

Influence of Strengthening the Training of Mathematical Innovative Thinking on the Cultivation of College Talents

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Abstract: After entering the 21st century, all aspects of society are in rapid development. People gradually realize that students' innovation ability is the focus of future competition. Therefore, it is particularly important to train excellent talents and strengthen innovative thinking training in modern mathematics education. This paper mainly studies the influence of strengthening the training of mathematical innovative thinking on the cultivation of college talents. This paper mainly relies on mind mapping tool to improve students' innovative thinking level in mathematics. By means of teaching practice and questionnaire survey, relevant data are obtained from the surveyed students, and various influences of strengthening mathematical innovative thinking training on college talents are analyzed. Research from the characteristic of mathematics teaching, aiming at strengthening the math creative thinking training of talents in colleges and universities, in order to improve the students' comprehensive ability, guide the formation of students' mathematics innovation thinking ability, for the purpose of the students' mathematical logic thinking combined with mind mapping of divergent, ultimately to cultivate more outstanding social talents as the goal, and applied to the mathematics teaching, change the traditional teaching of the single, boring and rigid teaching methods, inspire students' enthusiasm in learning mathematics course, gradually guide the formation of students' mathematics creative thinking. Do you think innovative thinking in mathematics is useful in your life and study? According to the survey data of the question, the number of affirmative answers accounted for 87.3%, and a small number of students chose to be uncertain. It can be seen that the students improved their ability to solve practical problems by strengthening the training of innovative thinking in mathematics and learned how to apply what they had learned.

1. Introduction

After entering the 21st century, all aspects of the society are developing rapidly, and the education and teaching mode is gradually breaking the traditional pattern and moving towards a more humanized and diversified direction. People gradually realize that students' innovation ability is the focus of future competition [1]. In the process of teaching mathematics in the past, the teacher-centered teaching model has greatly affected students' thinking activity, and even killed many children's special talent in mathematics. Therefore, it is particularly important to introduce innovative thinking in modern mathematics education [2]. Today, with the rapid development of science and technology, the cultivation of "innovative spirit" and "active exploration ability" has become a central topic of education. Intelligence is the main internal factor of human creation and invention, and thinking ability is the core part of intelligence [3-4]. Human activities are inseparable from thinking, and the development of thinking ability is the epitome and symbol of the whole intellectual development [5]. Due to the characteristics of mathematics itself, mathematics education bears the important task of "developing thinking". Modern educational viewpoint holds that mathematics teaching is the teaching of exponential thinking activities. In essence, mathematics teaching is a process in which students, under the guidance of teachers, learn the results of mathematical thinking activities through mathematical thinking activities, develop mathematical thinking, and transform their mathematical thinking structure into the mathematical thinking structure [6-7]. Therefore, the study of mathematical thinking training teaching is the need of developing students' thinking ability. The development of mathematical thinking is characterized by age. It needs to go through the stages of intuitive action thinking, concrete image thinking and abstract logical thinking (including dialectical thinking) [8-9]. The age characteristics of students in colleges and universities determine that their thinking features are mainly abstract logical thinking (including dialectical thinking). Mathematics course is a very important public basic course in colleges and universities. The thinking mode, thinking method and problem-solving strategy of mathematics can effectively promote the sustainable development of students. We should carry out a series of training on the profundity, logicity, rigor and flexibility of students' mathematical thinking in a purposeful and scientific way, so as to stimulate students' interest in learning and participate in thinking activities. The training of mathematical thinking not only enables students to acquire mathematical knowledge and methods, but also cultivates students' good thinking quality in the process of developing their mathematical thinking, thus improving their quality [10-11]. Therefore, the research on the teaching of mathematical thinking training is the need for quality education [12].

The Berna study used descriptive analysis techniques in the framework components to analyze the data. His research found that pre-service math teachers often stimulate students' interest in learning and mathematical thinking, but it is rarely supported and expanded. Although they have a certain theoretical understanding of mathematical thinking, this is the first time they have reflected this knowledge into practice. In this sense, he believed that pre-service teachers have made important efforts in the development of mathematical thinking and tried to realize appropriate teaching in the context of the framework [13-14]. Lee's study investigated how 38 prospective middle school math teachers learned to teach math in college courses while modifying bridging and divergent thinking tasks in textbooks. The work of the course enables prospective teachers to focus on their analysis of textbook tasks, including potential competency and creative educational constraints as well as textbook task modification and microteaching implementation. Prospective teachers are asked to consider the following aspects of research: the general view of creativity

education; Research that improves creativity by increasing or maintaining levels of cognitive need in a task; And research that encourages creative thinking by confronting and dealing with ambiguity or pathology and misunderstanding when revising textbook tasks; His findings show that prospective teachers have made different types of modifications to the textbook tasks of creativity education, which fall into four categories: meaningless change, blind variability, legitimacy and creativity. In addition, prospective teachers actively link the theory centered on textbook task and textbook task modification with practice to carry out creativity education. The quotations they quoted vary according to the task quadrants that classify textbook task modification [15-16]. Cruciani studied under the background of popularization of higher education, higher vocational education develops rapidly, but the vocational ability and job adaptability of higher vocational college graduates are not satisfactory. Although higher vocational colleges focus on education and teaching reform and put more energy into exploration and practice, the improvement of talent training quality is a developing and dynamic process. He believes that with the continuous development of productivity and the constant change of student structure, talent training still faces a severe test. [17-18]. Wei believed that the decline of college students' quality and the backward way of university talent cultivation lead to the low employ ability of college students and the prominent structural unemployment. He believes that under the background of mass innovation and mass entrepreneurship, colleges and universities should timely adjust the main body structure according to social development, cultivate innovative and entrepreneurial talents, and make the goal and quality of talent training adapt to the needs of social development [19-20].

Innovation points of this paper: (1) to strengthen the training of mathematical innovative thinking on the impact of college talent training. This paper analyzes the effectiveness and feasibility of applying mind mapping to the cultivation of mathematical innovative thinking based on the four main ways of mathematical innovative thinking, namely associative thinking, intuitive thinking, logical thinking and abstract thinking, and summarizes the advantages of applying mind mapping to students' mathematical innovative thinking. (2) Application cases are designed in the teaching of innovative thinking of mathematics training with mind mapping. Based on the analysis of the feasibility of the application of mind mapping in the training of students' innovative thinking in mathematics, the paper puts forward the goal that the application of mind mapping in the training of students' innovative thinking in mathematics. (3) Organize the teaching practice of cultivating students' innovative thinking in mathematics through mind mapping. This teaching practice activity, students after half a semester of teachers on the mind map knowledge teaching on the premise of a teaching case implementation. This activity not only to a certain extent, improve the mind map combined with mathematical disciplines, more important is to cultivate students learn to divergent thinking and logical thinking, the combination of using mind map to learn, play the potential of each student's thinking, to verify the mind mapping is applied to the effectiveness of training students' mathematical creative thinking.

2. Proposed Method

2.1. Relevant Theories of Mathematical Innovative Thinking

Mathematical innovative thinking is mathematical creative thinking, which is subordinate to creative thinking and mathematical thinking. The relationship between them is shown in figure 1.

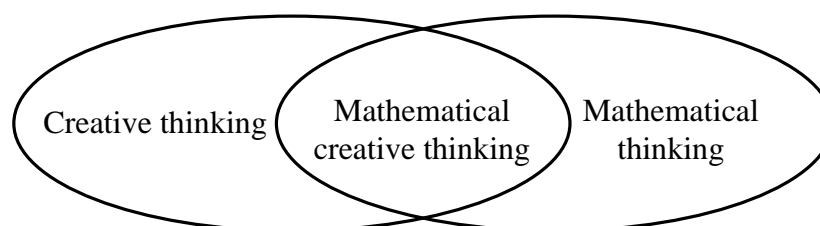


Figure 1. Relationship between mathematical thinking and creative thinking

Thinking is the embodiment of the human brain as a form of knowledge, thinking is implemented by means of human language, thinking and behavior, is a basic human ability, it is a summary of the essence of objective things, indirectly reflects the relationship between things and things, is the highest stage of awareness, after processing the information in many ways, we can get the essence of the information. Thinking is not only a high-level neural activity, but also a manifestation of a complex psychological activity. The subtle coupling between them forms a system, which becomes the theoretical basis of mathematical innovative thinking.

Mathematical thinking is a kind of universal mind, in the process of learning mathematics, mathematical thinking training is the human brain in contact with the general reaction of mathematical problems and mathematical model of collision and to solve effectively after reasonable understanding of inductive logic strong thinking activity, mathematical thinking is a complex of divergent thinking, abstract thinking, logical thinking, intuitive thinking, it has the characteristics of the general thinking, has the characteristics of mathematics unique operation mode at the same time. There are a variety of views on the concept of mathematical innovative thinking. In a broad sense, it refers to the mental operation process of people thinking independently when they encounter problems, and then an abstract process that generates ideas that are helpful and effective for human life or social progress. Mathematics, as a subject that pays attention to thinking, plays a significant role in its teaching process. Being able to understand and develop a behavior method in the process of problem solving is a direct form of thinking innovation, which is a prerequisite for the fundamental solution of the problem, and urges every student to innovate correctly and effectively and establish the understanding of innovation. It is to build the relationship between the knowledge points of the system under the guidance of the previous experience. This kind of network structure drawing urges students to continue to think along the extension direction of each vein to produce new thinking results. This result is the combination of mathematical thinking and innovative thinking.

2.2. Characteristics of Innovative Thinking in Mathematics

Here, innovation in mathematical innovative thinking refers to the advanced and unique thinking activities that inspire people with thinking as the theme. In other words, once the results of thinking activities have the nature of innovation, we call it innovative thinking. The stages of creative thinking in the process of learning mathematics are as follows: inducing factors of creative thinking, collection of necessary information, rational presentation and creative results. And here we narrow it down to the development of creative thinking in mathematics teaching and its unique characteristics: novel, unconventional and flexible.

Novel, thinking is usually beyond the existing traditional mode, is a new idea of the generation of new ideas, it is often based on a lot of theoretical basis and practical teaching process of sorting out the study of a burst of inspiration. It has a clear thinking direction, this novel is usually in

demand for creativity, personal or social and individual to have a strong interest on the premise of objective things, or the defects of the old theory or method or contradictory situation inevitably results, namely the generation of this kind of innovative thinking also has the initiative and passive.

Breaking the convention requires us not to be bound by standards, not only in the field of teaching, but also in all walks of life in the society all require the quality that talents in the 21st century should have. Of course, the existing standards gradually control our brain and even set our mind thinking, and the creation of new things has been held back. The standard defines us as "right" or "wrong", but is it really right? Or is it really wrong? People who stick to the so-called "standard" should get rid of this mental shackle. Speaking of children, in fact, their thinking is the most able to break the routine, because they are not bound by the existing views and patterns of the outside world. In this respect, we can try to think in the way of children's thinking on the basis of the problems we want to solve, and truly break the stereotypes.

Flexible, break the convention is not to deny what we have, but not to let the traditional model to hinder our divergent thinking, so innovative mathematical thinking should be able to effectively solve problems and withstand the test of traditional theory, which requires mathematical innovation thinking to have flexible characteristics. The essential difference between innovative thinking and ordinary thinking in the process of mathematical learning lies in their thinking process and steps. In the process of innovation, the divergent and undirected thinking is full of unknowns. What triggers people to keep thinking is a three-dimensional spatial model, so it is different from monotonous linear thinking. Therefore, innovative mathematical thinking is more likely to obtain comprehensive and macroscopic results. The essence of cultivating students' innovative mathematical thinking is to develop and guide students' various thoughts, so as to produce new effects after rearranging and combining relevant information.

2.3. Methods of Cultivating Innovative Thinking in Mathematics

The cultivation of the students' mathematics creative thinking can be a number of ways to reflect, mind mapping as a brainstorming tool, under the premise of building a relaxed and active classroom for students, teachers can cultivate the flexibility and fluency of students' thinking and promote the improvement of students' innovative thinking by guiding students to sort out and integrate scattered knowledge. Creative thinking and effective training in mathematics teaching are mainly embodied in divergent associative thinking, mysterious intuitive thinking, fuzzy abstract thinking and rigorous logical thinking. In the teaching activities mainly through the development of the four kinds of thinking to promote the formation of students' mathematical innovation consciousness.

(1) Associative thinking refers to diffusion thinking, which means not sticking to one's own way, but can associate with other contents from an objective thing, and then integrate the associative contents to think and solve problems from various perspectives. In essence, associative thinking refers to a kind of thinking model presented by people when they encounter problems and their brains think rationally. In the primary stage of innovative thinking in mathematics, students need to fully mobilize their thinking to think about problems from various aspects. Mind mapping just provides a platform for students to think about problems from various aspects. The essential structure of associative thinking is that it extends from one unit point to many spatial points. In learning, it can be shown as an interactive connection between different subject points. The common goal of associative thinking and mind mapping is to analyze and solve problems, while mind mapping can make learning or review plans. In the process of education, the most valuable thing for middle school students is rich imagination, curiosity and desire for new knowledge. In the

process of learning with mind mapping, students can carry out relevant divergent association based on a knowledge point. In this process, students can not only consolidate the knowledge they have learned, but also help students sort out the connections between knowledge in a unified way. Starting from a certain point of knowledge, they can connect to relevant knowledge and transfer knowledge flexibly.

(2) Logical thinking refers to the natural way of thinking, which is usually called abstract thinking. It is the thinking derived from memory block, and it is the existing memory and experience of human brain. Logical thinking is a kind of definite, orderly and grounded thinking, which is one of the advanced forms of thinking. Relying on the form tool of mind map, students can master and use the essence and method of logical thinking to exercise their logical thinking ability. It is the core of innovative thinking in mathematics.

(3) The external world is objectively reflected by abstract thinking, which is a kind of prediction of things and phenomena on the basis of understanding the objective laws of things, and a generalization of the image of things. In mathematical innovative thinking, abstract thinking is the source of innovation, abstract thinking is the analysis and summary of things, mind mapping is required students learn to analyze problems, through the analysis, induction and integration of different types of problems while exercising their thinking ability, improve their innovation ability.

(4) Intuitive thinking, in a sense, is the inspiration of everyone. It emphasizes instant thoughts and ideas. It is a kind of automatic summarization or even a complete set of rules generated by the accumulation of many experiences and methods. Intuitive thinking plays an important role in the process of people's innovation. It is not a reflection of the arrival of opportunities, nor is it a fantasy, but is generated under the premise of abundant knowledge accumulation. The famous French mathematician once said humorously, "could a monkey take the opportunity to write and print the entire constitution of the United States?" The rational arrangement of the spirit and the fascinating logical thinking are enough to let people see the infinite charm that mathematics shows to people. It is this charm that pulls countless mathematics educators to move forward. Decision level of the ability of mathematical thinking is often determined by the people's intuition thinking and mathematical abstraction requires people in every contact with a kind of new mathematical knowledge in order to accept understand faster and with the help of the intuition thinking through the mind map will be the nihility picture process specific presented before our eyes, faster and more accurate grasp the research focus. In the process of mathematics innovation, not only requires the logical thinking, more in need of abstract thinking, association thinking and intuition thinking, only when the four factors are combined organically can we successfully cultivate students' innovation ability in mathematics teaching, so that students can form a systematic carding of mathematics learning, enhance the consciousness of students develop their mathematics creative thinking.

2.4. Theoretical Basis of Applying Mind Mapping to Innovative Thinking Training of Mathematics

(1) Mind mapping was created to improve learning efficiency and presented in an unprecedented new form of note-taking. Its center is located on the central image, just like a tree, the trunk of which is divided into branches, with the theme of trunk as the center, and each branch forms a connecting node structure. With traditional linear records in a different way, mind mapping on the basis of radioactive thinking, is a divergent, visualization tools, with the deepening of thinking, and gradually formed a well organized and sequence of tree, students use a mind map to comb the content of the memory required, use knowledge in an intuitive way of "painting", to visualize

thinking process and the formation of an organized system of knowledge framework, convenient migration and integration between students with knowledge, thus fundamentally can improve the efficiency of student learning. Scientific research has found that the human brain is composed of two parts, which are divided into the left hemisphere and the right hemisphere. The left brain mainly controls language, action, analysis, logical reasoning and other functions. The right brain controls abstract abilities such as imagination, thought and creativity. The significance of the mind map is that it can control people's rational thinking of the left brain and right brain to control people's perceptual thinking, use the left brain thinking ability will there is the relationship between knowledge through the way of drawing the boring text messages into abundant memory map, fully develop the potential of the brain, so as to inspire creative thinking ability. Barzan, the founder of mind mapping, says that "in the past, note-taking methods were mostly linear and logical, using only a small part of our brain." Therefore, the reference of the image is just right. The image is a collection of rich elements. Its visualization and richness are more conducive to our memory. Mind mapping is a mental exercise for students. No matter how it is constructed or interpreted, it is a kind of brainstorming for both producers and learners. In this process, it is of great benefit to cultivate thinking. Figure 2 is the teaching process flow chart of cultivating students' innovative thinking in mathematics based on mind mapping.

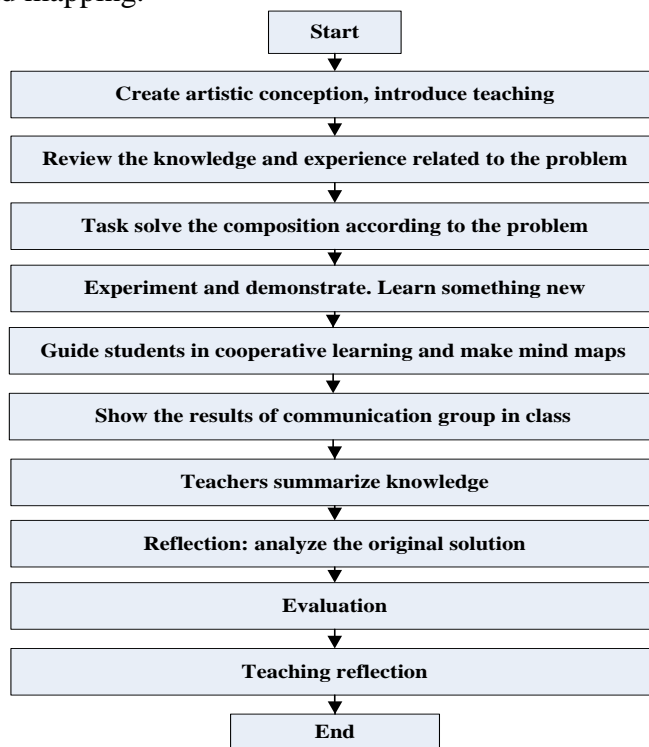


Figure 2. Flow chart of teaching process

(2) The characteristics of mind mapping: mind mapping is a thinking tool used for thinking, memory, innovation and other activities. Specific application needs certain conditions, and different purposes in the process of use will lead to different ways of application. At the beginning, mind mapping was realized by hand, and then gradually developed on computers. Some software, such as Mind Mapper and Mind Manager, can be used for mind mapping, and some commonly used software, such as Microsoft Office, PowerPoint and Word, can also be used to replace these professional mapping software. In the process of mind mapping, while divergent thinking, the key

points should be clearly highlighted and the layout should be clearly arranged, so that people can be clear at a glance and have their own style. The richness of color makes it a tool for people to distinguish things and strengthen memory. At the same time, the use of color can stimulate people's innovation to some extent. Therefore, drawing mind maps with elements of different colors and sizes can show different meanings and contents, thus making the memory clearer and stronger. As a basic subject, the purpose of knowledge learning is to train the mathematical thinking ability of learners. In the process of constantly improving the mathematical thinking ability, this ability can be applied to study, work and life, and be constantly reformed and innovated in the process of application.

3. Experiments

3.1. Experimental Design

The experiment in this paper mainly relies on mind mapping tool to improve students' innovative thinking level of mathematics. In the actual teaching process, adopt different teaching methods and teaching media will form different teaching design, teaching process design is an important part in the process of teaching, the experiment is mainly designed according to the principles of mathematics innovation thinking education, and to fully understand students' learning conditions, teaching process design including: the activities of the specific steps, the teaching organization form and teaching media. In order to better understand the learning and thinking mode of students, questionnaires were issued to the students in the class before the implementation of teaching, which mainly understood the learning and thinking mode of students from their understanding of the concepts related to mind mapping, their favorite learning style and their ability in mathematical innovation. In the questionnaire before the implementation of the teaching program, the representative values of students' abilities before strengthening the training of innovative thinking in mathematics were proposed. After the training experiment, in order to verify the effect of the experiment and analyze the problems in the experiment process, the author conducted a post-test questionnaire for students.

3.2. Data Collection

The experimental data in this paper are mainly collected from the college students in sample survey. This paper makes statistics on the questionnaire, presents the experimental data in the form of tables and pictures, and analyzes the influence of strengthening the training of mathematical innovative thinking on the cultivation of talents in colleges and universities by comparing the data of two surveys.

4. Discussion

4.1. Analysis of the Impact of Mathematical Innovative Thinking Training on College Talent Training

- (1) Analysis of learning ability

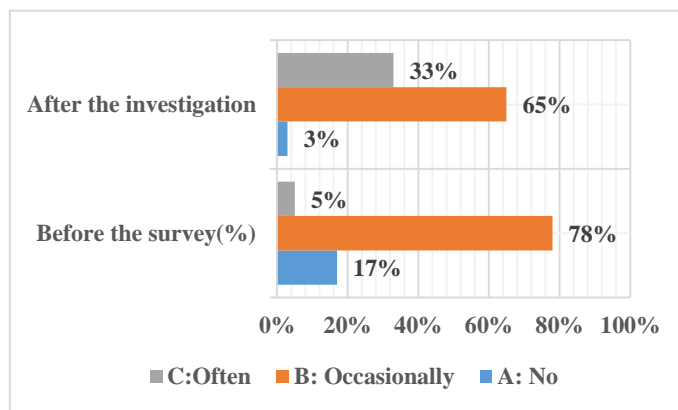


Figure 3. Proportion of problems encountered by adopting different methods

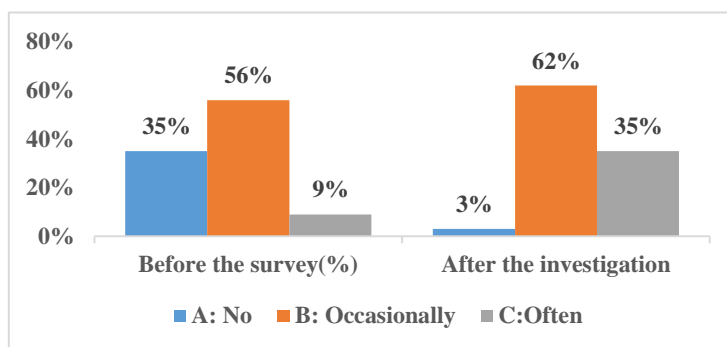


Figure 4. From one math point to another related to him

As shown in figure 3, a large number of students think that a learning method suitable for them is helpful to their learning, and students are more inclined to use concise structure diagrams to present the teaching content. In the process of learning, most middle school students use words to record the knowledge they have learned. By using mind mapping, they can directly show what they have learned in a pictorial way, and present the knowledge more intuitively, which is easy for students to accept. As shown in figure 4, it reflects the divergent thinking ability of students. The graph shows that most students are not very flexible in using knowledge.

(2)Analysis of the Curious Degree of New Things and Unexplored Exploration Ability

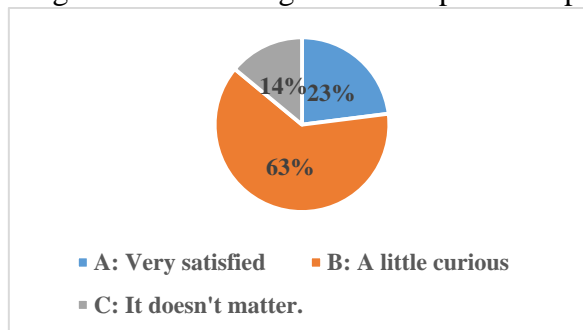


Figure 5. Students' curiosity about new things

As shown in figure 5, students' curiosity about new things is very important for the training of

innovative thinking. Students' thirst for knowledge plays an important role in the training of students' innovative thinking in mathematics. The use of mind mapping can stimulate students' exploration of innovation and improve their interest in learning. We can see from the data of the questionnaire by the traditional teacher-centered teaching mode, the influence of the student to the knowledge between flexible using ability is poorer, the traditional teaching can't for the cultivation of students innovative thinking to create a good external environment, change mind maps teacher-centered way of lectures, with students as the center, under the guidance of teachers to complete learning tasks, in this process, effectively inspire the students' interest in learning, the correct guiding students to carry on the independent thinking, and also learned how to communicate with others and the ability to solve the problem together, have strengthened the students' mathematics knowledge to strengthen understanding of the topic skills to achieve the desired teaching objectives.

(3) Practical flexibility analysis

Table 1. Questionnaire statistical results of students' innovative thinking training in mathematics based on mind mapping after application

Problem	A: Yes	B: Uncertain	C: No	Total
1. Can you make a mind map independently?	51	8	1	60
2. Do you think that the innovative exercises of mind mapping help you understand the knowledge?	57	12	1	60
3. By drawing a mind map, do you think your ability to solve problems has improved?	45	13	2	60
4. Use mind maps Do you think you can help you integrate old and new content in mathematics?	51	7	3	60
5. Do you think you have increased your interest in mathematics knowledge learning by completing the mind mapping task?	53	7	0	60
6. In the future study, will you use mind maps for study or life?	55	3	2	60

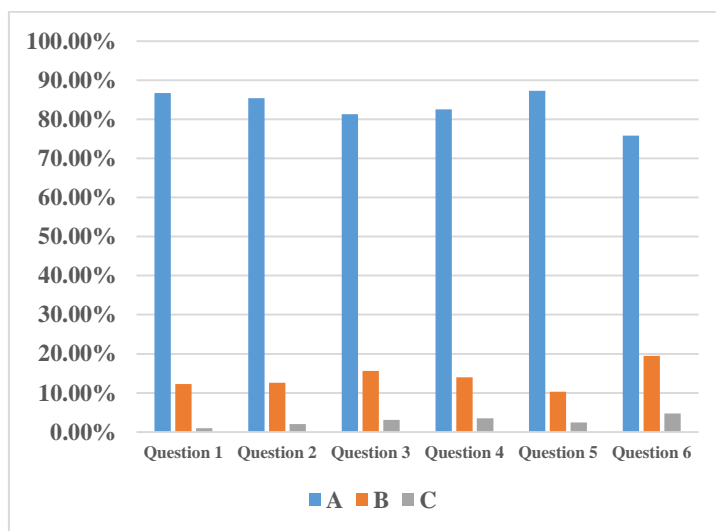


Figure 6. Statistical results

As shown in table 1, is the data statistics of the questionnaire survey. Figure 6 is analyzed from table 1. The figure 5 shows that based on mind mapping to the student mathematics creative thinking way of training students in the overall recognition problem students can independently make a mind map, 86.7% chose the sure answer, a small number of students chose not clear, after half a semester of mind mapping imparting knowledge, most of the students learned to independent production of a mind map. The question 2, 3, and 4 shows more than eighty percent of the students answer to the question is yes, that is to say they think through the production of a mind map to learning math knowledge are helpful to improve their thinking, able to stimulate their interest in learning, it can be seen that the use of mind mapping can promote the development of students' thinking, the cultivation of innovative thinking to lay the foundation for the students. The affirmative answer of question 5 reached 87.3%, and a few students chose to be uncertain. It can be seen that students have learned to solve practical problems by using the knowledge they have learned through teaching practice. According to the data of questions 4, 5 and 6, more than 75% of the students think that the application of mind mapping is helpful to the study of mathematics, and they realize that mind mapping can better help them sort out the knowledge they have learned.

(4)Analysis of the overall thinking development ability after the training of mathematical innovation thinking

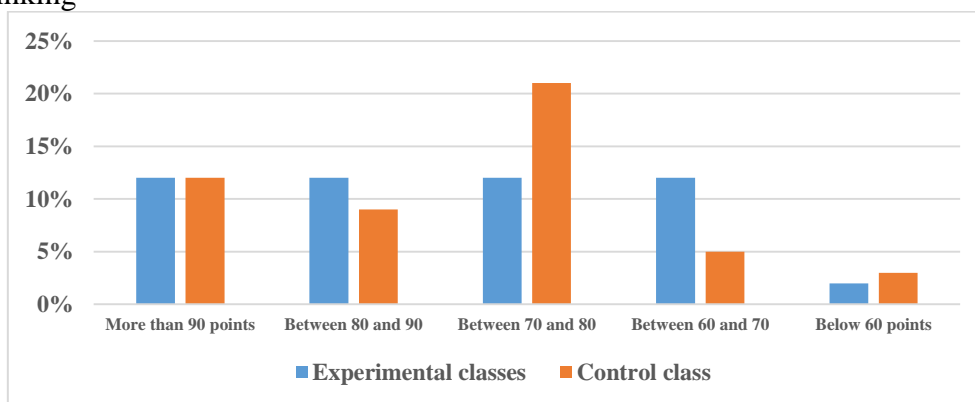


Figure 7. Statistical chart of score

As shown in figure 7 above line profile can be seen that in comparative classes and experimental classes grades respectively in 80 - a peak between 90 and 70-80 points, two class results in a greater difference between the two interval numbers, the students of class two grades in more than 90 points and the points of 60 two interval difference is smaller, the number of the main reasons may be for outstanding students, they have a set of suitable for their own learning method, the relative other learning methods for them is not very big, the influence of the basis of students with poor academic performance may be poor, though use another way to learn to let their thinking, but the effect is not obvious. It can be seen that, by teaching the content of this unit with mind mapping, the students in the experimental class have improved their understanding of learning to some extent, which not only improves their interest in learning, but also exercises their thinking ability.

5. Conclusion

At present, China's higher education is gradually transforming from "elite education" to "mass education". The ultimate goal of our education is to promote the comprehensive, harmonious and sustainable development of students. The content system and teaching method of mathematics course, especially the teaching idea and mode, should be changed in time to better adapt to this transformation. The study of mathematical thinking training teaching is far from enough in our country. Therefore, the in-depth study of mathematical thinking training teaching not only serves the reform of mathematics teaching in colleges and universities, but also needs to enrich the teaching theory of mathematics.

In the process of the experiment, due to the limitations of the author's knowledge and time, there are also many deficiencies that need to be further improved: 1. Although certain teaching effects have been achieved in this teaching practice, a lot of work is still needed to further complete the teaching objectives. Although the study is in the teacher to the student for half of the semester about mind mapping knowledge guidance, under the premise of teaching case but only in the students began to show a times, the number of subjects and the selection is limited, can't verify the validity of the method of teaching, mind mapping in the cultivation of the students' mathematics innovation thinking need validation for a long time. 2. The evaluation of this teaching experiment was conducted through a questionnaire, and the evaluation criteria are relatively subjective. Therefore, the experimental data obtained have some limitations and lack of objectivity. In view of this problem, the author will carry out several comparative experiments in the future teaching practice, and constantly improve this teaching method.

The formation of students' creative thinking requires a process, need to consciously cultivated for a long time, use a mind map to cultivate the students' mathematics creative thinking is focused on cultivating students' innovation consciousness and habits, change the traditional mathematics teaching boring tedious process, the author combined with their own learning experience in the process of research, theory with practice, to use a mind map for the cultivation of the mathematics creative thinking had certain understanding, but because the author own intellectual shortcomings, failed to establish a teaching mode of the system. Due to the limitation of teaching conditions, students' mind mapping design works were hand-drawn during this teaching practice and research, which was not easy to modify and add, which increased the creation time and failed to better reflect the advantages of mind mapping in teaching. In addition, there is still no unified evaluation scale on the application of mind mapping in the classroom in China. Educators can study this and design a mind mapping evaluation scale suitable for China's education system.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

- [1] Taylan, Didem R. *Characterizing a highly accomplished teacher's noticing of third-grade students' mathematical thinking*. *Journal of Mathematics Teacher Education*, 2017, 20(3):259-280. <https://doi.org/10.1007/s10857-015-9326-7>
- [2] Wentworth N M, Monroe E E. *Parent Beliefs about Technology and Innovative Mathematics Instruction*. *School Science and Mathematics*, 1996, 96(3):128-132. <https://doi.org/10.1111/j.1949-8594.1996.tb15826.x>
- [3] Achuonye K A. *Predominant teaching strategies in schools: Implications for curriculum implementation in mathematics, science and technology*. *Educational Research & Reviews*, 2015, 10(15):2096-2103. <https://doi.org/10.5897/ERR2015.2184>
- [4] Dyer E B, Sherin M G. *Instructional reasoning about interpretations of student thinking that supports responsive teaching in secondary mathematics*. *ZDM*, 2016, 48(1-2):69-82. <https://doi.org/10.1007/s11858-015-0740-1>
- [5] Kusumaningsih W, Darhim, Herman T, et al. *Gender differences in algebraic thinking ability to solve mathematics problems*. *Journal of Physics: Conference Series*, 2018, 1013(1):012143. <https://doi.org/10.1088/1742-6596/1013/1/012143>
- [6] Thomas M O J. *Inhibiting Intuitive Thinking in Mathematics Education..* *ZDM*, 2015, 47(5):865-876. <https://doi.org/10.1007/s11858-015-0721-4>
- [7] Jitendra A K, Dupuis D N, Star J R, et al. *The Effects of Schema-Based Instruction on the Proportional Thinking of Students With Mathematics Difficulties With and Without Reading Difficulties*. *Journal of Learning Disabilities*, 2016, 49(4):354. <https://doi.org/10.1177/0022219414554228>
- [8] King S O. *Catalyzing Genetic Thinking in Undergraduate Mathematics Education*. *Curriculum & Teaching*, 2016, 31(2):27-46. <https://doi.org/10.7459/ct/31.2.03>
- [9] Weintrop D, Beheshti E, Horn M, et al. *Defining Computational Thinking for Mathematics and Science Classrooms*. *Journal of Science Education & Technology*, 2016, 25(1):127-147. <https://doi.org/10.1007/s10956-015-9581-5>
- [10] Draeger J, Hill P D P, Mahler R. *Developing a Student Conception of Academic Rigor*. *Innovative Higher Education*, 2015, 40(3):1-14. <https://doi.org/10.1007/s10755-014-9308-1>
- [11] Khan F M, Sarmin N H, Khan A, et al. *Some Innovative Types of Fuzzy Bi-Ideals in Ordered Semigroups*. *Journal of Advanced Mathematics & Applications*, 2015, 4(1):24-36. <https://doi.org/10.1166/jama.2015.1070>
- [12] Carroll C, Gill O. *An innovative approach to evaluating the University of Limerick's*

- Mathematics Learning Centre. Teaching Mathematics & Its Applications International Journal of the Ima*, 2018, 31(4):199-214. <https://doi.org/10.1093/teamat/hrs008>
- [13] Berna T T, Ayten E, Adem C. A daunting task for pre-service mathematics teachers: Developing students' mathematical thinking. *Educational Research and Reviews*, 2015, 10(16):2276-2289. <https://doi.org/10.5897/ERR2015.2361>
- [14] Calcagnini G, Favaretto I, Giombini G, et al. The role of universities in the location of innovative start-ups. *Journal of Technology Transfer*, 2016, 41(4):670-693. <https://doi.org/10.1007/s10961-015-9396-9>
- [15] Lee K H. Convergent and divergent thinking in task modification: a case of Korean prospective mathematics teachers' exploration. *ZDM*, 2017, 49(7):995-1008. <https://doi.org/10.1007/s11858-017-0889-x>
- [16] Kai S C, Miller K F, Mckenzie R, et al. Where Low and High Inference Data Converge: Validation of CLASS Assessment of Mathematics Instruction Using Mobile Eye Tracking with Expert and Novice Teachers. *International Journal of Science & Mathematics Education*, 2015, 13(2):389-403. <https://doi.org/10.1007/s10763-014-9610-5>
- [17] Cruciani M. On the inference of meaning in use in explicit verbal communication. *Sistemi Intelligenti*, 2012, 24(2):227-240.
- [18] Brown A. Developing Career Adaptability and Innovative Capabilities through Learning and Working in Norway and the United Kingdom. *Journal of the Knowledge Economy*, 2015, 6(2):402-419. <https://doi.org/10.1007/s13132-014-0215-6>
- [19] Wei W U, Zhong Z, Chen M. A Study on the Training Mode of Discipline-oriented Innovative and Entrepreneurial Talents—Taking Agricultural, Forestry and Normal Universities as an Example. *Asian Agricultural Research*, 2018, 10(12):80-82.
- [20] Moodley U, Mudaly V. A study of leaners' conceptual development in mathematics in a grade eight class using concept mapping. *Journal of Educational Studies*, 2016, 14(1):20-40.