

Innovative teaching research based on the cultivation of mathematics core literacy

Yumei Huang, Liang Fang*

College of Mathematics and Statistics, Taishan University, Tai'an, China

*Email:fangliang3@163.com

Abstract—The new curriculum reform has put forward new requirements for teachers' teaching. Teachers should constantly innovate in the teaching process and improve the teaching mode in order to better enhance students' mathematical accomplishment, increase their interest in learning and improve their innovative quality. Starting from the cultivation of students' mathematics core literacy, this paper analyzes innovative teaching ideas, as well as the basic principles and general strategies of innovative teaching, and introduces the innovative application of different mathematical ideas in junior middle school mathematics teaching.

Index Terms— Core literacy, innovative teaching, classroom teaching, Mathematical thought.

I. INTRODUCTION

Teaching is one of the most important and fundamental factors that affect students' development. Innovation quality is an important part of student quality. Classroom teaching, extracurricular activities, family education and social practice can cultivate students' innovative quality, but the most fundamental way is classroom teaching. Scientific classroom teaching is not only to spread knowledge, its essential function is to promote the overall development of students. Middle school students' curiosity, thirst for knowledge, questioning spirit, critical spirit, these innovative qualities are formed in the long-term learning process, knowledge seeking process. The cultivation of students' innovative quality must be integrated into the subject teaching, and the position and function of classroom teaching in the cultivation of innovative quality cannot be replaced [1-2].

Chongde Lin believes that teaching plays a leading role in students' psychological development. Teaching makes the possibility of students' psychological development become reality; Teaching determines the direction, speed and quality of students' psychological development. Teaching makes students' psychological development show specific forms and individual differences. [3-4]

Mathematics core literacy is a comprehensive reflection of thinking qualities, key abilities, emotions, attitudes and values with basic characteristics of mathematics, mainly including mathematical abstraction, logical reasoning, mathematical modeling, intuitive imagination, mathematical operation and data analysis. Classroom teaching is the main channel to cultivate students' mathematical literacy and innovative

quality, and the cultivation of subject literacy and innovative education must be integrated into subject teaching [5].

II. A REVIEW OF INNOVATIVE TEACHING THEORIES

What kind of classroom teaching can cultivate students' innovative quality? Only innovative teaching can cultivate students' innovative quality. Innovative teaching is a kind of teaching which is guided by innovative theory, uses scientific teaching methods and teaching approaches, creates democratic, harmonious and relaxed teaching situation and atmosphere, and cultivates students' innovative spirit and ability while imparting knowledge and developing ability.

A. The concept of innovative teaching

What kind of classroom teaching can cultivate students' innovative quality? Only innovative teaching can cultivate students' innovative quality. Innovative teaching is a kind of teaching which is guided by innovative theory, uses scientific teaching methods and teaching approaches, creates democratic, harmonious and relaxed teaching situation and atmosphere, and cultivates students' innovative spirit and ability while imparting knowledge and developing ability.

(1) Innovation teaching is guided by innovation theory.

Teachers must learn the theory of innovative education, set up the idea of innovative education, understand that cultivating students' innovative quality is the new value orientation of education, and consciously take cultivating students' innovative quality as the most fundamental teaching goal.

(2) Scientific teaching methods, appropriate teaching approaches and good teaching atmosphere are the basic conditions of innovative teaching.

In innovative teaching, the selection of teaching methods must conform to the characteristics and rules of the formation of middle school students' innovative spirit and innovative ability, and teaching methods should be based on heuristic and discussion style, and at the same time reflect the characteristics of diversification. The way of teaching is open, in and out of class. The teaching atmosphere is democratic, harmonious, free and safe.

(3) The basic aim of innovative teaching is to cultivate students' innovative quality.

In innovative teaching, the ultimate goal of students' development is innovation, and cultivating students'



innovative quality, imparting knowledge and developing ability are an integrated organism. Innovative teaching is to train students' innovative quality in the process of imparting knowledge and developing ability. In innovation teaching, imparting knowledge, developing ability and cultivating innovation are intermingled.

B. Basic principles of innovative teaching

(1) The principle of subjectivity, respect for students' dominant position and teachers' leading role are the premise of innovative teaching.

In the process of innovative teaching, students are the main body of learning and development. Students' learning development can only be realized through their own learning and practice activities. The principal status of students must be respected. In class, teachers should provide students with opportunities for independent activities as much as possible, encourage students to participate actively, and stimulate students' initiative and enthusiasm in innovative learning. Teachers should constantly learn educational theories related to innovative teaching, improve their quality and have innovative theories.

(2) The principle of heuristic exploration, that is, in the process of innovative teaching, the teacher is the guide, and the basic task is to inspire and induce; Students are explorers whose main task is to discover new things through their own exploration.

The teacher's inspiration is intended to cause (not replace) the student's exploration. Heuristic exploration is the basic way of innovative teaching. In classroom teaching, teachers should not only pay attention to the results of students' thinking, but also pay attention to the process of students' thinking and problem-solving strategies, encourage students to question, tolerate students' childish ideas, encourage bold guesses and develop intuitive thinking.

(3) The principle of democratic pleasure means that in the teaching process, teachers and students should have equal dialogue, respect and inspire each other, and ensure that students have a good mood and happy mood.

Authority stifles innovation, and innovative teaching requires democracy. Only by teaching democracy can students think positively, imagine boldly and constantly produce new ideas. Teachers should respect students' personality and treat each other equally. Teachers should respect students' opinions and ideas and discuss them together. The teaching method is flexible and can arouse students' interest; Teaching content to appropriate difficulty, step by step, so that students feel within their power, and the weight is appropriate, will not form a heavy workload.

(4) The principle of practice operation is to guide students to innovate in innovative practice activities.

Making students use their brains, hands and mouth is an important way of innovative teaching. Innovation is a kind of practice, and innovative teaching must put innovative practice in a very important position, and guide students to come up

with real innovative learning works through their own brain, hands and mouth. These imperfect works may have a huge impact on students, even lifelong.

(5) The principle of unification of comprehensive requirements and teaching students in accordance with their aptitude.

Innovative teaching should be oriented to all students, which should not only make them as unified as possible and develop in an all-round way, but also recognize the individual differences of students, adopt different teaching measures according to the characteristics of different students, so that each student's innovative ability can be fully developed. Teaching should not only face all students, give consideration to both sides, so that all students can get development, but also correctly treat the individual differences among students, according to the different characteristics of students, cultivate their innovative consciousness and ability.

III. GENERAL STRATEGIES FOR INNOVATIVE TEACHING

A. Determine the goal of cultivating students' innovative quality and the corresponding teaching plan

The primary problem of education is the problem of training objectives, quality education is also the primary problem of training objectives. In order to cultivate students' innovative quality, we must first determine the goal of cultivating students' innovative quality. With the goal of cultivation, the cultivation of innovative quality has a clear direction and a specific measurement standard.

(1) To grasp the structure of innovation quality completely and accurately. To determine the goal of cultivating middle school students' innovative quality, we must first make clear the structure of innovative quality. Most scholars believe that people's innovation quality consists of three aspects: first, innovation consciousness; Second, innovation personality (or innovation personality); Third, innovation ability.

(2) To understand the characteristics of the development of middle school students' innovation ability. When determining the goal of cultivating middle school students' innovative quality, the structure of innovative quality should not be copied, but the characteristics of the development of middle school students' innovative ability should be fully considered, and the goal should conform to the characteristics of middle school students. We must fully consider the development of imagination, self-consciousness and creativity of middle school students in the formulation of goals, in order to determine the specific standards to meet the characteristics of the development of psychological quality of middle school students, to adapt to the characteristics of the development of innovation ability of middle school students.

(3) We should pay equal attention to innovation spirit and innovation ability and highlight the cultivation of innovation spirit. Innovation is not only a kind of ability, but more importantly, a state of mind. Those who contribute to the development and progress of human society with their



innovative achievements are always persevering and confident. The innovative quality training of middle school students must attach equal importance to innovative spirit and innovative ability. Innovation education in primary and secondary schools should focus on cultivating students' innovative spirit and guiding them to establish innovative consciousness and form innovative personality.

(4) The teaching plan of cultivating innovative quality should be made. After determining the goal of cultivating middle school students' innovative quality, these goals should be decomposed into different grades (sections) according to the characteristics of subjects. The same goal should have different standards and requirements in different grades (segments), thus forming the progressive level of the goal. These standards and requirements should conform to both the characteristics of the subject and the characteristics of the grade (segment). After making grade plan, we should also make semester plan to implement the training task to each semester.

B. Use innovative teaching ideas to guide lesson preparation

An essential characteristic of innovative teaching is to train students' innovative spirit and ability while imparting knowledge and developing ability. Innovative teaching regards imparting knowledge, developing ability and cultivating students' innovative spirit and ability as a process, which integrates into one and finds the most suitable carrier for cultivating innovative spirit and ability. It is necessary to find the joint point between imparting knowledge, developing ability and cultivating students' innovative spirit and innovative ability.

First of all, we should understand the teaching material correctly. With different ideas to examine the teaching material, the results are not the same, from the perspective of exam-oriented education teaching material, focus on the knowledge point of teaching material, training point, should be piloted, is its exam-oriented training value, no innovation at all. The innovative education requires us to examine the teaching materials with innovative ideas and excavate the innovative educational factors contained therein.

Secondly, we should make a bidirectional list of innovative teaching. The bidirectional list of innovative teaching is the best way to combine innovation theory with teaching content. The essence of the bidirectional list of innovative teaching is the combination of teaching material content and the goal of cultivating innovative quality. Only by compiling the bidirectional list can we ensure the organic combination of teaching material content and innovation training.

Finally, after compiling the bidirectional detail table of innovative teaching, the most important thing is to make the training target and innovative ability specialized and specific. In other words, when a general way of thinking is applied to a certain subject, it must be combined with the subject content to find out a more specific form and method with the characteristics of the subject. For example, the transformation

of mathematical concept learning narrative way, comparison; Computing learning in one problem, multiple solutions, simple operation; Pay attention to observation and use of knowledge in elementary geometry learning; The comprehensive perception, key finding, comparison and self-writing of application problems in application problem learning are not only beneficial to the mastery of mathematical knowledge and improvement of mathematical ability, but also play a huge role in promoting the development of creativity.

All the above forms are the concrete forms of creative imagination and creative thinking in mathematics. By finding these forms, the training of innovation ability can be really implemented, not just an ideal state or theoretical state. Therefore, the realization of creative imagination and creative thinking is the key to innovative teaching.

C. Reform homework and examination according to innovative teaching thought

Besides classroom teaching reform, students' homework and examination should be reformed accordingly.

In terms of homework, the content of homework should be adjusted appropriately, and some thematic homework, discussion homework and reading homework should be added. Thematic work refers to students working around a certain. Thematic study and research can cultivate students' ability to collect information and research problems, which is characterized by large topic capacity, long time to complete homework, and diversified evaluation criteria for homework. Discussion homework is based on the teaching content, combined with the reality of life, determine some discussion topics, students are required to carry out according to the cooperative learning group, the discussion results of the cooperative learning group as a unit to report. Discussion homework can train students' divergent thinking ability and oral expression ability. While reading homework refers to that teachers make appropriate reading lists for students according to the teaching content of the subject in the semester, set appropriate reading amount, and take appropriate ways to test the reading effect. At the same time, in terms of examination, we can adjust the content structure of the examination paper and set up a certain proportion of open examination questions. In the form of the test, you can add hands-on and social practice and other forms of the test.

IV. INNOVATIVE APPLICATION OF DIFFERENT MATHEMATICAL IDEAS IN JUNIOR HIGH SCHOOL TEACHING

A. The application of conversion thought in junior middle school mathematics teaching

(1) The thought of transformation is an important mathematical way of thinking, which has been transformed into a thinking of solving problems in application. The idea of transformation is to transform the problem to be solved into another problem in some ways when solving a certain mathematical problem, so as to solve the problem more



simply. The idea of conversion is used to turn some difficult problems into relatively easy problems, or to change the complex problems into simple problems, but also can not be solved problems into solved problems. The main function of normalization is to simplify complexity, and its general mode is shown in the following figure.

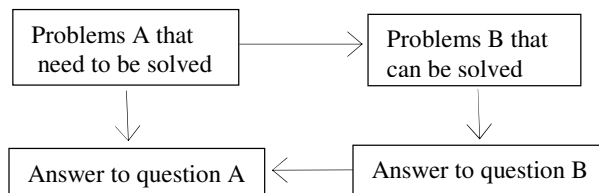


Fig. 1. The general mode of conversion thought

(2) Reduction exists in all aspects of mathematical problems, the core role is to transform unfamiliar, never seen things into known problems that have been solved or easy to solve. For teachers, mastering the prerequisite of transformation is the most important point in teaching activities. From the point of view of junior high school teachers, there are mainly the following aspects of understanding the thought of transformation.

First, through association to connect the knowledge, so that students can think of the knowledge they have learned before through association. That is to say, when students learn new knowledge, they can associate with old knowledge under the guidance of teachers, which is to transform unsolved problems into solved or easily solved problems in their thoughts.

Second, we should have a clear idea of how to transform the problems that need to be transformed and have a clear goal. In other words, in the process of transformation of new knowledge, it is not random transformation, but transformation with connected thinking, with flexible perspective to view the problem. In order to seek quick and effective solutions to seek transformation path, and then solve the emergence of new problems.

Third, to carry out in-depth analysis of the new problems, not to seek solutions to the half-knowledge, to clear research, the use of association to find the connection between the old and new things, and then find out the idea of the transformation of the old and new problems. For example, when the new problem comes, we should first analyze what knowledge points the new problem involves, where the knowledge points come from, and what is the key to solve the new problem. After such a process, we have a clear idea of the new problem. Then you can solve the problem according to the knowledge points involved and then according to the key points of the problem. In this way, the whole idea of solving the problem becomes very clear, definite, and easier for students to understand. If you do not analyze the problem and directly expand the association, then it is only association, can not be counted as transformation.

Therefore, on the basis of this understanding, the thought

method of transformation can be defined as: When learning new knowledge or meeting new problems, first of all, have a certain understanding of the new knowledge and new problems, then based on the old knowledge and old problems, and then carry out association, so as to find the relationship between the old and the new, straighten out the connection between the two, and strive to have the old knowledge as an important auxiliary to solve the new knowledge and problems. In junior middle school, although the mathematical knowledge I learned has been complicated, it is still the combination of number and form in the final analysis, which is the continuous evolution from shallow level of knowledge to deep level. Take the equation as an example, the one-dimensional equation is the most common, and only after thorough research can we gradually learn the multi-dimensional equation. This is the multiple equation is new knowledge, so in the process of learning can be on the basis of one variable equation, the use of reasonable association, the multiple equation into one variable equation for solving, this is a specific reflection of the idea of conversion in junior high school teaching.

B. The application of combination of number and form in mathematics teaching

(1) The meaning and characteristics of the thought of numerical-form combination

The combination of number and form is a basic mathematical method which combines algebra with geometric figure and uses its advantages to solve mathematical problems. In the process of its use, it can be divided into two situations:

- ① using form as a means, with the help of the visual image of the figure, reveal the hidden data connection in the figure;
- ② Some properties of figures are expounded by means of numbers and by means of the rigor of numbers.

Compared with other mathematical methods, the combination of number and form has its unique advantages in application, and has the characteristics of image, intuition and bidirectional.

(2) The function of combination of number and figure in mathematics teaching

The combination of numbers and shapes helps to form a complete mathematical concept. Concept is the foundation of mathematics learning and the basis of students' mathematical thinking, but the concept in mathematics teaching materials is abstract and difficult to understand. In concept teaching, teachers use the idea of combining number and form to explain concepts from two angles of "number" and "form", reveal the essence behind concepts, communicate the inner connection of knowledge, and help students to truly understand mathematical concepts.

The combination of number and form can improve students' ability to solve problems. The combination of number and form is an important mathematical thinking method in solving mathematical problems, which can help students to find a way to solve the problem. For example, in



the function problem, students can apply the idea of combining numbers and shapes to draw the function graph, analyze the image and properties of the function, and find the appropriate method to solve the problem according to the graph.

The combination of number and form can cultivate students' mathematical thinking. Image thinking is a kind of image thinking mode in which students can understand mathematical characters by means of figures. The combination of numbers and figures in teaching can help students develop the ability of image thinking and consolidate and master the concepts, formulas and theorems in mathematics. When solving mathematical problems, students can get the answer by analyzing the thought method of combining number and shape, which avoids the complicated reasoning process, promotes the development of students' image-thinking and reduces the difficulty of learning.

The combination of number and form can spread students' thinking of solving problems and help students to get algebraic solutions and geometric solutions when they meet problems. This method of multi-angle problem solving achieves the teaching goal of one problem and multiple solutions, which naturally diverges students' thinking and broadens their thinking of problem solving.

C. Application of mathematical modeling in mathematics teaching

(1) Mathematical modeling and ideas of mathematical modeling

Mathematical modeling is to use mathematical tools to transform problems encountered in real life into mathematical problems, solve them with learned mathematical methods, and then return the results to the reality, and constantly verify them. Mathematical modeling is a practical problem into a mathematical problem, is a kind of mathematical way of thinking, is a method that using mathematical language and build can approximate score by abstract, simplify and solve the practical problems of an effective means of mathematics, it is the important means and methods of the application of mathematics to solve practical problems, it can further cultivate and improve students' ability to analyze problems, solve the problem. Cultivate students' creative consciousness.

The purpose of mathematical modeling is to make students associate natural, social and humanistic knowledge with mathematics, feel the application value of mathematics, cultivate their application consciousness, strengthen their understanding of mathematics and their confidence in applying mathematics to practical life. Common junior middle school mathematical modeling equation (group) model, inequality (group) model, function model, geometric model, probability model.

The thought of mathematical modeling is a general thought method, and the main form of mathematical model is mathematical symbol expression and chart, so it has many similarities with the thought of symbolic, also has universal

significance.

(2) The value and effectiveness of applied mathematical modeling thought teaching

The teaching of applied mathematical modeling is of value to the cultivation of mathematics core literacy. Mathematics education is more and more emphasis on the practical application of knowledge and the cultivation of student's mathematics core literacy, the core concept of curriculum reform is based on the development of students, cultivate students' scientific spirit and innovation consciousness, develop students' ability of using mathematical language to express the real world, let the students experience found the problem, ask questions, analyze and solve problems. The application of mathematical modeling in classroom teaching can guide students to participate actively, explore actively, stimulate their interest in learning, promote their all-round development and cultivate their core qualities in mathematics. Mathematics education should return to the real life, the real life is the source of mathematics knowledge, but also explains the practical significance of teaching. Teachers should pay attention to explore the essence of mathematical knowledge, integrate the idea of modeling into the teaching process, encourage students to practice and innovation, cultivate students' application ability, help students to know and understand mathematics so as to establish a correct view of mathematics, and develop students' core literacy of mathematics.[6-8]

V. CONCLUSION

Aiming at the cultivation of mathematics core literacy, the innovative teaching concept is adopted, and the rational application of mathematical thinking and teaching methods, such as transformation thought, combination of number and form, and mathematical modeling, can be evaluated from different angles through students' classroom activities, so as to cultivate students' comprehensive ability, which is conducive to the overall development of students.

Junior high school mathematics curriculum reflects the future social development needs, according to the cognitive law of students and the characteristics of mathematics, the development of students' core quality of mathematics, cultivate thinking ability and innovation consciousness. Teachers should pay attention to the relationship between mathematical skills and mathematical core literacy, carry out innovative teaching, improve students' mathematical application ability and infiltration of mathematical culture, and comprehensively improve students' mathematical core literacy of mathematical abstraction, logical reasoning, mathematical modeling, intuitive imagination, mathematical operation and data analysis.

ACKNOWLEDGMENT

This paper is supported by Taishan University 2019



Teaching Reform and Research Project " Research on Teaching Reform of Economic Mathematics and Exploration of SPOC Mixed Teaching Mode" (201922), Taishan University 2021 Annual Teacher Education Research Project "Theoretical and practical research on the cultivation of Middle School students' Mathematics core literacy" (JY-01-202139), and Taishan University 2020 Annual Teacher Education Research Project "Research on the Core Literacy Cultivation of Primary and Middle School Students from the Perspective of STEM Education" (JY-01-202011).

REFERENCES

- [1] P.Wang, "Research on Junior Middle School Teachers' Innovative Teaching and Its Influencing Factors," M.S. thesis, Dept. Education. Eng. Chongqing Normal University, Chongqing, China, 2013.
- [2] C.D.Lin, *Psychology of Middle School students*, BEIJING: China Light Industry Press, 2013, pp. 15-35.
- [3] Y.B.Chu "Analysis on Teaching Adaptability of Junior Middle School Teachers in The Implementation of New Curriculum," M.S. thesis, Dept. Education. Eng. South China Normal University, Guangzhou, China, 2005.
- [4] P.Yang, "Evolution of Teachers' teaching methods under the Background of New Curriculum Reform," M.S. thesis, Dept. Education. Eng. Shandong Normal University, Shandong, China, 2016.
- [5] H.Zhang, "Research on effective Teaching in Junior middle School Mathematics Classroom under the Background of New Curriculum Reform," M.S. thesis, Dept. Education. Eng. China West Normal University, Sichuan, China, 2015.
- [6] J.Y.Sun, "Research on the Training of Junior Middle School Students' Mathematical Intuitive Thinking Ability," M.S. thesis, Dept. Education. Eng. Capital Normal University, Beijing, China, 2004.
- [7] G.P.Xia, "Application of Middle School Mathematics Thinking Method in Function Teaching," *Science and Technology Information*, vol. 0, no. 16, pp. 192-193, 2007.
- [8] Y.Wang, "The Cultivation strategy of Junior Middle school students' Mathematical Language Ability," *Education Science Forum*, vol. 0, no. 08, pp.49-51, 2020.

Authors' biography with Photo



Yumei Huang is a lecturer at Taishan University. She obtained her master's degree from Shandong University of Science and Technology in July, 2008. Her research interests are in the areas of applied mathematics and mathematics education in recent years. email id: huangyumei125@163.com



Liang Fang was born in December 1970 in Feixian County, Linyi City, Shandong province, China. He is a professor at Taishan University. He obtained his PhD from Shanghai Jiaotong University in June, 2010. His research interests are in the areas of cone optimizations, numerical analysis, and complementarity problems.