

The Application of the Research Results of Ancient Chinese Mathematicians in Primary School Mathematics Teaching

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Abstract: The research achievements of ancient Chinese mathematicians are an important part of China's excellent traditional mathematical culture and have important implications for primary mathematics teaching. By analyzing the research process and conclusions of mathematicians, we can understand the starting point and process of their research, their ideas and methods, and the basic facts and core concepts of mathematics. This will enable us to form a more comprehensive and profound understanding of related content and transform it into classroom teaching content for primary mathematics. We can then gain teaching insights from this and base our design of unit-based whole-curriculum teaching activities on it.

Keywords: Ancient Mathematicians; Primary School Mathematics; Excellent Traditional Chinese Culture; Mathematics History Education.

1. Introduction

The "Compulsory Education Mathematics Curriculum Standards (2022 Edition)" (hereinafter referred to as the "2022 Edition Curriculum Standards") in the revision principles, curriculum concepts, curriculum implementation suggestions, and textbook preparation suggestions all put forward specific requirements for the introduction of Chinese excellent traditional culture into the classroom, which clearly refers to It should be combined with the teaching content of "understanding the outstanding contributions of ancient Chinese mathematicians and spreading the excellent traditional Chinese culture in mathematics" [1]. Most of the contents of the mathematics curriculum in the former primary school can be found in the corresponding historical materials of our traditional mathematics culture, and the work done by mathematicians, both the breadth and depth of research, is the essence of traditional mathematics culture. Therefore, it is of great significance and value to promote the effective implementation of primary school mathematics teaching by studying the work of ancient Chinese mathematicians. Then, from the actual needs of primary school mathematics teaching, from what Angle can we sort out and interpret the research work of ancient mathematicians? How to find the connection between the research work of ancient mathematicians and the teaching content of mathematics in elementary school and get teaching enlightenment? How to apply the research of ancient mathematicians to mathematics teaching design? In order to better think and solve these problems, this paper studies the integration of Liu Hui's "Round field technique notes" into the whole teaching of primary school mathematics "round" unit.

2. The Relationship Between the Research Work of Mathematicians and the Teaching of Mathematics in Primary Schools

To carry out the integration of traditional mathematics culture into classroom teaching practice, we must first solve the problem of "making bricks without straw", that is to solve

the problem of obtaining mathematical historical materials. The main ways to obtain traditional mathematical culture or other mathematical historical materials are mathematical masterpieces, mathematical history works, objects found in archaeological research, and other literary and historical works. Among them, mathematical classics are works written by famous mathematicians on a certain mathematical topic, which can inspire wisdom and make people think, is the concentrated embodiment of mathematical wisdom of mathematicians, and is the most important and direct source of mathematical historical materials. The study of mathematicians' research methods, processes, viewpoints and conclusions on specific mathematical contents contained in mathematical classics is helpful to comprehensively and deeply understand and grasp the teaching contents, and form a holistic and consistent interpretation.

The ancient mathematicians explicitly mentioned in the "2022 edition Curriculum standards" include Liu Hui and Zu Chongzhi. Unfortunately, although Zu Chongzhi's research results on PI are world-famous, the book Shu Shu, which can reflect his mathematical wisdom, has long been lost, and we can only find a fragment of his research results on PI in the historical book Sui Shu Li Zhi. Fortunately, Liu Hui's research remains intact in the form of "Nine Chapters on Arithmetic". Liu Hui made a comprehensive discussion and proof of the contents of the Nine Chapters on Arithmetic, and made many important contributions, laying the theoretical foundation of ancient mathematics in China, including initiating decimal decimal, clarifying the "principle of uniformity", clearly defining the concept of positive and negative numbers, creating the "cutting the circle" and putting forward the concept of limit, and initiating the scientific method of finding PI. The principle of "complementing in and out" has been perfected [2]. Among them, in the process of studying the area of a circle, "in the history of world mathematics, Liu Hui introduced the limit idea and infinitesimal segmentation method into mathematical proof for the first time, which is the most outstanding contribution" [3]32. It can be seen that Liu Hui's research work is highly relevant to primary school mathematics teaching, which is a rare precious resource for

primary school mathematics teaching.

3. Dimensions of Analysis of the Research Work of Mathematicians

In-depth analysis of the research work of mathematicians is to "understand why it is better to know why it is", that is, not only to simply acquire knowledge, but also to experience the important mathematical thinking methods and the unique thinking mode and research perspective of mathematicians. Therefore, the research work of mathematicians needs to be comprehensively sorted out from the two aspects of its research process and conclusion. The analysis of the above contents can provide important learning materials for teaching activities, help to form reasonable teaching ideas, and help teachers to design and organize teaching activities from a more holistic and high-level perspective. Taking Liu Hui's research on the circle in the notes of "Round Field Technique" in "Nine Chapters of Arithmetic" as an example, it can be analyzed from the following perspectives: First, what was the process of Liu Hui's research on the circle? Second, what important conclusions did Liu Hui get? Of course, the research process and results of mathematicians are an inseparable unified whole, which is discussed separately in order to be more targeted and more in-depth in classroom teaching.

3.1. Analysis of the Research Process

Combing and analyzing the research process of mathematicians can clarify the research starting point and thinking path of mathematicians, accurately grasp the complete process of the development of mathematical content, and understand the mathematical thoughts and methods contained in it and the specific strategies adopted, which will become the path reference for the design of teaching activities. The sorting and analysis of the research process is mainly to clarify the logical sequence and the relationship between each step of the research, so that it is more in line with our current thinking habits. The "Round field Technique" in the Fang Tian chapter of "Nine Chapters on Arithmetic" records four calculation methods of the circle area, but the derivation process of these methods is not explained. Liu Hui has proved these four calculation methods in detail in the form of annotations, of which the proof of the first method "half-cycle radius multiplication to get the product step" is the core and most valuable part.

When sorting out the research process of ancient mathematicians, we should pay attention to the specific background of the generation and development of mathematical knowledge. For example, in Liu Hui's time, π was a very rough value, and precise π itself was a difficult problem. Therefore, it is relatively easier to approach the circle infinitely and find its area by means of the inner regular polygon of the circle, which is different from the order of finding the area of a circle that we know is precise. But for Liu Hui's research process, we can also question, that is, it is possible to calculate the side length and circumference of a regular polygon by means of the Pythagorean theorem, so that we can directly calculate π by bypassing the area, but why Liu Hui first calculated the area of the circle, then calculated the circumference according to the relationship between the area and the circumference, and finally calculated π ?

3.2. Analysis of Research Conclusions

The research conclusions of mathematicians often contain basic mathematical facts, important concept definitions, and key knowledge skills. In-depth analysis of the research conclusions can be used as a factual basis for breaking through teaching difficulties. The conclusions drawn by mathematicians often have a strong generalization and a wide range of applications, so it can be regarded as the core concept of the unit and play a leading role in the teaching content of the same unit. Due to the advanced thinking, quick thinking and concise language of mathematicians, it is necessary to link the conclusion with the process to study and analyze in order to better understand the viewpoints expressed by ancient mathematicians. At the same time, the process and conclusion should be made more intuitive by means of illustrations, and it can also be expressed in combination with modern mathematical symbols to make it more concise and easy to understand. For example, in the above conclusions about Zheng area and sector area, regular polygon area and circle area, there are more complex corresponding relations and deductive reasoning processes, so it is necessary to use diagrams in order to accurately grasp their internal logic.

4. The Revelation of Mathematicians' Research Work on "Circle" to Primary School Mathematics Teaching

4.1. The Relationship between the Research Work of Mathematicians and the Teaching Content of the "Circle" Unit

There is a certain distance between the specialization of mathematician research and student learning, so it needs to be properly transformed before it is used in teaching. The first is the translation of the research results of mathematicians, that is, the translation and semantic complement of classical Chinese, which is convenient for students to understand. The second is the analysis of learning situation, which mainly includes students' understanding and acceptance of mathematicians' way of thinking and research process. The third is the analysis of teaching and learning content, analyzing whether the traditional mathematics culture, including the professional research of mathematicians, can be compatible with the content of the textbook, and what adjustments and preparations need to be made. On this basis, we should fully consider the relationship between the infiltration of traditional mathematics culture, the achievement of teaching objectives and the development of students' ability, and clarify the role that the selected content can play in the teaching process.

In elementary school mathematics textbooks, the corresponding conjunctions can be found in Liu Hui's research, including: (1) Liu Hui proposed that regular polygons and circles can realize the conclusion that "the combination has nothing to lose" through "cutting and cutting again, so that they are not cut", which can help students to understand the relationship between regular polygons and circles as a whole, and realize that the two can be transformed into each other; (2) Liu Hui's research includes the isometric segments between the center point of a regular polygon and its vertex. The number of isometric segments helps students understand and summarize the concept of a circle (the same length in one center), its elements (the center and radius of the

circle) and its characteristics (there are countless radii of the same length); (3) Liu Hui's questioning of "Wednesday Path 1" can be used as a starting point for learning the circumference of a circle (PI). Liu Hui's research process from regular hexagon to regular nonnonhexagon using circle cutting technique can provide ideas for calculating the ratio of regular polygon circumference to diagonal length one by one to find the changing trend; (4) The transformation mode and area calculation method of regular hexagon can provide enlightenment for the transformation and area calculation of circle, and the limit thinking contained in circle cutting is helpful to understand the exact correspondence between circle and transformed polygon. Therefore, in order to make the teaching process more complete, provide a carrier for the generation, clarity, generalization and development of the limit idea, and better fit Liu Hui's research process, we can add "hexagon" as the starting lesson in the "circle" unit. In addition, the idea proposed by Liu Hui from the zither area to the sector area and then to the circle area can also be a useful exploration in the process of studying the circle area in addition to the conventional derivation method.

4.2. The Revelation of the Research Work of Mathematicians to the Whole Teaching of "Circle" Unit

Mr. Wu Wenjun, a famous mathematician in China, said: "We worship traditional Chinese mathematics, and we are by no means obsessed with the ancient, for the ancient... Our main and true aim is to make the past useful to the present." [4] It can be seen that integrating the research of ancient mathematicians into the teaching of primary school mathematics is to better serve the current teaching activities. Therefore, this is not a "icing on the cake" embellishment, but can effectively solve the current practical problems in teaching, and promote students to form a deep understanding of the "snow".

Although Liu Hui was a famous mathematician in ancient China, many of his ideas and methods were not only highly consistent with the contents of modern primary and secondary school mathematics teaching, but also superior to the existing teaching materials [3]. Liu Hui's research on the circle is a complex and rigorous process, including the relationship between regular polygons and circles, the area of circles, the circumference of circles, PI and other important contents, as well as an important mathematical thought method for the study of circles - the limit thought. For primary school mathematics teaching, important enlightenment can be obtained from the thought method, operation process, research conclusions and other aspects. In the aspect of thinking method, the main mathematical thinking method involved in Liu Hui's research on circle is the limit thought contained in circle cutting. The limit idea is not only the basis of the conversion between regular polygon and circle, but also can dispel the doubts about the gap between regular polygon and circle in the process of the study of the circumference and area of the circle. In the operation process, the number of sides of the regular polygon and the number of lines from the center point to the vertex of the regular polygon in the process of "cutting the circle" create conditions for understanding the number and characteristics of the radius of the circle. At the same time, taking hexagon as the starting point, PI can be studied with the help of the changing trend of the ratio between the circumference of different regular polygons and the diagonal, which can provide enlightenment for both

methods and processes. In terms of research conclusions, Liu Hui's discussion on the relationship between circles and regular polygons, the value of PI, the calculation method of circle area, etc., all provide a factual basis for the learning process and results. The whole teaching structure of the unit with circle cutting (limit thought) as the core is formed by synthesizing the above content, which is helpful to reflect the integrity and consistency of the core quality. In addition, Liu Hui's mathematical wisdom and scientific spirit can be seen from his research process and conclusion, which also reflects the broader educational value besides the teaching value.

5. Summary

The traditional mathematical culture embodies the humanistic factors behind the development of mathematics, the "cold" numbers contain "hot" thinking, and the inspirational stories of ancient Chinese mathematicians who are deeply concerned with their thoughts, their hearts are constantly changing, making the dual attributes of mathematics "reason" and "humanity" in pedagogy This not only has the role of motivating and inspiring students, but also can effectively cultivate the "core qualities of Chinese students' development" such as "scientific spirit" and "humanistic heritage".

Therefore, the purpose of combing and analyzing the research work of ancient mathematicians is to transform the most essential part of the excellent traditional Chinese mathematics culture from historical form and mathematical form into educational form, and integrate it into classroom teaching in a form that students like to hear and see, so that students can experience history firsthand He participated in the process of the occurrence and development of mathematical knowledge and inherited and carried forward the traditional mathematical culture in the way of "moisten things without sound" in the dialogue with ancient mathematicians. At the same time, teachers transform the research of ancient mathematicians into classroom teaching activities, paying attention not only to the acquisition of students' knowledge and skills, but also to the formation of students' core qualities, that is, in the process of knowledge learning and problem solving with the help of the excellent traditional Chinese mathematics culture, they learn to observe, think and express themselves from the perspective of historical development and in a way that reflects the characteristics of mathematics. [5]

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