

# Improvement of Teachers' Quality of History of Mathematics through Professional Development

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*The history of mathematics can play a positive role in teaching of mathematics, however, there is evidence that it is rarely addressed in teaching. This is, in part, some teachers lack good Quality of History of Mathematics. In this paper, we will distinguish QHM of mathematics teachers to include three elements: recognition of history of mathematics, knowledge about history of mathematics and the ability to utilize history of mathematics in teaching. We will discuss appropriate measures that can be taken to improve QHM among teachers.*

**Key words:** *Mathematics Teachers; History of Mathematics; QHM; Professional Development*

“The history of mathematics and mathematics education” is a hot topic of international educational research in mathematics. The educational value of history of mathematics has been increasingly highlighted. The mathematics curriculum standard in China emphasizes the history of mathematics, aiming at introducing the history of mathematics into mathematics classroom teaching. However, in the practice of teaching, the phenomenon of “high evaluation, low use” with the history of mathematics exists generally. Previous research showed: The key reason was that teachers' quality of history of mathematics (QHM) is relatively low (Li, 2005). This paper focuses on characterizing QHM of mathematics teachers and offers strategies for improving it.

## **Connotation of the QHM of Mathematics Teachers**

The QHM is an important part of mathematics teachers' professionalism. It is also an important vehicle for grounding teachers' understanding of mathematics and its structure. The QHM of mathematics teachers is different from the purely theoretical disciplinary knowledge of mathematical historians in that for teachers the QHM includes three elements: recognition of history of mathematics, knowledge about history of mathematics, and the ability to utilize history of mathematics in teaching. This paper discusses the relevance of QHM for middle school mathematics teachers.

## **Recognition on History of Mathematics**

How teachers view the curricular function of history of mathematics is an important influence on whether they use history of mathematics in teaching or not. For example, if teachers perceive the purpose of studying mathematics to be for students to grasp mathematical thinking and improve their mathematical skills then they may consider including the history of mathematics in curriculum and instruction as a burden, occupying valuable classroom time. Teachers with such thinking are less inclined to use history of mathematics in teaching. However, if teachers recognize the importance of history of mathematics, challenges that the mathematicians have encountered while developing new mathematical ideas, then they can rely on history to stimulate students' interest in not only learning mathematics as school subject but also the discipline. Teachers that realize such a potential are more likely to utilize the history of mathematics in their teaching. This point has been previously articulated by Siu (2006).

## **Knowledge about History of Mathematics**

The history of mathematics knowledge is multifaceted but a few major hallmarks are listed below. First, the background about mathematical concepts and the important achievement, such as, the emergence and development of the negative numbers, irrational numbers, and complex numbers, as well as the emergence of the analytic geometry and the finding of the calculus. Second, production of important mathematical thoughts, such as axiomatic thought, random thought, algorithm and so on. Third, the stories and anecdotes about the mathematicians, such as Euler who still finished writing many books after being blind, Descartes established the analytic geometry inspired by flies crawling on the ceiling, Lobachevsky still insisted on his own point of view face to others' doubts and disapprobation.

The amount of knowledge about history of mathematics is an important index to measure the QHM of mathematics teachers. It is important that a teacher of mathematics know about famous mathematicians and their contributions. While the list is long, the work of Chongzhi Zu, Hui Liu of China, Archimedes and Newton of the west, the western mathematical classic "Euclid's Elements" and "Nine Chapters" of ancient China provide a good starting point in building disciplinary knowledge. This knowledge becomes critical when school children begin to learn mathematical topics as the teacher can elaborate on the nature and genesis of those topics relying on historical development of those same ideas. Consider for instance the topic of imaginary numbers. It is rare that school children would know why these numbers are called "imaginary." The significance of this class of numbers to the advancement of mathematical ideas should certainly be included in school curriculum.

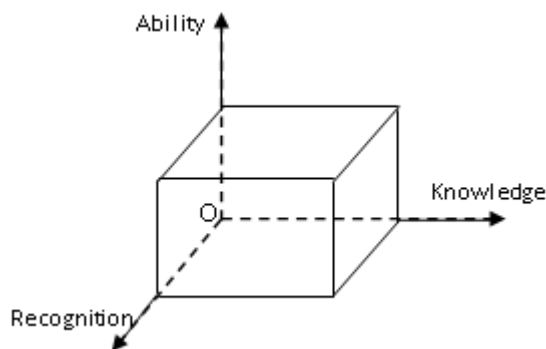
### **Ability to Use History of Mathematics in Teaching**

Some teachers tried to teach mathematics using the history of mathematics, but they find out that it increases the burden of students as well as brought down their test scores. So they conclude that: History of mathematics is useless for teaching. However, the following sentence said by Fulvia Furinghetti may be worth thinking, “the different conclusions drawn by the various authors are not to be ascribed to the role of the history of mathematics in teacher education, but to the way of dealing with history in teacher education programs” (Furinghetti, 2007, p. 132).

Some teachers may equate using the history of mathematics with telling stories about past mathematicians or reading historical materials. Although important, this type of use does not capture the true value of the history to mathematics education of children. In recent years, many scholars have advocated the idea of “integrating the history of mathematics into mathematics teaching” either explicitly or implicitly. Explicit integration is that teachers directly provide the history of mathematics clips to students. This is the type of integration that is common in instruction. The problem with this model is that it treats history of mathematics and mathematical knowledge as mutually exclusive. Implicit integration, on the other hand is that teachers put history of mathematics and knowledge of mathematics together to make “history set”, through which students can gradually grasp intricacies of mathematical thinking. For instance, when high school students study the formulas for sum or difference of trigonometric functions, teachers may directly use the typical proof method from the history of mathematics in classroom, without referencing their historical background. In this process, a majority of students may not become aware that the teachers had used the history of mathematics in instruction. Such integration saves classroom time whilst helping students to understand these formulas. In recent years, HPM group led by professor Horng Wann-Sheng have developed numerous teaching materials for teachers on how to use history of mathematics in teaching(details can be found in the journal of MATHMEDIA, issued by Taiwan of China). Learning about these specific examples can improve teachers’ ability to utilize history of mathematics in teaching.

From the above, we can see that recognition of history of mathematics, knowledge about history of mathematics, and ability to utilize history of mathematics in teaching are the three deeply intertwined elements of the QHM for mathematics teachers. If taking three elements as the coordinate axis respectively, we can set up three-dimensional coordinates system, so the model of QHM of mathematics teachers is constructed (See Figure 1). If each axis of the figure is scaled then the QHM of mathematics teachers can be quantified. The value of QHM is equal to the volume of the rectangular parallelepiped. Once any one of the dimensions is zero, the volume will be zero. Therefore, when the QHM of mathematics teachers is evaluated, all

three elements must be considered. In order to improve the level of QHM of mathematics teachers, all three elements must simultaneously be improved.



**Figure 1.** *Three-dimensional model of QHM of mathematics teacher.*

### **The Improvement of the QHM of Mathematics Teachers**

As discussed in previous sections, the QHM of mathematics teachers plays a decisive role in whether history of mathematics is effectively used in teaching. History of mathematics has the potential to stimulate students' interest in learning mathematics and help them to understand abstract mathematical ideas. However, the QHM of many mathematics teachers is presently low. Li Bochun surveyed 50 randomly selected junior high school mathematics teachers from three counties and six districts of Huai Bei and Su County Area. The survey elicited the teachers' knowledge about the history of mathematics needs improving. In the following sections we will discuss five specific strategies that may need to be used in teacher education to meet this need.

#### **Drive with Project Research or Carry out Effective Training**

In recent years, relevant educational departments have carried out some special training classes designed towards improving QHM of mathematics teachers, but these activities have not yet shown positive results

In our project, project research on integrating history of mathematics and mathematics teaching, we found that the QHM of teachers involved in the project research improved. In our project we utilized three components, each of which seemed to have positively impacted the teachers' QHM: (1) Using practical and classical materials on history of mathematics for teachers, such as "A History of Mathematics (2nd)" written by Li (2002), "The history of mathematics in middle school mathematics" written by Wang and Han (2002). Teachers listened to experts' reports and wrote research papers. (2) Combining teaching practice and learning. To improve the teachers' ability to utilize the history of mathematics in teaching, and prior to the conclusion of training we ask that each person must submit at least a video of their own

teaching utilizing history of mathematics. (3) Testing the knowledge of teachers which included the three elements of QHM as the basis for determining the content of the test

### **Encourage Teachers to Use History of Mathematics in Teaching**

Although the external environment is an important factor that influences teachers' development, the key is their own efforts. According to our analysis, the improvement of QHM is the result of improvement on three elements. To achieve this goal, teachers must be willing to invest time and effort to read books and journals related to history of mathematics, browse web sites and investigate topics. At the same time, when designing the teaching plan, teachers are encouraged to think not only about gaining mathematical knowledge, but also its associated connection with teaching content. Indeed, teachers need to be pursued to actively try to apply the history of mathematics to teaching.

### **Construct HPM teaching resource repository**

Designing lessons and units of instruction that utilize history of mathematics is an important pedagogical activity that can help improve teachers' own knowledge. However, teachers' busy teaching schedules and intense professional demands they may not have sufficient time to design materials while thinking about how to utilize history of mathematics in teaching.

The middle school teacher participants in our project repeatedly expressed an interest in seeing examples of how useful materials. In light of this need it seems important that HPM experts and scholars to begin compiling HPM teaching repository that teachers could utilize. Such repository can guide more teachers to utilize history of mathematics in their classrooms

### **Advocate Reflective Teaching**

Research has identified reflection as the chief ingredient to teachers' growth. As it relates to the teaching of history of mathematics reflection can allow teachers to assess their own progress towards implementing new lessons in their classrooms. If teachers find some deficiencies in the process of using history of mathematics in teaching, they can reflect on teaching design, teaching process to improve the effect of teaching. Likewise, if teachers are satisfied with their effort, they can reflect on elements that made their lessons successful. In both cases reflection allows for the refinement of practice.

As it is the case for implementation of any new idea in curriculum and instruction, reliance on collaboration and affiliation with a learning community can enhance reformed activities. The effort towards utilizing history of mathematics in instruction can certainly benefit from collaborative and collegial practice. The leadership of the school should organize some

activities, such as seminars about HPM, teaching competition on the utilizing of history of mathematics, or acknowledging exemplary teachers. We believe the level of QHM of mathematics teachers will surely be improved through such organized activities.

### **Reform the Education Model**

Presently, the history of mathematics is offered as an elective course in most normal universities in China. The results of survey of knowledge of teaching graduates highlighted that a significant number of students had little knowledge of the history of mathematics (Li, 2006). The results points at the need to raise the level of knowledge among teachers in teacher education. One venue to address this is to require a course in history of mathematics, as opposed to suggesting it as an elective. This action certainly raises the status of this body of knowledge for teaching. Additionally, the teaching of the course should also be reformed to reflect the study of history of mathematics as a research activity. This suggests that rather than focusing on development of the course content through a purely theoretical lens, it might be more effective to emphasize the history of discipline as human endeavour.

In order for such a course to be effective, repeated exposure to the content might be necessary. As such, we suggest that "history of mathematics" should be set as a sequence of two course required during junior and senior years. The Junior Level course teachers obtain the knowledge of the history of mathematics which is necessary for middle school teaching. The Senior Level course teachers lean how to utilize the history of mathematics in classroom teaching. Improving the quality of professional knowledge of teachers pertaining to the history of mathematics is necessary and should be taken seriously.

### **References**

- Furinghetti, F. (2007). Teacher education through the history of mathematics. *Educational Studies in Mathematics*, 66(2), 131-143.
- Li, B. C. (2000). A survey of the history of mathematics knowledge. *Mathematical Bulletin*, 3, 39-40.
- Li, H. T. (2005). The new horizon of curriculum reform: The history of mathematics goes into the new mathematics curriculum. *Curriculum. Teaching Material and Method*, 25(9), 51-54.
- Li, K. H. (2006). The problems, reasons and strategies of the mathematics graduates of normal universities on the knowledge of mathematics history. *Journal of Chongqing Normal University (Natural Science Edition)*, 23(6), 88-92.
- Li, W. L. (2002). *A history of mathematics (2nd)*. Beijing, China: Higher Education Press.

- Siu, M. K. (2004). No, I do not use history of mathematics in my class. Why? In F. Furinghetti, S. Kaijser, & A. Vretblad (Eds), *Proceedings of the HPM Satellite meeting*, 375-376.
- Wang, X. Q., & Han, X. L. (2002). *The history of mathematics in middle school mathematics*. Beijing, China: Science Press.

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