

The Structural Characteristics of MPCK for College Mathematics Teachers

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Abstract: Teachers' knowledge is an important basis for teachers' professional development. In addition to the knowledge of Mathematics (MK for short), the knowledge of general teaching method (PK for short) and the knowledge of mathematics learning (CK for short), university mathematics teachers should also have the knowledge of mathematics history, mathematics philosophy and mathematics methodology. The knowledge of mathematical history, mathematical philosophy and mathematical methodology makes it possible to transform the knowledge of mathematical form into the knowledge of educational form, which is also an important reason to improve the effect of classroom teaching.

Keywords: *Knowledge of University Mathematics Teachers; History of Mathematics; Philosophy of Mathematics; Mathematical Methodology*

I. A REVIEW OF THE RESEARCH ON TEACHERS' KNOWLEDGE CONTENT

Teachers' professional development is an important research topic in the educational circles of various countries. This research topic involves many aspects, such as the research on the concept of teachers' professional development, the construction of the connotation of teachers' professional development, the exploration of the ways of teachers' professional development, and so on. Teachers' professional development is based on Teachers' spirit, knowledge and ability. ^[1] From the perspective of teachers' professional development, teachers' knowledge is generally understood as teachers' general knowledge, subject knowledge, professional knowledge and practical knowledge, and can also be divided into theoretical knowledge and practical knowledge, some scholars divide teachers' knowledge into students' knowledge, environmental knowledge, subject knowledge and teaching method knowledge. No matter how to divide, subject knowledge and professional knowledge are very important for teachers' professional development. In 1986, the famous American educator Schulman put forward the theory of pedagogical content knowledge (PCK). Schulman divided teachers' knowledge into subject knowledge, general teaching method knowledge, curriculum knowledge, subject teaching knowledge, learners and their characteristics knowledge, educational background knowledge, educational objectives and values knowledge.

Although Shulman's classification of teacher's knowledge is comprehensive, its practicability in teaching process is not satisfactory. Chinese scholars divide the knowledge teachers should possess in routine teaching into three categories ^{[2][4]}, namely, mathematics subject knowledge (MK for short), general teaching method knowledge (PK for short) and knowledge about mathematics learning (CK for short). MPCK refers to the PCK of mathematics teachers, which is an important embodiment of mathematics teachers' professionalism and a key factor affecting their professional

development.

II. THE DEVIATION OF TEACHERS' KNOWLEDGE

In the traditional teaching process, there are some problems as follows. First, there is no clear distinction between teachers' mathematical knowledge and mathematicians' mathematical knowledge; Second, teachers' mathematical knowledge is equal to teachers' knowledge; Third, teachers' mathematical knowledge and professional knowledge should be equated with teachers' professional ability. It is the vague understanding of these problems that makes teachers only implement teaching according to their own teaching mode in the teaching process, rather than according to the needs of students. Therefore, it is difficult to achieve the ultimate goal of "teaching students how to learn" in the connotation of teachers' professional development, that is, how to teach students to learn and how to teach students how to learn, how to teach students how to learn something. Secondly, in the process of professional development, we can not make clear what knowledge we need and how to improve our professional ability through lifelong learning, so we lack a clear direction.

From the perspective of teachers' professional development, on the basis of the basic meaning of mpck, using the research results of domestic and foreign scholars, this paper discusses the knowledge of mathematics teaching content of university mathematics teachers, so as to make teachers clear the knowledge and structural characteristics that university mathematics teachers should have, and provide a new perspective for university mathematics teachers' professional develop

III. THE STRUCTURAL CHARACTERISTICS OF MPCK FOR UNIVERSITY MATHEMATICS TEACHERSMENT

First of all, the meaning of mathematical knowledge of mathematics teachers is different from that of mathematicians. "The core difference between the two is not in the depth or the shallowness of the quality or the quantity of their mathematical knowledge, but in the fact that mathematics teachers need to organize and use these mathematical knowledge from the perspective of teaching, in order to help students correctly understand and master middle and related mathematics; Mathematicians need to take the existing mathematical knowledge as the basis for exploring new fields from the perspective of research. "^[5] Secondly, the math teacher's math knowledge is not equal to the math teacher's knowledge, math knowledge is only a part of the math teacher's knowledge; Thirdly, the knowledge of mathematics teachers is only the basis of their professional development, and the professional ability of teachers refers to the practical ability of teachers, which is the result of teachers' continuous exploration and practice for a long time.

College mathematics is different from primary and

secondary school mathematics. College Mathematics emphasizes the systematicness, preciseness and application of mathematics in various majors. Through college mathematics education, we can not only cultivate students' logical reasoning ability, abstract generalization ability and intuitive thinking ability, but also pay attention to the practicability of mathematical concepts and mathematical thinking methods. More importantly, we can cultivate students' rational thinking in constructing mathematical theoretical system and pursuing the rational spirit in mathematical science.

According to the practice of college mathematics teaching for many years, researchers believe that the knowledge content of college mathematics teachers should include the knowledge of mathematics history, mathematics philosophy and mathematics methodology besides the general knowledge of mathematics subject, general knowledge of teaching method and relevant knowledge of mathematics learning.

A. Knowledge Of Mathematical History

The knowledge of history of mathematics involves the following contents: (1) the social and scientific background of the discipline;(2) the evolution process of the important concepts in the discipline, as well as the historical significance and mathematical value of the concept;(3)the thought and idea in the mathematics discipline, namely philosophy thought, mathematics view, mathematics thought;(4)The evolution and cognitive course of mathematical theory mainly refers to the thinking characteristics and creative psychological course of mathematicians;(5)the life, contribution and personality of mathematicians.

In the process of classroom teaching, the infiltration of knowledge of mathematical history is helpful not only to cultivate students' interest, but also to grasp and cognize the concepts, principles and related theories.

B. Knowledge of mathematical philosophy

The philosophy of mathematics mainly involves the ontology and epistemology of mathematics. The ontology of mathematics is about the nature of mathematical objects or the source of mathematical objects. The development of modern mathematics shows that mathematical objects can be divided into two types: one is derived from the quantitative relationship and spatial form of the real world, that is, mathematical objects abstracted from the real world, and the other is mathematical objects established due to the demand of mathematical internal logic."To recognize the dialectical relationship between mathematics and practice means to grasp the two directions of mathematical creation. We should not only be good at abstracting new concepts, new theories and new methods from the process of solving practical problems, but also constantly invent and create more abstract and general mathematical concepts and related theories on the basis of existing concepts, theories and methods, So as to promote the inheritance and further development of mathematical culture. " [6]

The basic problem discussed in epistemology of mathematics is the truth of mathematics, that is, the truth of mathematics and its test. The truth of mathematics includes three levels: logical rationality, model truth and reality truth. There are three corresponding test standards, and the final test standard is to find the application of theory in reality directly through practice. The three mathematical crises in the history

of mathematics development, including the origin of the crisis, the philosophical analysis and the methods to eliminate the crisis, the mathematical views of the three schools of higher learning and the Bourbaki School, and the proof of the Four color problem, should become the important components of the university mathematics classroom teaching content.

C. Knowledge of mathematical methodology

What is mathematical methodology? Xu Lizhi, a famous mathematician, has given such a definition: "Mathematical methodology is mainly a knowledge to study and discuss the laws of mathematical development, mathematical thinking methods and the laws of discovery, invention and innovation in mathematics." [7] Throughout the history of mathematics, any major problem cannot be solved without mathematical thinking. The discussion of the fifth postulate in Euclidean geometry led to the birth of non Euclidean geometry; The generation of group theory comes from the problem of whether there are formula solutions to the equation of five degree or more; Because of the ingenious treatment of the Seven Bridges in Konigsberg, graph theory is presented to us; and so on. Therefore, any mathematical discipline, mathematical theory or even a concept or a principle implies a wealth of mathematical thinking methods. As we all know, in the process of mathematics teaching, we must embody three basic links, namely "why to teach", "what to teach" and "how to teach". The above three links are inseparable from the guidance of mathematical methodology.

Mathematics education is inseparable from the history of mathematics. The history of mathematics can not only tell people the logical and historical course of mathematics thought, but also help to understand the social role and humanistic content of mathematics. Philosophy of mathematics is generally regarded as a bridge between mathematics and humanity, and the history of mathematics can provide abundant materials. Emphasizing that university mathematics teachers have the knowledge of mathematical history, mathematical philosophy and mathematical methodology can not only break the single deductive knowledge structure of teaching materials, but also reflect the integrity, hierarchy and process of classroom teaching content. Practice has proved that "whether mathematics teachers have the knowledge reserve of mathematics philosophy, mathematics methodology, mathematics history and mathematics culture has become one of the internal causes of efficient mathematics teaching behavior." [8]

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