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THE UNIVERSITY INNOVATIVE TEACHING INTEGRATING INNOVATIVE THINKING AND MODELING IDEAS DEEPLY

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ABSTRACT

Cultivating college students' innovative ability in the era of artificial intelligence cannot be separated from teaching and education both inside and outside the classroom. In view of the problems existing in university teaching and education, this paper describes the innovative requirements of social and individual development, and expounds the significance of the innovative practice of mathematical modeling thought and modeling competition. Through the proof of Chebyshev's inequality, it elaborates on how to deeply integrate innovative thinking and mathematical modeling thought into each link of university classroom teaching, Finally, it summarizes the importance of deeply integrating innovative thinking and modeling thought into classroom teaching and the significance of mathematical modeling competitions.

KEYWORDS: Mathematical innovative thinking; Mathematical modeling; Divergent thinking; Critical thinking

1. PROBLEM PRESENTATION

In the 21st century of economic globalization, humanity has entered the era of artificial intelligence, and innovation has received significant attention. In response, the Ministry of Education has issued guiding opinions on the training plan for undergraduate students, aiming to cultivate innovative talents with all-round development. University is a crucial stage for young people to enhance their scientific and technological levels and abilities, and to pursue and realize their dreams. How to cultivate a large number of young talents with strong innovative consciousness, innovative thinking ability, and the ability to solve practical problems in university classroom teaching remains a hot topic in today's educational reform.

In the 1960s, Western universities initiated the Mathematical Modeling Contest, aiming to encourage college students to apply mathematical knowledge to solve practical problems and cultivate applied mathematics talents. Since 1992, the Mathematical Modeling Contest for college students, with the goal of improving the comprehensive quality and innovation ability of college students, has become one of the largest subject competitions at home and abroad. Its wide coverage and significant

influence are unprecedented. The mathematical modeling course and mathematical modeling thought have emerged as the times require. Integrating mathematical modeling thought into university mathematics classrooms has received considerable attention. Zhang (2004) proposed that in mathematics teaching, one should present students with inspiring, fundamental, and essential questions that touch upon the essence of mathematics, guiding them to engage in passionate thinking. Qin (2010) provided specific approaches to integrating mathematical modeling thought and methods into probability and statistics courses through cases such as the concept of probability distribution and the proof of Poisson's theorem. However, due to the abundance of teaching content, tight schedules, and heavy tasks in current university mathematics education, some teachers, in order to complete the textbook content, neglect the mathematical background, applications, and modeling process, and skip some definitions and theorem proofs. They are accustomed to abstract thinking and logical reasoning, making students feel that university mathematics is rigorous, abstract, and dull, and view "learning mathematics" as a heavy burden. More importantly, many university teachers and students lack a sufficient understanding of the rich content of innovative thinking and only have a vague and general concept of it. It is of great significance for teachers to examine university teaching from the perspectives of innovative thinking and modeling thought methods and deeply integrate the two different thought methods into all aspects of classroom teaching. Below, we will elaborate on the deep integration of innovative thinking and mathematical modeling thought in university innovative teaching from three aspects: social and individual development needs, mathematical modeling innovation practice, and classroom teaching institutions (Kusumawati, 2023).

2. Clarifying Innovative Thinking and Innovation Ability, Enhancing Innovation Awareness

For universities, the cultivation of innovative thinking and innovation ability has become an important task to meet future social needs and promote the development of the country and individuals. Innovative thinking refers to the way of thinking that uses appropriate mathematical methods and principles to solve mathematical problems or discover new theories through observation, exploration, and thinking, and proposes novel ideas and methods. Innovative thinking is different from general thinking, and its key lies in creation and breakthrough. Usually, it first captures the essence and key points of the problem through non-logical thinking methods such as imagery and intuition, and then quickly opens up a breakthrough in problem-solving according to the most optimized ideas and methods, proposing unique new insights and methods, achieving a qualitative leap in the cognitive process; and then, through rigorous logical reasoning, makes rational judgments and proofs, thus achieving the success of creation. Innovation ability refers to the ability to continuously provide new ideas, theories, methods, and inventions with economic, social, and ecological value in the fields of science, art, technology, and various practical activities by applying knowledge and theories. The 1970s and 1980s were the golden age of research on innovative thinking and innovation ability in China. The renowned Chinese mathematician Xu Lizhi conducted in-depth and detailed research and summaries on creativity. Xu (1997) proposed that effective knowledge volume, divergent thinking, abstract analysis ability, and aesthetic ability are important factors of creativity. Intuition is the starting point and destination of abstract thinking, and imagination is one

of the psychological elements of mathematical creation. Qian (2018) considered the influence of long-term, medium-term and short-term value orientations and the importance of imagination, and believed that creative thinking mainly consists of knowledge, curiosity and imagination, and value orientation. Looking at the theory and practice of innovation, we believe that effective knowledge volume, abstract thinking ability, curiosity and imagination, value orientation, aesthetic ability, divergent thinking ability, and critical thinking are the seven key elements for cultivating mathematical innovative thinking and enhancing innovation ability.

First, effective knowledge volume and abstract thinking ability are the foundation of innovation. (1) The greater the effective knowledge volume of an individual, the broader the field of association, analogy, and imagination, and thus the more opportunities to generate new ideas and methods. Many mathematicians are also physicists, astronomers, etc., such as Archimedes, Newton, Euler, etc. They not only have a wide range of knowledge but also cover many fields. It is hard to imagine that a scholar with a narrow knowledge base can make significant inventions and creations. (2) Without strong abstract thinking ability, one will often feel confused and lack confidence when learning mathematics and other science and engineering subjects, and be afraid of learning and research. Therefore, having a certain level of abstract thinking and reasoning ability is the foundation of reasoning and proposition proof.

Second, **curiosity, value orientation, and aesthetic ability are the driving forces of innovation.** (1) Curiosity is inherent in everyone. As the original mental activity of innovation, curiosity is a behavioral tendency to pay attention to, explore, and question new things or new environments. Curiosity can increase the activity of brain waves θ (Theta), and is the inexhaustible driving force of innovative thinking. Einstein once said, "I have no special talent. I am only passionately curious." Therefore, a strong sense of curiosity is the fundamental driving force for the great inventions and creations of human society. (2) Value orientation refers to the positioning and orientation of people's value choices based on certain values. It shows a relatively stable tendency in the value choices of "what can be done, what cannot be done, what should be done, and what should not be done". (3) Aesthetic ability refers to the intuitive ability to perceive the harmony, simplicity, symmetry, and singularity in mathematics in the mind. Rooted in the deepest part of the human soul, aesthetic consciousness partly governs moral sentiments, values, and spiritual realms. Therefore, the great French mathematician Poincaré emphasized that only those who can feel the order, harmony, symmetry, neatness, and mystery of mathematics can make mathematical discoveries. History shows that the stronger a person's aesthetic consciousness and the higher their aesthetic ability, the higher their level of creation and discovery.

Third, **divergent thinking and critical thinking are the core means and treasures for achieving innovation.** (1) Divergent thinking is a non-logical thinking form based on sensation or intuition, a way of thinking to obtain reasonable arguments or conjectures, and an imprecise way of thinking or method, including association, imagination, simulation, analogy, and intuitive reasoning, etc. Mathematical innovation often begins with imprecise divergent thinking, so divergent thinking is

called creative thinking. By using divergent thinking methods such as association and analogy, many practical problems can be solved, demonstrating the importance of divergent thinking. (2) Critical thinking is the ability to question and challenge widely accepted conclusions and provide new explanations and judgments in an analytical, creative, and constructive way, including the process of reflecting on, questioning, and independently analyzing one's own and others' thinking methods and approaches.

Therefore, teachers and students in colleges and universities should deeply understand and constantly learn about innovative thinking and its methods both inside and outside the classroom, so as to fully apply innovative thinking in innovative practices such as course teaching and mathematical modeling competitions, stimulate innovative consciousness, and improve innovation ability.

3. Pay Attention to the Idea of Mathematical Modeling and Enhance Innovation Ability Through Mathematical Modeling Competitions

"Mathematical modeling" is the entire process of constructing, solving, and testing mathematical models of research objects. That is, through the analysis and abstraction of practical problems, determine the variable parameters, first use mathematical symbols or language to approximately describe the practical problem, then analyze and simplify the objective things, make reasonable assumptions, and then use appropriate mathematical tools to describe the problem, establish a mathematical model, solve the model results with the help of computing software, and finally return to the practical problem to verify its correctness. And a mathematical model is a mathematical expression proposed to quantitatively solve practical problems. To be precise, it is a mathematical structure obtained by making some necessary simplifications and assumptions for a specific object in the real world to achieve a certain purpose, according to its inherent laws and external conditions, and using appropriate mathematical methods. For example, the Pythagorean theorem formula, the universal gravitation formula, the calculus formula, and the relativity formula, etc., are all the most excellent mathematical models. Establishing a mathematical model is actually a process of discovery and innovation through divergent thinking such as association, analogy, and imagination. Its essence is to solve practical problems by using innovative thinking methods. The process of mathematical modeling itself contains many mathematical ideas and methods, such as from the particular to the general, from the finite to the infinite, induction, analogy, reverse analysis, trial and error, etc.The so-called mathematical modeling thought is the idea, approach, and way of thinking adopted in the process of mathematical modeling to solve practical problems. Li (2014) deeply felt that the mathematical modeling thought is a magic weapon for solving practical problems. Teachers should not only integrate the spirit of mathematical modeling and selected excellent mathematical modeling cases into classroom teaching, but also trace the origin of main concepts or important formulas, highlighting the origin and development of mathematical ideas. Integrating mathematical modeling thought into the main mathematics classroom is the sure way to inspire students' mathematical minds. Ye (2012) emphasized that the ideas and methods of mathematical modeling and mathematical experiments should be integrated into the teaching of advanced mathematics, starting from the first class of calculus.

And the practical effect was encouraging. Therefore, the innovative teaching of university mathematics that deeply integrates innovative thinking and mathematical modeling thought is worth in-depth research and discussion.

Mathematical modeling competitions are one of the most effective practical activities to enhance mathematical innovative thinking. The core issue is to activate the mathematical modeling thought, stimulate innovative thinking, and establish a reasonable mathematical model. Hou (2020) stated Mr. Peng Huanwu's creative research: "The most important thing in creative research in physics is to logically describe the physical model based on quantitative experimental results; creatively establishing an appropriate physical model based on experimental facts is the top priority of creative research." Mathematical modeling training and competitions can effectively enhance college students' self-study ability, divergent thinking abilities such as imagination and association, the ability to solve mathematical models, the ability of written expression and teamwork, etc. The practice of modeling competitions has proved that accurately posing questions, appropriately expressing mathematically, and being good at using innovative thinking to establish mathematical models are the three key elements of doing well in mathematical modeling. That is to say, when solving practical problems, one should strive to "ask questions well, express well, and think innovatively".

4. Innovative Teaching in University Classrooms with Deep Integration of Innovative Thinking and Modeling Thought

The classroom is the main battlefield for college students to acquire knowledge and wisdom and enhance their innovation ability. The ultimate goal of teaching is to develop students' innovative thinking and innovation ability. The innovative education and teaching that deeply integrates innovative thinking and mathematical modeling thought in university classroom teaching is called the integration of mathematical modeling and innovation teaching. That is to say, in the classroom teaching of science and engineering, for each teaching link such as concept teaching, theorem proof teaching, example and exercise teaching, respectively, the innovative thinking methods such as imagination, association, conjecture, and comparison are deeply integrated with the methods of problem-driven, abstract analysis, summary and generalization, symbolic and formulaic expression, deduction and promotion in the modeling thought. It enables students to be able to ask questions, express themselves, establish models, and solve practical problems by using relevant knowledge. The following uses the proof of Chebyshev's inequality in "Probability Theory" to illustrate how to conduct innovative and integrated teaching of mathematical modeling in the classroom.

Example: Taking a continuous random variable as an example, prove Chebyshev's inequality in probability theory and mathematical statistics

$$P\{|X - E(X)| \geq \varepsilon\} \leq D(X)/\varepsilon^2 \quad (1)$$

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(1) Fully understand the problem statement, clarify the known conditions and the conclusion to be proved. What is known is the expressions on both sides of the inequality, and what needs to be proved is that "the inequality holds". What does the probability on the left side represent? Through joint discovery by teachers and students, it is found that the left side is "the probability of the random variable falling within a certain region". How to calculate it? Through joint thinking by teachers and students, they recall "integrating the probability density over an interval" in the book, which can be expressed as $\int_{|x-E(X)|\geq\varepsilon} f(x)dx$. For the variance on the right side of (1), how to understand it? Considering that the left side contains expectation and integration, and by associating the definition and algorithm of variance, the integral expression form of the variance definition naturally comes to mind

$$D(X)=E[X-E(X)]^2=\int_{-\infty}^{+\infty}(x-E(X))^2\cdot f(x)dx \qquad (2)$$

(2) Compare the differences between the two sides of the inequality, and discover opportunities through innovative thinking such as association and intuitive inference. By comparing the integral expressions on both sides of (1), it is found that the integrands and integration intervals are different. By examining their differences and conducting logical reasoning, an opportunity can be discovered: by amplifying the inequality twice, once by amplifying the integrand and the other by amplifying the integration interval, an ideal proof can be obtained. That is:

$$P\{|X-E(X)|\geq\varepsilon\}=\int_{|x-E(X)|\geq\varepsilon}1\cdot f(x)dx\leq\int_{|x-E(X)|\geq\varepsilon}\frac{(x-E(X))^2}{\varepsilon^2}\cdot f(x)dx$$
$$\leq\int_{-\infty}^{+\infty}\frac{(x-E(X))^2}{\varepsilon^2}\cdot f(x)dx=D(X)/\varepsilon^2$$

(3) Display rigorous mathematical expressions and appreciate mathematical thinking and beauty. Under the guidance of the teacher's rigorous logical reasoning, students initially understood the proof of the theorem. Immediately after, the teacher asked emotionally: How can we accurately express it in mathematical language? Please look at the PPT. With a click, the teacher opened the strict PPT proof and showed it to the students, emphasizing the mathematical abstract logical thinking, divergent thinking and wonderful opportunities it contained. At this moment, the students' heads were up, their attention was concentrated, and they were immersed in the ocean of mathematical thinking, greatly improving their mathematical innovative thinking ability, sense of conviction and mathematical aesthetic sense, and were convinced by the charm of mathematical innovation.

5 SUMMARY AND ACKNOWLEDGEMENT

In summary, based on a profound understanding of innovative thinking and mathematical modeling ideas, mathematics teachers in classroom teaching can effectively enhance college students' innovative ability and autonomous learning ability through the innovative integration of mathematical modeling in concepts, proofs, examples and exercises. Teachers can significantly improve college students'

innovative awareness and skills by guiding them in mathematical modeling training and competition practices both inside and outside the classroom. Classroom innovation teaching practice has proved that integrating mathematical innovative thinking and modeling ideas and methods into university classroom teaching can make teachers enthusiastic and students highly motivated to participate in various innovation competitions, thereby enhancing their innovation ability and ability to solve complex problems, laying a solid foundation for them to exert their talents and serve the society in the future.

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BIBLIOGRAPHY

Dianzhou Zhang (2004). New Concept: Problem-driven Mathematics Teaching [J], Higher Mathematics Research, 7(3): 8-10.

Siyi Qin, etc. (2010). Exploratory Thoughts and Practices on Integrating Mathematical Modeling Thought into Basic College Mathematics Courses [J], China University Teaching, 3: 36-39.

Lizhi Xu (1997). Scientific Culture People and Aesthetic Consciousness [J], Journal of Mathematics Education, 6(1): 1-7.

Yingyi Qian (2018). Critical Thinking and Creative Thinking Education: Concepts and Practices [J], 39(4): 1-1.

Yude Hou (2020). The Way to Cultivate Innovative Talents - Centered on Born and Peng Huanwu, Starting from "Qian Xuesen's Question" [J], Journal of Taizhou University, 42(1): 18-26.

Daqian Li (2014). From Mathematical Modeling to Problem-driven Applied Mathematics [J], Mathematical Modeling and Its Applications, 3(3): 1-9.

Qixiao Ye (2012). Integrating Mathematical Modeling Ideas and Methods into Calculus Teaching [J], Mathematical Modeling and Its Applications, 1(3): 32-39.