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Research on the Construction of First-class Curriculum of Advanced Mathematics Driven by New Quality Productivity: An Innovative Path for the Cultivation of New Talents

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Abstract: *New quality productivity refers to a new form of productivity that promotes high-quality economic development through the deep integration of new technologies, new industries, new forms of business and new models, driven by scientific and technological innovation. The construction of a first-class course in advanced mathematics requires the selection of course content to be high-level, innovative, applied and challenging. At the same time, knowledgeable, applied and interesting cases are added to stimulate students' interest in learning. In the context of the development of new quality productivity driven by digital economy and intelligent technology, advanced mathematics courses are facing challenges such as lagging teaching content, single teaching mode, and disconnection from professional needs. Guided by the ability needs of "new talents" (emphasizing innovation ability, interdisciplinary thinking, and digital literacy), this study proposes to reconstruct the curriculum system, innovate teaching methods, deepen the integration of industry and education, and construct a first-class advanced mathematics curriculum model with high-order, innovation and challenge, so as to provide theoretical support and practical solutions for cultivating compound talents who support the development of new quality productivity.*

Keywords: *New Quality Productivity, New Quality Talents, Advanced Mathematics, Curriculum Reform*

1. Research background and significance

Since the 18th National Congress of the Communist Party of China, General Secretary has attached great importance to the important value of advanced productive forces and emphasized their crucial position in promoting high-quality development. In September 2023, General Secretary proposed the important concept of "new quality productivity" during local inspections (Xinhua News Agency, 2023). After the emphasis and deepening of the Central Economic Work Conference, in 2024, during the 11th and 12th collective learning sessions of the Central Political Bureau, General Secretary provided a systematic and in-depth explanation of the new quality of productive forces; During the second session of the 14th National People's Congress, the implementation path of "developing new quality productivity according to local conditions" (Xinhua News Agency, 2024b) was specified. General Secretary’s important discourse and major deployment on new quality productive forces reflect the firm determination and scientific deployment of the Party Central Committee to lead industrial innovation driven by scientific and technological innovation, further liberate and develop productive forces, and comprehensively promote Chinese style modernization on the new journey (Xinhua News Agency, 2024a), providing scientific theoretical guidance for promoting high-quality development of education and building a strong education country[1].

New quality productivity refers to a new form of productivity driven by technological innovation, which promotes high-quality economic development through the deep integration of new technologies, industries, formats, and models. It is mainly reflected in the following aspects: 1. Technological innovation: promoting industrial upgrading through cutting-edge technologies such as artificial intelligence, big data, blockchain, etc. 2. Industrial upgrading: Traditional industries leverage new technologies to improve efficiency and competitiveness, while emerging industries develop rapidly. 3. New formats and models: New formats such as digital economy and sharing economy continue to emerge, changing production and consumption patterns. 4. High quality talents: Relying on high skilled talents, promote education system reform to adapt to new demands.

The development of new quality productivity requires the support of new quality talents who can adapt to it. The cultivation of talents is achieved through education, therefore the development of new quality productivity has put forward systematic, forward-looking, and adaptive new requirements for higher education. As the core carrier of talent cultivation, technological research and development, and social services, higher education must actively adjust its educational philosophy, discipline layout, training mode, and service capabilities to support the needs of the development of new quality productivity. Advanced mathematics is an important foundational course in higher education, supporting the development of disciplines such as physics, engineering, and computer science. It is also a tool for cultivating students' logical thinking and problem-solving abilities. Advanced mathematics courses are not only a knowledge system, but also a way of thinking, and the mathematical thinking patterns they cultivate will become the core elements of personal competitiveness. The teaching content of traditional higher mathematics courses lags behind and is disconnected: courses mainly focused on calculus and linear algebra do not cover emerging needs such as machine learning and optimization algorithms. Single teaching method: lecture based teaching accounts for over 80%, lacking problem-solving training in real-life scenarios (Ministry of Education's "2022 Higher Mathematics Teaching Status Report"). One sided evaluation: final exams account for 70%, neglecting innovation and practical ability assessment. There are problems such as a single teaching mode, lack of application scenarios, disconnection from professional needs, and insufficient cultivation of innovative abilities. Therefore, studying the construction of first-class courses in higher mathematics for the cultivation of new quality talents is of great significance for exploring the adaptability of mathematics education to the needs of new quality productivity and exploring the reform of university courses[2].

2. The New Requirements of New Quality Productivity for Higher Mathematics Curriculum Teaching

New quality productivity requires higher mathematics teaching to break away from traditional frameworks and reconstruct the curriculum system with "application as the core, technology as the wing, and interdisciplinary as the foundation". Its core is to cultivate composite talents who can combine mathematical theory with cutting-edge technology through real problem driven approaches, digital tool empowerment, and innovative thinking guidance. The key to the success of teaching reform lies in whether teachers have interdisciplinary perspectives, whether courses keep up with technological trends, and whether evaluations truly reflect practical abilities. In the future, mathematics education will not only be a "problem-solving training", but also a "thinking toolbox for solving complex real-world problems"[3].

The transformation of ability requirements from mathematical operation ability to mathematical modeling and algorithm design ability strengthens the application of modern mathematical tools such as probability statistics, matrix analysis, optimization theory, etc., and cultivates systematic thinking for interdisciplinary problem solving[4].

New quality productivity emphasizes the leading role of innovation, and higher mathematics curriculum teaching should also pay attention to the introduction of innovative content. This includes but is not limited to incorporating modern technological elements: integrating digital, networked, and intelligent new technologies into higher mathematics teaching, such as using mathematical software, online platforms, and other tools to assist teaching, improving teaching efficiency and quality. Expanding application areas: Combining the characteristics of new quality productivity, expand the application of advanced mathematics in emerging fields such as artificial intelligence, big data, and cloud computing, so that students can understand the importance of mathematics in solving practical problems[6].

Improvement of teacher literacy. The development of new quality productivity has put forward new requirements for teacher literacy. Higher mathematics teachers should continuously improve their professional literacy and teaching ability: continuous learning: pay attention to the latest research results and teaching concepts in the field of mathematics, constantly update their knowledge structure and teaching methods. Strengthen practical exercise: Actively participate in scientific research projects and practical activities, improve one's mathematical application and innovation abilities, and lay a foundation for better cultivating students.

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3. A first-class curriculum construction path for cultivating new quality talents

Based on the requirements of new quality productivity for new quality talents and the current situation of higher mathematics course teaching, we can build first-class courses from the following aspects [5]:

3.1. Refactoring course objectives

Build a three-dimensional goal system of "mathematical foundation+technical application+ innovative thinking", is shown in Table 1, and establish a linkage mechanism with majors such as artificial intelligence and intelligent manufacturing.

Table 1: Three-dimensional goal system

Dimension	Target	Implementation Path
Mathematical foundations	Strengthen core theories (such as calculus, differential equations, series)	Adopting the "intensive teaching and multiple practice" mode, combined with visualization tools (such as GeoGebra)
Technical application	Develop algorithm design and data analysis skills	Develop Python/Julia mathematical experiment case library
Innovative Thinking	Enhance interdisciplinary problem-solving skills	Mathematical modeling, school enterprise joint design of complex projects (such as supply chain optimization, medical imaging analysis)

3.2. Content system optimization

The course content is the core of the course, and the construction of first-class courses driven by new quality productivity should closely follow the needs of national development, rely on the latest developments in disciplinary research, adapt to new changes in social demands, and optimize and update the knowledge system and reconstruct the course content system. Modular design of content, divided into basic theoretical module, technical application module, and cutting-edge expansion module. The basic theory module retains the concepts of classical calculus, such as limits, derivatives, integrals, etc., but simplifies redundant calculations (such as reducing manual integration training). The technology application module can be personalized according to different majors, such as: data science direction: Monte Carlo simulation, statistical machine learning basics. Engineering direction: Fundamentals of Finite Element Analysis Mathematics, Differential Equations in Control Theory. At the same time, it is possible to increase the use of mathematical experimental content and mathematical modeling cases in Matlab and Python, and achieve project driven learning (PBL) through modeling to achieve active knowledge construction, enabling students to upgrade from "memory understanding" of knowledge to "application analysis creation". The frontier expansion module can be set as an elective course on the mathematical principles of graph neural networks.

3.3. Innovation in teaching methods

(1) Flipped classroom and blended learning: Before class, students are encouraged to self-study basic knowledge through micro courses, MOOCs, and other resources. Classroom time is used to discuss higher-order problems such as reverse deduction of theorems and construction of counterexamples. Real time tracking of learning progress through activities such as answering questions and discussions in the classroom using the Learning App. For some moderately difficult knowledge points, students can explain them, exercise their self-learning ability and language expression ability, let them feel the difference between passive acceptance and active learning, and guide them to develop a good learning atmosphere.

(2) Project driven learning (PBL): Students can choose problems with practical application backgrounds, such as mathematical problems in physics, engineering, economics, and other fields. They are encouraged to develop project tasks and plans, break down the project into several sub tasks, and each sub task should have clear goals and outcomes. Develop a detailed schedule, including key milestones such as project initiation, implementation, mid-term inspections, and results display. Encourage students to present their achievements through reports, papers Present project results in the

form of PPT, including mathematical models, calculation results, practical application effects, etc. You can also organize a showcase of achievements, inviting experts, teachers, and other students to participate for communication and evaluation. The project evaluation adopts a combination of process evaluation and outcome evaluation to comprehensively evaluate students' project performance. Process evaluation focuses on students' participation, cooperation ability, problem-solving ability, etc. in the project implementation process; The evaluation of results focuses on the quality and innovation of project outcomes.

(3) Normalization of mathematical modeling: Teachers can integrate the ideas and methods of mathematical modeling into the daily teaching of advanced mathematics. While explaining theoretical knowledge, introduce mathematical models that are highly relevant to the taught knowledge points, and demonstrate the application of mathematical modeling in solving practical problems through case analysis. This can not only enhance students' understanding of theoretical knowledge, but also improve their mathematical modeling awareness and ability. At the same time, in higher mathematics teaching, teachers should pay attention to combining practical problems, guiding students to understand mathematical concepts from multiple aspects and perspectives, and recognizing that mathematical concepts are mathematical models abstracted from the quantitative relationships of objective things. By introducing real-life practical problems, students can establish mathematical models and solve them, thereby deepening their understanding of mathematical concepts and methods.

3.4. Reform of evaluation system

(1) Diversified assessment methods: In the course assessment of higher mathematics, a combination of quantification and generalization, as well as a combination of exam scores and daily process management, can be used to objectively and accurately evaluate students' learning outcomes. This not only focuses on the results of students' learning, but also on their learning process; Pay attention to the level of students' mathematical learning, and pay more attention to their emotions and attitudes displayed in mathematical activities, helping students understand themselves and build confidence. The evaluation of daily grades focuses on process management, using various methods such as quizzes, chapter summaries, assignments, book reports, questioning, and group competitions. We do not consider one exam as the final grade for students, but instead use different levels and types of assessments to comprehensively understand students' learning habits, levels, and methods, and then pay attention to the changes in students' state throughout the entire learning process. Encourage students to self evaluate and peer evaluate: Introduce peer evaluation mechanism in group projects, evaluate each other from dimensions such as innovation, logic, and practicality, and promote the development of multidimensional abilities. Attempt interdisciplinary comprehensive assessment: collaborate with teachers in computer science, engineering, and other fields to design assessment criteria, such as evaluating the application effectiveness of mathematical modeling in robot path planning.

(2) Encourage trial and error and reflection: In higher mathematics courses, estimating students' trial and error and reflection abilities is a complex but crucial process that directly affects the improvement of teaching quality and the enhancement of students' learning outcomes. The following is a detailed analysis of this issue:

①. Observing the problem-solving process: Teachers can evaluate students' trial and error abilities by observing their problem-solving process in the classroom. Pay attention to whether students are willing to try different problem-solving methods and whether they are willing to make multiple attempts when encountering difficulties.

②. Analyze homework and exam mistakes: Carefully review students' homework and exam papers, especially those that are incorrect. Analyze the types of errors, such as calculation errors, conceptual confusion, or deviation in problem-solving thinking, in order to determine the direction and depth of students' trial and error.

③. Design experimental tasks: Teachers can design challenging and open-ended mathematical tasks to encourage students to explore and try. By observing students' performance in completing tasks, evaluate their trial and error abilities and problem-solving strategies.

4. Conclusion and Prospect

The reform of higher mathematics curriculum needs to be anchored by the dynamic demand for new quality productivity, and build a curriculum ecology that is "solid foundation, flexible application,

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and continuous innovation". The construction of first-class courses in higher mathematics should actively connect with the development needs of new quality productivity, and cultivate compound talents with mathematical thinking and technological innovation abilities through curriculum system reconstruction, innovative teaching methods, and reform of evaluation mechanisms. In the future, it is necessary to further deepen the collaborative innovation between mathematics curriculum and industrial technology, and explore the interdisciplinary training model of "mathematics+X".

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