



Exploration and Practice of Practical Teaching System for Mathematics and Applied Mathematics

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Abstract—Taking the cultivation of applied talents as the starting point, this paper explores and practices the reform of the practical teaching system of mathematics and applied mathematics, defines the ideas of the reform, obtains a number of achievements, and improves the quality of talent training. As we all know, application ability is very important for the future development of any professional students, especially for application-oriented students. Although some teachers realize the importance of application ability to mathematics and applied mathematics majors and take some measures, the effect is not ideal. This paper analyzes the problems existing in the cultivation of practical application ability in the teaching of basic courses of mathematics and applied mathematics, and gives the strategies for the cultivation of practical application and innovation ability in the teaching of basic courses of mathematics and applied mathematics.

Index Terms—Mathematics and applied mathematics; Practical teaching system; Basic subject courses; innovation ability; Application ability.

I. INTRODUCTION

Taishan University is a local undergraduate college, shouldering the important task of cultivating applied talents for local economic and social development. Mathematics and applied mathematics specialty is a first-class discipline and key specialty in our university. In order to develop its characteristics, we must build a practical teaching system suitable for the orientation of professional development and explore a way of cultivating applied talents suitable for our own development.

Practical teaching is an important part of higher education. It plays an important role in guiding students to integrate theory with practice, cultivating innovative spirit and improving comprehensive quality. Several opinions on comprehensively improving the quality of Higher Education issued by the Ministry of education pointed out that colleges and universities should strengthen the links of practical education. Measures should be formulated to strengthen practical education in Colleges and universities. Practical teaching standards should be formulated by classification in combination with professional characteristics and talent training requirements. The proportion of practical teaching should be increased to ensure the necessary credits for

practical teaching of various majors (class hours). Strengthen the construction of laboratories, practice and training bases and practical teaching sharing platforms. Strengthen practical teaching management and improve the quality of experiments, practice and training, practice and graduation design (Thesis).

With the further deepening of the reform of mathematics education in Colleges and universities, the requirements of middle school basic mathematics education and Society for the required talents in knowledge, ability and quality are gradually improved, which puts forward new requirements for the teaching of basic courses of mathematics and applied mathematics. Its reform is multifaceted and multi-level. The requirements for mathematics application and innovation ability of students majoring in mathematics and applied mathematics have been further improved, setting off a wave of "strengthening practical teaching and improving application ability" [1-15]. Facing the rapid development of science and technology, cultivating high-quality talents with innovative spirit and ability is the primary task of higher education. Cultivating the mathematics application and innovation ability of mathematics majors is the inevitable trend of mathematics education reform, the inevitable need of implementing mathematics quality education in China, and the inevitable path of mathematics science and social development.

Practical application and innovation ability are inseparable from creative thinking. Creative thinking is the core of mathematics quality education. This ability must not only be cultivated through the teaching of effective knowledge, especially basic knowledge, but also guide students to apply their knowledge, analyze and creatively solve practical problems, and stimulate their creative enthusiasm and interest. Because the basic courses of Higher Algebra and mathematical analysis are far from cutting-edge topics, it is difficult for students to put forward new scientific concepts or discover new theories in the process of learning. However, the knowledge learned is brand-new for novice students. In this sense, students' learning process contains creative thinking activities. In teaching, through the improvement of teaching methods, inspire students to ask questions with innovative ideas, guide students to feel the joy of creation and the joy of success, gradually cultivate students' scientific working



attitude, rigorous research spirit and strong dedication, and improve their creative thinking ability. For example, for the problem "Let A be a n -order real square matrix, then $\text{rank}(A'A) = \text{rank}(A)$ ", we can guide students to use the theory of linear equations and the theory of quadratic form to prove it respectively. After proving this question, the teacher can ask the question: "If the real square matrix in the above proposition is replaced by the $n \times m$ matrix in the real number field, is the above conclusion still true?" Furthermore, "If the real number field in the above proposition is replaced by the complex number field, is the conclusion still valid? If not, what conclusion can we get in the complex field?" Teachers don't have to give the results directly, but through inspiring students' positive thinking, and let students explore their own conclusions, give specific proof process.

II. PROBLEMS IN PRACTICAL TEACHING OF MATHEMATICS AND APPLIED MATHEMATICS

A. Lack of a complete practical teaching system

In the teaching of mathematics and applied mathematics before 2009, there was a phenomenon of emphasizing theory and neglecting practice. The form of practical teaching is single, and there is no other practical teaching content except military training, professional practice and graduation thesis design. Talent training is out of touch with social needs, resulting in the narrow employment scope of graduates and weak employment competitiveness. The lack of a complete practical teaching system is an important factor causing this situation.

B. The teaching methods and means of professional courses lag behind

Most of the courses offered by the major of mathematics and applied mathematics have many concepts and abstract theories. Influenced by the traditional teaching thought, the "cramming" teaching method occupies a dominant position, and students always accept it passively. Teachers' single teaching methods and lagging teaching means lead to students' lack of interest in learning, and teachers' teaching effect is not ideal. Relatively mature practical teaching methods such as case teaching and research teaching are rarely used, which weakens the cultivation of students' innovative ability and leads to students' poor ability to solve practical problems.

C. The main courses lack practical teaching links

There are few practical teaching contents in the main courses of mathematics and applied mathematics. Courses such as numerical analysis and mathematical modeling require students to practice, which accounts for a high proportion of the total class hours. However, there are some problems in teaching, such as the serious separation

between the lecturer and the experimental instructor, the weak ability of the lecturer to use the mathematical application software, and the poor awareness of students' practical skills training, which are the main reasons restricting the practical teaching of the main courses.

D. The practice teaching base is not perfect

The practice teaching base includes various laboratories in the school and practice teaching bases outside the school. In terms of in school laboratories, unlike physics, chemistry and biology, the teaching of main mathematics courses requires more experimental equipment. It only needs to equip students with a computer and related teaching software, and the experimental cost and equipment loss rate are very low [2-6]. However, the equipment that the laboratory can provide for the practical teaching of mathematics related courses is very limited, which limits the development of practical teaching. In the construction of off campus practical teaching base, due to less contact and communication, the relationship between the school and educational practice school is weakened, resulting in difficulties in contacting with the practical teaching base and randomness of practical teaching. It is not conducive for teachers to guide and solve students' problems in practice in time.

E. Practice teaching management is not standardized.

On the one hand, the management methods of school practical teaching are not standardized, the practical teaching activities carried out by students are lack of teaching quality monitoring system, and the quality of practical teaching is difficult to guarantee. In addition, there is a lack of scientific and reasonable practical teaching assessment methods [2-5], which is obviously not conducive to the cultivation of students' practical application and innovation ability.

III. THOUGHTS ON THE REFORM OF PRACTICAL TEACHING SYSTEM OF MATHEMATICS AND APPLIED MATHEMATICS

The construction of practical teaching system of mathematics and Applied Mathematics Specialty must closely focus on the cultivation of applied talents, adhere to the market demand as the basis, employment as the guidance, ability and quality improvement as the core concept, emphasize the relationship between theory and practice, and highlight the cultivation of practical ability.

A. Build a practical teaching system according to the combination of inside and outside the school

It is difficult to cultivate applied talents with coordinated development of knowledge, ability, quality and personality only by schools and classrooms. We need to make full use of off campus resources and reasonably arrange practical

projects so that students can exercise and cultivate their practical ability in a variety of environments. Mathematics and applied mathematics need to be closely connected with industry enterprises outside the school, establish an off campus practical teaching base, and invite industry enterprises to participate in the whole process of applied talent training, so as to realize the seamless connection between skill training and professional posts; The school needs to further improve the practical teaching conditions, such as building a professional laboratory so that students can get full training opportunities in the school; At the same time, the school should fully organize and carry out second classroom activities, organize students to participate in various competitions, improve students' professional application ability and innovation ability, and make students get more comprehensive development in the "second classroom".

B. Build a practical teaching system according to the combination of practical training and practice

The practical teaching composed of experiment, practical training and practice is the key to make students develop from knowledge to professional ability and comprehensive quality. Since the experiment has accumulated relatively mature experience, it will not be repeated here. To improve the quality of applied talent training, we focus on the construction of practical training and internship links. From the second semester to the seventh semester, we take two weeks to carry out targeted project training at the end of each semester. Before students go out for internship, they strengthen pre job training, and arrange instructors to guide students' graduation thesis and post internship, The double tutor system is adopted for the guidance and management of students' practice, that is, the school tutor and the internship unit tutor jointly guide, so as to ensure the quality of talent training.

C. Build a practical teaching system according to the combination of quality development and teaching production integration

The core component of professional ability is professional quality. Solid professional quality is an important guarantee for college students to obtain employment smoothly, base on their posts, serve the society and realize professional development. Therefore, we must actively carry out college students' professional quality development training and build a practical teaching system combining quality development with off campus practice. By inviting industry experts to hold academic lectures, students can enhance their cognition and understanding of their posts and majors. Adhere to the cooperation with enterprises and industries, and actively guide students to carry out rich and colorful quality development and social practice activities, such as market research, social investigation, post cognition, internship and practice, so as to enable students to improve professional theoretical knowledge, find deficiencies and expand their

quality in the environment of school enterprise cooperation and teaching industry integration.

D. Build a practical teaching system according to the combination of skill training and innovative ability practice

The cultivation of applied talents should take the cultivation of ability and quality as the main line, and build a practical teaching system combining skill training and innovative ability practice. The basic skills training of mathematics and applied mathematics should include Putonghua, eloquence, calligraphy, writing, multimedia courseware making, etc; Professional skills training should include mathematics teaching materials, teaching methods, teaching skills training and other courses in primary and secondary schools; Comprehensive skill training is a practical activity for students to comprehensively apply the knowledge and ability they have at the university stage. It is very key to the cultivation of students' ability and the improvement of their quality. In the construction process of the whole practical teaching system, the cultivation of practical application, innovative consciousness and innovative ability runs through the four years of the University, so that students can have strong application ability, innovative ability and ability to solve practical problems of mathematical knowledge through training and exercise, so as to lay a good foundation for lifelong development.

IV. CONSTRUCTION OF A NEW PRACTICAL TEACHING SYSTEM

Taishan University is a general undergraduate college for the purpose of cultivating applied talents. The purpose of its practical teaching is to enable students to consolidate their professional theoretical knowledge, lay a good foundation, and cultivate students' ability to analyze problems with applied knowledge and solve practical problems with hands-on practice. Therefore, we have made a great adjustment to the talent training plan of mathematics and applied mathematics, put forward a new practical teaching mode of paying equal attention to the practical teaching of major courses and other practical links, and reconstruct a new practical teaching system of mathematics and applied mathematics.

A. Practical teaching links of major courses

Integrate the ideas and methods of mathematical modeling into the teaching of major courses, so that students can learn to use mathematical knowledge and computer means to solve practical problems and enhance their practical ability [6]. On this basis, curriculum experiment practice links are also added in teaching practice. For example, 2-3 relevant curriculum experiments are set in professional courses such as advanced algebra, probability theory and mathematical statistics, ordinary differential equations, numerical analysis and optimization methods, so that students can deepen and understand their mathematical theoretical knowledge through



these curriculum experiments, Experience the happiness and frustration of mathematical exploration and discovery, and cultivate the ability to solve practical problems by using computers and mathematical software.

B. Extracurricular practice

Organize students to participate in college students' mathematics competition and mathematical modeling competition. Students' mastery of professional theoretical knowledge is tested through mathematics competition. The mathematical modeling competition first organizes the school competition, and carries out the mathematical modeling training based on the tutorial system by using the holidays and after-school time. The students form a team to complete the competition papers. The school modeling guidance group selects the team members according to the evaluation criteria of the papers of the National College Students' mathematical modeling competition to participate in the National College Students' mathematical modeling competition. The school modeling Guidance Group will conduct pre competition training and Simulation Competition for the selected team members.

C. Graduation thesis (Design)

Graduation thesis is a thesis written and submitted by students before completing their studies. It is one of the important parts of teaching or scientific research activities. The main purpose of the graduation thesis is to cultivate students' ability to comprehensively use the knowledge and skills learned, integrate theory with practice, independently analyze and solve practical problems, so that students can be engaged in their professional work and carry out relevant basic training. In order to give better play to the role of graduation thesis in talent training, we should focus on the application of graduation thesis and control the topic selection and quality. It is required to be closely combined with the reality of life and production, and serve the place for the purpose of reflecting strong application value.

D. Graduation practice and social practice

In order to enable students to have a broad and in-depth understanding of the practical application problems involved in their major during their study in the University, enhance students' practical ability, and closely combine their professional theoretical knowledge with practice, we have established cooperative and mutual assistance relations and stable practice bases with relevant primary and secondary schools and enterprises according to the characteristics of mathematics and applied mathematics, Apply the learned knowledge to social practice, help local people improve their computer application ability, cultivate students' social practice ability and improve their comprehensive quality. Through the establishment of practice base, students can really contact many aspects of practical work and experience the characteristics of practical work and the use value of

theoretical knowledge learned by the school in practical work.

V. EFFECT OF THE NEW SYSTEM OF PRACTICAL TEACHING

Through our exploration and Practice for more than two years, we have achieved remarkable results. In order to ensure the successful completion of the practical teaching system, we take the initiative to contact industry enterprises and establish a number of off campus training bases, mainly undertaking teaching tasks such as project training and post practice. In order to improve students' practical ability, we actively carry out second classroom activities and set up interest groups closely combined with majors, such as mathematical modeling group. In order to strengthen practical teaching, we revise the professional talent training plan from time to time. Students' knowledge application ability and innovation ability have been greatly improved. The quality of talent training has been significantly improved, and students have achieved good results in the National College Students' mathematical modeling competition and the American Mathematical modeling competition.

VI. CONCLUSION

Strengthening the research of practical teaching and clarifying the objectives of practical teaching are of great significance to deepen the reform of practical teaching and improve the quality of practical teaching. Only by following the law of higher education, renewing educational concepts, and exploring and innovating talent training mode according to the actual situation of the University, can we run the major of mathematics and applied mathematics well. The establishment and implementation of the new practical teaching system of mathematics and applied mathematics has effectively promoted the education and teaching reform of the specialty, and is the "indicator" to effectively strengthen all links of practical teaching, which makes the practical teaching management more scientific and standardized, and overcomes the subjectivity and randomness of the previous practical teaching. Practice shows that arranging practical teaching according to the framework of the new practical teaching system not only has simple operation, strong regularity, adapts to the changes of teaching content and teaching links, but also plays a role in monitoring the process of practical teaching. Of course, the improvement of practical teaching system is an endless work, which needs to be constantly updated and revised while paying attention to the development of similar majors and combined with the characteristics of students in the new era. At present, we are also taking necessary methods and measures to make the content of the practical teaching system more scientific and the structure more reasonable, and cultivate professionals with stronger social adaptability.

In short, the reform of practical teaching system of mathematics and applied mathematics specialty is complex and long-term. We can only continue to explore in practice, strengthen practice in exploration, strive to achieve the

important goal of teaching reform, realize the dislocation development of majors and the transformation and development of schools, and cultivate more applied talents for the society.

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REFERENCES

- [1] R. Yang, Practice teaching reform of Mathematics Specialty Based on system construction, *Laboratory Research and Exploration*, 2013 (6).
- [2] W.F. Wang, Z.Y. Wu, C. Xu, Exploration and Research on the comprehensive reform of mathematics and Applied Mathematics in local colleges and universities Science, *Education and Culture Collection*, 2015 (4).
- [3] Y. Li, Research on the reform of practical teaching curriculum system of Applied Mathematics Specialty in Newly-built Local Colleges, *Journal of Baise University*, 2015 (5).
- [4] Y.F. Huang, Thoughts on perfecting the practical teaching management of mathematics undergraduate specialty, *Higher Science Education*, 2007 (2): 41-44.
- [5] J.P. Huang, L.J. Fang, L.J. Huang, Exploration on the new practical teaching system of digital specialty in Colleges for nationalities, *JOURNAL OF GUANGXI UNIVERSITY FOR NATIONALITIES (NATURAL SCIENCE EDITION)*, 2008,14 (4): 87-90.
- [6] J. Feng, On the practical teaching of normal mathematics and Applied Mathematics in local colleges and universities, *Education and Occupation*, 2009 (17): 178-180.
- [7] S. Wang, C.Y. Yu, Mathematical model of practical teaching evaluation method in applied undergraduate colleges, *Science and Technology Innovation Guide*, 2009 (1): 167-168.

- [8] X. Chen, X. Zhang, X. Niu, Exploration and practice of mathematics and Applied Mathematics Specialty Construction in Applied Undergraduate Colleges and universities, *College Mathematics*, 2012,28 (1): 5-9.
- [9] F. Yan, S.M. Zhang, Q. Zhang, Reflections on the practical teaching of normal mathematics and Applied Mathematics in Newly-built Local Colleges and universities, *Teacher*, 2012 (23): 31-32.
- [10] X.Y. Deng, long Guangqing, Chen Xiaokun Thinking and Exploration on several problems in the cultivation of College Students' mathematical quality, *Journal of Guangxi Normal University*, 2006 (9).
- [11] M.M. Tang, Cultivation of thinking method and thinking quality in higher algebra teaching, *Journal of Xiangtan Normal University*, 2006, (6).
- [12] X.R. Geng, On the research status of applied ability of higher mathematics, *College Mathematics*, 2008, 24 (2): 7-10.
- [13] Z.C. Yang, Cultivation and exploration of College Students' mathematical application ability, *Journal of Chongqing Institute of Education*, 2007, (3): 21-23.
- [14] C.Y. Bai,, Y.H. Xie, J.N. Li, On the cultivation of students' innovative ability from the reform of college mathematics teaching, *Journal of Jilin Institute of Education (late)*, 2013, (6): 16-17.
- [15] G.Q. Liu, On the ways and measures of Cultivating College Students' innovative ability, *Journal of Donghua University of Technology*, 2008, (12): 385-387.

Author's biography with Photo



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