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Research on the Development of Knowledge in the Core Literacy of High School Mathematics Teachers Based on History of Mathematics

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The core literacy of mathematics teachers includes knowledge, skills, and professional dispositions. The degree of mastery knowledge is the key factor to measure the core literacy of mathematics teachers. The study of the history of mathematics has a certain impact on the mastery of mathematics teachers' knowledge. With the help of the evaluation framework of integrating the history of mathematics into teaching practice, this paper analyzes the relevant knowledge of 12 high school mathematics teachers who carry on the teaching of introduction to trigonometry. The research shows that the history of mathematics promotes the knowledge of high school mathematics teachers to some extent, and forms a model of the history of mathematics to promote the knowledge development of mathematics teachers on the basis of analysis.

Keywords: history of mathematics, core literacy, knowledge of mathematics, introduction to trigonometry

Introduction

The professional literacy of teachers plays a crucial role in education itself. The education department has put forward new requirements for both students and teachers in the new high school mathematics curriculum standards. In this case, the high school mathematics teachers should deal with the new curriculum standards' challenges actively and improve their literacy constantly, keeping pace with the development of the times so as to arrive a new level of their mathematics teaching. However, the keys of effectively cultivating the mathematics core literacy of high school students in teaching depend largely on the mathematics core literacy of high school mathematics teachers themselves.

There are many different definitions about "teacher literacy" at home and abroad (Zhang & Yu, 2018), but it is agreed that "teacher literacy" includes knowledge, skills, and professional dispositions. "Knowledge" and "skills" include the four elements: subject knowledge and subject teaching knowledge and skills, pedagogical content knowledge and skills, and knowledge about the students' learning. The "professional literacy" requires teachers to hold a fair faith to all students in learning and consistent emphasis on the teaching behavior at the same time. Therefore, the high school mathematics teacher must not only have solid subject knowledge and

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teaching ability but also supplement his knowledge base in the process of teaching, update his teaching concept, and improve his literacy constantly.

Mathematics teacher knowledge is an important index to evaluate the core literacy of mathematics teachers. But how to promote the development of mathematics teachers' knowledge to further improve the mathematics teachers' core literacy has attracted more and more attention.

The analysis of existing literature shows that the study of mathematical history can promote the development of teachers' subject knowledge and subject teaching knowledge (Arcavi & Isoda, 2007). Based on the content of high school trigonometry, this paper studies the promotion effect of mathematical history on high school mathematics teachers' knowledge by integrating mathematical history into teaching.

Theoretical Framework

As early as the 19th century, the relationship between the history of mathematics and mathematics education has attracted the attention of European and American mathematicians and mathematics educators. In 1972, at the Second International Conference on Mathematical Education, the International Study Group on the Relations Between the History and Pedagogy of Mathematics (HPM) was founded. At present, HPM has formed a complete set of theories, and has a good guiding role in integrating mathematical history into teaching practice (Wang, 2017).

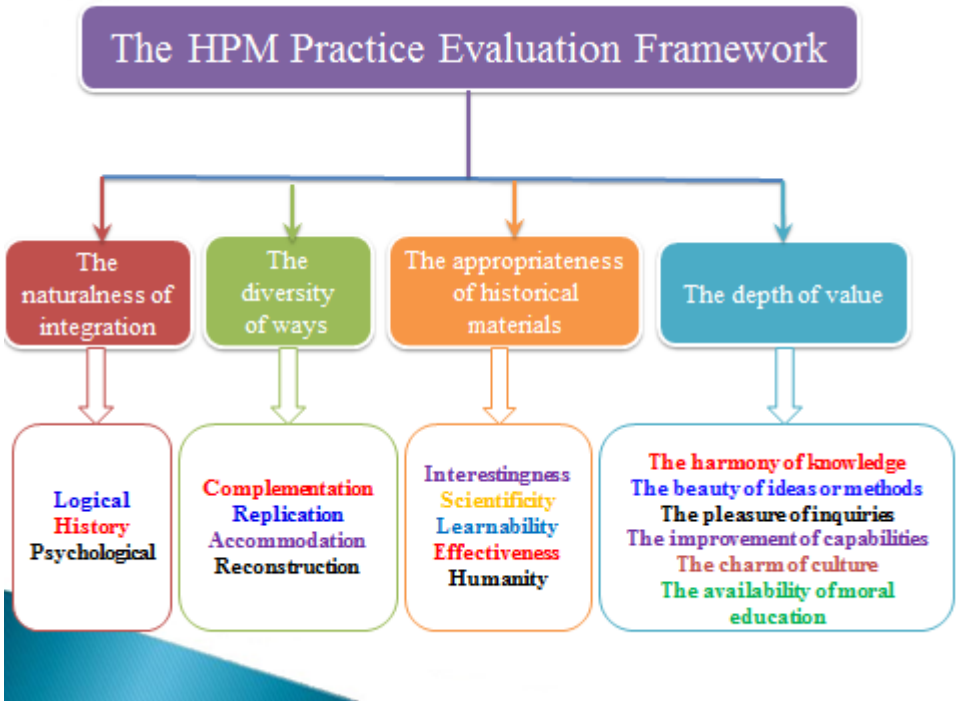

Figure 1. The HPM practice evaluation framework.

Based on the existing theory of HPM: two bridges (history and reality, mathematics and the humanities), three-dimensional object (for teacher professional development, includes knowledge, belief, and ability), four ways (attach, copy, adapt to, and refactoring type), the five principles (interesting, scientific nature, each, effectiveness, and novelty) and six class value (the harmony of knowledge, the beauty ideas or methods, the

pleasure of inquiries, the improvement of capabilities, the charm of culture, and the availability of moral education) and combining the HPM teaching practice to experience a four dimensional framework of HPM teaching evaluation (Shen, Li, & Wang, 2017), the classroom teaching of introduction to trigonometry in the view of HPM is analyzed. The HPM practice evaluation framework is shown in Figure 1.

Method

Samples

For the convenience of the study, 12 teachers from zj, yx, sh, and gd provinces were selected. All the 12 teachers volunteered to participate in the case study of "Introduction to trigonometry in the view of HPM", whose detailed information is shown in Table 1.

Table 1

Backgrounds of the 12 Samples

Name	T01	T02	T03	T04	T05	T06
Gender	Male	Female	Female	Female	Male	Male
School age	12	17	11	13	17	21
Experienced HPM	More	More	Less	Null	More	Null
Teaching time	17.4.7	17.4.5	17.4.1	17.4.7	17.10.26	17.12.2
Name	T07	T08	T09	T10	T11	T12
Gender	Female	Male	Female	Female	Male	Male
School age	23	25	17	6	12	21
Experienced HPM	More	More	Less	More	Most	More

Research Process

All the 12 high school teachers' schools adopt the teaching textbook A version. The contents of this study on trigonometry are distributed in the first and third chapters of Compulsory 4 and the first chapter of Compulsory 5. There are contents: trigonometric functions, trigonometric identity transformation, and solution of the triangle. This part is an important learning content in high school, which plays a key role in further in-depth learning. Trigonometry is also widely used in other aspects. However, through the survey found that there are many high school teachers and students, there are many doubts of trigonometry content, such as why triangles contents learned during junior high school will be learned during high school, why we generalize the angle, what is the necessity of introducing radian system, why in learning trigonometric function to introduce what is the unit circle, what is the purpose of the study trigonometric functions, and why use trigonometric function to research cycle phenomena.

Each teacher received a pre-test of trigonometry knowledge before the lecture, an interview, and a post-test of trigonometry knowledge after the lecture, and each teacher wrote a teaching reflection. Through interviews, teaching practice, and teaching reflection, researchers want to explain the reasons why the history of mathematics has changed the specialized contents knowledge in the core literacy of teachers. Since none of the 12 teachers had any theory about HPM, the researchers chose 12 literatures about HPM theory and 28 literatures about trigonometry to share with the teachers. First, HPM theoretical literature by learning, teachers of history of mathematics into mathematics teaching, purpose, value, and the significance of being integrated into the ways to conduct a preliminary understanding, through learning about knowledge of trigonometry historical development process of the concept, formula, and theorem of trigonometry have a deeper understanding of knowledge, and

then by studying existing HPM case teaching design about specific mathematical history into the teaching process have a preliminary understanding, the teacher teaching design through the understanding of the material to try.

Results of the Development of Knowledge in the Core Literacy of High School Mathematics Teachers Based on History of Mathematics

The four teachers who improved their knowledge in the core literacy through HPM teaching practice have rich teaching experience, they were interested in the history of mathematics, and they can select materials closely related to the teaching content according to the five principles of appropriateness of historical materials to the mathematical historical materials shared by researchers; they studied the existing HPM cases seriously, and discussed and implemented the teaching design of "Preface to High School Trigonometry From the Perspective of HPM" for many times; after practice, they made a summary after class, and reflected on whether the selection of mathematical historical materials is appropriate and whether the way of integrating historical materials is appropriate.

Through the teaching practice of HPM, the three teachers' mathematical knowledge in the core literacy level is basically unchanged. The three teachers in the preparation of HPM teaching design all have a common process: (1) The researchers share mathematics study and sort out the historical data closely associated with the teaching content of material; (2) HPM case study studies the case of the HPM into the way to the history of mathematics and to the history of mathematics in the role of teaching links; (3) practice before and after discussion with experts and colleagues should choose what kind of math historical reflection and study how to naturally take these historical data into mathematics teaching.

Among the five teachers whose knowledge of mathematics in the core literacy was reduced through HPM teaching practice, the reasons for the decline in mathematical knowledge are as follows: (1) Teachers have a wrong understanding of the history of mathematics. They think that the history of mathematics is to tell the story of mathematicians; (2) they cannot organically integrate the historical development of concepts and the proof of theorems in history into the classroom; (3) lack of understanding of HPM theory; (4) they have not experienced the implementation process of HPM teaching practice.

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