally by use presentation software, visualization tools, and online collaboration platforms to present research processes, mathematical models, and project outcomes.

By completing a complete project, students not only deepen their understanding of mathematical knowledge, but also integrate various digital skills through the process of "learning by doing".

3.4 Optimizing Evaluation Mechanisms

The mathematics curriculum standards released by the Chinese Ministry of Education emphasize the cultivation of "core competencies" in both basic education and high school, including mathematical abstraction, logical reasoning, mathematical modeling, intuitive imagination, mathematical operations, and data analysis. This transformation coincides with the goal of cultivating digital literacy. Vocational mathematics courses should be guided by this and deeply map the various dimensions of digital literacy with the cultivation of core mathematical literacy.

We should incorporate more evaluation indicators into the system that evaluates students based on traditional homework and exams, so as to enable students to develop in a balanced way to meet industrial and social demand.

For example, in process assessment, performance based assessment requires students to demonstrate their knowledge and skills by completing a specific task or project. This is an ideal way to evaluate comprehensive abilities such as digital literacy. At present, although there is a lack of specific assessment tools specifically validated for vocational mathematics courses, we can draw on common digital literacy assessment frameworks and tools for design.

Students can submit a project portfolio that includes a complete process record of their use of digital tools for mathematical modeling, data analysis, and visualization. The evaluation focuses on the rationality of students' tool selection, the standardization of data processing, the creativity of model construction, and the clarity of conclusion presentation. We adopt real-life cases for modular teaching, record students' contribution on the digital collaboration platform and reward those who post high-quality content in the discussion forum or make significant contributions to mathematical modeling interest groups. We can also organize performance simulation design tasks that simulate real occupational scenarios. For example, students are required to use mathematical parameters from software to design a part, or use spreadsheet software to develop the optimal cost budget plan for a small and micro enterprise.

Developing and using Rubrics is important too. Rubrics are a key tool for implementing performance evaluations, which clearly define standards for different levels of performance, making evaluations more objective and transparent. We can draw on existing digital information literacy metrics, such as Diginfo Rubric in America and combined with the characteristics of vocational mathematics, carry out localization transformation, evaluate from multiple dimensions such as "application of mathematical knowledge", "selection and operation of digital tools", "data processing and interpretation", "collaboration and communication".

In outcome assessments, besides exams, diversified forms are adopted. Quantitative methods such as questionnaires can also be used to measure students' computer self-efficacy, Internet attitude, digital learning ability and other potential characteristics, so as to more comprehensively understand the factors affecting their digital literacy development. Completing specific outcomes can also be counted as part of the grade, such as programming code, data visualization reports, and video explanations of knowledge points. This not only improves the pass rate and stimulates students' learning motivation, but also cultivates students' habit of autonomous learning.

4.Direction and Successful Cases

Since the introduction of digital literacy, many Australian curriculum reforms have embedded computational thinking into mathematical content descriptions, such as emphasizing algorithm design and optimization in calculus teaching. Tsinghua University information literacy program designs a three-level training system for mathematics, including basic search skills such as using MathSciNet, LaTeX typesetting, and academic writing. American mathematics teaching practice integrates

MATLAB and Simulink courses to help students transition from abstract theorems to engineering problem modeling. These are all successful cases about using programming language to improve students digital literacy[10].

We can see from the implement of digital literacy education that it helps students form a rigorous academic attitude and the spirit of exploring truth. For example, when teaching mathematical induction, teachers can emphasize the importance of strictly following step-by-step derivation, which is not only the embodiment of a rigorous attitude in academic research but also the shaping of a scientific spirit of being responsible for facts and pursuing truth. Through this process, students are able to gradually develop critical thinking and complex problem-solving abilities. The research and application of some problems often require team cooperation, which also help students to get a bright future career.

5.Challenges in Practice and Corresponding Strategies

Although digital literacy in higher vocational mathematics curriculum has become a new fashion in educational reform, it still faces many challenges in practical implementation and theoretical exploration. The construction of digital literacy in basic curriculum lags behind other major disciplines, and the existing resources are difficult to meet the social needs, leaving us to solve the problems reflected in teachers and students.

5.1 Teacher level

There are technical obstacles at the aspect of teachers. Since the successful implementation of the curriculum framework highly relies on the digital literacy level of teachers, we should think it first. The Chinese Ministry of Education released the industry standard “Teacher Digital Literacy” in 2022, providing clear guidance for the professional development of teachers. This standard covers five dimensions: digital awareness, technical knowledge and skills, digital applications, digital social responsibility, and professional development. Vocational mathematics teachers need to continuously improve their technological pedagogical content knowledge. Only by integrating technology, teaching methods, and mathematical content knowledge can we truly design and implement courses aimed at enhancing students’ digital literacy.

In the internal survey, 67% of staffs believe that the main bottleneck is the insufficient software and hardware equipment. Some vocational colleges have insufficient investment in hardware facilities, software procurement, online course resource construction, and lack effective evaluation and guarantee mechanisms, which hinders the development of digital teaching. In detail, a teacher’s working hour has already been occupied by teach or study task. They do not have time or ability to build or construct a platform in new technology.

Therefore, it is necessary to strengthen systematicity and authority, which means cooperation between schools and enterprises, leverage enterprise technology, and develop digital resources needs to be taken into consideration. In addition, teacher training should be carried out, and teacher mutual assistance communities should be established to leverage the two major advantages of experienced teachers and skilled new teachers, complementing and improving together.

Next is job burnout. 89% of teachers believe that teaching reform has increased their workload, and it may not necessarily lead to a significant improvement in teaching quality, so they are unwilling to put in more effort. The inertia of curriculum and evaluation system also leads to stagnation. Reforming the existing curriculum outline, teaching plan, and exam centered evaluation system will touch on multiple interests and face significant practical resistance.

In response to this phenomenon of professional inertia, it is necessary to optimize curriculum design templates, provide reusable digital teaching resource packages, and design incentive measures to create a positive atmosphere. Besides, we should promote the current evaluation mechanism of higher vocational mathematics curriculum to overcome the shortcomings about workload. Institutes and educational authorities should design systematic teacher training programs. Although there is currently insufficient research on the evaluation effectiveness of such projects, their content should cover: updating digital education concepts, practical operation of mainstream mathematical software and data analysis tools, hybrid and project-based teaching design methods, as well as the development and application of performance evaluation tools.

If we can build a teacher learning community will be better, it will encourage teachers to form interdisciplinary and cross school learning communities, share successful experiences and lessons learned from integrating digital technology through collective lesson preparation, teaching observation, case studies, and other forms, and jointly develop teaching resources. It needs institute providing strong guarantees tilting towards teaching reform in terms of resource allocation, teaching workload recognition, and professional title evaluation, providing institutional guarantees and incentives for teachers' innovative practices, and creating a cultural atmosphere that encourages exploration and tolerates failure.

5.2 Student level

There is a significant variation in student quality, with notable differences in student proficiency between the eastern and western regions. The gap or divide in information technology skills cannot be overlooked[11]. As some teachers still use the traditional teaching method and textbooks, all students can catch up, or at least not showing their misunderstandings. But when it comes to plentiful technology practice, we can not ignore the lack of interaction and participation of some green-hand students.

To make this condition better, teachers should design tasks at different levels (such as using Excel for basic tasks and introducing SPSS for advanced tasks) and provide equipment borrowing services.

Next is the weakness in content creation. Most students encounter difficulties in mathematical modeling thinking and multimedia expression. Therefore, before implementing specific projects, teachers should provide more demonstrations and give students enough time to respond.

6.Conclusion and Outlook

By combining the characteristics and advantages of emerging technologies with the practical needs of teaching, this paper proposes a series of innovative course construction techniques to improve students' digital literacy.

New age is coming. We can also integrates digital literacy with ideological and political education in the curriculum, such as infiltrating mathematical history[5], it will strengthens scientific spirit and national sentiment. By incorporating more artificial intelligence assistance into teaching, develop intelligent tutoring systems such as GPT-based math problem-solving assistants[6], it will implements personalized learning path recommendations. By strengthening the collaborative construction of industry, academia, and research, jointly develop industry case libraries (such as blockchain technology applications in financial mathematics) with enterprises, it will enhances the practicality ability.

We can foresee its deepening connotation. The future cultivation will go beyond software operation skills and shift the focus to data literacy and computational thinking. Students should not only be able to collect data, but also be able to analyze, interpret, and visualize data, and understand algorithm logic, so as to be able to use data-driven decision-making and solve complex problems in professional fields. it is a comprehensive integration from "one course" to "one literacy". The cultivation of digital literacy will no longer be limited to one or two information technology courses, but will permeate all professional courses, practical training, and even campus culture as a core competency. By using "digital twin" technology to simulate real production lines and conducting skill training in virtual environments, students will internalize their digital literacy through immersive experiences. Also a new value guidance is followed. With the widespread application of artificial intelligence technology, the focus of cultivating digital ethics and security awareness will be added. Students need to understand the principles and limitations of AI technology, possess critical thinking skills, be able to use technology responsibly, address challenges such as information silos, data privacy, and algorithmic biases, and achieve the unity of technological empowerment and humanistic care.

Ultimately, the digital transformation of vocational mathematics education is not about technology for the sake of technology, but about returning to the essence of education - cultivating technically skilled talents who can adapt to and lead future social development and possess sustainable competitiveness. This path of exploration is arduous and requires the joint wisdom and unremitting efforts of education policy makers, university administrators, frontline teachers, and researchers. We hope individual along with organization conducts longitudinal research to track graduates who have received mathematics courses with enhanced digital literacy, analyze their employment rates, salary levels, and career development trajectories in the technical field, and ultimately test the long-term effectiveness of teaching reforms. It will aligns with broader educational goals and prepares our high-quality technical and skilled talents for the digital era.

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Conflict of Interests

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