

Investigation and Research on the Mathematics Content Knowledge of Students in Yunnan Local Normal Universities

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Abstract: In this research, the method of questionnaire is adopted to investigate the components of PCK of the senior students majoring in mathematics in four local normal universities in Yunnan Province, which finds that the present situation of the mathematics content knowledge structure of normal students is not optimistic. According to the results of the survey, it is proposed that normal universities should carry out the tutorial system of professional growth to enhance the mathematics content knowledge structure level of normal students.

1. Introduction

In 1986, an American scholar Schulman put forward the idea of Pedagogical Content Knowledge (PCK), and believed that the knowledge structure of teachers includes seven components. Inspired by Schulman's research, scholars from all over the world began to think deeply about what kind of knowledge a teacher needs to have can promote the professional development of teachers. In particular, for the specific disciplines such as mathematics, teachers need to have MPCK, that is, Mathematics Pedagogical Content Knowledge. Under the background of comprehensively deepening the curriculum reform, how do teachers to teach mathematics in all stages of mathematics education to ultimately achieve the goal of cultivating students' core literacy has become an important problem to be solved urgently in current mathematics classroom teaching. For normal students who are about to become teachers, they naturally will face greater pressure and challenges. The level of understanding and mastering the pedagogical knowledge is an important index to judge whether normal students are competent for teaching. Yunnan is a multi-ethnic province, with a population of ethnic minorities accounting for about one third of the total population, and the total population of ethnic minorities is second only to that of Guangxi Zhuang Autonomous Region, ranking second in the country. Among the 55 ethnic minorities in China, there are 52 in Yunnan, and the Yi nationality has the largest population, while there are 15 nationalities including the Bai nationality, the Dai nationality, the Lisu nationality, the Naxi nationality, the Pumi nationality, the Hani nationality and the Va nationality are only in Yunnan. The overall level of education in Yunnan lags behind, especially the education in minority areas, border areas and backward poverty-stricken areas is a weak link in basic education. Since 2008, the main source of recruitment for rural special post teachers in Yunnan is local colleges and universities in Yunnan Province. The mathematics content knowledge level of students in Yunnan local colleges and universities will affect the overall quality of rural teachers in Yunnan Province.

2. Research Methods

On the basis of studying Shulman's core components of PCK theory and Grossman's connotation of PCK and Magnusson's perfection of Grossman's components of PCK from the perspective of constructivism, the theoretical framework proposes that MPCK includes three main components: (1) knowledge of mathematics content, which refers to the understanding of the basic concepts of mathematics; (2) knowledge about students, that is, knowledge that can predict the difficulties and

misunderstandings that students may encounter in learning; (3) knowledge of teaching strategies, which refers to understanding various ways of representation for mathematical concepts, rules and formulas.

The questions of the questionnaire test come from Wu Mutong's master's thesis "Study on MPCK of Normal Students in Local Universities" in Minnan Normal University. The objects of the formal test are senior students majoring in mathematics and applied mathematics from four local colleges and universities in Yunnan Province: Qujing Normal University, Zhaotong College, Dali University and Wenshan University, and the objects have already studied the related courses of mathematics education and have returned school after finishing internship. A total of 200 questionnaires were issued, and 182 effective questionnaires were collected.

The research method is a combination of quantitative and qualitative research. A questionnaire survey is conducted at first, then data collection and collation are conducted, and the collected data are analyzed and processed by SPSS10.0.

3. Research Result Analysis and Conclusion

3.1 The first five questions of the PCK self-assessment results questionnaire were self-evaluation of the test object's own PCK.

From the questionnaire, it can be concluded that after going through high school and university studies and conducting educational internship in primary and secondary schools, the test objects were still very confident about the main points of knowledge in primary and secondary schools. They were also very confident in revealing concepts in teaching and making students understand concepts. However, the test objects also need to read more materials to deepen their understanding of the main mathematical concepts and sources of thoughts in primary and secondary schools., and they also need to have an in-depth understanding of the students during the internship process, so as to easily analyze the reasons for the students' error-prone knowledge and prevent them from happening.

3.2 Investigation Results of the Three Main Components of PCK for the Test Objects

3.2.1 The performance in mathematics content knowledge

Question 6: How do you understand the three concepts of fraction, ratio and proportion? I mainly examined the test objects' mastery degree on the content knowledge. From the questionnaire, it can be concluded that the performance of the test objects is not good in understanding the basic concepts of mathematics. Only 15.4% of the participants are able to write the concepts of fraction, ration and proportion completely and correctly. 56% of the participants can only write up to two concepts, and half of them can not correctly give the text definition instead of illustrating by symbols. While 28.6% of the participants can't write a concepts, and some of them can only use numbers or formulas to illustrate (All can indicate fraction, but are confused with ration and proportion). The reasons why the participants can not write or incompletely write these concepts may be: (1) The concepts of fraction, ratio and proportion are learned in the primary school stage. In primary school stage, they didn't fully understand the three concepts, and in the middle and high school stage, they focused on learning the nature and application of fraction and proportion, so if there was no internship in the primary school during university, many of the basic concepts of the primary school were forgotten, and most of them only remembered the form. (2) Although each of the normal colleges and universities offered the courses of Mathematics Education Introduction and Mathematics Textbooks Teaching Methods during the university, the class hour arrangements are different, because the personnel cultivating programs of schools are different. Especially for the courses of teaching method in undergraduate majors, the cases cited by teachers are mainly junior high school and high school content, and primary school are rarely involved. Due to differences in student bases and learning attitudes, some normal students are not familiar with the basic concepts, rules and formulas of junior high school and high school, let alone the derivation of basic concepts m formulas and rules, so the concepts easily

confused in primary schools are more blurred.

3.2.2 Performance in teaching content and student knowledge

The (1) and (2) of question 8 is to give the wrong answers that the students may have in calculating at first, and then explain the reasons why the students may make mistakes. According to the answers give by the participants, the reasons for the errors are summarized into four categories. The number and percentage of each explanation are as follows: 78% are no sign change when parentheses are removed, 25.3% are no reduction for the final results, 8.08% are negative transfer affected by the addition and subtraction knowledge of integers, and 31.9% are other reduction of fractions to a common denominator or calculation errors. The parentheses removal rule is an important basic knowledge of number and algebra in middle and primary schools, and is also one of the important foundations of simplifying algebraic expressions, solving equations and inequalities, so when the participants see the questions with parentheses, the parentheses removal rule is naturally appeared in their minds. According to the statistical results, 78% of the participants mentioned that there is no sign change when parentheses are removed, which is really a mistake that students can easily make. The knowledge point of “parentheses removal” is both important and difficult for seven grade students. When the students just start to learn the four hybrid operations with parentheses, they need to observe whether the parentheses are preceded by plus or minus signs, and the rules are different if the symbols are different, so students need not only observation ability, but also reasoning ability, as well as developing their habits of careful and meticulous calculation. While 25.3% of the participants mentioned the second explanation (no reduction for the final results). In the stage of compulsory education, the focus of “number and algebra” is to cultivate and improve students’ calculating ability and initially cultivate students’ symbolic consciousness; therefore, it is particularly emphasized that the calculation results should be simplified, and do reduction if it can be reduced, which is also the application of the basic nature of the fraction. The algebraic field of high school and university focuses on cultivating students’ ability of abstraction and generalization, logical thinking ability and problem analyzing ability, so it is not particularly emphasized that the calculation results should be simplified. It can be seen that although the participants have undergone internship, most of the schools which the participants undergo internship are junior high schools and senior high schools, so the learning requirements of mathematics calculation in primary school are not mastered comprehensively enough. 8.8% of the participants mentioned the third explanation (when fractions with different denominators are added, adding numerators are a new numerator and adding denominators as a new denominator). Due to students learn the addition and subtraction of fractions only after they have learned the addition and subtraction of integers, and the addition and subtraction of decimals are obtained by the analogy of integers’ addition and subtraction. And the essence of the addition and subtraction rule of decimals is the additional and subtraction rule of integers, only adding a decimal point, so students tend to have a fixed mindset to transfer the rule of decimal addition and subtraction to the addition of subtraction of fractions. But they have undergone the calculation of the addition and subtraction of fractions with different denominators in primary schools and junior high schools, so most of the participants think that the students will not make such mistakes, so they don’t know enough about the students and the explanation 3 is written the least. 31.9% of the participants mentioned the reduction of fractions to a common denominator and calculation errors. This is one of reasons why students make the most mistakes in calculating problems. From the analysis of the statistical results, most of the participants can give examples to explain the reasons why students are prone to make mistakes in the calculation, indicating that the participants have some understanding of the common errors in the calculation, but not comprehensive enough. The (1) and (2) in question 8 can be scored after the participants giving the reasons for the students’ errors, they can be scored 1 points each reason. The corresponding scores are converted into corresponding MPCK levels: Level 1 (lacking) performance: the common difficulties or mistakes that students may encounter in the learning process can not be predicted, accounting for 8.2%; Level 2 (general) performance: the common difficulties or mistakes that students may encounter in the learning process can be partly predicted, accounting for 78.6%; Level 3 (abundant) performance: the

common difficulties or mistakes that students may encounter in the learning process can be wholly predicted, accounting for 13.20%.

3.2.3 Performance in pedagogical knowledge

The (3) of question 8 asks the participants to write a teaching method that allows pupils to understand the addition and subtraction of fractions. The answers of the participants are mainly summarized as the following four kinds, and the number and percentage of each kind are as follows: Mastering the “rule” of addition and subtraction of fractions and the reduction of fractions to a common denominator, accounting for 73%; method of physical objects, graphics and models, accounting for 23.6%; Mastering the unit of fraction, accounting for 5.5%, and the method by giving examples and doing a lot of exercises, accounting for 43.9%. Numerical mathematics should emphasize arithmetic, so the addition and subtraction of fractions with different denominator not only highlights the reduction of fractions to a common denominator, but also break through why it needs to reduce fractions to a common denominator. In fact, the principle of addition and subtraction of fractions, decimals and integers is the same, that is, only the unit is the same can be added and subtracted. The unit of integers and decimals is decimalism, but there are infinite units of fractions, and as long as the fractions with numerator 1 are the fractional units, so the fractional units are the key to understand the principle of addition and subtraction of fractions with different denominators. As long as the participants have this answer, their level of MPCK are considered to be the abundant level; the participants have other answers, their level of MPCK are considered to be the general level; and if there are no answers, their level of MPCK are considered to be the lacking level .

4. Research Results and Implications

4.1 Main Conclusions and the Research

The current situation of mathematics content knowledge structure of normal students is not optimistic. Firstly, only 15.4% of the participants’ mathematics content knowledge level are abundant, 13.2% of the participant’s knowledge level about students are abundant, and only 5% of the participants’ teaching strategy level are abundant. The employment rate of the graduates majoring in mathematics and applied mathematics in 2016 in a local college was only 15.7% (some students get jobs by taking the teach recruitment examinations in Yunnan, Guizhou and Sichuan provinces, while others get jobs by taking part in independent recruitment in middle schools). The level of understanding and mastering pedagogical knowledge is an important index to judge whether normal students are competent for teaching. Through participating in training(the training contents are mainly the basic knowledge of mathematics major, mathematics teaching skills in middle and primary schools, pedagogy and psychology), the employment rate can reach 50% within two years, and 90% within three years.

4.2 Implications

Normal students are the important guarantee for the future teachers, and the content knowledge of mathematics and corresponding pedagogical knowledge of normal students are the preconditions for them to become qualified teachers, therefore, how to improve the knowledge of the two aspects of normal students is of great significance. Almost all the suggestions put forward by the existing research are to constantly strengthen the students’ mastery and understanding in content knowledge, to strengthen the understanding of curriculum standards and mathematics textbooks in middle and primary schools, and to pay more attention to the teaching practice in middle and primary schools^[3], but no specific measures are given. In *Qualitative Meta-Analysis of MPCK Source Studies on Chinese Teachers*^[4], Yin Yaofang and Kong Qiping used the method of Qualitative Meta-Analysis to analyze the articles about MPCK sources in mainland China, and found that the sources of MPCK are from three levels. The first are the important sources: own teaching experience and reflection and daily communication with colleagues; the second are the secondary important sources: professional

development activities of the school after entering the school, professional books and periodicals (books and periodicals of mathematics education in middle and primary schools), textbooks and other reference books, and attending lectures or competitions in quality classes or observation classes; the third are the general sources: participation in pre-service training, on-the-job continuing education and experience as a student. Especially, the main sources of MPCK for the western rural mathematics teachers are “own teaching experience and self-reflection” and “textbooks”, and the development of rural mathematics teachers’ MPCK from other sources is not big.

5. Summary

Therefore, in order to develop the MPCK level of normal students, professional tutorial system for normal students in local normal colleges and universities should be implemented. The professional tutorial system for normal students refers to the student education system in which teachers with higher ideological and moral qualities and professional qualities give individual guidance to students’ learning, scientific research, thinking and life. The emphasis is on the guidance of normal students, mainly reflected in: first, enhancing normal students’ ability to solve problems in middle school entrance examination and college entrance examination; second, instructing students to read the articles in *Mathematics Bulletin*, *Mathematics Teaching*, *Mathematics Teaching Reference in Middle School*, so that students can share their feelings and experiences; third, undergoing internship in middle and primary school, participating in the activities of teaching and research section of middle and primary schools, and attending the class listening and evaluation of quality class and observation class; fourth, implementation of lesson study : selecting topics → drafting learning content → determining learning content (key and difficult points) → teaching design and classroom practice → teaching evaluation (analyzing teaching) → improving teaching design → sharing, communicating and writing reports.

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