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Students' and Teachers' Conceptions of Mathematics in the New Curriculum of Mainland China

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In this research, we interviewed primary school teachers and students with hypothetical situations questions and got a comprehensive picture of the status quo of what is happening in the new mathematics classrooms of Mainland China, that is, teachers' conceptions of mathematics and their teaching approaches influence the students' conceptions of mathematics to a large extent. For the teacher who emphasizes the precision and rigidity of mathematics, her students focus on the superficial characteristics of mathematics. On the contrary, for the teacher who believes that mathematics is an open process, related to real life and rich in content, her students are more interested in mathematics and have more diverse conceptions.

Keywords: conception of mathematics, lived space
ZDM Classification: D30, C70
MSC2000 Classification: 97C99

BACKGROUND

Since 1963, every syllabus of mathematics issued in Mainland China has taken the Three Basic Abilities (computation, logical thinking and spatial visualization) as the main goals of mathematics education, with special attention given to the enhancement of logical thinking ability (Basic Education Bureau 2002). Research had indicated that the content of curriculum and teaching materials together with ideologies of teaching would affect teachers' conceptions of mathematics, while teachers with different conceptions of mathematics would consciously or unconsciously create different learning environments,

which in turn affects students' conception of mathematics as well as their mathematics learning outcomes (Wong, Lam, Wong, Ma & Han 2002). Previous studies also showed that the Chinese mathematics learning environment is associated with close ended problems and emphasis on skills with examples remote from students' real life situations (BEB 2002). Through a series of studies conducted by the research team at the Chinese University of Hong Kong on conceptions of mathematics, Wong and his co-workers found that in general, students and teachers in Mainland China possess relatively narrow conceptions of mathematics. Teachers think that mathematics is associated with precision and rigidity (Wong, et al. 2002). Students regard computation as the absolute characteristic of mathematics and estimation is not an appropriate method to do mathematics (Wong & Sun 2002).

In September, 2001, China launched the Basic Education Curriculum Reform, which advocated constructivism in learning, curriculum and teaching. In the case of mathematics, problem-solving was stressed, which suggests that the major task of mathematics-learning is to pose and solve problems. We can find such new ideas in Mathematics Curriculum Standards (trial) (abbr. Standards) (Ministry of Education, PRC 2001) and Interpretation of Standards (BEB 2002). For instance,

Mathematics is a kind of human activity and it should be close to students' everyday life;

Mathematics is a way of communication among people, and the process of learning mathematics should be full of inquiry and creation;

Mathematics curriculum should embody the construction of mathematics knowledge and enhance the discovery capacity of students;

Mathematics-learning is a process of formulating mathematical problems and solving them;

Hands-on practice, self inquiry, co-operation and communication should be taken as major means of learning.

Various textbooks were thus developed according to Standards and teachers were recruited for in-service courses of new curriculum. Despite large scale evaluations had been administered by Ministry of Education (Ma & Tang 2003), we would like to know a clear picture of the status quo of what is happening in mathematics classroom, including the possible change of students' and teachers' conceptions of mathematics and mathematics-learning, which is precisely the purpose of the present study. And some research questions were set accordingly:

What are students' and teachers' conceptions of mathematics in the new curriculum?

What is the relationship between them?

Have they changed since the implementation of the new curriculum?

Here, conceptions of mathematics are regarded as the participants' perceptions to what is mathematics or doing mathematics.

METHODOLOGY

Participants

There are eleven primary school students (denoted as S1 to S11) and two primary school teachers (Mrs. Zhao & Mrs. Xu). They are all in the same school.

S1, S2 and S9 were studying in primary 5 (P5), they used the old textbooks and their mathematics teacher had not been recruited for in-service courses of new curriculum. S3 and S4 were in primary 4 (P4), they used the new curriculum textbooks, published by Beijing Normal University (BNU), but their mathematics teacher (Mrs. Zhao, a middle aged woman, having taught mathematics for many years) had not been recruited. S5, S6, S7, S8, S10 and S11 were in primary 2 (P2), they used the new curriculum textbooks, also published by BNU, and their teacher (Mrs. Xu, a woman around 30 years old, teaching two classes with different textbooks) had been recruited.

Procedure

Hypothetical situations (Kouba & McDonald 1991) were used to tap students' conceptions of mathematics (see Wong 2001). Students were also asked to work on some open problems and explain how they approached these problems (see Wong, Lam & Wong 1998). Some documents like Standards, textbooks, test paper and homework were collected and analyzed.

RESULTS

Students' conceptions of mathematics

P5 students' conceptions of mathematics

S1, S2 and S9 are very confident in their criterions to determine whether he/she in a hypothetical situation is doing mathematics. They simply look for key mathematical words, computation requirements or if the problem requires accurate results and they believe that estimation also needs accurate numbers. S9 thinks that situations with numbers and computations do not necessarily mean it is mathematics, but what the criterions would be. S9 doesn't know.

P4 students' conceptions of mathematics

S3 and S4 don't think having numbers is a characteristic of mathematics. They both emphasize computation, but there are some differences between them. S3 thinks that estimation isn't mathematics, mathematics is what has been taught in mathematics classroom and one can apply mathematics in reality. S4 thinks that although estimation is mathematics, it must be very calculable estimation. He emphasizes that computation is a major characteristic of mathematics and he is not accustomed to relating everyday life to mathematics.

P2 students' conceptions of mathematics

The differences among students in P2 are great. S5 thinks that estimation is an important method to do mathematics, he emphasizes the implication of mathematics in real life and he said that "mathematics is a process of solving problems." S6 stresses that estimation in mathematics, not just casual guessing, but should be according to certain rules. S10 gives some examples to illustrate the function of mathematics to solve real problems. S11 thinks there is not much relevance between mathematics and real-life, but he admits that comparison, thinking, and categories are main characteristics of mathematics. S7 has the lowest mathematics score in his class and almost can't understand the problems correctly. However he also thinks that mathematical estimation is different from other estimation because it needs some rules. S8 also has difficulty to understand the problems. When she answered the hypothetical situation problems, she just looked for information about numbers and computation.

Summary

From this interview results, we find that there are great differences in students' conceptions of mathematics among different grades and different achievement levels. We even found some contradictory ideas such as mathematics' relation to everyday life and whether estimation is mathematics. Students' conceptions of mathematics in P5 is very narrow, they focus on the superficial characteristics of mathematics, like computation, accuracy, and numbers. Although using the New Curriculum textbooks, P4 Students' conceptions of mathematics have not been improved much. They still emphasize computation. They differ in their views of estimation and relevance between mathematics and everyday life. While students in P2, except S7 and S8, all look for the interior characteristics of mathematics, they think estimation reasonably is doing mathematics, doing mathematics is process to solve real problems, recheck is part of this process and most of them stress applying mathematics to everyday life.

Teachers' conceptions of mathematics

Mrs. Z's conceptions of mathematics

We collected two P4 students' homework for the whole term, two test papers and a mathematics newspaper made by students. All students' homework is about computation. Other than computation, two traditional word problems and a maze computation problem are the only different approaches that appear in their test paper. The mathematics newspaper is colorful, but all about definitions and computation, without any open problems.

More and more teachers in Mainland China think that mathematics is related to practice and comes from everyday life (Wong, et al. 2002), but the degree to which he/she put this idea into teaching practice is diverse. Although Z said that "Mathematics comes from life, and applies to life," she think some problems are not mathematics, because "this is everyday life". From Z's words, we know that she is very careful, which can't be separated from her everyday teaching habit, so it is not strange that her students pay much attention to accuracy. Z thinks the content appeared in the textbooks is a criterion to judge if it is about doing mathematics, which is the same with X, but she has narrower knowing about textbook content than X. Z also has some different opinions with her students about estimation and the relationship between mathematics and life. Maybe we can find some answer in the collections. Although Z said that estimation is part of mathematics and mathematics comes from life, she almost never emphasizes them in exercise and assignments, so accuracy is an absolute criterion of mathematics in her students' eyes.

Mrs. X's conceptions of mathematics

We collected test papers, two items of homework (one is about big numbers in life, one is a line map from school to home), and one evaluation portfolio from X. X told me her students had kept some more interesting homework. There is much freedom and creativity shown in these collections.

Following are some examples of the collected data.

1. Test paper: Estimate the total number of wild geese. (A picture of many wild geese arranged in a pattern)

2. Homework

Figure 1. Big numbers in life - S10

3. Journal

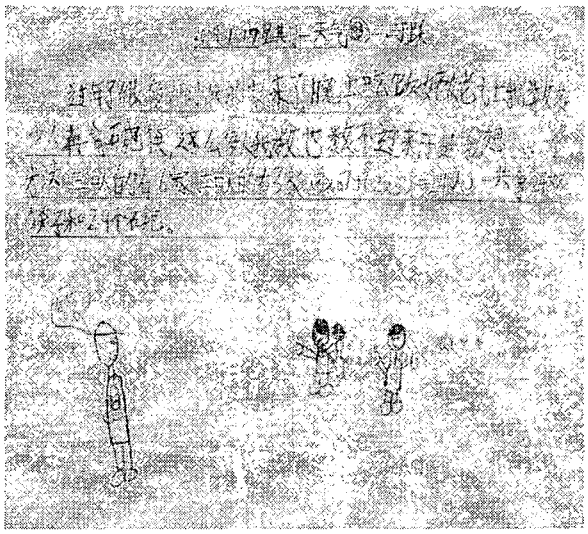

Figure 2. Spring Festival - Yu Yue

X thinks that mathematics is a process to design, research and find, and mathematics is close to life and has rich mathematics content. It seems that X is more willing to consider estimation, design, and appreciation as mathematics because these are included in the textbook she uses.

Summary

The distinction between the two teachers is obvious through analysis of the documentary and interview data. P4 teacher emphasizes the precision and rigidity of mathematics. Although she said estimation is mathematics, all the homework and tests that she gave to students are problems requiring accurate results. The P2 teacher gave students some open homework and permitted students to write or draw on it, and she asked students to do a weekly journal to record their real-life math-experiences. There are more open problems in her tests, which also include hands-on activities, estimation and real-life problems. Although both of them accept the content in the textbook as mathematics, they have different understandings of the textbooks. X believes that appreciation and design etc. is undoubtedly mathematics, but Z doesn't.

DISCUSSION

If we put together the results obtained from the students and the teachers, we can get a comprehensive picture, that is, teachers' conceptions of mathematics and their teaching approaches influence the students' conception of mathematics to a large extent. For the teacher who emphasizes the precision and rigidity of mathematics, her students focus on the superficial characteristics of mathematics and the accuracy of mathematical results. Though she has probably encountered the notion of estimation, due to the narrow "lived space" she set, her students only believe that except for "calculable estimations" (e.g. approximations), all other kinds of estimations are not mathematics. Even when students were given other forms of mathematical opportunity, they could not link mathematics and life together. On the contrary, for the teacher who believes that mathematics is an open process, related to real life and rich in content, her students are more interested in mathematics and have diverse conceptions of mathematics. Not only can they write or draw their experienced mathematics problems and solving process, but they also believe mathematics is a process of solving problems involving appreciation and estimation. Due to such a broader "lived space" of mathematics, students would like to take the initiative to find mathematics phenomenon in life and explore it. But low academic achievement students haven't great differences with P4 and P5's students; frequently they still focus on the superficial characteristics of mathematics.

Kloosterman (1996) said that hidden curriculum is the key point affecting how students learn and what they learn. De Corte, Greer & Verschaffel (1996) suggested that teacher's knowledge and beliefs don't affect students' learning directly and simply, but is mediated by the teacher's teaching behavior. Through this pilot study, we also find that the teachers' understandings of the curriculum's ideology and their practice in the

classroom set a particular "lived space" of mathematics for the students, which consequently influences the students' learning outcomes. In subsequent study, we define the "lived space" as "students' perceptions of classroom environment", so according to the theories of De Corte, et al (1996) and research model of Wong (2001), we construct a framework for future research to explore the following questions.

What are teachers' conceptions of mathematics? And what factors affect them?

Does teachers' teaching behavior consistent with their conceptions, and why?

What is the relationship of students' performance (including students' conceptions, approach to learning and cognitive outcomes), their perceptions of classroom environment, teachers' teaching behavior, and teachers' conceptions of mathematics?

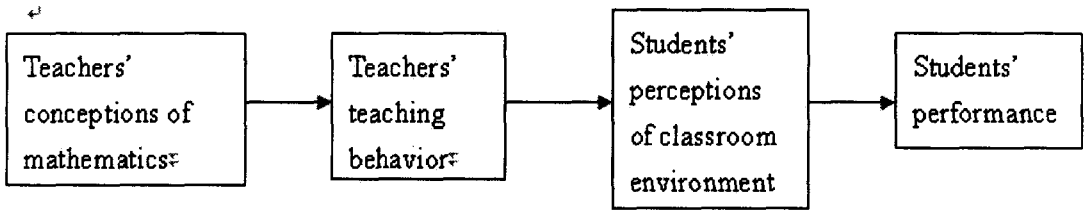

Figure 3. Framework for future research

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