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Exploration of Strategies for Integrating HPM Concepts into High School Mathematics Teaching and Learning

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Abstract: *HPM is an educational concept that combines the history of mathematics and mathematics education in China and abroad. This paper analyses the general requirements and distribution of the history of mathematics into high school mathematics teaching materials, and then discusses the significance of the integration of HPM ideas into high school mathematics teaching. Then it analyses the current situation of the integration of the history of mathematics into high school mathematics teaching, and finally puts forward the teaching strategies for the integration of HPM ideas into high school mathematics classrooms.*

Keywords: *History of mathematics; high school mathematics; mathematics teaching; strategies*

1. Introduction

In China's general junior and senior high school mathematics curriculum, the study of the history of mathematics is often neglected, and at the same time, teachers do not integrate the knowledge about the history of mathematics in China and abroad into classroom teaching, which leads to the fact that many children are unable to form a holistic framework for the understanding of mathematics in their minds, and their strong interest in the subject of mathematics is also declining. However, nowadays, due to the successful holding of the HPM Congress, the importance of integrating the history of mathematics with the general mathematics curriculum has attracted widespread attention, and the integration of the history of general mathematics and mathematics education is a good medicine to guide students to learn mathematics well and to be interested in mathematical knowledge.

2. General Requirements and Distribution of the History of Mathematics Integrated into Senior Secondary Mathematics Textbooks (Using the Northern Normal University Edition as an Example)

2.1. General Requirements for the Integration of the History of Mathematics into Senior Secondary Mathematics Textbooks

The Standard for General Senior Secondary Mathematics Curriculum (2017 Edition) emphasises that teachers should be committed to the cultivation of students' basic qualities, and advocate the teaching methods of independent thinking, independent learning, and collective participation in discussions. At the same time, the teaching process should also focus on the formation of students' mathematical basic quality in different cultural knowledge. The teaching principle of "integrating the content with mathematical culture and reflecting the contemporary nature" is also highlighted. Meanwhile, it is also clearly stated in the opinions on the preparation of the curriculum that the curriculum must incorporate mathematical ideas into the content of the curriculum, so as to correctly introduce the advances in mathematics and scientific research, broaden students' horizons in mathematics, mobilise their motivation and self-confidence, and cultivate students' mathematical ability and self-confidence. This will broaden students' horizons in mathematics, mobilise their motivation and self-confidence in mathematics, and cultivate their scientific spirit. The above facts show that the importance of the history of mathematics in mathematics education is not only expressed at the level of scientific research, but also determined at the level of the teaching system. As the current reform of the mathematics education curriculum will pay more attention to the significance of the history of mathematics in China and abroad, the textbooks can introduce the relevant background knowledge in a more timely manner.

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2.2. Approximate Distribution of History of Mathematics Incorporated into Senior Secondary Mathematics Textbooks

In the new textbook of Beishi University edition, a rich educational content on the history of mathematics in China and abroad is arranged, and a total of 39 knowledge points on the history of mathematics in China and abroad are involved in the nine sets of textbooks from senior one to senior three, among which the types of knowledge points on the history of mathematics in China and abroad mainly include "reading materials", "small information", "introduction to people" and "a small history of mathematics". The types of knowledge points provided in the history of mathematics mainly include "reading materials", "small information", "introduction to the characters" and "a small history of mathematics", of which "reading materials" are the most common, and the content of the history of mathematics it includes:

- introduction of the history of mathematics;
- tell mathematical anecdotes;
- the main introduction of Chinese and foreign famous mathematicians.

At the same time, the number of history of mathematics arranged in each textbook is not the same. The five textbooks from Compulsory 1 to Compulsory 5 include as many as 25 pieces of knowledge on the history of mathematics, and most of them are reading materials, which are simple and easy to understand, and very suitable for the learning characteristics and psychology of senior secondary school students, and they are good materials for teachers to carry out interest education. While the number of history of mathematics contents arranged in the elective courses is relatively small, Elective 3-1 is specifically an elective lecture on the history of mathematics. Elective 3-1 illustrates to high school students the close connection between the history of mathematics and mathematics education from eight aspects, namely, the origin of the basic mathematics curriculum, early evolution,,, the formation of elementary mathematics, number and symbols, the history of the development of geometry, the monument in the history of mathematics-calculus, infinity, and the appreciation of famous problems, and helps students of middle and high school levels to consciously integrate knowledge of the history of mathematics, thus developing students' literacy in the history of mathematics.

3. The significance of integrating the history of mathematics in teaching high school mathematics

Mr Zhang Dianzhou, a well-known scholar, once said that learning some Chinese and foreign history of mathematics and improving students' understanding of the essence of mathematics are not only the requirements for first-line mathematics teachers and high school students, but also the necessary way for first-line teachers and high school students to explore the wonders of mathematics. Understanding the history of mathematics in China and abroad and experiencing the humanistic spirit of mathematics in the history of mathematics in China and abroad can improve the understanding of mathematical concepts and ways of mathematical thinking, as well as the spiritual power of the predecessors in their inexhaustible quest for the essence of mathematics, so as to achieve the goal of students being able to overcome the difficult problems independently. The correct and reasonable penetration of the theoretical knowledge of the history of mathematics in high school mathematics classroom teaching is of great social value and significance for the organic integration of knowledge and classroom. It can be briefly analysed as follows:

3.1. Motivating students to learn maths

Interest is the best teacher. The biggest problem for students who are poor in mathematics is the lack of interest in learning mathematics[1] , which is why they are intimidated by those boring, abstract figures, so it is important to stimulate their interest in learning and make them full of curiosity and curiosity about the subject of mathematics. As secondary school students have strong interests, it is important to turn maths materials into interesting fairy tales. Then closely integrated with the content of mathematics, and implemented in each high school mathematics education materials, high school students will be actively involved in the study of mathematics, and therefore, their learning results will be greatly enhanced. Interesting stories such as Liu Hui, Zu Chongzhi, Archimedes and Gauss are good topics to introduce into the classroom to stimulate students' interest in learning.

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3.2. Appreciating Mathematical Ideas and Cultivating Cultural Literacy

The history of Chinese and foreign mathematics often contains mathematical thinking, in high school mathematics textbooks in the history of Chinese and foreign mathematical knowledge is relatively simple, but also contains a simple mathematical education way of thinking, including the whole, the transformation, the limit idea. The great Chinese mathematician Hua Luogeng once said: "Number is less direct when it lacks shape, and shape is harder to penetrate when it lacks number". The way of thinking is through the integration of mathematics and shape to solve the problems in the mathematical image graph, showing distinct advantages. The direct presentation of "shapes" and the precise presentation of "numbers" complement each other to optimise the solution of problems and resolve difficult knowledge. The history of mathematics is usually a vivid and clear reflection of the basic steps of mathematicians in considering and solving problems, which has a great influence on students' mathematical thinking. Combining the history of mathematics with mathematics textbooks enables learners to experience the way of thinking of mathematicians unconsciously, so that they can internalise the thinking of mathematicians by further integrating them into their teaching practice.

4. Analysis of the current situation of the integration of the history of mathematics into the high school mathematics classroom

Domestic research on the integration of the history of mathematics in the high school mathematics classroom has been slow, and it was not until the end of the twentieth century that the history of mathematics was integrated into the mathematics curriculum, which is also somewhat related to the history of China's social development. It was only at the beginning of the 21st century that the educational concept of "the cultural value of mathematics should be embodied in the high school mathematics classroom" was put forward[2] .However, up to now, the theoretical research results on the integration of the history of mathematics education into the higher education classroom and the practice of embodying the cultural significance of contemporary mathematics education in the higher education classroom in China have only gone through a journey of two decades, which is comparatively less than that of the developed countries in Western Europe for nearly more than a hundred years. This is too superficial compared to the history of mathematics education in developed countries in Western Europe, which is more than a hundred years, because we are only at the initial stage of incorporating the history of mathematics education into the university classroom. In fact, as early as in the 18th century, Kant mentioned the importance of the historical order of knowledge in the teaching of Chinese children. From theory to practice, both at home and abroad have done relevant seminars and teaching work on the inclusion of the history of mathematics education in higher education classrooms, and the teaching arrangement of the new curriculum is of great significance for the resources of the history of mathematics to enter the modern classroom teaching. However, the survey[3] found that in the front-line classroom teaching, many senior high school mathematics teachers' attention to the history of mathematics and the awareness of its application are seriously low, and the reason for this is that they are often affected by the evaluation of the teaching in the school, and many of them have no idea about the specific contents of the resources of the history of mathematics. Teachers are still interested in the specific contents of the resources of the history of mathematics at the stage of occasional interest, but their main concern is more inclined to the content knowledge related to the college entrance examination, and they almost turn a blind eye to the other contents, which are virtually useless. The problem is mainly manifested in the following aspects:

4.1. Reading materials become neglected by teachers

Some frontline teachers in some schools simply turn a blind eye to the large amount of Chinese and foreign materials on the history of mathematics in the curriculum. According to the survey, there are two main factors: on the one hand, the teachers themselves do not have enough knowledge of the history of Chinese and foreign mathematics and have no professional training in this area, which results in a low awareness of the history of mathematics; at the same time, some school teachers also lack case studies on the integration of the history of Chinese and foreign mathematics into teaching and learning, and they do not organise teachers to carry out training and scientific research in this area, which results in the absence of Chinese and foreign historical and cultural flavour in the curriculum of Mathematics and Science Education. Chinese and foreign history and cultural flavour. On the other hand, some high school teachers think that the college entrance examination doesn't test these things, so there is no need for students to learn the knowledge related to the history of mathematics, which leads to the fact that the

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teachers only let the interested students understand the reading materials during the lectures, and indirectly makes the majority of high school students have no consciousness of learning the history of mathematics in China and abroad.

4.2. Deficiencies in the organisation of the new teaching materials

Although contemporary secondary school textbooks are deliberately compiled to instil in our high school students knowledge about the history of mathematics in China and abroad, they are still deficient in many factors such as universality, geographical characteristics, national characteristics and so on. For example, some of the knowledge is too complex to guide students who are struggling. For example, the problem of "things don't know how to count" is written in ancient language, and the meaning of "three and three and two" makes it difficult for many students to understand, so teachers need to give the necessary notes. In addition, the type of presentation is predominantly analytical and brief articles, which are more tedious and abstract, and there is also some teaching content that is only superficial, which does not allow you to read the original history of mathematics education in high school, and does not reveal the history of the development of mathematical ideas and thinking in high school.

5. Strategies for Integrating History of Mathematics into High School Mathematics Classroom Teaching

The main way in which the history of mathematics is integrated into the teaching of mathematics in high schools is through the inclusion of the history of mathematics in the mathematics classroom.[4] The design of the classroom is not a mere fetishisation of the history of mathematics, but rather an application of the history of mathematics in the context of the learning process. Teachers need to strictly follow the curriculum plan to teach the history of mathematics in Chinese and foreign countries in accordance with the content of the textbook. The classroom design of the history of mathematics in high school needs some materials on the history of Chinese and foreign mathematics, but the materials on the history of Chinese and foreign mathematics in the high school mathematics textbook are too limited to meet the needs of the education on the history of Chinese and foreign mathematics integrated into the classroom design of the high school mathematics, and the teacher needs to choose a more suitable textbook on the history of Chinese and foreign mathematics. However, the materials in the selected textbook on the history of Chinese and foreign mathematics are too complex, which will naturally put forward a higher demand on the curriculum design of high school mathematics teachers' teaching classes. Teachers not only need to strictly follow the chapters of mathematics teaching, but also need to scientifically and effectively combine the history of Chinese and foreign mathematics and mathematics education. Moreover, history of mathematics education can only be regarded as a supplementary teaching tool in the new senior secondary mathematics curriculum reform, and teachers should not spend a lot of time on the history of international mathematics in the classroom and completely ignore the requirements and empirical knowledge of the guiding curriculum programme. The social value and social impact of the education of the history of mathematics in China and abroad into the high school mathematics classroom is undoubtedly very significant and far-reaching, so how to infiltrate the education of the history of mathematics in the classroom of the new mathematics education is a problem that every front-line teacher and scholar must think about, but if we can more effectively integrate the education of the history of mathematics with the classroom, it is bound to form a beautiful landscape in the context of the new curriculum reform. Personal countermeasures are given from the following four aspects[5] Measures[6] .

5.1. A more colourful presentation of the content of the history of mathematics

At this stage, it is not difficult to find out in the study of the historical status of the former text of the high school mathematics textbook of the North Normal University edition, due to the presentation of the history of mathematics in our country mainly focuses on the project of "reading materials", and are briefly described in the form of articles, in order to attract the attention of the front-line teachers. Textbook arrangement of the history of mathematics project should be appropriate diversification, detailed, in the form of illustrations or cartoons can also be selected for the development of secondary school students to grow up in the history of the subject, and arranged some information about mathematics education, more than some such as Han Xin point troops, etc., in order to inspire students to think, and thus inspire mathematical thinking. In addition, if the textbook is arranged with rich mathematical information, which is also related to the knowledge points taught by the teacher, what kind of digital reading content is more suitable for entering the core knowledge curriculum of senior secondary mathematics? Of course, it is up

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to the frontline teachers to study the curriculum carefully, and to select the knowledge points of the history of mathematics, so that the history of mathematics that is more conducive to secondary school students can be incorporated into the mathematics curriculum, which can yield good results.

The principles of screening for the history of mathematics are as follows:

■ A strong interest in the history of mathematics integrated into and relevant to the classroom;

■ The history of mathematics as it relates to classroom teaching and learning is to be reflected in classroom teaching and learning in terms of its mathematical thinking, mathematical methods and techniques;

■ The history of mathematics that students learn must have long-term developmental implications for their mathematical and scientific qualities.

5.2. Principles of Science, Purpose and Interest in Integrating the History of Mathematics into Classroom Teaching and Learning

The incorporation of the history of mathematics into the teaching of mathematics and textbooks in upper secondary schools must adhere to the characteristics of science, purpose and interest. The scientific character is reflected in the fact that the historical information contained in history of mathematics textbooks should be objective, authentic and authoritative, not fabricated, and that adequate attention should be paid to the historical information. To respect the objective reality, do not use subjective judgement or fabricate modern mathematical legends to make the mathematics class more vivid; the characteristics of the purpose is to clarify the purpose of the mathematics class, the history of Chinese and foreign mathematics into the classroom needs to pay attention to certain goals, rather than hoping that the mathematics classroom has a humanistic atmosphere, the Chinese arithmetic class as a historical subject, and teaching arithmetic for the sake of teaching history, ignoring the Chinese mathematics classroom. Essence. Interesting performance should be adapted to the psychological development and ideological characteristics of high school students, and for high school students, the performance of Chinese and foreign mathematical history can also be taught in a pictorial way.

5.3. Provide relevant training to improve teachers' literacy in the history of mathematics

The responsibility for integrating the teaching of the history of mathematics into the classroom should rest with frontline teachers, and improving teachers' literacy in contemporary Chinese mathematics and science is a prerequisite for realising this new teaching approach, which will be more readily applied in teaching when the quality of teachers' own knowledge of the history of mathematics in China and abroad is improved. In this way a traditional Chinese mathematics culture class can be established .

The following three areas can be developed[7] History of Mathematics Quality for High School Mathematics Teachers:

(1) Establishment of relevant elective courses in higher teacher education to arouse the awareness of students in teacher training colleges. It was found that many higher teacher training colleges have already established such an elective course as the history of mathematics, which is examined in the form of an elective course, and is taught casually by the instructors and studied casually by the teacher training students. In the eyes of the teachers-to-be, the history of mathematics in China and abroad has become an empty space, and no one pays attention to it or sees the importance and value of studying it. Therefore, there is a great need to raise the awareness of teacher training colleges to the fact that it is only through an understanding of the history of mathematics education that the mathematical experience can be better constructed.

(2) Increase the threshold of the teaching profession and make it necessary for the majority of prospective teachers to be well trained in the history of Chinese mathematics before recruitment. In the recruitment assessment of all kinds of teachers at all levels of schools, the professional knowledge of the history of Chinese and foreign mathematics can be strengthened accordingly, so that on the one hand, prospective teachers can be attracted; on the other hand, teachers can be more proactive and active in studying the history of Chinese and foreign mathematics, so as to improve their own quality of teaching.

(3) Creating new opportunities for in-service teachers to train. Many in-service mathematics teachers have not been able to catch up with the pace of modern pedagogical changes, especially for older teachers, who are mainly taught by experience. However, if the local education authorities carry out appropriate centralised training activities in the history of mathematics, or if schools organise training for teachers at

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public expense, the quality of the history of mathematics of the teachers will inevitably go up to the next level, laying the foundation for the integration of the history of mathematics into the teaching of the subject.

5.4. Conduct classroom research on maths culture

Along with China's new curriculum reform movement in full swing, a variety of forms of research and sharpening activities in different colleges and universities across the country or local activities, but the study of the history of mathematics in China and abroad into the high school mathematics classroom research activities are few and far between, although there are a number of young teachers have the potential to do this, but due to the university, the relevant teaching department did not pay attention to the teacher's ability to always be in the nascent situation[8].First of all, the relevant departments of colleges and universities should set up scientific research organisations of different specialties to develop new research modes, and in the field of mathematics education, they should also take the "construction of mathematics education materials rich in Chinese cultural temperament" as the main theme of the research courses; then, teachers should organise classroom teaching competitions on the history of Chinese and foreign mathematics for them to make new and innovative ideas. Then, teachers should organise classroom teaching competitions on the history of mathematics in China and abroad, in which they can make use of their strengths and avoid their shortcomings to bring novel classroom designs into the actual mathematics classroom, and in this way cultivate the teachers' quality of the history of mathematics, so that mathematics education can be more lively and interesting in the classroom.

6. Conclusions

The development of mathematics education in the ascendant, mathematics education must keep pace with the times, and strive to achieve the modernisation of mathematics education, the history of mathematics provides us with a new perspective.By going back in history and pursuing the essence and truth, we need to build a teaching and learning environment that incorporates the history of mathematics in order to guide students to‘think and explore as deeply as the mathematicians in history’.Therefore, the study of Chinese and foreign knowledge of the history of mathematics into the high school mathematics classroom has become one of the major issues in the field of mathematics education. This paper discusses the importance of integrating the knowledge of the history of mathematics into the high school mathematics classroom, and also discusses the teaching strategies of integrating the knowledge of the history of mathematics into the high school mathematics classroom, hoping to inspire teachers and provide them with some references in the teaching of mathematics classroom. How to integrate the knowledge of history of mathematics into the high school mathematics curriculum has yet to be explored in depth, which must be further explored in the teaching practice.

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