A Study of Teaching Knowledge Development of a Chinese Senior-High School Math Teacher Based on One Class in Xinjiang Province

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Teaching knowledge sources for prospective senior high school math teachers obtaining new curriculum background are mainly derived from several following aspects: self-directed learning and self-reflection teaching practices and experiences, communication with colleagues, training in continuing education, pre-employment training in mathematics specialty and teaching method of mathematics. Among them, the first three aspects shall play a significant role in developing the teaching knowledge of a math teacher in senior high school. Post-training continuing education and pre-employment training also can play a certain role in developing teaching knowledge of a math teacher in senior high school to some extent.

Key words: prospective, math teacher, teaching knowledge, development.

Introduction

In his doctoral paper "*Study on Development of Teaching Knowledge for Teachers,*" Mr. Fan Lianghuo did research on the problem "How do teachers develop their teaching knowledge?" through a quantitative approach (questionnaires) and qualitative method (classroom observation and interview). His final conclusion is that: teaching knowledge of mathematics teachers originates mainly from "their teaching experience and review" as well as "daily communication with their colleagues," while their personal experience as a student, especially pre-service training, is of least importance. Taking into account that his sample is from the 25 best high schools in Chicago, Illinois, America, it deserves much attention on how to develop Chinese teachers' teaching knowledge. The two nations share common ground and salient differences in terms of social conditions, school education and especially the cultivation development environment for teachers. This paper, with

observations in a math class in a senior high school, attempts to explain how domestic mathematics teachers develop their teaching knowledge in senior high schools. In particular, we try to answer the following questions:

(1) Do mathematics teachers in Chinese high schools obtain their teaching knowledge from different sources?

(2) Those different sources pose influences on the development of teaching knowledge of mathematics teachers in Chinese high schools. How much influence?

"Teaching knowledge" herein is quoted as defined in, namely the knowledge that the teachers applied in teaching of mathematics, covering three parts: course knowledge, content knowledge, and method knowledge, which will be further explained.

Research Process

Subject

We selected one from 21 mathematics teachers at No.8 High School of Urumqi (hereinafter referred to as Teacher L). His background is as follows: male, 31-years old, 8 years of teaching experience, bachelor's degree, graduated from Shaanxi Normal University.

Instruments

We collected information mainly through observation of a mathematics class and interview with teachers. This class covers the content of the Ninth (B) version of solid geometry for sophomores in high school, with its topic as "Determine line, plane and angle by adopting normal vector" and the subsequent interview is arranged on the next day. Why did we take such measures to collect such data and information? That is because the teaching knowledge of mathematics teachers is a "contextualized, recessive" one, which usually depends on specific time, place and situation. This knowledge in nature is lack of salient characters like mathematics, physics knowledge and can only be reflected and revealed in an actual teaching environment. Through visiting a mathematics class can we find what teaching knowledge a teacher has and through interviews can we discover and prove the actual condition and corresponding source hereof.

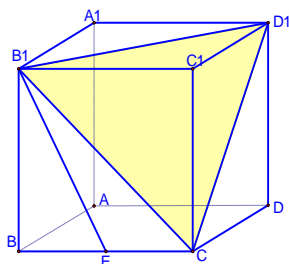### Data collection and coding
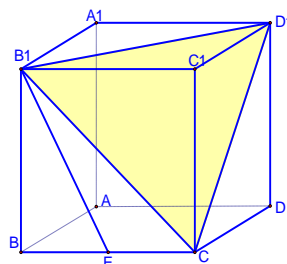
Figure 1.   *Figure 2.*

Besides on-site records, we also took video and notes for this class and the interview. The main points and links of the class by Teacher L are as follows:

(1) Topic Introduction: in Cube AC_1, E is the midpoint of BC, please determine the measure of the angle between Line B_1E and Plane B_1D_1C (refer to Fig 1)

(2) Figure 1 Exploring: how do we determine the angle between a line and a plane through a normal vector?

(3) Analysis of Example:

Example 1: In a cube, the length of Edge AC_1 is 2, E and F are the midpoints of Edge BC and CD respectively. Please set up appropriate coordinates and determine one normal vector of each plane as follows:

(1) ABCD;   (2) BDD_1B_1;   (3) ACC_1A_1;   (4) A_1B_1CD;   (5) $B_1D_1C_1$; (6) EFC_1

Example 2: In Cube AC_1, E and F are the midpoints of Edge BC and Edge CD respectively.

(1) Determine the angle between Line B_1E and Plane B_1D_1C

(2) Determine the angle between Line B_1E and Plane B_1C_1F

Example 3: Given the rectangler ABCD, Line PD $\perp$ Plane ABCD, PD=AD, AB=$\sqrt{2}$BC, E is the midpoint of Line CD, F is the midpoint of PB.

(1) Please Prove that Line PB $\perp$ Plane AEF.

(2) Determine the angle between Line AC and Plane AEF.

Results and Conclusion

Just as the above mentioned, a mathematics teacher should possess three kinds of teaching knowledge: course knowledge, content knowledge and method knowledge. Now, I'd like to focus on the Lesson "Determine a line,

plane and angle by adopting a normal vector" given by Teacher L, and study the origins of the three kinds of knowledge and study the relative importance of each origin.

Diverse Origins of Course Knowledge of High-school Teachers and Relative Importance of Each Origin

The course knowledge for a mathematics teacher focuses on such knowledge concerning mathematics textbooks, teaching material, computer and projector. Frankly speaking, it means the teacher needs technical knowledge of textbooks, materials, computers and projectors themselves, and operation specifications of such material and equipment. An example for course knowledge is the knowledge on tapping a computer and using a computer to conduct mathematics teaching.

> **Question:** Although your topic is "Determine a line, plane and angle by adopting a normal vector," there is no expression of how you obtain such knowledge.

> **Answer:** The textbook (Ninth (B) version of solid geometry for sophomores in high school) only gives a general profile on normal vectors other than its application on space angles. It is my first time to teach such content. I am basically a stranger. After consultation with a teacher in my office, I began to know the normal vector and to understand its excellence in seeking space angles. That teacher has taught this class twice.

> Q: Do you often communicate with that teacher?

> A: No, we are busy and we only discuss a view when it is necessary.

> Q: In your opinion, the normal vector enjoys its excellence in seeking space angles. How did you know it?

> A: My experience of doing problems. I used to seek space angles by the definition method, but later I found that it is simple through a normal vector.

According to the aforesaid conversation, we could know that Teacher L obtained the knowledge of this class mainly from his "consultation with colleagues" and "personal experience." We notice that the knowledge on space and vectors is covered in a college course "Space Analysis Geometry," so we designed the following questions to examine whether professional courses in college posed an influence on his class.

Q: We notice that is a college course "Space Analysis Geometry" covers the knowledge on space and vectors. Is such knowledge helpful to your class?

A: Yes, it is helpful. Although I forgot some, I am impressed with some basic ideas.

We noticed that Teacher L also used a computer and a projector, so our conversation enters this field.

Q: A computer and a projector are used in class. How did you learn to use them?

A: I mainly rely on my personal operation, although I received related training at an adult training center.

Q: This class is subject to "Geometric Sketchpad." Is that taught at that training center?

A: No, that center only offered operation methods on common software, such as word processing, film making etc. "Geometric Sketchpad" is a professional drawing software and a teacher taught me its basic operation. Later I often used it in class. The more I use it, the more fluently I do so.

So, we are aware that Teacher L mainly obtained his computer knowledge from his consultation with colleagues, self learning and his training program. Now, in order to discover other channels of his course knowledge, we set forward the following topic.

Q: Other than self learning, consultation with colleagues, personal experience and training programs and professional courses in college, do you have any other channels? For example, what is your experience in primary school and middle school? Teaching research programs at your current school or municipally education center? Or other channels conducive to your knowledge on normal vector or computer operations?

A: When I was a middle-school student, I had no access to vectors or computers. There is little relevant knowledge in the teaching research programs.

Q: Why is there little knowledge in those teaching research programs?

A: Those programs lack pragmatic and effective items.

With respect to the 5(?) channels in question, Teacher L gives his order: No. 1 is self-learning and his teaching experience; No. 2 is peer consultation; No. 3 is professional courses at college; then temporary training.

After our observation and interview, we could come to a conclusion: This teacher obtained his course knowledge from five different channels, which are self-learning, personal teaching experience, peer consultation, professional courses at college and temporary training.

Diverse Sources of Content Knowledge and Relative Importance of Each Source

Content knowledge for teaching refers to such knowledge concerning specific content methods and approaches. It also means, as for a specific teaching content, how many effective methods. What methods? What are their advantages and disadvantages? What problems will occur when students try to comprehend a specific mathematics concept? Are there any easy ways for students? These items all belong to content knowledge for mathematics teachers.

We also noticed that Teacher L began this class with a note that the definition method is not an easy one for determining the lines, planes and angles in a cube. Then he compared the normal vector to "grass" on the ground. In addition, he emphasized correct calculations of the coordinate of a normal vector. So our interview focused on this teaching content.

Q: You began this class with a question rather than a direct deployment. Why did you choose such a way?

A: I want to make my students aware of the excellence of normal vectors when determining the lines, planes and angles. As you see, it is difficult for its definition to seek its XMJ in the cube.

Q: How do you command this method? Did you access this method by yourself or from other teachers?

A: When I prepared this class, I determined to show students the excellence of normal vectors, so this question came out. In another words, no one told me to conceive such a question, which is designed by me alone.

Q: I see that you take a vivid analogy, to describe the normal vector, which is like grass on the ground, vertical, long and short. How did you get this idea?

A: It is only my own idea. I often think how to carry out my teaching in a simple and vivid way. Besides, we all just began to engage in normal vector teaching; no one could tell me how to teach.

Q: For students, what is the most difficult point in this class?

A: Undoubtedly calculating the coordinate of a normal vector with the coordinate method.

Q: How did you know that calculating the coordinate of a normal vector is the most difficult point?

A: According to my teaching experience, students often make mistakes, and quite a number of mistakes are due to error calculation.

According to this part of our interview, we could say that his content knowledge mainly resulted from individual thinking and review and his teaching experience. As for the content of this class, this conclusion is acceptable. By virtue of new content, teachers are all strangers and communication with colleagues is not constructive. On the other hand, this reflects that the training for a new textbook is lagging, delayed, or invalid.

Diverse Origins of Teaching Method of High-school Teachers and Relative Importance of Each Origin

Knowledge of teaching methods means such knowledge on common teaching skills and class organization models. Another name is "Common Teaching Method Knowledge," referring to such knowledge as effective teaching skills, class regulations, action management models, organization process as well as stimulus skills. For instance, what is collaborative learning? How do we apply it in mathematics teaching? This is a kind of method knowledge, which obviously surmounts discipline knowledge.

Our conversation transferred into the origin of the teaching method because he applied a teaching method reading, "Raise a question, answer the question, class practice, step by step, discover conclusion and method."

Q: Do you often begin a class with a challenging and interesting question?

A: Yes, because a question serves as the heart or engine of the mathematics body.

Q: How did you come to command this introduction method?

A: This is the common practice for sophisticated teachers. I learned from them.

Q: You asked a total of eight students. Why did you choose frequent asking and ask and answer?

A: Ask and answer could help me command students' thoughts and find the crux.

Q: How did you learn this method "Ask and Answer"?

A: it is a common practice now in many schools. When I was at college, my teachers advised us of this method. Now, school leaders often call for this method rather than the cramming method.

Q: You put forward 3 examples, from easy to difficult, step by step. Is this also your common practice? How did you know this?

A: Yes, it is my common practice. And it is my teaching experience.

What's more, our interview covers the origin of such teaching methods as "Ask and Answer" and "Conclusion Review." His answers are respectively "his teacher's habit" and "his teaching experience and review."

With respect to the relative importance of the above origins, he gives his order: No. 1 is his teaching experience and review; No. 2 is peer consultation; No. 3 is the training program at college; then his experience in his primary school.

According to our conversation, we could come to a conclusion: This teacher obtained his method knowledge from 4 different origins, namely his teaching experience and review, peer consultation, training program at college, and his experience in his primary school.

We also noticed that the training program ranks third, indicating that training is conducive to improving the teaching method of a teacher.

Discussion

Although our conclusions are of certain unilaterality and limitation, the problems that we discovered are important: During a new course, mathematics teachers in high schools will encounter many challenges, such as vectors, probability statistics, limits and derivatives, as well as how to teach. This indicates that teachers should improve their course knowledge and content knowledge under the context of a new course. Therefore, the priority should be given to making good use of adult education and part-time training to benefit mathematics teachers. According to this paper and our investigation, when they encounter a new textbook, teachers rely much on self-learning and experience rather than adult training and education.

We also notice that peer consultation plays a role in improving knowledge and skills of teachers. Unfortunately, this consultation is temporary and inconsistent (encountering a problem). Those research and exchanging programs failed to play an active role in improving skills of teachers. That shows that those programs are not pragmatic and effective.

Pre-service courses (general pedagogical knowledge, mathematics teaching method) plays little role in improving a teacher's knowledge and skill. This calls for reform an innovation in pre-service courses. On the contrary, pre-service professional courses play a potential role in improving course knowledge and content knowledge of a mathematics teacher. During the reform of new courses, much mathematical knowledge in college has been transferred to high-school textbooks.

Reference

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