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The Research of Innovation Ability of University Students Majoring in Mathematics in China

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Abstract

It is an important topic that higher education attaches great importance to and urgently needs to solve to carry out the training objectives of innovative talents and the guiding ideology of the construction of innovative talents cultivation system. The review aims to contribute to this discussion and provide enlightenment for the innovation education reform in universities by providing a comprehensive overview of the use of innovation ability of university students majoring in mathematics in China. We reviewed 32 previous innovation studies about students majoring in mathematics in China, summarized all the results of those studies using literature method and coding analysis. The results show that: (1) The studies have published mainly focus on the situation and problems of the cultivation of the innovation ability of the students majoring in mathematics, and the strategies for improving the innovation ability of them. While the number of predecessors' studies is relatively small, these studies have already involved fundamental topics, and the predecessors' achievements have laid a good foundation for future research. (2) There are some deficiencies in previous studies. At first, the theoretical research method was used in previous studies so that they lacked accurate research data to support their conclusions. Secondly, the depth and breadth of research were very limited, and the scientific of the research process and the depth of research content were far from enough in this field. (3) There are some blanks on this subject, such as the factors affecting the innovation ability of mathematics students, the specific content of the innovation ability evaluation system, and the more feasible innovation ability improvement measures. In conclusion, we must adopt more scientific methods, expand the scope and space further, and explore suggestions to improve the innovation ability of mathematics majors in many aspects to make future research more in-depth and comprehensive.

Keywords

Mathematics Major, College Students, Innovation, Current Situation, Strategies

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1. Introduction

In recent years, The Chinese Government put forward a series of development strategies, such as building an innovative and powerful country in higher education. The new educational goal that we should cultivate innovative talents to adapt to the development of social economy and culture was put forward undoubtedly of China's higher education [1]. The comprehensive renewal of the information era makes mathematics not only play an important role in the fields of science, technology, and industry but also penetrates various domains that affect social development at an unprecedented depth, becoming a key tool for national development [2]. To clarify the situation of the studies on the innovation of mathematics major students, the flaws in the research, and the gaps that have not been involved, the author intended to make a comprehensive summary of the previous research. This study can not only provide clear and complete suggestions and strategies for the innovation education reform of mathematics majors in universities but also give the mathematics education researchers new inspiration to promote in-depth research on

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the innovation education of mathematics majors.

The main research questions of this paper are as follows: (1) What are the results of the current studies on the innovation ability of the students majoring in mathematics? (2) What are the deficiencies and blank points in the current research on the innovation ability of mathematics majors?

2. Methods

2.1. Database Selection

The database we selected papers for this study is CNKI. CNKI is a large-scale and full-text database that covers and widely disseminates various forms of materials in China, and it is the most authoritative literature retrieval tool which contains all the content of national academic journals. Therefore, we selected this database to ensure its comprehensiveness and reliability because of the integrity of its literature collection and huge academic influence in China.

2.2. Paper Selection

The author selected papers both through a systematic database search and by carefully checking cross-references from all relevant results. The author conducted a database search in CNKI and considered studies that were published until and including 2020. The first step was the database search, for which we used the search string: (innovation ability of mathematics major) AND (innovation ability of students majoring in mathematics), referring to titles and themes. This resulted in a total of 190 studies. Step two involved screening titles and abstracts using the following criteria: (1) the research topic was highly related to the innovation of university students; (2) the research objects must be the students majoring in mathematics; (3) We only chose the articles published in journals, books or in conference proceedings. Step three was to check all the references that met the above criteria. After the screening, 32 studies remained.

2.3. Coding Procedure

First of all, the author sorted out all the data by taking notes and found that the results on the innovation ability of mathematics major students can be divided into the situation, problems and countermeasures. Therefore, we coded the data combined with the research aspects and questions.

The situation and problems of the cultivation of students' innovative ability in mathematics major are as follows: (1) The current state of students' innovation; (2) The problems in professional settings; (3) Teaching problems (such as teaching, low-quality teachers, the misplacement of students' subject status, practical teaching problems, etc.); (4) Innovation evaluation systems.

The measures of cultivating the innovative ability of mathematics majors are as follows: (1) Macroscopic teaching modes and principles; (2) Reform of education system and curriculum design; (3) Teaching strategies from the perspective of teachers (including teacher-training, education concept updating, reform of teaching contents and methods, and reconstruction of the innovation environment, etc.); (4) Teaching strategies from the perspective of students (including students' innovative ability and quality, cultivation of students' emotion, and mathematical thinking and knowledge learning); (5) Practice teaching and innovation activity strategies; (6) Innovation capability evaluation system strategies.

3. Results

3.1. Statistical Results of Research Objects

In addition to coding the research content, the author also counted the research objects of all of the papers and divided them into students from mathematics normal major, mathematics major, mathematics and applied mathematics major, mathematics education major. Another article discussed how to implement innovative education in mathematics teaching. Among them, one article of students majoring in mathematics education studied the cultivation of innovation of junior college students. In the category of mathematics curricula, the cultivation of college students' innovation ability in mathematics teacher education curriculum was studied. The detailed statistical results are shown in Table 1.

Table 1. Statistical Results of Research Objects.

Research Objects	Mathematics Major (Normal)	Mathematics Major	Mathematics and Applied Mathematics	Mathematics Education	Mathematics major courses
Number of Studies	5	15	7	4	1

3.2. The Situation and Problems

In terms of the status and problems of the cultivation of students' innovative ability, the author divided the previous research contents into four aspects: the status of students' innovation (A1), the professional settings (A2), the problems of teaching (A3) and innovation evaluation system (A4). The detailed statistical results are shown in Table 2.

Table 2. Codes of the situation and problems of the innovation cultivation of students majoring in mathematics.

Primary coding	Secondary coding	Three-level coding (Some Examples)
The situation and existing problems of the mathematical innovation cultivation (A)	Status of Students' Innovation (A1)	Lack of Innovation Consciousness (A11): (Tang) Students' awareness of professional innovation is insufficient; (Yuan) Some students don't pay attention to the cultivation of their innovation ability. They are Innovative but don't know how to use creativity (A12): (Yao) They think quickly but lack of innovation; (Yao) They have inspiration, but lack of innovative skills.
	Professional Settings (A2)	Major division (A21): (fan, & Du, etc.) The division of specialties is too detailed and the setting is too specialized; (Wu) Professional education is out of touch with social development.
	The problems of teaching (A3)	Teaching (A31): (Yang, & Wei) The teaching content and education mode of mathematics in colleges and universities are backward; (Zhu) The content is not updated in time; (Yuan) The teaching situation of emphasizing form and neglecting effect. Low-quality teachers (A32): (Yuan) Lack of professional innovation ability to train teachers. The misplacement of students' subject status (A33): (Wu) The subject position of students has not been established; (Yang, & Wei) Teachers occupy the main position and always use more traditional teaching methods. Practical teaching problems (A34): (Wang) Teachers lack a large number of comprehensive practice opportunities; (fan, & Duan, etc.) The setting level of the practice link is too low, and the extracurricular training link is not standardized.
	Innovation evaluation system (A4)	The evaluation system is not comprehensive (A41): (Tang) The innovation evaluation system is not perfect, evaluation and implementation are out of touch.

3.2.1. The Status of Students' Innovation

In the aspect of students' innovation consciousness, some researchers thought that the innovation consciousness of mathematics major students is not strong. For example, Tang thought that the students' awareness of innovation and profession is insufficient due to the lack of infiltration in the teaching process [3]; Yuan also believed that some students do not pay attention to the cultivation of their innovative ability [4]. some researchers thought that students have a sense of innovation, but do not know how to use it. For example, Yao put forward that students majoring in mathematics have quick thinking and innovative inspiration, consciousness as well as enthusiasm, but their innovation goals are not clear, they lack innovation skills and are not good at creating and using conditions [5]; Wang and others drew the conclusion that the students' awareness of using the knowledge they have learned to solve practical problems is not strong [6].

In the aspect of theory and practice, Tang thought that the consciousness of the combination of them is insufficient, and they only pay attention to the learning of professional knowledge and ignore the accumulation of experience [3]; However, Wu pointed out that students did not pay attention to the learning of professional knowledge, which led to the lack of theoretical knowledge [7].

3.2.2. Professional Settings

In terms of specialty setting, Zhu thought that the division of mathematics major in colleges and universities is unreasonable [8]. Wu believed that mathematics professional education has been divorced from social development, and gradually away from the training objectives of higher education [7]. According to Yang, Fan and others, there are some problems in college mathematics curricula, such as overspecialization and too fine division of specialties [9, 10]. Wang and others believed that mathematics major undergraduates lack integrate knowledge structure and cannot fully grasp the knowledge [6].

3.2.3. The Problems of Teaching

For the teaching problems exposed in the process of innovation ability training, firstly, in the aspect of classroom teaching, Yang, Fan, Wang and others agreed that the mathematics teaching modes and content in colleges and universities are backward in varying degrees, and the teaching content is serious lack of innovation [9-11]; Zhu also thought that the content of mathematics teaching in colleges and universities is not updated in time, and pays too much attention to classroom teaching [8]; Yuan believed that mathematics teaching pays too much attention to form and ignores teaching effect [4]; Wang and others thought that teachers' teaching methods in the class are much rigid. [6].

In terms of teaching staff, secondly, Yuan believed that there is a lack of a professional innovation system to train teachers [4].

In addition, in terms of students' status, Wu, Yang and others believe that teachers occupy the main position, while students' dominant position is not established [7, 9]; Fan, Wang and others think that students lack free-thinking space, so it is difficult to stimulate creativity because of too many lessons

[10, 11]; Wang and others put forward that the disadvantages of exam-oriented education stifle students' creativity [6]; For students' practical activities, some researchers believed that students lack a large number of comprehensive practice opportunities, and the implement of practice and the extracurricular training links are not standardized [10, 11].

3.2.4. Innovation Evaluation System

Finally, some studies mentioned the evaluation system of innovation ability training, pointing out that the evaluation system of innovation ability is not perfect, and the evaluation and implementation are out of touch [3].

3.3. Implement Strategies for Innovation Education of Mathematics Majors

According to the previous results, the author divided the cultivation strategies into macro training modes and principles (B1), education system and curriculum design reform strategies (B2), teaching strategies from the teacher's perspective (B3), teaching strategies from the student's perspective (B4), practice teaching strategies and innovation activities (B5), and innovation ability evaluation system reform (B6). The detailed results are shown in Table 3 and the following chapter.

Table 3. Codes of innovation ability cultivation of students majoring in mathematics.

Primary coding	Secondary coding	Three-level coding (Some Examples)
Implement strategies for innovation education of mathematics majors (B)	Macroscopic teaching modes and principles (B1)	Macroscopic training modes (B11): (Tang) Adopting the team cooperation mode of "specialty + research + innovation"; (Tang) Adopting the collaborative training mode of "thematic analysis + action research"; (Yang et al.) "The whole course, progressive, integrated" practical ability training mode. Cultivation principles (B12): (Sun, Lu) The principles of initiative, practicality, and modeling.
	Strategies of the education system and curriculum design (B2)	Curricula design and reform (B21): (Li, & Duan) A curriculum system suitable for cultivating innovative talents in mathematics should be set up; (Wang, & Chu) The experimental curriculum of this major should be optimized; (Kang, etc.) The teaching of mathematical modeling and computer programming language should be strengthened. The innovation of the education system (B22): (Wang) The innovative education system engineering should be developed; (Yan, & Li) The construction of relevant hardware facilities and provided material support should be paid attention to.
	Teaching strategies from the perspective of teachers (B3)	Teacher-training (B31): (Kang, etc.) The construction of teaching teams at the grass-roots level and optimize the allocation of teachers should be strengthened; (Yan, & Li) Making full use of modern educational technology and resources to strengthen teacher-training. Education concept updating (B32): (Tian) Renewing the educational concept; (Wu) Correcting the teaching concept and putting the cultivation of innovation ability of students majoring in mathematics and applied mathematics in a prominent position. Reform of teaching contents and methods (B33): (Yuan et al.) Correctly handling the dialectical relationship between “no child left behind” and “teaching students according to their aptitude”; (Zhai, & Pi) The teaching of knowledge principles should be paid attention to; (Li, et al.) Teaching methods and knowledge should be reformed based on modern teaching means; (Wang, etc.) Teaching means should be reformed, such as access to the Internet, the use of multimedia teaching equipment. Reconstruction of the innovation environment (B34): (Wu) Promoting the reform of the teaching system; (Zhang) Breaking the traditional teaching habits and creating an open classroom atmosphere; (Zhang) A harmonious and friendly relationship between teachers and students should be established.
	Teaching strategies from the perspective of students (B4)	Students' innovative ability and quality (B41): (Liu) Combining with mathematics education theory course to establish innovation consciousness; (Zhu) Cultivating students' divergent and initiative thinking, and thirst for knowledge; (Tian Yang) Cultivating students' original ability in problem posing and solving. Cultivation of students' emotion (B42): (Yao) Putting forward questions boldly and holding an innovative and realistic attitude; (Zhang) Enriching the teaching content from the students' interest. Students' mathematical thinking and knowledge learning (B43): (Li) Grasping the basic knowledge and skills of mathematics firmly; (Zhong) The thought of analogy, conjecture and induction; (Zhong) Problem-oriented thinking.
	Practical teaching and innovation activity strategies (B5)	Practical teaching (B51): (Yang) The application of theory teaching in mathematics curriculum should be strengthened; (Yan, & Li) Various forms of practical activities should be carried out (such as writing papers, doing mathematical experiments, learning multimedia courseware production, conducting program and web design);

Primary coding	Secondary coding	Three-level coding (Some Examples)
		(Yan, & Li) Encouraging students to go to primary and secondary schools for investigation and research to grasp the dynamics. Strategies for innovative activities (B52): (Meng, & Zhou) Practical teaching projects, innovation and entrepreneurship training programs for college students, and extracurricular academic and technological competitions for college students; (Yan, & Li) Organizing mathematical modeling contests and other activities.
	Innovation capability evaluation system strategies (B6)	Building a reasonable evaluation system (B61): (Kang et al.) Bringing innovation into the evaluation system of students and teachers; (Yang) Adding practical problems to the assessment system; (Yang) Deepening the reform of the credit system, and establishing a comprehensive system including students' management, talent training objectives, evaluation of teachers, and other systems matching the credit system.

3.3.1. Macroscopic Teaching Modes and Principles

Tang proposed two training modes, namely the teamwork mode of "profession + research + innovation" and the collaborative mode of "thematic analysis + action research" [3]. Yang and others put forward a practice ability training model of "whole course, gradual and integration", in which "Integration" refers to the integrated training of students, schools and employers. Then they established a practical innovative teaching system of "one mainline, overall package type and multilevel", such as pay attention to stimulating students' innovative consciousness, consider the characteristics of the majors, teach students according to their aptitudes, and so on [21]. Xie and others put forward the "group driven" innovation ability training mode: to create an atmosphere for innovation ability training; to provide an exchange platform for students to freely show themselves and form a group after knowing themselves; schools and educational departments should pay attention to control each group; group activities should focus on joint participation and continuity to recruit new students at any time [22]. Gou put forward that we should pay attention to constantly explore split-new innovation ability training mode in the process of innovation ability training [23].

In addition, Sun and others put forward the principles that should be followed in the process of innovation ability cultivation from a macroscopic perspective, that is, the principle of autonomy (taking the cultivation of student ability as the mainline and the acquisition of innovation ability as the chief purpose), and the principle of practicality.

3.3.2. Strategies of Education System and Curriculum Design

In terms of curriculum design and reform, some researchers put forward suggestions from a macroscopic perspective. Yuan and others put forward that curriculum reform should be carried out based on the relationship between undergraduate professional courses and their careers [12]; Liu and others put forward that we should optimize the curriculum structure and establish a curriculum system suitable for cultivating innovative talents in mathematics [13, 14]; Wang and others put forward that the curriculum system should be reformed to cultivate applied talents, while a few courses with less applicability should be cut down or replaced by elective courses [15]; Wang and others proposed that we should optimize the experimental curriculum of mathematics [16].

Some researchers also put forward suggestions for specific courses. Kang and others think that statistical software course should be set up, and it is necessary to strengthen mathematical modeling courses and computer programming language teaching [17]; Yang and others proposed to strengthen students' application of mathematical software further, set up mathematical software experiment courses, tap students' potential and improve their practical ability [18, 19]; Yan and others think that elective courses should be offered, such as mathematical software programming, mathematical experiments and modeling, which highlight the ability of application, practical and innovation [20]; Wang and others believe that freshmen seminar, professional introduction and a series of entrepreneurship courses can improve students' innovative consciousness and ability [16].

In the aspect of construction and innovation education systems, some studies emphasize that it is necessary to construct and develop the innovation education system to improve its corresponding advantages [9, 10, 11]; Kang and others pointed out that we should make full use of network resources to develop information-based teaching system [17]; Fan and others proposed that we should use the public experimental platform to construct the sharing environment, and take the website of the teaching and experimental center as the platform to carry out the informatization construction of professional courses and practical teaching [10]; Yan and others proposed that we should pay attention to the construction of relevant hardware facilities and provide material support, such as the establishment of multimedia classrooms and mathematical laboratories [20]; Wu proposed that we should establish an innovative orientation, and the cultivation of students' ability to problem posing and solving should be paid attention to so that students can learn with problems [7].

3.3.3. Teaching Strategies from the Perspective of Teachers

In terms of teacher construction, Kang, Wu and others propose that we should attach great importance to the improvement of teachers' quality, strengthen the construction of the grass-roots teaching team and optimize the allocation of teachers [7, 17]. Yuan and others believe that we should build a professional and high-level teaching staff with innovative ability and thinking [4, 14, 23]. Yan and others proposed that we should make full use of modern educational technology and resources, and pay attention to innovative training of teaching methods for teachers [20].

In terms of education concept renewal, Yuan, Wang and others all believe that teachers must change and innovate mathematics education ideas, and timely update and change the thinking mode [4, 11, 6, 25, 26]. Fan and others believe that the cultivation of innovative ability must be guided by the innovation of teachers' educational ideas [10]. Gou believes that mathematics teachers must adhere to human-oriented and change their educational concepts [23]. Wu put forward that teachers' teaching ideas that the cultivation of students' innovation in mathematics and applied mathematics should be put in a prominent position should be corrected [7]. Zhu thought that teachers should pay attention to the construction of teaching ideas and clarify the teaching purpose [8].

In terms of reform in teaching content and methods, Liu proposed to take knowledge teaching as the mainline to cultivate innovative ability in the learning process [26]. Yang and others believe that in the process of cultivating innovative ability, we should pay attention to the reform of teaching methods and promote the development of students using guidance, encouragement, respect, and practice [9]. Zhu proposed that we should pay attention to the renewal of basic courses and teaching contents of mathematics majors [8]. Zhang believed that it is necessary to select teaching contents reasonably to cultivate students' innovative ability [27]. Gou thought that we should adjust the teaching content, reform the teaching methods, rearrange the teaching plans and courses, construct the teaching mode and innovative training system of the subject participation; we should broaden the scope of students' curriculum selection, encourage students to study across majors while implementing the system of compulsory and elective courses [23]. Li and others believed that we should vigorously apply internet and multimedia related equipment and according to them to reform teaching methods and knowledge [14, 15]. Yang proposed that teachers should closely combine with students' professional characteristics to carry out reform [18]. Yuan and others believed that teachers should correctly grasp and handle the dialectical relationship between teaching and students' aptitude [12]. Zhang thought that life is good teaching material. Teachers should start with teaching reality and pay attention to the students' life experience [28]. Zhai and others believed that we should encourage the implementation of discovery education and attach importance to the teaching of knowledge principles [29].

In terms of the objective environment of innovative education reconstruction, Wu proposed that universities should promote the reform of teaching systems and carefully consider the teaching system of innovative education [7]. Zhang believed that we should break the traditional teaching habits and create a lively atmosphere in the classroom [28]. Zhang believed that teachers and students should establish a harmonious and equal relationship between them, but also encourage students to put forward their different views on the problems posed to create a free and relaxed learning environment [27]. Zhai and others put forward that teachers should create a more objective innovation environment for students [29].

3.3.4. Teaching Strategies from the Perspective of Students

In terms of students' innovative ability and quality, previous studies have discussed from the three angles of mathematics students' innovative consciousness and potential, thinking, and learning ability. From the perspective of students' innovative consciousness and potential stimulation, Liu believed that the combination of mathematics education theory courses can help students establish innovative consciousness [30]; Yao thought that students should consciously cultivate themselves by creating free thinking space, thinking actively and looking for research subjects to improve innovative ability [5]; Zhu thought that teachers should guide students to imagine and inspire [8]; Zhang believed that teachers should lead students to think actively, and explore students' potential through the way of "leading learning by asking" and "guiding thinking by exercising" [28].

From the perspective of students' thinking, Zhu proposed that we should pay attention to cultivate students' curiosity, divergent and intuitive thinking [8]; Zhai and others proposed that we should pay attention to the training of students' divergent thinking [29]; Tian proposed to cultivate students' reverse thinking in mathematical reasoning [25]; Li believes that teachers should lead students to use the imagination, divergence and intuitive thinking, select typical mathematical knowledge and problems with strong divergence, pay attention to creating problem situations, activate students' thinking, and let students carry out independent thinking activities [31]; Yuan and others believed that it is necessary to strengthen the cultivation of students' thinking extension as well as contrary thinking [12].

For students' learning ability, Zhang proposed that we should strengthen the cultivation of students' innovative ability, help

students develop innovative skills, and pay attention to the development of students' observation and conjecture ability [27]. Zhang proposed to strengthen students' ability as well as the way of rational thinking and improve their comprehensive quality [28]. Wang and others put forward that teachers' cyberspace should be taken as a platform to cultivate students' autonomous learning ability [15]. Wang proposed that the innovation ability should be improved further by cultivating observation ability [11]. Tian thought that it is necessary to cultivate students' originality in the process of problem posing [25]. Wang and others also proposed that we should pay attention to the cultivation of students' ability to search for papers [6].

In the aspect of students' emotion cultivation, Zhang and others thought that teachers must pay attention to the education of mathematics majors' learning interest, enrich the teaching content and stimulate the innovation consciousness [25, 27, 28]. Li and others believed that it is necessary to cultivate students' interest and motivation in learning, and the dominant position of students must be highlighted [14]. Zhong believed that students' interest in mathematics learning and teachers' qualities are the premise of cultivating innovative ability [32]. Yao encouraged students to cultivate themselves, to hold an innovative and realistic attitude and challenge boldly [5]. Zhang thought that the innovation education of mathematics is not only a purely intellectual activity but also needs to be driven by emotion and backed by a good personality. Therefore, teachers should pay attention to the development of emotional education for mathematics majors [27]. Zhai and others agreed that students' personalities should be found and developed in mathematics innovation teaching [29].

In terms of students' mathematical thinking and knowledge learning, Li believed that students must have a firm grasp of basic mathematical knowledge and skills [31]. Zhang proposed that teachers should improve students' ability to understand and master the basic concepts, content, and learning methods of relevant knowledge [28]. Yu and others believed that research learning can cultivate students' innovative consciousness and independent learning ability [33, 34]. Zhong proposed to pay attention to the infiltration of mathematical modeling ideas, and select appropriate mathematical model questions to add to the relevant courses according to the actual situation of students; he also emphasized that teachers should focus on guiding students to develop problem-oriented thinking, analogy conjecture, and induction thinking, and guide students to join problem posing and solving process [32].

3.3.5. Practical Teaching and Innovation Activity Strategies

Some researchers theoretically pointed out that it is necessary to strengthen the innovation of college students' practical activities. Wang and others pointed out that the proportion of practical teaching should be increased, the reform of practical teaching should be carried out, and the content and links of teaching practice should be renewed and strengthened [7, 13, 16]. Yang pointed out that we should strengthen the application of theory teaching in mathematics courses, cultivate students' practical ability, encourage students to solve problems in daily life and cultivate the spirit of inquiry [18]. Yang and others proposed that universities and colleges should provide a comprehensive practical teaching guarantee mechanism [21]. Liu believed that the principle of gradual and orderly progress and combining theory with practice should be adhered to to cultivate innovative consciousness and ability [26].

Some studies have pointed out specific practical measures. For example, Yan and others cited various forms of practical activities, such as papers writing, mathematical experiments, multimedia courseware production, program and web design; They also suggested that students should be encouraged to conduct investigation and research in primary and secondary schools to master the dynamics of mathematics learning [20]. Wang and others proposed that we should increase the proportion of practice and training courses in talent cultivation programs [15].

In terms of innovation strategies, Kang and others pointed out that it is necessary to increase the participation proportion of college students in innovative activities, competitions, and scientific projects, and to expand the practice and innovation platforms [17, 18, 23, 26]. Yang discussed the idea of building an innovation studio, which takes the studio as a unit to establish discipline, professional skills competition and scientific and technological innovation team [18]. Meng and others proposed to carry out practical teaching projects, innovation and entrepreneurship training programs for college students, and extracurricular academic contests for college students to cultivate their innovation ability [34]. Yan and others advocated the organization of mathematical modeling competitions and other innovative activities [20, 16]. Liu suggested that groups in mathematics education research should be established, and students should be encouraged to participate in competitions and scientific research activities [30]. Wang and others believed that it is necessary to set up innovation training centers, hold mathematical modeling and mathematics contests, and scientific and technological innovation competitions for college students to cultivate students' innovation [15].

3.3.6. Innovation Capability Evaluation System Strategies

Kang and others proposed to integrate the innovative evaluation into the evaluation system of students and teachers [17]. Yang believed that it is necessary to increase the

proportion of the resolution of practical application problems in the assessment, deepen the reform of the credit system, and establish the system of students' management, talent training goals, and teacher evaluation matching the credit system [18]. Li and others proposed to reform the evaluation methods according to students' achievements and personal abilities [14, 6]. Gou put forward suggestions for the reform of the evaluation system for mathematics and applied mathematics major, such as establishing a comprehensive evaluation system including scores, problem-solving abilities, practical abilities as well as other indicators, and motivating teachers and students by scholarships and funds [23].

4. Discussion

This research investigated the cultivation of innovation of students majoring in mathematics, addressing two research questions. We discuss the results in the order of these questions.

4.1. Analysis of Research Objects and Publication

It can be seen from the above statistical results of the research objects that the previous studies focus are mainly on general mathematics students, that is, the number of studies on the innovation ability of general mathematics students is the most; There are also a small number of researchers who explored the creativity of college students majoring in mathematics in normal universities. Secondly, as for a certain mathematics major, the major of mathematics and applied mathematics is the most studied one, which includes two different types: normal and non-normal; Mathematics education has also received the attention of some researchers, so there are some professional targeted conclusions. There is only one study on how to cultivate innovative ability in the teaching of specific mathematics courses. In conclusion, expanding the sample scope of this topic and exploring the cultivation of innovation ability in specific mathematics majors and specific courses of mathematics to enhance the depth and breadth of future research is a rational direction.

In addition, detailed information about publication time and journals can also be obtained from the references. Judging from the publication time of the papers, the earliest article was published in 2000. That is to say, the topic of the innovation ability of mathematics majors began to gradually arouse the attention of scholars around the beginning of this century. This shows that the starting time of this topic late. Also, the level of these magazines is much low according to the published journals, and there are barely a few articles published in Chinese core journals, CSSCI journals, and others with high scientific recognition. It can be seen that predecessors' studies of the innovation ability of mathematics majors are at a shallow level, and we can improve and explore this topic so much more.

4.2. Summary of Previous Research Results

The previous studies mainly discuss the situation and problems of innovation ability training from four aspects: the situation of students' innovation ability, professional settings, teaching problems and innovation evaluation systems. For the situation of students' innovation ability, previous studies have pointed out that the students' innovation consciousness is insufficient, and the teachers' ideological penetration needs to be strengthened; some researchers thought that the students have a certain degree of innovation consciousness, but their ability to use the innovation potential and learning skills need to be improved. For professional settings, researchers generally agreed that the division of majors is unreasonable [8], and the professional settings are out of touch with social development [7]. Regarding the problems of teaching, previous studies have discussed the deficiencies of daily teaching, practical activities, strength of teachers and the status of students. Regarding the innovation evaluation system, previous researchers pointed out that the innovation evaluation system still needs to be improved.

As for the measures of improvement of innovation ability, the author divided the previous results into six aspects, including macroscopic training modes and principles, strategies of educational system and curriculum design, teaching strategies separately from the perspective of teachers and students, practical innovation activities and evaluation system of innovation. First of all, researchers have put forward a lot of innovative training models from a macroscopic perspective, including the content of innovative teaching principles; Secondly, the researchers discussed some strategies on how to innovate the education system and professional curricula from the angle of school education, which provided the direction for the overall reform of school education; Also, in terms of teaching strategy reform, previous researchers have discussed teaching strategies separately from the perspective of teachers and students, mainly including the construction of teachers qualities, the transformation of educational ideas, the renewal of teaching content and methods, the construction of innovative environment, the improvement of students' abilities and qualities, emotional education, and learning of mathematical thought and knowledge and so on. Researchers have also discussed the reform proposals of practical teaching and innovation activities and put forward new ideas for the evaluation system of innovation education.

From the above summaries, it can be seen that the previous studies on how to cultivate the innovation of mathematics majors have a high degree of concern and research depth. From the strategy summaries, we can find that many aspects

are involved. It can be said that the previous research has a certain depth and breadth, which lays a good foundation for follow-up research.

4.3. The Deficiencies and Blanks

While the previous research has concluded more achievements, there are still some flaws.

Firstly, the depth and breadth of research are very limited, and the scientific methods and processes need to be strengthened urgently. From the analysis of the publication time, journals, and research objects of the previous studies, the studies on this topic started late, the overall level of journals was not high, and the categories of research objects were not comprehensive enough. So, on the whole, there are loopholes in the processes and conclusions of previous studies, and the scope of the research samples and objects are not comprehensive enough. From the perspective of methods, in the process of sorting out and summing up, the author did not find any studies using empirical methods, and all of them adopted the method of theoretical speculation. Research without data support can not guarantee scientific, objectivity and persuasiveness.

Secondly, while the previous research involved many aspects of mathematical innovation training strategies, the feasibility needs to be verified. As for the scientific nature, most studies started to discuss strategies after analyzing the status and problems without analyzing the causes of them, which is not rigorous enough. Besides, reviewing measures mentioned in previous studies, many items are much broad and theoretical, such as explaining the necessity to reform the evaluation method [14], proposing to promote the reform of the teaching system [7], but it is not clear that how to establish the assessment method, what kind of assessment method to establish, what kind of teaching system should be implemented, and how to implement them. Therefore, such theoretical measures are too broad to be carried out.

Finally, there are some gaps in previous studies, which need further exploration in the future. First of all, most of them have discussed the status and strategies of the innovative ability of the students majoring in mathematics. However, the influencing factors of the innovation of the students majoring in mathematics are not mentioned. Consequently, it is scientific to find out the causes of the situation and make more practicable suggestions according to the factors. In addition, predecessors have not paid enough attention to the evaluation system of innovation of students and just recognized the significance to reform the evaluation system, but how to establish a fair, feasible and scientific evaluation system is truly one of the most important issues. Finally, regarding the feasibility of the strategies for cultivating the innovative ability of mathematics major students, most of the strategies contained in the results are very broad. It is very significant to explore more feasible measures from a practical perspective.

5. Conclusions

It is of great significance to review and summarize the research on the innovative ability of mathematics majors. Through reviewing, combing and analyzing the previous studies, we found that:

At present, the Chinese studies mainly focus on the situation and problems of the cultivation process of the innovation ability of the students majoring in mathematics, and the strategies of improving their innovation ability. Firstly, this review mainly discussed the status and problems from four aspects: the situation of students' innovative ability, the problems of profession settings, the teaching problems, and the innovation evaluation system; We also discussed the improvement countermeasures from six parts: the macroscopic teaching modes and principles, the reform of education system and curricula design, the teaching measures separately from the perspective of teachers and the students, the practical teaching and innovative activities, and the innovative assessment system. While the number of predecessors' studies is relatively small, these studies have already involved fundamental topics, and the predecessors have laid a good foundation for future research.

There are some deficiencies in previous studies. First, the theoretical research method was used in previous studies so that they lacked accurate research data to support conclusions. Second, the depth and breadth of research were very limited, and the scientific nature of the research process and the depth of research content were far from enough.

There are some blanks on this subject, such as the factors affecting the innovation ability of mathematics students, the specific content of the innovation ability evaluation system, and the more feasible innovation ability training strategies. Consequently, researchers must adopt more diversified and scientific research methods based on the existing research theory, expand the research scope and space of the innovation ability of mathematics majors, and explore related research further; To make this research more comprehensive, systematic, and in-depth, it is necessary to explore the measures and suggestions to improve the innovative ability of mathematics majors from broader views and aspects.

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