Studies on the Cultivation of Innovation Ability of Chinese College Students Majoring in Mathematics

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ABSTRACT

To obtain more innovative personnel, the outline of the national program for medium and long term education reform and development in China calls for the reform of the training systems to find new models and explore new methods. Therefore, a series of related researches have been conducted on it in the field of mathematics teaching in college and university in recent years. By using the literature analysis method, through collecting, identifying and sorting out the research on the cultivation of innovation ability of college students majoring in mathematics in recent 10 years, this study summarizes the current situation and strategies of the cultivation. The results showed that the current research mainly focused on the situation and the cultivation strategy. As for the current situation of the cultivation of innovation ability of students majoring in mathematics, the researchers think that the current college curriculum is unreasonable, the cultivation method is not scientific, the practical teaching system is not perfect, the students' consciousness is weak, lacking of the specialized teachers and the evaluation mechanism is not perfect. As for how to cultivate the innovative ability of students majoring in mathematics, the current researchers suggest that we should change the educational concept, optimize the curriculum structure, carry out practical teaching reform, cultivate excellent teachers and build a reasonable evaluation mechanism. Overall, the current research is still relatively scattered, there are many gaps. Therefore, it is suggested that future studies should be conducted in a comprehensive and systematic manner.

Keywords: *Innovation ability, Mathematics, College students, Curriculum, cultivation, strategy.*

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Highlights of this paper

- To obtain more innovative personnel, the outline of the national program for medium and long term education reform and development in China calls for the reform of the training systems to find new models and explore new methods.
- The results showed that the current research mainly focused on the situation and the cultivation strategy.

1. INTRODUCTION

May 2015, the General Office of the State Council published the implementation opinions on deepening the reform of higher education and pointed out: deepening the reform of innovation and entrepreneurship education in institutions of higher learning is an urgent need for the country to implement the innovation-driven development strategy (Luo & Li, 2017). While mathematics is an indispensable tool for social progress and development. Innovation is a process of conceptualization characterized by new thinking, new inventions, and new descriptions, and it is an inexhaustible driving force for social development (Bu, 2017). A college education is an important stage to train students' innovative thinking and ability. Therefore, it is one of the important tasks of higher education reform to improve the innovation ability of college students majoring in mathematics. What college trains is not high-end talents who study mathematics, but practical talents who can use mathematical knowledge and methods to solve practical problems (Nie & Li, 2014). In order to better promote the cultivation of college students' innovation ability, this study intends to review and sort out the related researches in recent 10 years and put forward some countermeasures and suggestions on how to improve their innovation ability on the basis of analyzing the current situation of the cultivation of innovation ability of students majoring in mathematics.

2. METHOD

Firstly, a literature search was conducted on CNKI with the theme of "innovation ability of college students majoring in mathematics". From 2008 to 2019, there were 88 papers, many of which were published in recent years. Secondly, a detailed analysis was carried out. Results show that some experts studied students' analogy, transference and other innovative performance from the use of mathematical formulas and mathematical software. Some experts led students to participate in mathematical modeling, challenge cup, their own experimental projects, directly observed the students' innovative performance. With the help of the innovation ability training plan of students majoring in mathematics in colleges and universities, combined with the actual situation and data, most experts elaborated on the current situation and problems of the innovation ability training of students majoring in mathematics. In addition, some suggestions are put forward, such as optimizing the curriculum, increasing practical teaching, training excellent teachers and reforming the evaluation mechanism.

3. THE CURRET SITUATION AND PROBLEMS

3.1. The Division of Majors is Too Detailed and the Curriculum is Unreasonable

Nie and Wang believed that the specialized curriculum was too detailed, which limited the cultivation of students' practical ability and innovation ability to some extent. This will lead to a single knowledge structure of students and is not conducive to the improvement of comprehensive ability and quality (Nie & Li, 2014; Wang & Chu, 2016). Dong, Ma, Fan, and Yang also believed that over the years, basic courses and specialized courses in Chinese colleges and universities are too narrow. Especially the mathematics courses, they are outdated, repetitive and boring. All these are not conducive to broadening students' knowledge and improving their comprehensive

quality, thus affecting the cultivation of students' innovation ability (Dong & Liu, 2012; Fan, Du, Wei, & Yang, 2008; Ma, Huang, & Song, 2008; Yang & Wei, 2015).

3.2. The Method of Cultivating Students' Innovation Ability is not Scientific

Nie and Wang pointed out that teachers taught with a single teaching method during the whole class, leading to students' weak self-learning consciousness. When encountering problems to be solved, if there is no ready-made method to apply, the students will be at a loss, lack innovative consciousness and innovative thinking ability (Nie & Li, 2014; Wang & Xiang, 2016). Wang, Zheng, and Yuan also believed that most mathematics teachers use the explanation method to teach, and students are almost deprived of time and space for thinking. If the innovation ability cultivation route is wrong, then students' innovation ability will not be greatly improved (Wang & Chu, 2016; Yuan, 2019; Zheng, 2007).

3.3. The Practical Teaching System of Cultivating Students' Innovation Ability is not Perfect

Wang and Xiang pointed out that the proportion of practical training courses in the training program for mathematical professionals was relatively small. Students have less time to participate in practical activities, which is not conducive to the cultivation of students' innovative thinking (Wang & Xiang, 2016). Ma also pointed out that students have fewer opportunities to participate in mathematical science research. Involving students in mathematical research projects is the most direct cultivation of students' innovation ability, but some universities, especially ordinary institutions, provide students with fewer opportunities to participate in scientific research projects. Some teaching practices are mere forms, lacking both effective theoretical guidance of teaching practice and effective management of the practice (Ma et al., 2008; Sun, 2019).

Luo and Wang pointed out that practical teaching is an important link to achieve practical results in innovative education. Many colleges and universities lack a stable platform to practice innovation and an atmosphere for students to carry out scientific research activities. Most of them resort to "challenge cup" and other competition projects, with low student participation and narrow coverage, and neglect the cultivation of students' scientific research and innovation abilities in the teaching process (Luo & Li, 2017; Wang & Chu, 2016).

3.4. The Sense of Innovation for Students is Weak

Yuan pointed out that the cultivation of innovation ability cannot only rely on teachers' efforts but also needs a comprehensive impetus, especially students' own recognition of innovation ability (Yuan, 2019). Zheng and Li pointed out that students' self-study ability and expressive force are also the expression of innovation consciousness. Creative teenagers are often unafraid to be unconventional and unafraid of authority, while students in our college classrooms rarely express their personal opinions and dare not express themselves (Li, 2010; Zheng, 2007). Wang pointed out that today's students majoring in mathematics seldom think about problems from the perspective of mathematics, and their initiative to learn is not high, so their pursuit of knowledge is not high. It is almost impossible to talk about innovation at this time (Wang & Yan, 2014).

3.5. Lacking of Professional Innovation Ability to Train Teachers

Teachers are the key to the development and implementation of an innovative curriculum and the main force to cultivate college students' innovative ability. But the teachers are uneven, which brings great difficulties to the teaching work. Nie pointed out that at present, college teachers have become a weak link in the cultivation of innovation ability. In teaching, innovation education is not well integrated with conventional teaching (Nie & Li,

2014). Yuan pointed out that many teachers regard the cultivation of innovation ability as a form, and although some measures have been taken, the actual effectiveness of innovation ability has not been studied in a later stage (Yuan, 2019). At the same time, Sun pointed out that although some mathematics teachers agree with the goal of cultivating students' mathematical innovation ability, they often do not know how to cultivate students' mathematical innovation ability due to their lack of awareness of innovation, innovation ability, and understanding of the process of mathematical innovation (Sun, 2019). Luo and Jiang pointed out that the number of teachers in innovative education courses is seriously insufficient. Teachers have not undergone strict training and learning, and do not have basic professional knowledge and teaching skills. Many teachers follow the traditional teaching model and adopt more teaching and analysis while ignoring new teaching methods such as guidance, discussion, interaction, summary and induction (Jiang, Zhao, & Wang, 2015; Nie & Li, 2014).

3.6. The Assessment and Evaluation Mechanism of Students is not Perfect

The disadvantages of exam-oriented education limit the cultivation of innovation ability. According to the view of Wang, Chu, and Sun, the current methods of evaluating students are mainly based on the level of academic performance, which leads to the phenomenon of students' one-sided pursuit of test scores to some extent (Sun, 2019; Wang & Chu, 2016). Wang and Yan proposed that most colleges and universities usually adopt the examination method in the assessment of mathematics major courses, which makes students tend to take passing the exam as the goal during studying. In addition, teachers mainly focus on teaching students to solve problems, while neglecting to cultivate students' ability to think and put forward problems, which undoubtedly limits the development of students' innovation ability (Wang & Yan, 2014).

4. THE STRATEGY OF THE CULTIVATION

4.1. Changing Educational Idea, Innovating Training Model

Fan and Yuan believed that it is an important measure to improve students' innovation ability to set up a correct concept of innovation ability education and explore an education model that meets students' actual needs (Fan et al., 2008; Yuan, 2019). Luo, Bu, Wang, and Li proposed to set up the educational teaching concept that takes students as the main body of teaching activities and takes ability cultivation and quality improvement as the orientation, which should not only pay attention to students' knowledge level, but also cultivate their innovative consciousness and critical thinking quality (Bu, 2017; Li., Shuang, & Fang, 2013; Luo & Li, 2017; Wang & Chu, 2016). Kang, wang, and Li proposed to make full use of modern teaching methods when setting up training programs. We not only should attention be paid to the support of mathematical science for information technology, but also to the use of information technology to expand the application of mathematical knowledge (Kang & Guo, 2011; Li.. 2015; Wang 2016). Li and others pointed out that it is necessary to change the phenomenon of 'more knowledge and less understanding' in traditional Chinese mathematical teaching, increase the teaching content of mathematics practice, synchronize teaching, learning, and research, and complete the change of teaching model (Li..., Du, & Wang, 2008).

4.2. Optimizing the Course Structure and Teaching Methods, Promoting Students' Independent Learning

Wang, Sun and Liu believed that the content of innovation should be displayed in textbooks so that students can recognize what is mathematical innovation and show the process of mathematical innovation in teaching so that students can master how to innovate. We should implement the overall optimization of the course of the principle, select and update teaching content to ensure that students have a solid foundation of knowledge. We should

introduce frontier knowledge and latest scientific research results into textbooks (Liu, 2010; Sun, 2019; Wang & Chu, 2016). Nie, Wang, Li and Wang believed that the design of curriculum types should be diversified, it should include interactive teaching, open teaching, case teaching, discussion teaching, and intuitive teaching. We should encourage students to speak up loudly and participate actively, so as to cultivate students' curiosity and innovative spirit (Li. et al., 2013; Nie & Li, 2014; Wang & Xiang, 2016; Wang 2016).

4.3. Putting the Discipline Competition as the Carrier, Developing a Practical Teaching System

Luo, Wang, Wang, Diao, and Liang believed that college students should be encouraged to participate in a scientific research project, invention patent. Colleges and universities should consciously organize students to participate in the national mathematical contest in modeling for college students, the mathematical contest for college students and the "challenge cup" scientific and technological innovation work competition for college students, so as to cultivate practical and innovative talents (Diao & Sun, 2009; Liang, 2017; Luo & Li, 2017; Wang & Xiang, 2016; Wang & Yan, 2014).

Wang and Ma believed that we should increase the proportion of practical teaching and strengthen the effect of practical education within the existing academic hours and credits framework, such as adding the courses "MATLAB foundation and application", "mathematical modeling experiment" and "statistical analysis software". We should focus on cultivating students' grasp and understanding of mathematical thoughts, methods, and applications, and cultivating students' innovative consciousness, innovative ability, and practical ability (Ma et al., 2008; Wang & Chu, 2016).

Luo and Kang proposed that in addition to organizing students to participate in the competition, the school also should strengthen the construction of a professional training room so that students learn to challenge the set of thinking in the hands-on operation. They can cooperate with local government and enterprises to set up some science and technology competition activities combining with the local economy to expand students' innovation practice platform (Kang & Guo, 2011; Luo & Li, 2017).

4.4. Building Specialized Faculty for Innovation Cultivating

Sun and Gou believed that only when teachers themselves have the consciousness and ability of innovation, it is possible to cultivate students' ability of innovation. Teachers should keep ahead of the times in their ideas and consciously strengthen the cultivation of students' innovative consciousness, innovative thinking, innovative ability and innovative personality in the teaching process. They should be able to create a lively learning situation centered on college students with our own innovative consciousness, innovative thinking, and innovative ability, so as to stimulate their passion for innovation (Gou, 2010; Sun, 2019).

Yuan and Yuan believed that teachers should set an example in knowledge accumulation and innovation awareness. They should not only have a solid foundation in mathematics and rich teaching experience but also study how to improve students' innovation ability. Only in this way can the quality of the teaching staff be guaranteed, thus ensuring the efficiency and quality of the corresponding work (Yuan, 2019; Yuan., Peng, & Zhang, 2011). Zhong also proposed that in addition to having solid professional knowledge, teachers must also have a holistic view of the courses they teach, including the origin, development, and application of their history. Without good mathematical quality and accomplishment, it is impossible to develop an innovative ability (Zhong, 2012).

Li, Wang, and Jiang put forward that teachers should pay attention to the process of the development of mathematical knowledge in the process of implanting theoretical knowledge, guide students to discover mathematical laws, and cultivate the consciousness of solving problems by means of mathematics. Only when there

is need can there be innovation, and only when there is consciousness can there be innovation. Teachers should often choose some of the typical divergent mathematical knowledge or problems to activate students' mathematical thinking. They should guide students to be brave and good at finding or raising problems, and love, support and encourage all students' thoughts and activities containing creative factors (Jiang et al., 2015; Li, 2010; Wang & Yan, 2014).

4.5. Constructing Reasonable Evaluation and Incentive Mechanism

Wang, Gou, and Wang believed that we should change the previous practice of taking examination results as the sole criterion for evaluating students and establish a comprehensive evaluation system. In the process of teaching, students are evaluated by making special reports, writing academic papers, participating in teachers' scientific research projects, participating in innovation and entrepreneurship training programs and other forms (Gou, 2010; Wang & Chu, 2016; Wang & Yan, 2014). Kang also proposed that the learning style, learning ability, learning attitude, emotional values and other basic qualities and abilities that students must have for lifelong learning and development should be included in the evaluation system. Attention should be paid to students' learning activities and learning needs, and teachers' teaching feedback should be taken as one of the evaluation contents and indicators (Kang & Guo, 2011).

According to the points of Wang and Li, students' scores should not be taken as an important indicator to test teachers, otherwise, teachers will focus on students' mastery of knowledge and neglect the cultivation of students' abilities for their own assessment (Li. et al., 2013; Wang & Yan, 2014). Li and others mentioned that their comprehensive mathematical practice ability can be evaluated in the experiment and society, so as to strengthen the development and training of their mathematical innovation ability and provide a scientific approach for the selection of innovative talents (Li et al., 2008).

Gou pointed out that encouraging the faculty and the backbone of the staff by profits and letting them feel their innovation achievements received social recognition and corresponding return. At the same time, a special reward fund will be established to reward teachers who have achieved outstanding results in cultivating students' innovation ability and providing funds for teachers to guide students' innovation activities. Students are encouraged to carry out innovative activities through scholarships, innovation funds, award credits, innovation credits, and quality development credits. And providing financial support and professional guidance to students' innovative activities (Gou, 2010).

5. DISSCUSSION

In general, the present situation and the strategy of cultivating the innovation ability of students majoring in mathematics are mainly studied. As for the present situation of the cultivation of innovation ability of college students majoring in mathematics, previous studies have argued that the current college curriculum is unreasonable, the cultivation method is not scientific, the practical teaching system is not sound, the students' awareness is weak, the specialized teachers are lacking and the evaluation mechanism is not perfect. As for how to cultivate the innovative ability of students majoring in mathematics, previous studies suggested that we should change the educational concept, optimize the curriculum structure, carry out practical teaching reform, cultivate excellent teachers and build a reasonable evaluation mechanism.

Although the above studies have been more in-depth, it can be seen from them that, on the whole, the current studies are relatively fragmented and not systematic, so there are many gaps. For example, there are few studies on the cultivation of university teachers' innovation ability, few studies on the current methods of college students'

innovation evaluation and few studies on college students' innovation practice, etc. These are all directions for future research.

6. CONCLUSION

To cultivate more innovative talents, many aspects of college mathematical teaching have been studied at present. Reviewing existing studies, we can see that they mainly focus on two aspects, one is the current situation of cultivation, and the other is the cultivation method. As for the present situation of cultivation, most researchers believed that the current university teaching has many defects and deficiencies. As for the training methods, previous researchers suggested that we should change the educational concept, optimize the curriculum structure, carry out practical teaching reform, train excellent teachers and build a reasonable evaluation mechanism. However, previous studies also have many gaps and are not very systematic. Therefore, it is suggested that all aspects should be combined in future research.

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