

Mathematics Teacher's Needs in Their Professional Development¹

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In this paper, I would like to introduce some ideas and problems in mathematics teachers' education. The aims and content of teachers' professional education are discussed with an oriental perspective. What are mathematics teachers' needs in their professional development? What contradictions do they meet in mathematics instruction? The problems are described with the result of my survey.

Keywords: professional development, teacher education, mathematics teacher's need.

ZDM Classification: B59, C79

MSC2000 Classification: 97B50, 97C70

INTRODUCTION

The Chinese National Curriculum Standards of Compulsory School Mathematics was published in (Chinese National Ministry of Education 2001b), another National Curriculum Standards of Senior High School Mathematics was published in (CNME 2003). The two sets of Standards offer challenges to in-service and pre-service mathematics teachers. In the face of National Curriculum Standards of School Mathematics, teachers recognize that their original knowledge is not enough for carrying out the new curriculums.

Modern science and technology are developing with rapid progress; they are the force of evolution of teachers' education and also mathematics teachers' training. According to the above important documents, Chinese teachers try to cultivate the School pupils who have ability in creativity, high quality of thought and practice. As educators, mathematics teachers also need a series of professional qualities. Based on the above consideration,

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teachers' educational institutions try their best to enhance the professional education of mathematics teachers. Teachers' education is one of the old and important topics of mathematics curriculum development. Since the start of the 21st century, we have made great progress and also met a series of problems that should be further studied.

Teachers' preparation is one of most important factors of implementing the new standards of school mathematics, so that the mathematics teachers' educators need to know the current situation of mathematic teachers. Based on that consideration I made a study from last term; the study is continuing.

The study was conducted using comprehensive methodology. The approach included questionnaire, data statistics and analyses, interview and seminar, etc. The goal of my study is to find teachers' needs and learning styles in professional training. The survey is based on my professional training classes of teachers-students. Some mathematics teachers from other high schools and a group of senior undergraduate students are also involved. The methodology was grounded in an interpretive approach. Two questionnaires and follow-up clinical interviews conducted with the three groups. Group one consists of teacher-students who study as post-graduate students and for the masters degree of education. Part 2 consists of in-service mathematics teachers. Most of them are serving in senior high schools. Part 3 consists of senior under-graduate university students who are studying in South China Normal University and will serve as real mathematics teachers very soon.

1. Do the teachers have enough preparation for the challenge of National Standards of Senior High School Mathematics?

What objects are suitable for in-service mathematics teachers' education? Their particular program has a different kind of training. We try to update the learners' structure of cognition of mathematics.

According to the Chinese New Curriculum of High School Mathematics (CNME 2003), a large amount of modern mathematics is entering in senior high schools mathematics, for example:

Required courses, such as probability and statistics, introduction of algorithm, plane vector, etc.

Limited optional courses, such as derivative and its application, space vector, cases of statistics, principle of counting, etc.

Freely optional courses, such as selection of history of mathematics, security of information and code, spherics, symmetry and group, Euler's formula and classification of curved surface, one third of an angle in classical Euclid's Geometry, matrix and 2-D transformation, etc.

From September 2003 to April 2004, I made a short survey; this is continuing. It is about the professional development of mathematics teachers.

Aim of study. Firstly to investigate mathematics teachers' preparation for the new national standards of senior high school mathematics, secondly to find mathematics teachers' needs in their professional development. What topics are they interested in? What subjects do they need to learn in further study?

Table 1. Recognition of the new course in high school mathematics

| Types of module | Topics of modules | Recognition of new course | |
|---|--|---|--|
| | | I know it and have confidence to teach. (%) | I don't know and could not teach it. (%) |
| Required courses | Introduction of algorithm • | 69 (51 %) | 67 (49%) |
| | plane vector | 119 (87%) | 17 (13%) |
| Limited optional courses 1 and courses 2 | derivative and it's application | 117 (86 %) | 19 (14 %) |
| | principles of counting | 79 (58 %) | 57 (42 %) |
| | cases of statistics | 94 (69 %) | 42 (31 %) |
| | Vector in space | 100 (74 %) | 36 (26%) |
| | Simple logical language | 89 (67 %) | 47 (33 %) |
| Freely optional courses 3 of school mathematics | selection of history of maths | 78 (65 %) | 58 (35%) |
| | information safety and code • | 20 (15 %) | 116 (85 %) |
| | spherics • | 37 (27 %) | 99 (73%) |
| | symmetry and group • | 58 (43 %) | 78 (57 %) |
| | Euler's formula and classification of closed surface • | 30 (22%) | 106 (78 %) |
| Freely optional courses 4 of school mathematics | One third of an angle and expanding of number system • | 43 (32 %) | 93 (68 %) |
| | Geometrical proof | 102 (75 %) | 34 (25 %) |
| | Matrix and transformation | 117 (86 %) | 19 (14 %) |
| | Number sequence and difference | 104 (74%) | 32 (26 %) |
| | Coordinate system and parametric equation | 120 (76 %) | 16 (24 %) |
| | Selection of inequality | 108 (79%) | 28 (21 %) |
| | Introduction of number theory | 82 (60%) | 54 (40 %) |
| | Introduction of optimum seeking method and experimental design • | 41 (30 %) | 95 (70 %) |
| | Scheduling method and instruction of graph theory • | 53 (39%) | 83 (61%) |
| | Risk and making decision • | 34 (25 %) | 102 (75%) |
| Opening and closing circuit and Boolean algebra • | 17 (13%) | 119 (87 %) | |

Population. These are in-service and pre-service mathematics teachers. The in-

service mathematics teachers graduated from normal universities. They have worked as school mathematics teachers for 3–5 years. Some of them attend my further professional education class. The pre-service teachers are still studying in the department of mathematics of my university, they will graduate and work as mathematics teachers from the coming autumn.

Sample. The first group consists of 40 teacher-students. They are at the beginning of study for a master degree in mathematics education. All of them took part in and passed the entrance examination for master degree study; they were accepted from over one hundred candidates. The second Group consists of about sixty in-service mathematics teachers, who come from 4 senior high schools. The third Group of the sample consists of about 40 senior under-graduate students; they will be mathematics teachers soon. The content of the sample is about one hundred teachers.

152 invitations were issued and 136 effective questionnaires were returned. The questionnaire is about preparation for the new National Curriculum Standards of High School Mathematics.

From Table 1 we can see that most of the above topics are not familiar to many mathematics teachers, so that they need to learn the subjects from the beginning. Some other topics were known a few of their content by the teachers. They hope to review and enhance their recognition of the courses. This is a great challenge for both in-service and pre-service mathematics teachers' professional development. From the above results of the survey we can see:

- Only one topic of the required courses- algorithm—was not familiar to about half of mathematics teachers, the others mathematics teachers know something about the topic but not very deep.
- Two topics of the limited optional courses were not familiar to more than half of mathematics teachers. These two topics are: principles of counting and cases of statistics.
- Five topics from the six freely optional courses 3 are not familiar to more than half of mathematics teachers, these five topics are: information safety and code, spherics, symmetry and group, Euler's formula and classification of closed surface, one third of an angle and expanding of number system, etc.
- Four of the freely optional topics 4 are not familiar to about 70% of mathematics teachers. These four topics are: Introduction of optimum seeking method and experimental design, Scheduling method and instruction of graph theory, risk and decision making, opening and closing circuit and Boolean algebra, etc.
- The topics which are not familiar to mathematics teachers can be divided into two kinds: the first kind is about modern pure mathematics and the second kind is about

applied mathematics.

- Most topics, those the teachers have confidence to teach, they also learned them well when they studied in higher education institutions.
- For some topics, such as algorithm, the senior pre-service teachers have better preparation than in-service teachers. In fact, some normal universities have set up the course of algorithm, so that about 68% of senior undergraduate students have confidence to teach this topic, but only about 35% in-service mathematics teachers have the confidence to teach it.
- For some other topics, such as the introduction of number theory, the in-service mathematics teachers have better preparation than pre-service mathematics teachers. In fact, there are only about 37% senior undergraduate students who have confidence to teach this topic, but about 75% in-service mathematics teachers have the confidence to teach it. The reason for this difference is related to the teaching program of mathematics in higher education institutions. In recent years, some universities did not pay enough attention to the subject of number theory, so that a large proportion of the senior pre-service teachers have not had enough preparation in this topic. In general, young teachers have advantage in some topics related to informational technology, and senior teachers have more confidence in traditional topics.

In the process of interview, some mathematics teachers told me: “though we did not learn some new topics of higher mathematics, we will try our best to recognize them by both self-learning and attending professional training. We believe that we can learn them well, and we will have enough confidence to teach them.” From their words, we can see, they have a warm desire for further learning!

2. What are the mathematics teacher's needs?

Currently, high school mathematics teachers do not have deep recognition of, and enough preparation for, new mathematics courses in high schools. It is a great challenge for all mathematics educators and also for the professional education of mathematics teachers. It is also a great challenge for pre-service mathematics teachers' education. Colleges and universities have a significant impact on school mathematics, primarily through their work with students who will become teachers. Faculties of mathematics of higher education also have the responsibility of professional development for in-service mathematics teachers. At present, a large group of topics related to the new standards of school mathematics were set up. As an overview of “Principles and Standards for School mathematics” (NCTM 2000, p. 19) said:

The Standards for high school students are ambitious. The demands made on high school

teachers in achieving the Standards will need extended and sustained professional development and a large degree of administrative support.

As the Chinese administration try to help mathematics teachers to satisfy the needs of the new standards (CNME 2001a), I wonder how we can guarantee that the reformation of the new curriculum will be developed forward in a stable and smooth progression? I suggest that the historical experience should be recalled.

Based on the current situation of teachers' professional development, our central and provincial governments try to increase the support for mathematics teachers' professional development. More and more mathematics teachers are given an opportunity for further study. For the investigation of mathematics teachers' needs, 107 invitations were issued and 101 effective questionnaires were returned. From the questionnaires of "What courses do you hope to study in the process of professional development?" I have found:

Table 2. What subjects do mathematics teachers need to learn in professional development?

| Type of courses | I strongly need | I need | I only need some | I do not need |
|--|-----------------|--------------|------------------|---------------|
| Higher mathematics which related to the new standards of curriculum | 45 (44 %) | 29 (29 %) | 22 (22 %) | 5 (5 %) |
| Primary mathematics which related to the new standards of curriculum | 45 (44%) | 31 (31%) | 21 (21%) | 4 (4%) |
| Philosophy, structure and implement of new standards of curriculum | 36 (36%) | 36 (36%) | 19 (19%) | 10 (9%) |
| Paper composition of mathematics education | 55 (54 %) | 17 (17 %) | 16 (16 %) | 13 (13 %) |
| Psychology of mathematics teaching and learning | 61 (60 %) | 26 (26 %) | 9 (9 %) | 5 (5%) |
| Mathematics courseware designing | 63 (62%) | 29 (29 %) | 6 (6%) | 3 (3%) |

- Mathematics teachers have some common needs of further learning. For instance, most of the testees expressed their strong desire for developing and maintaining the mathematical and pedagogical knowledge they need to teach their students well. Only a few people said "I do not need any further study."
- Different teachers' interests and aspirations may be different; their needs in professional development are also not the same. In fact, we have found some differences between teacher-students who are receiving professional training and in-service mathematics teachers who work in high schools. On average, most teacher-students strongly hope to learn the subjects which be shown in table 2, more than half in-service mathematics teachers said they need (on a general level) to learn the subjects, so that we can see teacher-students have a stronger desire for further

learning.

- Four years ago, most mathematics teachers thought that their mathematics to be enough for school mathematics instruction, because they made good preparation when they were undergraduate students in university. Pedagogy and psychology are the most important subjects they needed to learn. Now, mathematics teachers think that they also needs to be learning advanced mathematics, because they meet a lot of new topics, new problems requiring to be solved. After the publication of the National Curriculum Standards of Senior High School Mathematics (CNME 2003), most mathematics teachers worry about how to teach the new topics of advanced mathematics. Based on the teacher's requirement, a group of topics in new mathematics was designed as the main content of a teacher's professional training.

Teachers should catch up with the development of society and technology. Teachers should continually study in order to make up their knowledge, enhance their own ability, so that they can be able to go forward along with our century, to catch up with the development of science and technology.

CONCLUSION

Summing up my research, I can set out the following conclusions:

- The National Curriculum Standards of High School Mathematics have made a great challenge to the professional development of mathematics teachers. They recognize that they need to learn a large group of new topics so that they can satisfy the instruction needs of new courses.
- Currently Chinese mathematics teachers actively pay close attention in preparing the instruction according to the Standards of the mathematics curriculum, but the preparation is far from enough. A large number of mathematical topics are not familiar to many mathematics teachers. How can we help them to recognize the new topics? This is a serious task for the professional development of mathematics teachers.
- Mathematics teachers' needs are wide and various. They need to increase their knowledge of pure mathematics and applied mathematics, advanced mathematics and elementary mathematics, etc. They also need to learn the subject of pedagogy, psychology, technology, etc.
- Our world is diversiform, different mathematics teachers have their particular backgrounds, desire and interests, they hope to develop in some special fields, so that they need ample opportunities and wide space for professional development.

Mathematics Teachers' needs are changeable, the professional education of mathematics teachers should also be reformed along with the development of the curriculum of mathematics.

- The professional development of mathematics teachers' and the reformation of the mathematics curriculum are closely related with each other; both of them are large projects. Mathematics teachers needs ample opportunities and also need enough time. Therefore, the speed of going forward with a new mathematics curriculum should be suitable and stable.
- The results of the questionnaire are based on the mathematics teachers' perceptions of their recognition of the topics. Are there any differences between their self—sense and their real competence in teaching the new topics of high school mathematics? A further assessment should be continued.

We have achieved in some kinds of training but also met some challenges. We hope to learn some new ideas and experience from our colleagues overseas and try our best to solve the problems.

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