

Study on Teaching Mode of History of Mathematics Based on "Outcomes-Based Education (OBE)" & "History and Pedagogy of Mathematics (HPM)" Taking Harbin University as an Example

Chunyan He^{1,*} Gang Zhu¹

¹Education & Science College, Harbin University, Harbin, Heilongjiang 150006, China

*Corresponding author. Email: 693775267@qq.com

ABSTRACT

Based on professional certification concept "Outcomes-based Education (OBE)" and some relevant research results on "History and Pedagogy of Mathematics (HPM)", a teaching mode was constructed in the course "History of Mathematics". The feedback of the teaching in past years shows that the mode can effectively integrate mathematical history into teaching design in following series courses for training the student's instruction skills.

Keywords: Outcomes-based Education (OBE), History and Pedagogy of Mathematics (HPM), teaching mode, mathematical history

I. INTRODUCTION

"Mathematics history" is a compulsory course for primary education major of Harbin University. It aims to cultivate the cultural quality of mathematics discipline of normal students majoring in primary education, pave the way to accumulate knowledge reserves for reasonably integrating mathematical culture into teaching design and improving teaching ability in the following series of training instruction skills courses, so as to provide post service teaching work and professional development to better serve for normal students.

Based on the past final examinations of each semester, it can be seen that although most students have a good grasp of the life of mathematicians, the main achievements of mathematicians, important mathematical works and mathematical events involved in this course, they cannot reasonably integrate the mathematical culture into teaching plans design text and simulated teaching in the following series of training instruction skills courses. There is no means and ability to judge the correctness of mathematical culture content not involved in this course.

In view of the above teaching effect is not ideal, the author, as a teacher, hopes to improve the teaching effect and improve the teaching efficiency by constantly thinking and exploring an effective teaching mode.

II. THEORETICAL BASES

A. Outcomes-based education

With the implementation of "the Measures for the Implementation of the Accreditation of Teachers' Majors in High Education (Interim)" issued in 2017 and "the National Standard for Teaching Quality of Undergraduate majors in High Education" issued in 2018 by the Ministry of education of China, the OBE concept followed by them has been widely valued.

As a national standard of teaching quality, OBE is an Output-Based Education model, which is "student-centered, output oriented and continuous improvement". Among them, student-centered emphasizes following the law of normal students' growth and development, allocates educational resources, organizes courses and implements teaching with students as the center; output orientation emphasizes taking the learning effect of normal students as the guidance, and evaluates the training quality against the requirements of graduates' core competence; and continuous improvement emphasizes the comprehensive and whole process evaluation of teaching and the application of evaluation results in the teaching improvement, to promote the continuous improvement of the training quality of normal major.

OBE first appeared in the basic education reform of the United States and Australia. From the 1980s to the early 1990s, OBE was a very popular term in the

American education field. In the book " Outcome-Based Education: Critical Issues and Answers" [1] written by American scholar Spady, OBE was defined as "clearly focusing and organizing the education system to ensure that students got the experience of achieving substantial success in future life." He believed that OBE had realized the transformation of educational paradigm.

As in [2],OBE requires that teachers should first make clear the learning achievements, cooperate with the diversified and flexible personalized learning requirements, let students complete the self realization challenges through the learning process, and then feedback the results to improve the original curriculum design and teaching.

B. History and Pedagogy of Mathematics

As a research field, History and Pedagogy of Mathematics (HPM) originated in 1972 and was proposed at the second International Conference on Mathematics Education held by Exeter, UK. It was the abbreviation of the international study group on the relationships between history and mathematics teaching. In 1976, it has been subordinate to the International Committee on mathematics education.

At the beginning of this century, the research team of East China Normal University has made great contributions to HPM. Its master students, doctoral students and master of education in mathematics education have written graduation theses on HPM. The research team has carried out HPM teaching practice and case development, and has given the process of teaching design, implementation and evaluation.

There are some difficulties in integrating the history of mathematics into the teaching of mathematics [3], [4], [5], [6]. There is a big gap between the willingness and action of mathematics teachers to integrate the history of mathematics into teaching. The existing curriculums do not match cultivating teachers' ability of integrating the history of mathematics into mathematics teaching. This makes the research object of HPM need to be extended from teachers to pre service teachers. The teaching of mathematical history in primary education major in universities is very important to improve pre service teachers' attainment of the mathematical history. It is urgent for teachers to explore an effective teaching mode. Normal students and pre service teachers have the same connotation in this paper for illustration purposes.

III. PROCESS OF STUDY

This course has experienced about three stages in the past ten years (as shown in "Fig. 1"). In the first stage, the teacher taught in the order of the textbook structure completely. In the second stage, the teacher combined the textbook with few selected topics which

closely related to primary education. And in the third stage, the teacher selected a lot of topics which closely related to primary education and finished by normal students, except topics which have to complete by the teacher. Based on the normal students' final examination results and the rationality of finishing tasks in the follow-up series training instruction skills courses, it can be concluded that the teaching effect of the third stage is the best. So the improvement of the teaching mode is explored based on the teaching mode of the third stage.

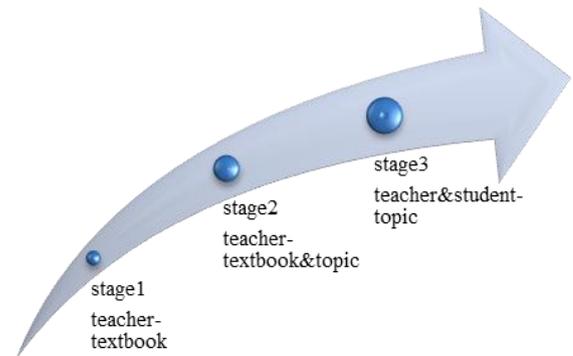


Fig. 1. Three stages of curriculum development.

According to the requirements of professional certification and OBE concept, teachers strive to create a teaching mode that can reflect the effectiveness of the course, students' participation and form of interest. The course is guided and based on the content of mathematics culture in the primary mathematics textbook published by PEP and carefully deals with the parts that are not clear enough in the material. The main textbook is A History of Mathematics (3rd) by Wenlin Li, supplemented by other authoritative works. Different theme will be talked about each time. Normal students study a topic thoroughly, and complete the lecture in the way of cooperation between teachers and students.

The research shows that pre service teachers most welcome the content of mathematical history with both knowledge and interest. Therefore, teachers choose the mathematical history with both knowledge and interest in the primary mathematics textbook published by PEP. The teaching of macro themes is mainly accomplished by teachers; the teaching of micro themes is mainly accomplished by the normal students. The macro theme refers to the introduction to the course and final review . The micro theme refers to the specific mathematical events, mathematicians, mathematical works and ancient Chinese famous problems related to the mathematical culture mentioned in the primary textbooks. The two parts of teaching are completed by teachers and students together, not separated. In the part of teachers' lectures, teachers interact with students by pre-test, mid-test and post-test to test students' learning

achievements. And in the part of normal students' lectures, the teacher should evaluate the correctness and the familiarity of the speaker, guide the basic teaching posture of the speaker, and supplement the part of the topic that the lecturer fails to explain thoroughly and the normal students cannot complete on their own.

The team is the unit and the task is the driving force. 3-4 normal students form a team which works on a topic (as shown in "Fig. 2"). They should reasonably split the team's tasks, such as organizing manuscripts, finishing PPT, constructing test papers and explaining to classmates. In the process of division and cooperation, normal students undertake different tasks and achieve different goals according to their own wishes, such as obtaining effective methods of material collection, improving writing and the teacher's professional ability (such as producing PPT, mastering the rules of test paper preparation, the ability of speaking standard Chinese and writing beautiful chalk characters). A list of books and papers is provided by the teacher before the normal students begin to study their topic. Before the lecture, the teacher will read the lecture notes and PPT, and point out the mistakes, loopholes and ambiguities, so that they can have more confidence in the lecture, the content displayed will be more reliable, and the teaching efficiency will be improved.

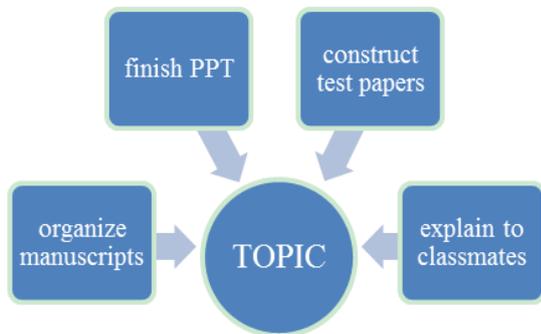


Fig. 2. Form of team cooperation.

The design of the course highlights the effectiveness. The teaching content is closer to the primary school mathematics content, and the teaching method is "task driven". In the process of completing the task, students not only cultivate the cooperation ability of members, but also improve the individual ability of material collection, sorting and organization, and strengthen the familiarity of primary school textbooks.

Research [7] shows that with the increase of learning time of mathematical history, pre service teachers' mathematical history literacy is getting higher and higher. They not only recognize the educational value of mathematical history more and more, but also greatly improve their ability to integrate the

mathematical history into teaching designs. Through the study of this course, pre service teachers can better interpret the mathematical culture in primary textbooks, improve the knowledge system through grasping the relevant main knowledge in the history of mathematical development, and gradually improve their mathematical literacy. With good mathematical literacy, normal students can reflect the awareness of mathematical culture infiltration in the series follow-up courses for training of teaching skills. They can pass on the mathematical culture and highlight the charm of mathematical culture in their post service teaching.

IV. ANALYSIS

Although the teaching mode of the third stage has made great progress in teaching effect compared with the first two stages, there are still some imperfections in the selection of the theme and the angle of interpretation. Thematic design will destroy the structure and continuity of knowledge. It is difficult for normal students to form a complete structure of mathematical history because of the small connection between different topics. In the future teaching, we can change the order of the topics from the present random order to the time order of the topics; arrange related topics in the adjacent time, so that normal students can structuralize their knowledge.

The research shows that HPM teaching case is the most suitable learning method for pre service teachers. Video case can help pre service teachers better transform the mathematical history into mathematical teaching, and arrange appropriate assignments related to the integration of mathematical history into mathematics teaching for pre service teachers to complete, which is of great help to deepen the understanding of mathematics history and mathematics teaching for pre service teachers. In the future teaching, we can set up some small tasks to promote students to establish the connection between mathematics history and primary mathematics teaching. Normal students should associate primary mathematical knowledge points with the specifying topic of mathematics history; on the contrary, normal students should associate mathematical culture with specifying primary mathematical knowledge points. This design should help normal students internalize HPM into their own cognitive structure. In addition, we should learn from the textbooks other than PEP, try to present the advantages of different primary textbooks, so as to improve the effectiveness of this course.

V. CONCLUSION

The focus of OBE philosophy is to emphasize clear results specifications in curriculum design, curriculum evaluation, program evaluation and accountability. HPM should pay attention to the combination of the

focus of historical segments and educational issues. In order to improve the teaching quality, we should deeply understand the characteristics, shortcomings and development of OBE concept and HPM.

References

- [1] Spady WG, Outcome-Based Education: Critical Issues and Answers, AASA, 1994.
- [2] Cook D A, Bordage G and Schmidt H G, "Description, justification and clarification: a framework for classifying the purposes of research in medical education," *Medical Education*, 2010.
- [3] Biggs J B, *Teaching for Quality Learning at University: What the Student Does*, McGraw-Hill Education (UK), 2011.
- [4] Guangmei Li, "Achievement oriented education theory and its application," *Education review*, 2007.
- [5] Qiang He, "Exploring the influence of mathematics history on primary school mathematics classroom teaching efficiency," *Curriculum education research*, 2018.
- [6] Wei Fu, "Research on the strategy of integrating mathematics history into primary school mathematics teaching -- taking five primary schools in Changsha as examples," unpublished, Hunan Normal University, 2019.
- [7] Youchu Huang, "Research on the development of pre service teachers' teaching knowledge based on the course of mathematical history," unpublished, East China Normal University, 2014.