



The research on infiltration of mathematical culture in junior middle school mathematics teaching in China

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Abstract

With the improvement of the psychological development level and acceptability of students entering the middle school stage, and in order to adapt to and meet the requirements of quality education and the Compulsory Education Mathematics Curriculum Standards (2011 edition), the demand for mathematics culture in junior high school mathematics teaching is increasing. There have been many studies in the country that have infiltrated mathematics culture in junior high school mathematics teaching. These studies not only perfected and enriched the theory, but also put it into practice, and obtained good feedback in the actual classroom teaching. The research includes aspects such as meaning, method, and status quo, and there are also some shortcomings. This paper sorts out the literature on the infiltration of mathematics culture in junior high school mathematics teaching, sums up relevant viewpoints and conclusions, puts forward their own views and forecasts the future research.

Keywords: junior high school mathematics teaching, mathematical culture, middle school mathematics, mathematical learning

1. Introduction

The junior high school stage is the key stage of the development of students' abstract thinking ability, and also an important stage of mathematics basic education. Popularizing mathematics cultural knowledge is of great significance for students to lay a good foundation in mathematics, cultivate innovative thinking ability and solve practical problems (Zhang, J. H., 2013) ^[1]. On the one hand, the "Compulsory Education Mathematics Curriculum Standards" (2011 edition) (hereinafter referred to as "Standards") states that for the third semester (grades 7-9) students should conduct reasonable teaching and active guidance of mathematics culture, and pay attention to the cultivation of students' humanistic spirit (Ministry of Education of the People's Republic of China, 2011) ^[2]. On the other hand, the junior high school stage is not only the third semester of the compulsory education stage, but also the first stage of the middle school stage. It plays a connecting role for primary school and junior high school. Infiltration of mathematics culture is conducive to perfecting the cultural quality of students and adapting to the teaching and examination requirements of math culture in high school. Therefore, in recent years, more and more university researchers and middle-school educators have devoted themselves to research in this area, and have achieved fruitful results in both theory and practice. In order to further enrich the study of mathematics culture in junior high school mathematics teaching and fill in the blank aspects of research, this paper reviews the related research on the infiltration of mathematics culture in junior high school mathematics teaching.

2. The Meaning of Mathematical Culture

As for the meaning of mathematical culture, the researchers give their own understanding from different angles. Wu

Haifeng believes that from a narrow perspective, mathematics culture is to explore the thoughts, spirits, methods, viewpoints, languages of mathematics and how they are formed and developed. In a broad sense, in addition to the above connotations, mathematics culture also includes mathematicians, mathematics consciousness, mathematics history, mathematics beauty and mathematics education, as well as human emotion and close connection with society in the process of mathematics development (Wu, H. F., 2018) ^[3]. Mao Xiaofeng believes that mathematics culture has a long history and is inclusive. It is often found in vast historical materials such as Hegel's "Lectures on the History of Philosophy", Morris Kline's "Mathematical Thought from Ancient to Modern Times", and Liu Hui's "The Nine Chapters on the Mathematical Art" and so on. These historical materials contain the most profound meaning of mathematical culture and are the best materials for learning mathematics culture (Mao, X. F., 2009) ^[4]. Zhou Zhenshu elaborated from the perspective of "Standards": "Mathematics is a culture of human beings, and its content, methods, ideas and language are one of the important components of modern civilization. In the stage of compulsory education, mathematics culture is a profound educational concept. It is necessary to establish a cultural view of mathematics education, emphasizing the humanization of teaching, and paying attention to humanistic care in teaching (Zhou, Z. S., 2013) ^[5]. Chen Jianfang's understanding of mathematics culture is easy to understand, that is, to infiltrate and understand mathematics from the perspective of culture, only when we look at the teaching activities of mathematics from the standpoint and perspective of mathematics culture, can we have a deep and complete understanding of the nature of such teaching activities, and embody the value of mathematics teaching to the most complete beautification (Chen, J. F., 2015) ^[6]. In short, the

meaning of mathematical culture is multi-faceted, multi-level, multi-angle, and is not static. With the deepening of research and the passage of time, the meaning of mathematical culture will be more abundant and perfect.

3. The Status of Mathematical Culture in Junior Middle School Mathematics Teaching

The important role of the infiltration of mathematics culture in junior high school mathematics teaching is self-evident. I will summarize the status of mathematics culture in junior high school mathematics teaching from three aspects.

From the perspective of relationships with other disciplines: Peng Ying and Liu Yan believe that mathematics culture has established a close relationship between mathematics and other disciplines. (1) The relationship with philosophy: Explaining the teaching contents from the point of view of dialectical materialism. "Two negatives make a positive" reflects the negative law of negation. From the introduction of the number of squares and the expansion of the number, we can see that the contradiction inside things is the driving force for the development of things. In the content of the power theorem (the intersection chord theorem, the cutting chord theorem), etc., through the perspectives of movement, development, and universal connection, the law of quality mutual change is revealed. (2) The relationship with aesthetics: The primary characteristic of mathematics is that its simplicity, the simplest part, the simplest quadratic form, the merger of similar items, and the extraction of common factors all reflect the simple beauty of mathematics given by mathematics culture. Symmetry is common in mathematics, and symmetrical beauty has become an important ideological method for people to solve practical problems. In the real numbers and numerical points, the image of the function and its analytic expression, you can see the figure of unity. Zero can't be used as a divisor; a negative number can't be squared, etc. This strange beauty also caused great interest and concern. (3) The relationship with literature: Many famous sayings of mathematicians and philosophers, some ingenious riddles, such as "cheating in exams" (false scores), "the fight between two bulls" (opposite angles), and so on, all reflect the penetration of literature education in mathematics culture education. (4) The relationship with economics: Exchange rates, interest, taxes, securities, etc., which are closely related to daily life, are reflected. In the teaching of junior high school mathematics, properly revealing the mathematical principles in economic activities and other social activities, and using mathematics knowledge to solve practical problems is the proper meaning of quality education (Peng, Y., 2004; Liu, Y., 2012) [7, 8].

From the perspective of the necessity of infiltrating mathematics culture in junior high school mathematics: Chen Jianfang, Zhang Jihai, and Qi Zhiqiang believe that (1) mathematical culture is the interpretation of the culture of human progress, which is an important part of mathematics and more importantly a spirit. (2) Infiltrating mathematics culture in mathematics teaching, students can feel the humanistic value, scientific value, aesthetic value and creative value of mathematics. (3) Students' exposure to mathematics culture when appropriate is an important part of their promotion and development of mathematics learning behavior

and healthy development (Zhang, J. H., 2013; Chen, J. F., 2015; Jin, Z. Q., 2011) [1, 6, 9].

From the perspective of the feasibility of infiltrating mathematics culture in junior high school mathematics: Zhang Jihai puts forward three points. (1) From the perspective of the age of students, junior high school students gradually began to form abstract thinking and innovative thinking ability. This age is the stage of comprehension and curiosity for the natural world and social culture. (2) From the perspective of teaching content, the basic subjects such as geometry and algebra have rich content reflecting the concept of mathematical culture. (3) From the perspective of cultivating students' comprehensive ability, cross-cultural education has certain value for innovation ability (Zhang, J. H., 2013) [1].

4. The Significance of Infiltrating Mathematical Culture in Junior Middle School Mathematics Teaching

Jin Zhiqiang believes that the penetration of mathematics culture in junior high school mathematics teaching has great value. From the macroscopic level, it can be divided into the following three points. (1) From the perspective of cultural development: Mathematics is not only a discipline, but also a phenomenon of human culture, while the junior high school teenagers are in the period of accepting cultural thought development, and in the mathematics classroom, the middle school students are influenced by the mathematics culture, which is conducive to the cultural development of a country and a nation. (2) From the perspective of mathematical influence: Mathematical culture is an important part of modern civilization. With the development of society, mathematics is widely used in various fields, which is related to social life and people, and becomes an important means of communicating and storing information in society. (3) From the perspective of modern education: "Standard" puts mathematics culture as a separate topic and gives the teacher the attention of teaching. As a junior high school mathematics teacher, you can deeply understand that mathematics culture has gradually entered the middle school classroom and supported exercises. The background material and related topics on mathematics culture in books have also increased (Jin, Z. Q., 2011) [9].

From the perspective of students' personal development, Gong Tianjun, Yan Yulan, Wang Litao and others believe that infiltrating mathematics culture in junior high school mathematics teaching has the following meanings. (1) Increase the human touch of mathematics and stimulating students' motivation for learning. Integrating mathematics culture into junior high school mathematics teaching is conducive to changing the one-sided cognition that mathematics students think is only symbolic operation and graph solution. It is helpful for them to understand the efforts of mathematicians in understanding the birth of mathematical formulas. Experience the humanistic spirit of mathematics, and stimulate the enthusiasm and initiative of learning and inquiry. (2) Improve the cultural quality of students and promote all-round development. Let students feel the connection between mathematics and Chinese, history, art and other disciplines, establish a network of penetration between all disciplines, and form a healthy learning concept while learning mathematics culture, so as to realize the

comprehensive development of students' comprehensive quality. (3) Inspire students' national self-confidence and cultivate patriotism. Junior high school students basically know the brilliance of ancient Chinese civilization, but the great achievements in the history of mathematics are rarely known. Historically, China's mathematical development has been at the forefront of the world, and there have been such landmark works as the "The Nine Chapters on the Mathematical Art" and "Zhou Jing". Combining mathematics learning with the history of mathematics not only increases the interest, but also cultivates students' national consciousness and patriotic feelings. (4) Cultivate students' excellent ideological quality and hard work spirit. Many junior high school students are now only children and the quality of students' will is poor. By explaining the case of a mathematician who is in a harsh environment but still succeeding through struggle, the teacher has a subtle influence on the students, and the spiritual quality of the students has qualitatively leap (Gong, T. J., 2015; Wang, L. T., 2013; Yan, Y. L., 2012; Li, J. Y., 2017) ^[10-13].

5. The Status Quo of Infiltrating Mathematical Culture in Junior Middle School Mathematics Teaching

Some studies have two attitudes towards the current research status of infiltrating mathematics culture in junior high school mathematics teaching. Some researchers, such as Liu Lifang and Zhang Weizhong, believe that (1) the overall level of infiltration education in mathematics culture is not high. As far as the study of mathematics culture and mathematics education is concerned, there is a lack of high-level systematic research. (2) The level of research problems is uneven. The research trend that links the study of mathematical knowledge with gender differences, racial characteristics, ethnic characteristics, etc., is a more extensive cultural, historical and social research perspective of mathematics education, which should be extended to the study of mathematics culture and mathematics education. (3) The scope of the topic is narrow, the research perspective is single, and there is no empirical research. (4) The teaching concept of "cramming teaching" and one-sided pursuit of scores in some areas hindered the penetration of mathematics culture in mathematics teaching (Liu, L. F., 2008; Zhang, W. Z., 2011) ^[14, 15].

Xu Wenbin and Li Jingye believe that the current infiltration of mathematics culture in junior high school mathematics teaching is optimistic, because that (1) Chinese junior high school mathematics textbook (for example, in the Beijing Normal University edition), the mathematics historical materials are presented in an add-on and compliant style. There are 40 topics covered in this textbook from grade 7 to grade 9, thus helping to establish a teacher's textbook view from the inside out, emphasizing the method design of case study, and pursuing the final result of forming mathematical thinking. (2) Mathematical culture is included in quality education. On the basis of learning mathematics culture, students deepen their understanding of the nature of mathematics, which is conducive to the formation of students' literacy. Mathematical culture and quality education have mutually beneficial symbiosis, mutual influence and promotion (Li, J. Y., 2017; Xu, W. B. & Peng, L., 2014) ^[13, 16].

6. The Methods of Infiltrating Mathematical Culture in Junior Middle School Mathematics Teaching

Gong Tianjun, Mao Xiaofen, Zhu Yongsheng, etc. believe that mathematics culture can be infiltrated in junior high school mathematics teaching from the following aspects. (1) Follow the principles of closeness, fun, and openness in teaching. The choice of mathematical culture is close to the mathematical knowledge; let the mathematics culture serve mathematics. Based on the characteristics of students' thinking agility, the open integration and attention to coherence in the integration can better expand students' vision. (2) Pay attention to the interaction between teachers and students in the classroom. In the process of introducing mathematics culture, teachers should pay attention to the creation of a good interactive atmosphere. In the process of integrating mathematics culture, teachers should infiltrate teachers' educational thoughts and have ideological collisions with students. (3) Cleverly tell the story of the mathematician and enhance self-confidence. For example, Newton and Kepler are both imaginative people, which not only break the long-standing rigid tradition, but also establish new and revolutionary concepts. (4) Compile mathematics experiments and games to cultivate students' practical ability and interpersonal coordination ability. Students are entertaining during the game, learning both knowledge and comprehensive skills. (5) Guide students to write mathematics weekly notes and develop students' expressive ability. The so-called "mathematics weekly notes" is to let students record the mathematical problems and knowledge they found in life and study in the form of weekly notes, and the methods of using the knowledge they have learned to solve problems and the experience and gains in this process, expressing the students' true mindset and thoughts (Gong, T. J., 2015; Zhu, Y. S., 2013; Yang, T., 2018) ^[10, 17, 18]. Yang Tao, Wu Haifeng, Chen Jianfang and others believe that the ways of infiltrating mathematics culture in junior high school mathematics teaching is as follows. (1) Create problem situations and infiltrate mathematics culture. For example, when learning the "quadratic equation with one unknown", combined with the mathematical titles of the "chicken and rabbit cage" in the ancient Chinese excellent mathematics "The Mathematical Classic of Sun Zi", which can stimulate students' curiosity and initiative. (2) Contact the reality of life and explore the cultural background. For example, the characteristics of the equal diameter of the circle determine so that the sewer manhole cover is round; the hexagonal building saves material and takes up a small space, so the bee hive is shaped into a regular hexagon. In addition, the stability of triangle and the instability of parallelogram are widely used in daily life. (3) Mathematical aesthetic education can be carried out with the help of mathematical historical materials. The "Golden Section" was proposed by the ancient Greek mathematician Pythagoras more than 2,500 years ago. It is considered by the posterity to be the most beautiful combination of mathematics and aesthetics. When teaching, teachers can use multimedia to show students some classic architecture and painting works, so that students can better experience the magical beauty of mathematics. (4) Integrate the spirit of mathematics in the teaching process to cultivate students' application and innovation consciousness. The junior

high school stage is an important period for the development of students' intelligence and thinking. It is also a crucial period for cultivating them to form good study habits and excellent ideological quality. In the actual teaching process, teachers should thoroughly implement the mathematics spirit into various knowledge points in order to cultivate students' pragmatic and persevering, conscientious and rigorous learning attitude. (5) Grasp the opportunities of infiltration in the class and integrate into the teaching skills. In the textbook, the relevant chapters will be accompanied by reading materials of mathematics history. Although these reading materials are all in the back of chapters, teachers should arrange the order of teaching in advance, and arrange the penetration of mathematics history within a reasonable period of time (Zhang, J. H., 2013; Wu, H. F., 2018; Chen, J. F., 2015; Wang, L. T., 2013; Yan, Y. L., 2012; Liu, L. F., 2008; Xu, W. B. & Peng, L., 2014; Zhu, Y. S., 2013; Jia, Y.P. & Yang, W. F., 2018)^[1, 3, 6, 11, 12, 14, 16, 17, 19].

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7. Research review

7.1 Conclusion

1. Most of the current research literatures come from first-line teachers, with rich practical experience, and the examples are actually applied in practical teaching and are convincing. In the process of literature retrieval, a large number of master's thesis with this background was also found. It can be seen that the study of infiltrating mathematics culture in junior high school mathematics has attracted extensive attention in colleges and universities, especially in the master of education.
2. At present, China's research on the infiltration of mathematics culture in junior high school mathematics mostly stays in the theoretical aspect, and mainly focuses on the status quo, methods, and significance of the theory. There are few related to practical researches, and most of them are general studies of the junior high school teaching stage with few sub-thematic studies.
3. The junior high school stage is the transitional stage of the transition from the beginning to the end. On the one hand, it is the third semester of the compulsory education stage, which is closely related to the primary school. On the other hand, it is the primary stage of secondary school learning, laying the foundation for entering high school. Therefore, the penetration of mathematical culture is crucial in the junior high school stage. In the study, there is a lack of convergence and integration of the mathematics culture of elementary and high school, and the infiltration process is abrupt.
4. There are many examples in the literature, and some studies have proved that the reading materials of mathematics culture in junior high school textbooks are also very rich. However, in teaching, mathematical historical materials are often introduced as a kind of knowledge introduction, lacking specific examples to explain the process of important inspiration to students,

and do not give a complete mathematical culture infiltration process in a knowledge point or an example explanation.

5. There is no detailed statistics and analysis on the mastery of students after the infiltration of mathematics culture. Only by grasping the degree of students' acceptance can we judge if the methods teachers used to infiltrate mathematics culture in teaching are feasible.

7.2 Recommendations

I think the follow-up study should include two aspects.

1. In terms of the theory research: On the one hand, we can't talk about the theory in the whole range of junior high school mathematics teaching, and we should start to study more in different modules, such as numbers and algebra, graphics and geometry, statistics and probability, etc., one-to-one correspondence with the course content. Forming a complete theoretical system not only contributes to the formation of students' knowledge network of mathematical culture, but also can deal with the new requirements of the Standards on mathematics culture. On the other hand, paying attention to the status and role of mathematics culture in junior high school in primary and high school education, and exploring research methods with strong cohesiveness are not only conducive to fully demonstrating the meaning of infiltrating mathematics culture in junior high school mathematics, but also beneficial to students' development and improvement of capabilities in mathematics.
2. In terms of the practical research: On the one hand, it should be implemented in knowledge points and examples, so that students can truly feel the application and role of mathematics culture in junior high school mathematics as well as cultivate cultural awareness. On the other hand, it is necessary to produce a special quantitative assessment, make timely measurements, and obtain feedback so as to guide the next teaching activities in a targeted manner.

In addition, it is necessary to absorb the advanced research results of foreign countries timely, take the essence and discard its dross, then, apply it to teaching practice in order to better promote the penetration of mathematics culture in mathematics teaching in junior high schools in China.

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