

## Mathematics Pedagogical Value System Oriented Towards the Acquisition of Knowledge in Elementary School

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*The purpose of this study is to investigate the mathematics pedagogical values of a fifth grade elementary school teacher. The main methodology encompasses classroom observations and interviews. The result of the research reveals that the teacher has three mathematics pedagogical values, which are emphasized differently. However, the statement "the goal of mathematics teaching is to induce students to acquire knowledge from the textbook" serves as the main core of these three values.*

### **Introduction**

After six years of development and pilot tests, a new national elementary mathematics curriculum in Taiwan was launched in 1996. The new curriculum emphasizes on problem solving, communication, reasoning and mathematical connections, as the Standard in the United States stressed (NCTM, 1989). The reform-oriented modes of teaching tend to transfer from teacher-centered lecturing into pupil-centered learning, and put more emphasis on group discussions than classroom lecturing. Taiwan's elementary schools' mathematics curriculum and teaching is deeply influenced by that of the West. Do we have to cogitate if this approach is suitable in Taiwan's education environment? Is this approach worthy of advocating? When we are considering if it is worthwhile, we shall discuss about the mathematics pedagogical values we hold.

Mathematics pedagogical value is a new research domain (Chin, Leu, & Lin, 2001; Bishop, FitzSimous, Seah, & Clarkson, 2001). According to the view of Bishop et al, there is widespread misunderstanding that mathematics is the most value-free of all academic subjects. Since mathematics is human and cultural knowledge, teachers inevitably teach values at mathematics class. It is generally agreed that the quality of mathematics teaching would be improved if there were more understanding about teachers' values and influences. But what are those salient values regarding mathematics, mathematics education and education in general, that Taiwan's experienced elementary school mathematics teachers have?

Do those values accord with current education policies?

In this paper, the values regarding mathematics education are investigated. We identified an elementary school teacher's three mathematics pedagogical values, disclosing the relationship among these values.

### **Sample and Methodology**

The research sample of this study was Ms. Lin, who has had nine years of teaching experience in elementary school. She is currently teaching one class of twenty-seven fifth graders. In the first interview, she mentioned that "I would give extra exercises to my class in addition to the official workbook", "I felt a lot of pressure following the syllabus since there was too much material in the textbook for fifth or sixth graders", and "I struggled a lot because I felt that I was unable to help students obtain good scores". These thoughts were typical of the views expressed by most elementary school teachers when asked about their mathematics teaching experience in Taiwan. They emphasized good scores, asked students to do more exercises, and felt lots of pressure to follow the syllabus. Hence, we chose her as one of our research subjects.

According to the theory of the process of valuing by Rath, Hariman & Simon (1987), values are defined as any beliefs, attitudes, activities or feelings that satisfy the following three criteria: choosing, prizing, and acting. What satisfies the criterion of choosing is the belief or attitude chosen under free will, among several differing options or after thorough consideration. What satisfies the criterion of prizing is the belief or attitude of cherishing showing pride of or willingly made known publicly. The belief or attitude that satisfies the criterion of acting is a performance acted out repeatedly.

Based on Rath et al's theory, we used classroom observations and interviews to collect data. The purpose of classroom observation is to notice repeated behavioral patterns during the mathematics lessons. The purpose of the interviews is to recognize the reasons why Ms. Lin developed these behavioral patterns in order to form some value indicators, as well as to examine if the value indicators met the criteria of "choosing" and "prizing". The time for research is one year. Ten lessons are observed and 18 interviews are conducted.

### **Results**

Ms. Lin's three mathematics pedagogical values are of the following goals: to teach students to acquire mathematics textbook knowledge, to have students enjoy learning mathematics, and to use mathematics in solving their daily problems. According to Rath et al's theory (1987), we present our data in attempt to explain Ms. Lin's first acting value under the criteria of acting, choosing, and prizing. The

latter two values are only outlined briefly.

In the following excerpts, “I” stands for the interviewer and “S” for Ms. Lin’s students.

### **1. Acquiring knowledge from the mathematics textbook**

**Acting** Ms. Lin instructed her students to preview the mathematics material before the respective class because she believed that preparation would help her students to understand the lectures more easily. Besides, preparation also allowed the more capable students to help explain the contents in the mathematics textbook to the class as teaching assistants.

Ms. Lin’s teaching method consisted in teacher-centered lectures. She admitted that she liked being given the leading role to lecture. She usually requested students to read out loudly the textbook problems and then they were explained by the teacher. Then, she guided students to solve problems by additional practice testing questions (Ainley, 1988), as demonstrated in case 1.

#### **Case 1**

(A problem on page 93 of the textbook: Draw a circle with a diameter of 5 cm, and then compute the circumference of this circle.)

Lin: What is  $\pi$ ? 3.14. In other words, how many times of diameter is the circumference? 3.14. Since we know the diameter, how do you solve this problem then? How many times should the diameter be multiplied by?

S: 3.14.

Lin: The answer is the diameter times by 3.14, isn’t it? Thus, the answer to this problem is  $5 \times 3.14 = 15.7$ .

A self-answering questions style by the teacher is often adopted in the classroom, such as “What is  $\pi$ ? 3.14.” in the above case. There are also some testing questions such as, “How many times should the diameter be multiplied by?”. Taking a forty-minute classroom observation on June 8<sup>th</sup>, 1999 for example, there were 24 questions which she raised and answered on her own, as well as providing 69 practice testing questions in that class.

Sometimes, Ms. Lin would have students solve problems on the podium and explain the solutions to all students. She said, “There are about two problems on a page in the textbook. I do one first, and then have some students to do the other similar one in front of the whole class.” When asked would she have students try the first problem? She replied, “Yes, but not often. If the students do not give good explanations, it will take me more time to clarify the confusions”.

From the interview described above, we realized that Ms. Lin emphasized more on whether students learned how to solve problems in the mathematics textbook.

And that was the reason why she would always solve and explain those problems one by one in detail. Meanwhile, she does not stress the cultivation of students' active attitude in solving problems on their own. Therefore, she did not let students first try to solve problem on their own, in order to avoid spending more time to correct students' misconceptions. Nonetheless, we also found that in her class, she seldom allowed the students to express different solving strategies from those written in the mathematics textbook. Neither did she discuss the incorrect problem solving strategies of some students.

Why didn't she have students express their different strategies in solving mathematics problems or discuss those incorrect problem solving strategies that students used?

According to interview data, there are two reasons to explain why Ms. Lin did not encourage students use their own strategies different from those in the mathematics textbook. One is the obedience of authority. She believed strategies developed by the experts were more suitable for students. The other is the examination score issue. She was afraid that the slow speed of students' own strategies would affect their scores on paper-and-pencil tests.

The reason why Ms. Lin would not discuss the incorrect problem solving strategies is that she found more errors raised in Chinese language workbooks after showing students those errors during Chinese language class. She extended her disastrous experience from the Chinese language class to the mathematics class and thus would try not to discuss mathematics misconceptions in class.

In addition to the teaching behaviors described above, we also discovered that Ms. Lin would ask her class to review what they had learned before the end of each lecture. "The object of review on the same day is to seize the golden time for memorization when students still can remember clearly what had just been taught", she explained. From the word, "memorization", it is obvious that she emphasized not the 'process' of learning but rather the actual 'results' of learning mathematics from the textbooks.

Judging from the request for preview and review, the development of testing questions, and the avoidance of explaining incorrect problem solving strategies, we concluded that Ms. Lin's value toward goal in mathematics teaching was to have students only acquire knowledge from the textbook.

**Choosing** We raised two different ways of teaching and Ms. Lin commented on them. The first one was for teachers to take a leading role and for students to follow the textbook. The other was for students to initiate learning and for them to discuss and solve problems in a group. Ms. Lin favored the first approach for the speed and effectiveness of the whole learning process. But the drawback of this approach was

that some students may become absent-minded. She said, "The advantage of the latter approach would be to develop an awareness of the possible incorrect problem solving strategies and mistakes and to avoid them. However, if students are too lazy to participate in discussion, the group leader will let me know. I will then instruct the distracted students to be attentive." She said at the interview, "The drawback is schedule delay. Sometimes, I felt that even if I spent twice as much time, I still could not finish all the materials." "Some students might even be misled with the incorrect problem solving strategies discussion and become confused, consequently."

Ms. Lin reviewed all the pros and cons for these two approaches of mathematics teaching, considering also the time constraints involved and students' misunderstandings over incorrect problem solving strategies. She still chose the first approach where teachers took the leading role in order to instruct students to learn knowledge from the textbooks.

**Prizing** Ms. Lin emphasized previews and reviews on mathematics textbooks because she said, "Going over them three times is better than going over them twice; and twice is better than once." These words revealed that she stressed that students must acquire knowledge from the textbooks well.

According with the three criteria of acting, choosing and prizing, we are able to identify that the mathematics pedagogical value of Ms. Lin is to induce students to obtain mathematics knowledge from the textbook.

## **2. Learning mathematics happily and using it to solve daily problems**

In her mathematics class, we sometimes saw Ms. Lin use daily life examples to demonstrate mathematical concepts. For example, when she was teaching how to compute the area of circles, she mentioned cakes, and cake diameters. Why would she mention things such as cakes? She said, "To mention something edible would revive tired students, draw attention, and regain classroom focus. In the mean time, I hope students would apply what they learned in class to aspects of daily life. Mathematics is not as hard as someone would imagine. It relates with one's daily life."

In one interview, she also said, "I asked students to do an assignment about Kao's lottery last year. I gave the data from the lottery enrollment showing the winners from the newspaper, and then asked them to figure out the probability of winning a car based on the data given. It turned out that the students were very interested in this assignment, since figuring lottery probability is applicable to daily life. Through this assignment, they realized and accepted that is one of the reasons for learning mathematics in school."

From the above quoted, we know that Ms. Lin preferred students to relate

mathematics with aspects of their daily life, in hope that this would revive an interest for mathematics. She added, “I tried to use examples from daily life, making those examples as vivid as possible with jokes and humor during mathematics class, thereby transferring more joy in the learning process. Besides, operating with tools for learning on their own, students justify more joyful learning. Students like using their own instruments for learning mathematics because they could relax with their group members when solving a problem. Of course, they may converse among the group members, however, it provides for a better learning atmosphere, since students feel comfortable talking and focusing in class”.

Although she had the idea of grouping students together to operate with their own learning tools, she seldom conducted this because she had a tight schedule to keep up with. She would instruct the class to be absolutely quiet, or else she would scold the students, timing them to stand when they were noisy. Therefore, Ms. Lin acknowledged the learning tools to allow for more joyful learning, but she was unable to use this systematic learning process and to have the students to learn actively the mathematics knowledge.

According with the above situation, note that two of Ms. Lin’s value indicators are that, “Mathematics teaching’s goal is having students learn mathematics happily” and “Mathematics teaching’s goal is for students to use mathematics in solving their daily problems”.

However, Ms. Lin chose to help students learn mathematics happily and relate mathematics problems to things in daily life only when she could keep up with the syllabus and students’ examination scores. In addition, she believed, “It was most important to have students learn mathematics without pressure and happily.” She also said, “Through solving specific problems in daily life, students became more aware the reasons to learn mathematics.” Those words showed that Ms. Lin emphasized the importance of these two value indicators. Based on the criteria of acting, choosing, and prizing, we concluded that the above two value indicators enlist as two of Ms. Lin’s mathematics pedagogical values.

### **3. Relationships among mathematics pedagogical values**

Ms. Lin mentioned that one of the most important things about teaching mathematics is allowing students to happily learn mathematics. However, learning happily became just a means for learning mathematics well in the interview Case 2. Case 3, showed that teaching mathematics contents of the tests took priority over solving daily mathematical problems and learning happily.

**Case 2**

I: Ms. Lin, You said that when students learn with joy, it was to induce their motivation for learning even if they could not learn well. Hence, it seems that the ultimate goal of mathematics teaching is to motivate students to learn mathematics and learn well. Thus, learning with joy is not the ultimate goal, isn't it?

Lin: No, learning happily would not be the ultimate goal.

**Case 3**

I: Earlier in the interview, you mentioned that some abstract and mechanical topics, would later become the base for future learning, like the common divisor and common multiple. If there were some topics you had to teach within a given period before an examination, including such abstract and mechanical topics mentioned, along with those related with daily life and enjoyment, how would you schedule them under time limitations before the examinations?

Lin: I probably would compromise with the examination, giving priority in teaching topics about the common divisor and common multiple.

To synthesize teaching behaviors of mathematics at interviews and analyze mathematics pedagogical values of Ms. Lin, we maintain that relating mathematics to daily life was a means only for Ms. Lin to encourage students to joyfully learn mathematics. Correspondingly, learning with joy also meant to facilitate learning mathematics. That is, the value that mathematics teaching aims to help students use mathematics to solve their daily problems was only the instrumental value (Chen & Chen, 1990) which is a means to get the other value that teaching mathematics is to have students learn mathematics happily. While the value that teaching mathematics is to have students learn mathematics happily was also only an instrumental value which is a means to get further value that the goal of mathematics teaching is to teach students to learn the knowledge in the textbook. Therefore, "the goal of mathematics teaching is to induce students to acquire textbook knowledge." became the core of the above three values.

**Implication**

In exploring the mathematics pedagogical values of Ms. Lin, we discussed the pros and cons of teacher-centered teaching and group discussion. Ms. Lin only accepted them as teaching strategies, without realizing their hidden values and implications. For example, allowing students to solve problems in discussion groups would cultivate students' to initiate problem solving, thinking, and reasoning

abilities. The findings revealed that during teacher education of mathematics teachers, educators must not only discuss effective teaching strategies, but also those values hidden behind the strategies. Accordingly, teachers will know which strategies to choose and why those strategies are selected for teaching mathematics.

We identified, “The goal of mathematics teaching is to teach students to acquire the knowledge from the textbook.” “Teaching mathematics is to have students joyfully learn mathematics.” “Part of mathematics teaching is to help students use mathematics to apply to daily life problems.” These were the three mathematics pedagogical values of Ms. Lin. The relationship among the values are illustrated in Figure 1.

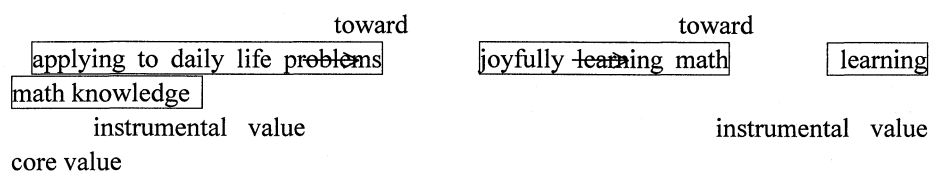


Figure1: Mathematics Pedagogical Value System, centering on mathematics knowledge acquisition in elementary school

The mathematics pedagogical value system in Figure 1 provides mathematics teacher educators the implications. Though teachers in elementary schools have many mathematics pedagogical values, their values are emphasized differently. The relationship among the values must be clarified and the core values must be identified first. Then, we may examine further whether the core values accord with current education policies. If not, then in modifying teachers' mathematics pedagogical values, changing of those core values becomes an underlying solution. Of course, how to change teachers' mathematics pedagogical values is a new research subject.

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