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Reconsidering the Category Framework for Describing Mathematics Teachers' Values[1]

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This paper proposes a modified category framework derived from VAMP and VIMT projects for describing teachers' mathematical and pedagogical values, and examines the dialectical relations between values awareness/willingness and teaching, based on case studies of student teachers of secondary mathematics from a follow-up project of VIMT. The preliminary results show that student teachers would teach certain values depending on the awareness of values priority, willingness to teach, their teaching capabilities and classroom conditions. So, mathematics teacher educators should provide relevant courses to facilitate student teachers to be aware of their implicit values and be willing to enact these values, and to empower student teachers with the knowledge and experiences to teach the values.

Keywords: awareness, teacher education, values, willingness
MESC Classification: B50
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1. INTRODUCTION

An important yet neglected aspect of mathematics education is about values teaching, as Bishop, FitzSimons, Seah & Clarkson (2001, p. 169) indicated that "there is little knowledge about what values teachers are teaching in mathematics classes, about how aware teachers are of their own value positions, about how these affect their teaching, and about how their teaching thereby develops certain values in their students". Although there is lack of literature about values teaching in mathematics, however, it has been increasingly understood that to neglect the role of values played in mathematics teaching is not sensible. Mathematics is just as much human and cultural knowledge as is any

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other field of knowledge; teachers inevitably teach values, and adults certainly express feelings, beliefs and values about mathematics which clearly relate to the mathematics teaching they experienced at school (Bishop *et al.*, 2001; Karsenty & Vinner, 2000). Many mathematics educators recognize that "the values which teachers of mathematics bring to various aspects of their work profoundly affect what and how they teach, and therefore what and how their students learn" (Bishop, Seah & Chin, 2003, p.718). It is also generally agreed that the quality of teaching would be improved if there were more understanding about teachers' values (Bishop *et al.*, 2001; Leu & Wu, 2002).

The 'Values and Mathematics Project' (VAMP) based in Australia was a 3-year research study focusing on investigating teachers' intended and implemented values in the mathematics classroom. This project raised an important aspect of understanding whether the teachers nominated particular values that they were intended to teach and how these nominations related to whether the teachers were observed to be teaching the values explicitly or implicitly (Bishop *et al.*, 2003). However, a comparison of the above categories of values found that "not all intended values are mentioned by the teachers and not all values mentioned by the mathematics teachers are explicitly or implicitly expressed in the curriculum" (Lim & Ernest, 1997, p.7). The cases observed in VAMP (Bishop *et al.*, 2003) illustrate that the factors influencing categorization of different values taught in mathematics classrooms are the teachers' degrees of awareness in their own intentions to teach particular values, and of their explicitness in teaching such values.

The 'Values in Mathematics Teaching' (VIMT) projects initiated in Taiwan covered different contexts of schooling focusing on exploring the contents and relationships of in-service mathematics teachers about intended and implemented values, and examined the extent and deepness to which the teachers could clarify or change their own values. Results of the VIMT projects (Chang, 2000; Chin & Lin, 2000; Leu & Wu, 2000) showed that some teachers were unwilling and even resisted to teach certain values; and the extent of willingness depended on their judgments of whether these values could be taught in the classroom. Therefore, we suggest that awareness and willingness are the two emerged dimensions that should be further examined in studying mathematics teachers' values (Bishop *et al.*, 2003). The present study is part of the results from the first year of a 3-year follow-up project of VIMT.

In the combination of the frameworks of VAMP and VIMT to study student teachers' pedagogical values, we found that there were no cases fitting in the 'not nominated-taught explicitly' and 'not nominated-taught implicitly' categories, but fitting well into the remaining categories (Chang, 2005). Our emergent categories appeared to be related to contents taught, student teachers' capabilities and experiences of teaching, and the awareness of values in classroom teaching. Moreover, values awareness was the crucial factor influencing student teachers to teach the values intentionally-usually they are

aware of some pedagogical values first, later feel the importance of the values, and then show a higher willingness to teach such values. The research findings in Australia (Fitz-Simons, Seah, Bishop & Clarkson, 2001) also supported that different values were taught by different teachers related to the degree of awareness of the teachers' intentions to teach certain values.

We believe that the above observations are related to our educational cultures. Perhaps Taiwanese mathematics teachers do not nominate the pedagogical values that they are not going to teach; however, they are not necessarily to realize that whether they are teaching the nominated values or not. In this case, we suspect that whether teachers implement certain values or not seems little to do with 'nominated' or 'not nominated', and the former category framework needs to be re-considered and re-integrated in terms of these new observations. It might be the teaching of a value depends largely on teachers' awareness of the degrees of importance of that value, their willingness to teach such value, their teaching capabilities and classroom conditions. In this paper, we will propose a modified category framework to locate the values observed in our present study. It consists of three facets concerning the degree of importance (superiority, inferiority) as the intended level, the extent of classroom practice (enacted, not enacted) as the implemented level, and the two former individual dimensions (awareness, willingness) as the meta-cognitive level.

2. RESEARCH METHODS

The case study method, including questionnaire survey, interviews and classroom observations, was used as the major approach of inquiry to investigate the pedagogical values of a group of 6 student teachers. The systematic induction process and the constant comparisons method (Strauss & Corbin, 1998) based on the grounded theory were used to process data and confirm evidence characterized the method of our study. A questionnaire (Chin & Lin, 1998), concerning varying views of mathematics and mathematics teaching using 5-point Likert format, was used to select the participants from a class of 46 student teachers at the third year of teacher education program who participated the methods of mathematics teaching course taught. Based on the questionnaire responses, we chose 6 representative students in terms of the statistical procedure of factor analysis (SPSS, 2004) with principal components extraction and varimax rotation, as the cases for this 3-year longitudinal study. The resulting 6-factor model, explaining 65% of total variance, was used to construe their shared beliefs. In considering both the course design and the needs of data collection, we separated the study into two significant stages (values-imaginative and values-experimental) to collect the first year empirical data. In the first stage, ques-

tionnaires, observations and critiques of a group of 5 experienced secondary teachers' classroom videotapes, and the interviews were used to uncover the 6 cases' intended mathematical and pedagogical values and the degrees of importance for these values. In the second stage, they were separated in 6 groups and trying to practice the previously professed values during micro teaching for few selected topics in secondary school curriculum. In the next section we will report one (Ning) of the 6 cases in detail.

3. RESEARCH RESULTS

The values-imaginative stage

According to the values questionnaire survey and interviews before micro teaching, Ning indicated that the values priority for her to teach the topic of functional figures and linear functions is:

(1) Mathematical essence,
(2) Thinking metaphorically,
(3) Learning with pleasure, and
(4) Communicating mathematically.

In terms of her consistent nominated these 4 out of 8 given values in the questionnaire, we classify the first two values as her superiorities, and the latter two as inferiorities (see table 1).

Table 1. Categories of Ning's intended and implemented values observed

Values		Implemented/Classroom practice	
		Enacted	Not enacted
Intended/ Degree of importance	Superiority	Mathematical essence	Thinking metaphorically
	Inferiority	Communicating mathematically	Learning with pleasure

She mentioned that mathematics teachers should address the mathematical essence and convey it to the students, and also examine the extent of students' understandings of that essence; and would use mathematical essence as the most important guideline of her classroom teaching. As she said "I do my best to get them (students) access to the nature of mathematics, because I think it is very important" and "I feel that obtaining the nature of the contents is more important for them to learn mathematics, rather than being familiar with the content knowledge". In her end of semester written report, she pointed

out particularly that "through reflecting on the process of my school learning, although I remembered lots of mathematical forms, but understood little at the time about the underlying meaning of those forms...I was not satisfied".

In responses to the questionnaire, she indicated that 'thinking metaphorically' is an important guideline for her to develop classroom teaching activities. When we asked her to explain the importance of metaphors in designing the selected topic for micro teaching, she said "it is very important but difficult to implement in the classroom", and "in looking at the videotapes of those experienced teachers, I hope that I could use their ideas to let my students come up with 'Aha'. But I found it was not easy to design the relevant activities". When we asked her if there were any possibilities to actualize such idea in the future? She answered "I will be very much like to do so, if not, I think it is because of lacking teaching experiences".

For the value of learning with pleasure, she thought that teachers must be able to handle classroom atmosphere and get the students feel the positive attitudes of learning mathematics; that teaching is trying to increase students' positive emotions of learning mathematics; and that the activities should let the students perceive pleasure. For example, she strongly agreed with the two propositions 'Mathematics teachers have to build the active atmosphere in teaching secondary school mathematics' and 'Mathematics teachers have to promote the learning atmosphere of classes in teaching secondary school mathematics'. She added that "the process of learning mathematics should be interesting and happy". Thus, when teaching mathematics she hopes that "the activities can let students enjoy the mathematics they are learning". When we asked 'Do you want to let your students get the feeling that learning mathematics is a happy moment?', she answered firmly "yes, because I find many students are panic in learning mathematics, it is better to get them feel the happiness of learning mathematics and be willing to stay with it". But she also argued that the premise of good class atmosphere is to do with teachers' arrangements of the teaching, and hope that her lessons would not be disordered. She concluded with "I would try to let them experience learning with pleasure, while not expecting students over active in the class and as regular would be the best".

Ning pointed out that she will try to communicate with students every lesson if possible. And she also hoped that students can talk about their opinions actively, so that she is able to understand the students' implicit thoughts. She said that "it is excellent if teacher and students could talk to each other, because students would then express themselves freely" and "through teacher-student dialogues I could encourage students to re-construct their mathematical ideas". She also agreed that "if there are many student talks I could then know more about students' naïve conceptions" and "I could then understand my students more about their 'blind spots' of mathematical thinking". But she did not accept the format of teacher talks and student answers.

In this stage, Ning is aware of four pedagogical values and anticipates teaching those values in her section of micro teaching. However, at the teaching experiment stage, we actually find that her values teaching are very limited for a higher willingness to teach some values rather than others. We describe the relationships among degree of importance, awareness, willingness and implemented values of Ning as follows.

The values-experimental stage

Ning was one of the 6-person team. The topic of micro teaching was the first lesson of 'functional figures and linear functions' in junior high school mathematics curriculum. She was the third of the team to teach the lesson lasting about 6 minutes. In this period, her main activity was to evaluate students' understanding of functional figures taught by the other two leading partners. She first reviewed the concept, then drew two different figures of linear function, and encouraged students to distinguish the difference between those two figures and asked them to decide which figure is $f(x) = 2x - 3$. She let them discuss each other for a moment and demonstrated the solutions, then talked to 3 individual students; in the end, she explained the underlying mathematics concepts to the students.

During this 6-minute micro teaching, on the one hand, we saw Ning explained the concept of functional figures three times, her reasons were "I always concern the 'correct mathematics concepts' in my teaching, because students would have difficulties with the concepts. I wanted them to know that the figures have to be the exactly right according to the definition, therefore I tried to emphasize the underlying concepts". On the other hand, we found that the major activity of her was to assess student learning outcomes through dialogues. In the post-lesson interview, we asked her reasons of talking to students so often? She said "I intended to talk to the students...to solve the question by the concepts of functional figures, to test and examine their understanding of the concepts. So, I just tried to make sure if they understood the concepts or not through dialogues". We then followed by asking her if 'communicating mathematically' is crucial or not? She replied "I thought mathematical communication is very important in my teaching".

But, we didn't observe Ning's use of metaphors in micro teaching. When we asked why she didn't use metaphors? She said "In fact, I like to try it...but I am afraid of using metaphors not properly. Because I have not been well prepared for teaching (lack of capabilities) and if the metaphors were used inappropriately, this would even confuse the students". In the lesson, we found that Ning was nervous and her teaching was going fast, and she looked seriously all the time. In the post-lesson interview, she confessed that "it didn't match my earlier intentions as I planned to let students feel that learning mathematics is a happy moment, and so I tried not to be too serious". When we asked about what

kind of activities were in her pre-lesson design for getting students such feelings? Her answer was "to let students get the sense of achievement in dialogues, but the situations were out of my hands at that moment and I was handling not very well". We then asked how would she do next time, she answered "I will try to do it by interaction with students".

In this stage, Ning's values of 'mathematical essence' and 'communicating mathematically' are salient in her teaching activities as shown in table 1. She intends to teach all the 4 values nominated in the previous stage. In the post-lesson interview, she re-addressed the importance of these two values and the intention to convey them to the students. Although she expressed at the same time a higher willingness to convey the contents taught to students using the appropriate metaphors, and to make them feel learning mathematics is a pleasant affair through teacher-student dialogues. But it seemed that she did not teach these two values explicitly, perhaps due to short of teaching capabilities and experiences.

Although it is not possible for us to report the values revealed in the other 5 student cases, but a temporary proposal for the modified framework is given in table 2.

Table 2. Categories of intended and implemented values observed (other 5 cases)

Cases	Values	Intended/Degree of importance (Values-imaginative stage)		Implemented/ Classroom practice (Values-experimental stage)	
		Superiority	Inferiority	Enacted	Not enacted
Ji	Mathematical essence	V		V	
	Learning with pleasure		V		V (unaware)
Han	Learning with pleasure	V		V	
	Communicating mathematically		V	V	
Tong	Individual thinking	V		V (unaware)	
	Reasoning mathematically		V		V (unaware)
Yu	Communicating mathematically	V			V (unaware)
	Learning with pleasure		V (unwilling)		V (unwilling)
Ying	Communicating mathematically	V		V	
	Learning with pleasure		V (unwilling)		V (unwilling)

4. DISCUSSIONS

The present results show that each of the 6 cases possesses the values of different degrees of importance. For student teachers, it seems fairly to say that the inconsistencies across the two stages may be due to their unfamiliar of the selected teaching topics, lack of teaching capabilities, or unawareness of the values taught. To further examine the dimensions of values awareness and willingness, their "pedagogical identities" (Bishop *et al.*, 2003, p. 726) reflected three different states, as the '*concrete*' (clearly aware of the values taught), '*indistinctive*' (not clearly aware of the values taught) and '*intermediate*' (between the previous two states) nature of the professed values. Ning, Han and Ying stayed with the concrete pole, their awareness and (un-)willingness was consistent; Tong revealed the indistinctive pole, he was unaware of being teaching some values at the values-experimental stage. Certain values such as thinking metaphorically (Ning) and communicating mathematically (Yu) were committed to be superior and also the cases had willingness to practice them but not actually observed in the classroom practice; and this 'not enacted' phenomenon was mainly related to lack of teaching capabilities and classroom conditions. Some values such as communicating mathematically (Ning and Han) were aware of as inferiorities at the first stage however enacted at the second stage, because the superior values were "felt easy to know but difficult to act" (Chin, 2002, p. 245) and the inferior values were easier to teach for them.

Therefore, we argue that the relationship between teachers' awareness and willingness of enacting values, the degree of values importance and the values that they actually practice in the classrooms are *pedagogically dialectical*. Most cases are aware of teaching some values or not, and they are willing to implement the values in the future or try to modify their teaching activities to portray those values more fully. Some cases are aware of some values but still resisting practicing them in the classrooms. Moreover, some student participants are unaware of teaching the values previously nominated during micro teaching.

Two issues of educating pre-service teachers of mathematics about values teaching need to be further investigated. One is about their awareness and willingness to teach the values in real classrooms, and the other is about the abilities and experiences to teach them. Although some student teachers are aware of and able to teach the values, however, they resist trying them out as Yu and Ying showed. There are also problems with the abilities and experiences of teaching the intended values as shown by Ning and Yu. And other difficulties are concerning with the unawareness of being teaching some values as Ji, Tong and Yu showed. Therefore, mathematics teacher educators should provide relevant courses to facilitate student teachers to be aware of their implicit values and be willing to

enact these values, and to empower student teachers with the knowledge and experiences to teach the values. We may also further examine *the proposition 'the more the student teachers are aware of the values professed, the higher the willingness that they will have to implement such values?'*

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