

# Research on the Relationships between Students' Beliefs about Mathematics Teaching-Learning and Mathematics Classroom Culture

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The students' beliefs about mathematics teaching-learning come from the social activities in mathematics classrooms; and the mathematics classroom culture to a large extent decides the social activities in mathematics classrooms. So, the students' beliefs about mathematics teaching-learning are decided indirectly by the mathematics classroom culture mainly. The students' beliefs about mathematics teaching-learning react to the social activities in mathematics classrooms, and the social activities in mathematics classrooms react to the mathematics classroom culture. Therefore, the students' beliefs about mathematics teaching-learning react indirectly to the mathematics classroom culture. So, the relationships between the students' beliefs about mathematics teaching-learning and the mathematics classroom culture are dialectic, and the social activities in mathematics classrooms are the medium. In addition, the relationships have some inspirations to the current mathematics curriculum reform in the mainland China.

*Keywords:* mathematics classroom culture, beliefs about mathematics teaching and learning, social activities, relationships

*ZDM Classification:* C60

*MSC2000 Classification:* 97C60

## 1. INTRODUCTION

Both the research of the students' beliefs about mathematics teaching-learning and the research of the mathematics classroom culture appeared only about 20 years. Although the time is short, because of their important roles in mathematics education, they all become important topics in the modern mathematics education.

The current studies mainly concentrate on the relationships between them and students' mathematics learning. It is now generally agreed that both have tremendous influence on students' mathematics learning. This paper will study the relationships

between them, and explore the relationships realistic meanings to the current mathematics curriculum reform in the mainland China.

## 2. THE MATHEMATICS CLASSROOM CULTURE TO A LARGE EXTENT DETERMINES THE STUDENTS' BELIEFS ABOUT MATHEMATICS TEACHING AND LEARNING

### **2.1. Students' beliefs about mathematics teaching-learning come from the social activities in the mathematics classrooms**

Students' beliefs about mathematics teaching-learning are their internal recognition to mathematics, mathematics teaching and learning, teachers and students' roles in mathematics classrooms, and other related aspects. Researchers generally hold such a standpoint, namely the students' beliefs about mathematics teaching-learning will produce important influence on their mathematics learning processes and results. For example, De Corte, Verschaffel & Op't Eynde (2000) think that, if a student wants to become a capable problem solver, he has to have mathematical disposition. The mathematical disposition is integrated by five factors. The fourth of these factors is the beliefs about teaching and learning. As for the importance of the students' beliefs about mathematics teaching and learning, National Council of Teachers of Mathematics (1989, p.233) believes:

“These beliefs exert a powerful influence on students' evaluation of their own ability, on their willingness to engage in mathematical tasks, and on their ultimate mathematical disposition.”

The students' beliefs about mathematics teaching-learning can be subdivided into some small compositions. For example, Underhill (1988) divided them into four small compositions, which are the beliefs about mathematics, about mathematics learning, about mathematics teaching, and about self in the social context where mathematics teaching-learning occur. McLeod (1992) also divided the beliefs into four small compositions, which are the beliefs about mathematics, about self, about mathematics teaching, and about social context. Kloosterman (1996) divided the students' beliefs about mathematics teaching-learning into two parts: the beliefs about mathematics and the beliefs about the mathematics learning, and the latter were divided into three small parts: the beliefs about self, about the teachers' roles, and the others. Pehkonen (1996) divided the students' beliefs about mathematics teaching-learning into four parts: the students' beliefs about mathematics, about self in mathematics learning, about mathematics teaching, and about mathematics learning.

Though the researchers divided the students' beliefs about mathematics teaching-

learning into some small parts from different perspectives, the results are not incompletely consistent, but basically, they all include the belief about mathematic, about mathematics teaching, about mathematic learning, about self in the mathematics instruction, and about the social context where mathematics teaching-learning occur.

From the social perspective, the students' beliefs about mathematics teaching-learning mainly come from the social activities in their mathematics classrooms, that is to say, the social activities in the mathematics classrooms to a great extent determine the students' beliefs about mathematics, about mathematic teaching, about mathematics learning, about self in the mathematics instruction, and about the social context. As an example, the following analysis briefly explains the forming of the students' beliefs about social context from the social perspective.

The students' beliefs about social context where mathematics teaching-learning occur are mainly the beliefs of the social norms in mathematics classrooms. The social norms in mathematics classrooms include the general social norms and the socio-mathematical norms (Cobb & Yackel, 1996). The former are the norms that the teachers and the students abide by while they interact in the general classrooms<sup>1</sup>. The latter are especially the norms that the teachers and the students abide by when they interact in the mathematics classrooms, which have definite mathematical characteristics<sup>2</sup>.

Mathematics classrooms have the commonness with general classrooms, they also have the peculiarities. So, the norms of the two kinds of social activities must be considered at the same time in the mathematics classrooms. The students' beliefs about the social context are the internal recognition to the norms that are formed in the processes of the interactions among the teachers and students and that must be obeyed by teachers and students. More accurately, the students' beliefs about social context are the beliefs about general social norms and socio-mathematical norms in the mathematics classrooms.

In mathematics classrooms, the teachers and the students interact mutually. In order to make the mathematics activities carry through successfully and promote the students' learning effectively, the teachers and the students must obey some norms. Obviously, these norms didn't exist in the beginning; they are formed gradually through the teachers and students' "consultation" and "running in" again and again in the mathematics activities in mathematics classrooms. In the participating the social activities of the mathematics classrooms, the students gradually realize and approve these norms, and

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<sup>1</sup> The students should cooperate friendly in their learning. When a student has a difficulty in his/her learning, the teacher or other students should give him/her a hand. If a student makes a mistake in his/her learning, the other classmates should not laugh at him/her, etc.

<sup>2</sup> What kind of explanation is acceptable? What kind of the solution is different from other one in mathematics? What kind of solution is easy and simple and more effective? What kind of vindication is acceptable and what kind of debate is reasonable. Etc.

internalize these norms. When students have held these beliefs about the social context, they will express their beliefs through the behaviors in the activities in mathematics classrooms.

The students' beliefs about mathematics teaching-learning come from the social activities in mathematics classrooms, then, a further question is: what decide the social activities in the mathematics classrooms? The analysis of the mathematics classroom culture provides this question a good answer.

## **2.2. The mathematics classroom culture to a large extent decides the social activities in the mathematics classroom**

The culture involved in mathematics education research generally has two levels, which are the microcosmic level and the macrocosmic level. The microcosmic level culture is the culture of mathematics classrooms, and the macrocosmic level culture is the culture of out of mathematics classrooms, which is described as "broader sociocultural milieu" by some researchers (Wertsch, *et al.*, 1993). What this paper involves is the microcosmic level culture, as for the macrocosmic level culture and the relationships between two levels, some researchers have done some interesting works (*e.g.*, De Abreu, 2004), which is not involved in this paper.

The definitions to the mathematics classroom culture are not same in the literatures. In this paper, the mathematics classroom culture are what the teachers and students together create in the mathematics classrooms, which are invisible but shared by the teachers and the students, and it determines the interactions among the teachers and the students in mathematics classrooms. The definition stresses three points. First, the mathematics classroom culture stresses the invisibility, which removes the materiality (such as textbooks, teaching tools, etc.) from the mathematics classroom culture. Second, the mathematics classroom culture is created and shared by the teachers and the students, which is not decided only by the mathematics teachers, and it belongs to the whole classroom or the mathematics learning community included by teachers and students. Third, the mathematics classroom culture can exert direct influence on the interactions among the teachers and the students in mathematics classrooms, that is to say, the mathematics classroom culture can affect directly the behaviors of the teachers and the students in mathematics classrooms, and those that can not directly affect the behaviors of the teachers and the students are not included in the scope of mathematics classroom culture.

The definition of the mathematics classroom culture show that it should include the teachers and the students' sharing recognition about mathematics, mathematics teaching and learning, and the norms of teachers and the students' interactions, etc. It is not

difficult to understand that there are many kinds of mathematics classroom culture in despite of they use the same mathematics textbooks. So, the mathematics classroom culture is corresponding to the certain mathematics classroom. In different mathematics classrooms, because of having different mathematics classroom culture, the social activities will not be same completely.

Theoretically speaking, it is very clear that the mathematics classroom culture to a large extent decides the social activities in mathematics classrooms. For example, from the social perspective, there are two kinds of different mathematical views, one view is that mathematics is social, and the other is that mathematics is non-social. If the mathematics classroom culture looks mathematics as non-social, the abstraction of mathematics and individuality of mathematics learning will be emphasized in the mathematics classrooms. Conversely, if the mathematics classroom culture looks mathematics as social, the various leaning contexts, the interactions among the teachers and the students, discussion, investigation, challenge, cooperation and competition will be emphasized. If the mathematics classroom culture looks mathematics teacher's role as imparting knowledge and students' role as accepting knowledge, the teacher-centered instructional style will be taken for granted. Conversely, if the mathematics classroom culture thinks that "the students are the masters of mathematics learning, the teachers are the organizers, guiders, and cooperators of mathematics learning (Developing Group of the Mathematics Curriculum Standards, 2002)", the student-centered instructional style will be natural. If the mathematics classroom culture looks mistake-making as a normal phenomenon in the mathematics activities, the students will not laugh at the peers' mistakes.

Some empirical researches also prove that the mathematics classroom culture to a large extent decides the social activities in mathematics classrooms; these researches include Desforges, Cockburn, Cobb, and Jaworski's works (*cf.* Nickson, 1989), although these researcher's aim are not to find the relationships between mathematics classroom culture and the social activities in mathematics classrooms.

That the mathematics classroom culture to a large extent decides the social activities in mathematics classrooms means that the mathematics classroom culture don't decide the social activities completely. The mathematics classroom instruction is a complex social phenomenon. Expect for the mathematics classroom culture, other factors may also affect the social activities to some extent; these factors include attitudes, emotion, and physical condition, *etc.*

All the analysis shows that the students' beliefs about mathematics teaching-learning are decided by the social activities in mathematics classrooms, and the social activities in mathematics classrooms are decided by the mathematics classroom culture to a large extent. As a result, the students' beliefs about mathematics teaching-learning to a large

extent are decided by the mathematics classroom culture indirectly.

### 3. THE STUDENTS' BELIEFS ABOUT MATHEMATICS TEACHING-LEARNING REACT TO THE MATHEMATICS CLASSROOM CULTURE

#### **3.1. The students' beliefs about mathematics teaching-learning react to the social activities in mathematics classrooms**

It has been gained that the social activities in mathematics classrooms decide the students' beliefs about mathematics teaching and learning, or say that the students' beliefs about mathematics teaching-learning are formed in the social activities in mathematics classrooms. But, the students' beliefs about mathematics teaching-learning also react to the social activities in mathematics classrooms.

In the long-term social activities of mathematics teaching and learning, students gradually establish their beliefs about mathematics teaching and learning. Once established, the beliefs about mathematics teaching-learning are fairly stable to resist change. Just as Lester (2003) said:

“The beliefs are notoriously resistant to change, even in the face of overwhelming evidence to the contrary.”

In the social activities of mathematics classrooms, the students will understand the contents, tasks, technologies, and peers through their beliefs about mathematics teaching and learning, and their behaviors are accord with their beliefs about mathematics teaching-learning to a large extent. So, the students' beliefs about mathematics teaching-learning affect their behaviors in mathematics classrooms. Today, many countries are carrying through the mathematics curriculum reforms. The reforms want to change the traditional mathematics activities in mathematics classrooms, and changing the traditional mathematics activities means changing students' traditional behaviors, and changing students' traditional behaviors means to changing students' traditional beliefs about mathematics teaching and learning. Because the stability of the students' beliefs about mathematics teaching and learning, changing them will be very difficult.

Some empirical researches have proved that the students' beliefs about mathematics teaching-learning react to the social activities in mathematics classrooms. For example, in their researches, Kloosterman, Raymond & Emenaker (1997) discover that the students' beliefs about mathematics teaching-learning are very stable, and the new environments can't challenge their beliefs, their behaviors are fairly stable. In a research involved the students of grade 7 and 10 using a new mathematics curriculum, Joao Pedro, et al. found that the students of grade 10 are more different to change their behaviors than the students

of grade 7 in mathematics classrooms (Joao Pedro, *et al.*, 1994). These researches all show that the students' beliefs about mathematics teaching-learning are fairly stable in the new contexts of mathematics instructions, accordingly, their behaviors also are stable; when students' beliefs about mathematics teaching-learning have some change, and their behaviors in the social activities will also have some change. The students understand and participate in the social activities from their beliefs in the mathematics classrooms, so the social activities are according with their beliefs.

### **3.2. The social activities in mathematics classrooms react to the mathematics classroom culture**

It has been gained that that the mathematics classroom culture to a large extent decides the social activities in mathematics classrooms, but the social activities in mathematics classroom also react to the mathematics classroom culture.

Similar to the students' beliefs about mathematics teaching and learning, the mathematics classroom culture is formed slowly through the long-term mathematics activities, and it is difficult to change as it is established. Changing the mathematics classroom culture means abandoning and amending the sets of beliefs, attitudes, norms, and languages etc. that already have been established, and setting up a new sets of beliefs, attitudes, norms, and languages etc., in other words, changing the mathematics classroom culture means the mathematics classrooms' reacculturation, which just as Bruffee (1993) said:

“Reacculturation involves giving up, modifying, or renegotiating the language, values, knowledge, mores and so on that are constructed, established, and maintained by the community one is coming from, and becoming fluent instead in the language and so on of another community.”

Therefore, the changing the mathematics classroom culture is not an easy thing, it is a long-term and gradual process.

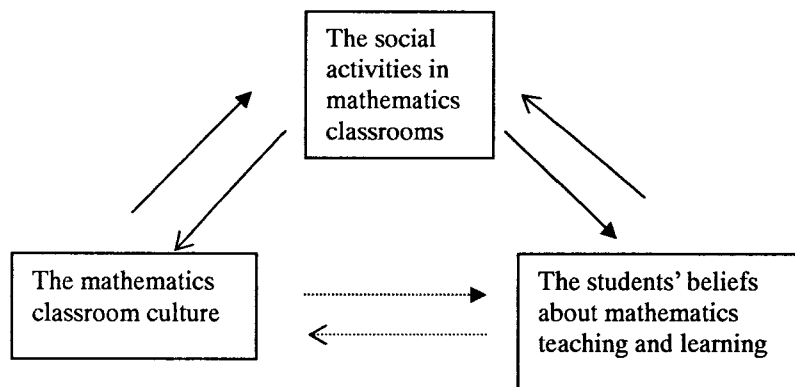
Since the social activities in mathematics classrooms react to the mathematics classroom culture, the teachers should encourage and coach the students to participate the new social activities that are according to the desire of curriculum reform. In the social activities, the teachers should enlighten the students to compare current social activities with traditional social activities, and make them understand the new social activities' values to mathematics learning. Thus, the new social activities will be accepted gradually by all students in mathematics classrooms. In the process of the new social activities replacing the old social activities and being accepted by all students in mathematics classrooms, the new mathematics classroom culture replaces the old one. Of course, the process will be gradual and not be achieved overnight.

In a word, the students' beliefs about mathematics teaching-learning react to the social

activities in mathematics classrooms, and the social activities react to the mathematics classroom culture, thus, the students' beliefs about mathematics teaching-learning react to the mathematics classroom culture indirectly. So, on the one hand, the mathematics classroom culture to a large extent decides the students' beliefs about mathematics teaching and learning, on the other hand, the students' beliefs about mathematics teaching-learning react to the mathematics classroom culture. Thus it is obtained that the relationships between the mathematics classroom culture and the students' beliefs about mathematics teaching-learning are dialectical.

In above analysis, the social activities in mathematics classrooms play an important medium role between the mathematics classroom culture and students' beliefs about teaching and learning. By this medium, the mathematics classroom cultural affects the students' beliefs about mathematics teaching and learning; also by this medium, the students' beliefs about mathematics teaching-learning react to the mathematics classroom culture. If no this medium, the students' beliefs about mathematics teaching-learning can not relate to the mathematics classroom culture.

It can also say that no social activities in mathematics classrooms is no students' beliefs about mathematics teaching and learning, and the forming of mathematics classroom culture is impossible. So, the social activities in mathematics classrooms play a very important role. The following diagram illustrates the relationships among the social activities in mathematics classrooms, the mathematics classroom culture, and the students' beliefs about mathematics teaching and learning.



*Figure 1.* The social activities in mathematics classrooms

The dialectical relationships between the mathematics classroom culture and the students' beliefs about mathematics teaching-learning are of great theoretical significance. It sets the contact explicitly between the mathematics classroom culture and the students'



beliefs about mathematics teaching and learning, which are two important topics of mathematics education research recently. When researching the mathematics classroom culture, the students' beliefs about mathematics teaching-learning must be considered; and researching the students' beliefs about mathematics teaching and learning, the mathematics classroom culture can not be ignored. Moreover, it also has the important practical significance, and can help the current mathematics instruction.

#### 4. SOME ILLUMINATIONS TO CURRENT MATHEMATICS CURRICULUM REFORM IN THE MAINLAND CHINA

Like many countries, the mathematics curriculum reform is implementing in the mainland China. The current mathematics curriculum reform changes the traditional mathematics education in many aspects, which include contents, the methods of teaching and learning, technologies, and evaluation, etc., but these changes are extrinsic, correspondingly, the mathematics classroom culture and the students' beliefs about mathematics teaching-learning are internal. From the beliefs, it is necessary to change the students' traditional beliefs about mathematics teaching-learning and to make them form the new beliefs in the reform. From the culture, it is necessary to change the old mathematics classroom culture and to establish the new mathematics classroom culture in the reform. The dialectical relationships between the mathematics classroom culture and the students' beliefs about mathematics teaching-learning have some illuminations to the current mathematics curriculum reform in the mainland China.

Firstly, it is impossible to gain the anticipant aims of the mathematics curriculum reform in a short time. The mathematics curriculum reform also means changing the mathematics classroom culture or changing the students' beliefs about mathematics teaching and learning, and changing the mathematics classroom culture or the students' beliefs about mathematics teaching-learning needs a long-term effort. Therefore, the current mathematics curriculum reform absolutely can not be finished in a short time. The thought that the mathematics curriculum reform can be finished quickly is innocent. The mathematics teachers and school leaders should recognize that the reform is a herculean task.

Secondly, it is necessary to pay attention to the students' beliefs about mathematics teaching and learning. Changing the students' beliefs about mathematics teaching-learning means the reform's success to a certain extent, so changing the students' beliefs should be a very important thing. Usually, the difficulty of the implementing the mathematics curriculum reform is thought coming from the mathematics teachers, whose knowledge, ability, and beliefs maybe hinder the reform. In the mainland China's

mathematics education research, only few researchers recognize the importance of the students' beliefs about mathematics teaching-learning (Zhang, 2007). If the students' beliefs about mathematics teaching-learning are ignored, and mathematics teachers do not use some effective strategies to change the students' beliefs, then, students' traditional beliefs about mathematics teaching-learning will become an awful obstacle of the reform. So, in current reform, it should recognize the importance of students' beliefs about mathematics teaching-learning and, moreover, use some effective methods to change their traditional beliefs and form the new beliefs.

Finally, it is necessary to pay attention to the social activities in the mathematics classrooms. The social activities is a medium between the mathematics classroom culture and the students' beliefs about mathematics teaching and learning, they are keys to establish the mathematics classroom culture and the students' beliefs about mathematics teaching and learning, so they are also keys to the mathematics curriculum reform. In the mathematics curriculum reform, it should embark from the social activities. In mathematics classrooms, the teachers should organize and guide the students to develop the social activities that are according to the request of the mathematics curriculum reform. In the process of students' rejection, reluctance, positive participating, both the mathematics classroom culture and the students' beliefs about mathematics teaching-learning form gradually. Every mathematics teacher must know that the reform begins from the social activities, the reform is not by speaking, and it is by doing.

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