

Studies on the Infiltration of Mathematical Culture in College Mathematics Teaching in China

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Abstract

The infiltration of mathematical culture in mathematics teaching has already reached a consensus in the field of basic education and higher education, so the status of mathematical culture in the field of mathematics education can be seen. In order to further deepen the research level of permeating mathematical culture in higher mathematics teaching, to reflect on the previous research of permeating mathematical culture in university mathematics teaching, and to provide a new direction for future research, this study uses the literature method to summarize the relevant research in the past 20 years and draws the following conclusions: In the past, the effective ways to carry out the mathematical culture education in the university mathematics classroom were discussed in five aspects: Teachers' teaching, content selection of mathematics culture, teaching means and methods, extracurricular infiltration of mathematical culture and the infiltration of mathematical culture in specific higher mathematics courses; In the future, we can find the breakthrough from the reform measures of the teaching materials of higher mathematics courses, further deepening the research level of the infiltration of mathematical culture education in the narrow sense of higher mathematics courses, the ways to implement the development of the teaching materials of the elective courses of mathematical culture and the diversification of research methods.

Keywords

College Mathematics, Mathematical Culture, Teaching Measures

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1. Introduction

In recent years, the importance and status of mathematical culture in mathematics teaching has been generally recognized by researchers. As the university is the main position of spreading mathematical culture, and the higher mathematics curriculum is the main carrier of spreading mathematical culture [1], the research results of integrating mathematical culture into university mathematics teaching are constantly springing up, which not only provides a reform direction for higher mathematics teaching content and curriculum, but also improves students' interest and motivation in mathematics learning. In order to sum up the experience and lessons from the past research, this paper intends to reflect on the research of the integration of mathematical culture into university mathematics teaching in the past 20 years and summarize the specific

measures of infiltration of mathematical culture so as to find a breakthrough for further research in the future.

2. The Current Situation of Research on the Infiltration of Mathematical Culture in College Mathematics Teaching

2.1. Suggestions on the Teaching of Mathematical Culture for College Mathematics Teachers

Liu Weihua believes that the mathematics education of university is to improve the students' mathematics literacy and cultural quality so as to adapt to the society and work

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better. Therefore, in the teaching process, teachers should pay attention to the infiltration and sublimation of emotion, properly integrate into "frustration education" and shape a strong and sound personality [2]; Bin Honghua *et al.* believe that teachers should have a high sense of responsibility for liberal arts major students and pay attention to the emotional principle in mathematics teaching, that is to say to stimulate students' academic ability and interest in learning through the influence of mathematical history and mathematical beauty so that students love mathematics [3]. Huang Yaojun, Fang Yanxi *et al.* believe that the teaching of mathematics knowledge is no longer simply the basic task of higher mathematics curriculum. Teachers undertake the responsibility of cultural education which is a more difficult task. So teachers should strengthen their own mathematical culture attainment and become the disseminators of mathematical culture [4-6]. Peng Weiling *et al.* believe that teachers should change the concept of knowledge-based education and teaching and pay attention to the cultural education of students in the teaching process [7]. But at the same time, Li Qiang and Chen Zhibin believe that changing the traditional teaching concept is not the same as abandoning the past or not blindly pursuing cultural indoctrination, we should know that what students learn should be dynamic and cultural knowledge [8]. Ma Lijun also believes that teachers should renew educational concepts and integrate mathematical culture with mathematical knowledge and skills so as to achieve real cultural penetration [9].

Li Xiaoping believes that mathematics teachers in local colleges and universities should establish the concept of lifelong learning, constantly enrich their own mathematical culture reserve and enhance their ability to use mathematical culture in classroom teaching [10]. Li Qiang *et al.* believe that although the university mathematics lecturers have been applied themselves to the teaching of mathematics curriculum for a long time, they are not good at the education mode of infiltrating mathematical culture, so teachers should enrich their cultural reserve from two aspects of classroom case study and theoretical learning, only in this way can they be confident in the teaching process and teach naturally and fluently [8]. Luo Laizhen *et al.* believe that teachers should be strict with themselves, constantly improve their mathematical culture reserves and literacy and truly take mathematical culture as a concept throughout the whole process of teaching activities [11]. After studying the current situation of mathematical culture and education, Jiang Jiashang found that the current teachers' mathematical culture experience and the amount of mathematical culture knowledge reserve are insufficient. He also proposed the view of improving teachers' mathematical culture literacy [12].

2.2. Suggestions on the Selection of Infiltration Contents of Mathematical Culture in Colleges and Universities

Lou Yamin, Fang Yanxi *et al.* believe that in order to intersperse and highlight the point of mathematical culture in university mathematics teaching, we can start from the glue point, origin point, development point and aesthetic point of mathematics discipline itself as well as the common point and blend point of mathematics discipline and other disciplines. Teachers should be devoted to optimizing the teaching content of mathematical culture, learning and developing excellent mathematical culture to permeate teaching case study [13, 7]. Jin Siqin Tuya believes that there are unique mathematical cultural elements hidden in the depth of every theorem, axiom and other knowledge in the system of mathematics professional knowledge, so teachers should excavate these elements and apply them to the classroom for the interleaving teaching of cultural points so as to get twice the result with half the effort [5]. Fu Lihui and Xu congcong studied the teaching materials of higher mathematics. After that, they believe that the current teaching of advanced mathematics emphasizes the academic form of mathematics too much so that the status of cultural form of mathematics is lower. And they also believe that the knowledge of mathematics and the culture of mathematics should be carried out together and simultaneously [14]. Ge Yufeng believes that we should improve the social pertinence of the mathematical cultural content and expand the cultural elements of the mathematical content so as to serve the goal of humanistic education of mathematics [15].

Jiang weiqiong thinks that we should tell students more about the stories and life stories of mathematicians in the teaching process to arouse students' reverence for mathematicians, guide students to discover many aesthetic feelings in mathematics professional knowledge, enlighten students with beauty and make students get the influence of Mathematics culture in many aspects [16]. Chen Xumei, Hu Lianghua, Du Ying, Xue Qiong, Wang chen kai, Peng Weiling *et al.* all praised the method of presenting and introducing mathematical culture and history related to knowledge content to students in the process of university mathematics teaching, which will greatly deepen students' understanding of knowledge and improve the effect of mathematics teaching [17-21, 6]. Zhao Xin, Zhen Xinwu, Bin Honghua, Ge Yufeng, Xue Qiong *et al.* believe that symbols and equations in mathematics have unique aesthetic perception [22, 23, 3, 15, 20], while students lack interest and aspiration to discover this beauty in the long-term examination oriented education and teaching process, so teachers should guide students to discover and experience the beauty of mathematics.

Tan Hui believes that in the process of mathematical culture

infiltration teaching, we should pay attention to the combination of life examples to cultivate students' awareness of mathematics application [24]. Li Xue studies the teaching method of mathematical culture of ordinary differential equation and thinks that the application of the professional knowledge learned in mathematics course can be seen everywhere in students' real life, but students can't actively and carefully observe these practical applications due to the interference of various factors, so teachers should show more examples of mathematics application in the classroom to improve students' mathematics application consciousness [25]. Chen Xiaolin, Li Junling and so on also put forward the view that the historical facts and beauty of mathematics should be permeated in the process of mathematics teaching [26, 27]. Zhao Qi and others believe that students should integrate the characteristics of their own majors into appropriate mathematical culture cases, such as applying mathematical knowledge to economic cases, which can not only arouse students' interest in mathematics learning, but also broaden students' cultural vision. The research also shows that we should combine mathematics courses with other courses to achieve the goal of cultural education [28]. In his research, Zhuang Zhongwen pointed out that the current higher mathematics courses offered by colleges and universities are the same in terms of teaching materials and teaching methods and it is difficult to achieve a real organic combination with the major students have learned [29]. Therefore, in the mathematics culture education, we can start from the characteristics of the major, which not only enhance the characteristics of the major, but also enrich the cultural teaching content.

In the past research, Xue Qiong, Chen Chaojian *et al.* believe that one of the effective ways to carry out mathematics culture education is to add mathematics culture elective courses in students' learning curriculum system and improve students' mathematics culture quality through teachers' teaching of mathematics culture [30].

2.3. Suggestions on the Reform of Teaching Methods and Methods

Based on the background of the information age, Hu Huilan believes that the mathematics culture education should go hand in hand with the mathematics technology education and teachers should pay attention to the cultivation of students' application consciousness and confidence in mathematics, thus he also emphasizes the emotional promotion of students' mathematics learning [31]. According to Fu Lihui and others, the development of modern information technology has labeled mathematics as "experimental science". Information technology can fully display the dynamic process of mathematical knowledge, which is conducive to promoting students' intuitive understanding [14]. Li Junfei *et al.* believe that a platform for mathematical cultural exchange can be

established based on the convenient and efficient Internet [32].

Tan Hui and Peng Weiling believe that teachers can use situational teaching mode in the process of classroom teaching introduction and lead out the teaching content of mathematical knowledge by creating a relaxing and vivid classroom atmosphere, which is conducive to stimulating students' learning motivation and exploring the enthusiasm of new knowledge, as well as cultivating students' emotional experience [24, 6]. Yan Baoying reformed the mixed teaching mode and applied it to higher mathematics teaching based on mathematics culture, clarified the specific design ideas and adopted the layered teaching mode in the implementation process [33]. This research is of great significance for integrating mathematics culture into higher mathematics. In addition, Li Junling *et al.* also proposed to adopt the combination of heuristic teaching and after-school practice in the course of numerical analysis mathematics [27].

Wang Shaoyu, Peng Weiling, Zhao Xin, Yan Baoying *et al.* believe that the integration of mathematics culture education into teaching will inevitably lead to the reform of mathematics curriculum evaluation. They should not only pay attention to students' academic performance, but also pay attention to students' learning process and learning attitude and evaluate them. Moreover, Yan Baoying also elaborated the mathematics curriculum evaluation system of the hybrid higher mathematics teaching mode. He believes that it was necessary to establish an online and offline evaluation of students' mathematics learning, emphasizing the multi-dimensional and all-round process evaluation of students [33].

2.4. Suggestions on Integrating Mathematics Culture Education After Class

Xue Qiong *et al.* think that we should build a recessive mathematical culture environment and improve students' mathematical culture literacy by adding mathematical culture courses, organizing mathematical students' activity groups and using advanced information technology to build a mathematical culture exchange platform (such as a website) [20]. Zhuang also proposed to establish a mathematics mutual aid group in spare time, write small papers on mathematics practice and carry out activities such as mathematics related keynote speech competition to carry out imperceptible mathematics culture education for students [29]. Yan Baoying believes that in higher mathematics teaching, we should pay attention to the combination of explicit and implicit knowledge as well as learning and teaching and create a learning atmosphere. For this reason, we can carry out mathematics competitions, organize students to listen to lectures on mathematics culture and spontaneously organize students to set up mathematical activity groups (such as

mathematical modeling communities). She also proposes the combination of online and offline teaching methods and launch online mathematics courses related online courses of culture, such as MOOC [33].

2.5. Suggestions on Mathematics Culture Education in the Specific Higher Mathematics Courses

The researchers also discussed the path of permeating mathematical culture under the specific higher mathematics courses, and now there are many research results on the path of permeating mathematical culture in the courses of calculus, ordinary differential equation, numerical analysis, higher mathematics, probability theory and mathematical statistics, linear algebra, real variable function and functional analysis.

Li Junling's suggestion for the reform of numerical analysis course is that we should introduce real cases in the teaching process to enhance students' sense of substitution, intersperse the content of relevant mathematical historical facts to stimulate students' interest in learning and adopt the after-school practice connecting the preceding and the following to enlighten students draw their own conclusions [27]. Fu Xilian and others have studied the teaching strategy of calculus under the vision of integrating mathematics culture. They discovered that we should appropriately choose the ontology and epistemology of mathematics philosophy to integrate with the teaching content of calculus in the teaching process. They also pay attention to introducing the historical development of calculus to students and divide the thought and method of calculus into three levels for teaching and so on [35]. These measures will play an important role in guiding the future mathematics culture into calculus teaching. Wu Zhaoqi *et al.* made a research on how the two courses of mathematics, real variable function and functional analysis, integrate into the mathematics culture and came to the following conclusions: teachers should introduce interesting stories of mathematicians in order to arouse students' interest in learning and implement the principle of emotional teaching; they also should guide students to sort out the history and system of curriculum development so that students can have an overall understanding of the curriculum they have learned; at last, they should infiltrate the ideological methods and viewpoints of the course content to cultivate the students' ability to transfer and use knowledge [36]. Gao Qing and others give some feasible suggestions on the infiltration of mathematical culture in the course of probability theory and mathematical statistics. In addition to the parts that are repeated with the above contents, the researchers think that it is necessary to increase and create opportunities for students to participate in social practice and scientific research activities so that students can understand the

practical application of the learned contents and realize the practical value of mathematics in their own experience [37].

3. Evaluation and Prospect

In the past 20 years, the research on the path of mathematics culture education in university mathematics teaching has undoubtedly greatly promoted the reform and renewal of the teaching mode and content of mathematics courses. From the above review, we can see that the previous research is mainly devoted to how to effectively carry out the mathematical culture education in the university mathematics classroom. The research conclusions in recent years can be roughly divided into teaching suggestions for teachers, suggestions for the selection of the content of the mathematical culture education, suggestions for the innovation of teaching methods and methods, suggestions for the integration of the mathematical culture into the extracurricular life of college students and suggestions for the integration of the mathematical culture into the extracurricular life of college students. Some suggestions on the infiltration of mathematical culture into a specific higher mathematics curriculum. The previous research results have established and consolidated the status of mathematics culture in higher mathematics education. People's attention and sense of identity to mathematics culture education have also been improved unprecedentedly, which also plays an important role in the transformation of people's cultural education concept. Based on the summary of previous studies, the author not only realized the significance of the study, but also found some deficiencies.

First, the teaching material content of mathematics culture elective course needs to be developed urgently. In the past, many researchers mentioned that mathematics culture can be added to students' curriculum system as an independent course and they all realized the importance of setting up mathematics culture course. But at present, there are few textbooks about mathematics culture in the teaching material system of higher education in our country. Therefore, based on the current people's high attention to the elective course of mathematics culture and its own cultural and educational role, it is necessary to take the development of mathematics culture teaching material as one of the research focuses in the future research on mathematics culture education in colleges and universities.

Second, the research method is relatively single. Most of the researches on the infiltration path of university mathematics culture education are based on the previous theoretical research, using the methods of literature research and theoretical research and there is almost no relevant empirical research. The development of empirical research will undoubtedly greatly improve the accuracy and objectivity of the research results and the research data and conclusions

obtained by using quantitative analysis will be more convincing than the previous theoretical research. While improving the validity and reliability of the research, it can also test whether the previous mathematical cultural education suggestions have really improved the teaching effect and are really beneficial in the promotion of students' mathematical cultural literacy and core discipline literacy. Therefore, researchers should promote more empirical research based on the theoretical results of the current so that the research level of the subject will rise to a new height.

Thirdly, there is lack of research on the suggestion of infiltration of mathematics culture education in the narrow sense of higher mathematics curriculum. The so-called narrow sense higher mathematics course refers to the specific courses of mathematics in university courses, such as higher algebra, functional analysis, topology, etc. Combined with the previous research, we can find that the depth of previous research is mostly on the path of permeating mathematical culture in the general higher mathematics curriculum and there are few researches on the deep permeating path according to the characteristics of disciplines, which just becomes a new foothold of future research. Therefore, the future research should be on the basis of the previous research conclusions on a deeper level of mining, to explore how to effectively penetrate the mathematical culture in the narrow sense of higher mathematics curriculum.

Fourthly, it is necessary to explore the reform of higher mathematics teaching materials further. Jiang Haozhe and Wang Xiaoqin analyzed and studied the total amount, presentation mode, value concern and interdisciplinary utilization of mathematics culture in the textbook of linear algebra and its application in the United States and put forward the problems that should be paid attention to in the development and compilation of mathematics textbook in China [38]. In the future, we can put forward some ideas and suggestions on the content reform of the teaching materials of mathematics courses offered by universities from the following aspects: how to integrate the content of mathematics professional knowledge and mathematics culture organically into a whole, how to balance the proportion of the length of mathematics culture in the example exercises and how to explore more novel and indirect ways to integrate the historical facts of mathematics. Based on the influence of humanistic characteristics and regional factors, moreover, one of the problems that need to be solved urgently is how to embody the unique regional characteristics while ensuring the teaching objectives.

4. Conclusion

In a word, this study draws the following conclusions based

on the summary and review of previous research results on the infiltration of mathematical culture in college mathematics teaching:

- (1) In the past, the research mainly discussed the effective ways to carry out mathematical culture education in college mathematics classroom, which can be roughly divided into five aspects: In view of the teaching suggestions put forward by teachers, the content selection suggestions of mathematical culture education, the innovation suggestions of teaching means and methods, the suggestions of integrating mathematical culture into the extracurricular life of college students and the suggestions of infiltrating mathematical culture into a specific higher mathematics curriculum.
- (2) Combined with the shortcomings of previous research, future research can find a breakthrough from the following aspects: The reform measures of the teaching materials of higher mathematics courses; further deepening the research level of the infiltration of mathematics culture education in the narrow sense of higher mathematics courses; implementing the development of the teaching materials of mathematics culture elective courses; adopting more research methods for research.

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