Primary teachers' beliefs and emotional disposition towards mathematics and its teaching

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Abstract

As researches in mathematics education and as teacher educators we are strongly interested in facing the question "what is necessary for teaching mathematics effectively". The main directions of research emphasize the cognitive side of the answer to this question. In our view, attention from a purely cognitive dimension has to shift to a wider view encompassing also an affective plane, focusing on teachers' beliefs, emotions and attitudes. We conducted a study to investigate the attitude towards mathematics and its teaching of 189 primary school pre-service teachers. We used as tool a questionnaire composed by questions focused on the three components of attitude (emotional disposition, view, perceived competence), declined along the two dimensions of mathematics and its teaching, according to the *TAMT-model*. In this paper we discuss some of the results regarding the relationships among the different components of the model with a particular attention to the links among past experiences as students, present, and future perspectives as future teachers.

Introduction and theoretical framework

Our contribution stems from the following apparently simple question, which we face as researchers in math education and as teacher educators, and which is frequently asked also by teachers themselves: *What is necessary for teaching mathematics effectively?*

To answer this question, research on teacher education seems to have focused mostly on the epistemological side, and in particular on *knowledge*. In his seminal work, Shulman (1986) recognized three different components of knowledge necessary for teaching: Curricular Knowledge, Subject Matter Content Knowledge and Pedagogical Content Knowledge. Pedagogical Content Knowledge constituted the real innovation: a knowledge "*which goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching*" (p. 9). Shulman's perspective has had a great impact on the research concerning teachers in mathematics education. More recently, Ball and Bass (2003) developed the theory of Mathematical Knowledge for Teaching on the base of the same premises.

In our view, the attention to teachers' knowledge has to be complemented by an attention to teachers' *beliefs, emotions and attitudes*, since they are crucial for the perception of classroom situations and for the didactical decisions to be taken. In other words, attention from a purely cognitive dimension has to shift to a wider view encompassing also an affective plane. In fact, as Zembylas claims:

> *Teacher knowledge is located in 'the lived lives of teachers, in the values, beliefs, and deep convictions enacted in practice, in the social context that encloses such practices, and in the social relationship that enliven the teaching and learning encounter'. These values, beliefs and* emotions *come into play as teachers make decisions, act and reflect on the different purposes, methods and meanings of teaching* (Zembylas, 2005, p.467, emphasis as in original).

Furthermore, many studies have been arguing that what teachers believe and feel have a clear influence on what students believe and feel (e.g. see Tsamir & Tirosh, 2009).

As researchers, but also as mathematics educators, we are interested in investigating teachers' beliefs, emotions and attitudes towards mathematics and towards its teaching. These dimensions are crucial in order to support teachers' professional development, especially in those cases in which the teachers are not specialists in the discipline, as it happens in Italy for primary school. Therefore we set up a research project aimed at investigating beliefs and affective factors in future primary school teachers and the relationships between them.

In literature we can find not so much attention dedicated to such theme. In order to have a theoretical foundation, we borrow a model elaborated for

students' attitudes towards mathematics: the *three-dimensional model of attitude* (TMA model) developed by Di Martino and Zan (2010; 2011). The TMA model features *attitude towards mathematics* by three strictly interrelated dimensions:

- emotional disposition towards mathematics,
- view of mathematics,
- perceived competence in mathematics.

Research in mathematics education has underlined that to analyze teachers' affect it is necessary to consider not only their attitude towards mathematics but also towards its teaching (Relich et al. 1994, p.56). Accordingly, we extend the TMA model in order to consider also teacher's emotional disposition, view and perceived competence *towards mathematics teaching* (Coppola et al., 2012). The resulting model is called *Teachers' Attitude towards Mathematics and its Teaching* (TAMT-model), and includes six interrelated dimensions, as shown in Figure 1.

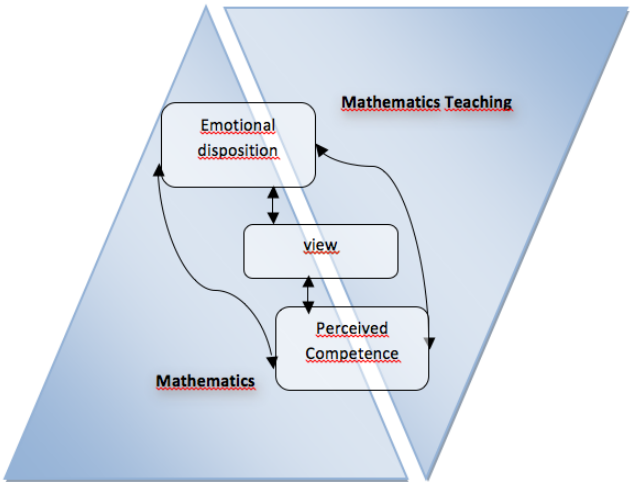

Figure 1. Teachers' Attitude towards Mathematics and its Teaching.

In this paradigm, the single affective construct is no longer a trait of the observed subject, predictive for his/her behaviors, but instead it is a model of the observer, useful to interpret and understand processes of teaching and learning (Ruffel et al., 1998).

Our research aim is on two levels. As researchers, our aim is to investigate about the six dimensions involved in attitude towards mathematics and its teaching, and their mutual relationships. As teachers' educators, our aim is to help future teachers becoming aware of the attitudes they hold: we believe in fact that this is a first and necessary step towards a possible change. In this paper, we report on the first level, and in particular on the results obtained in a study focused on primary pre-service teachers.

Methodology

The study involved 189 future primary school teachers of two different Italian Universities: a small University in the South and a bigger one in the North. Students were enrolled in the courses on Mathematics and its Teaching that take place during the first year of the University Degree for primary school teachers (the courses are compulsory in order to get the Degree). The investigation tools are an open questionnaire and an interview; in this paper we focus only on the questionnaire.

The questionnaire is composed by 12 questions focused on the three components of attitude (emotional disposition, view, and perceived competence), declined along the two dimensions of mathematics and its teaching, according to the TAMT-model (see Table 1).

The questionnaire was developed on the basis of results gained in previous research with primary pre-service teachers (Di Martino & Sabena, 2010; 2011). It was administered in the very first lesson of the course at both the Universities in the academic year 2011-2012, as the first activity in the course. Respondents were asked to answer on a volunteer base, anonymously, and providing a nickname.

The questionnaire is oriented to capture relationships and dynamics developing in the subjects over the time. In particular, we were interested in seizing links between the past experience as students and the perspective towards the future teaching. Present is of course pervasive, since every answer is filtered by the subjects' present views and emotions.

	Mathematics	*Mathematics teaching*
Emotional disposition	4. Write three emotions you associate to the word "mathematics". 5. How was your relationship with mathematics as a student? □Positive □Negative □Indifferent □Ups and downs Explain why you think that your relationship was so.	10. Which emotions do you feel in knowing that you will have to teach mathematics? Why?
View	1. Write three adjectives you associate to the word "mathematics". 2. What is, in your opinion, a positive feature of mathematics? Why do you think so? 3. What is, in your opinion, a negative feature of mathematics? Why do you think so? 6. Indicate three qualities you consider necessary in order to succeed in mathematics. 8. For which reasons, in your opinion, can students have bad results in mathematics? 9. In your opinion, why is it important that mathematics is taught at school?	12. Which characteristics should have in your opinion, a "good" mathematics teacher?
Perceived competence	7. In which measure do you think to have the qualities written in the previous answer?	11. Try to describe some difficulties you expect to meet in teaching mathematics.

Table 1. The questionnaire, according to the TAMT model.

Data analysis is carried out by means of descriptive statistics and qualitative methods. By the analysis of the answers to the questionnaire some future teacher's profiles seem to emerge, influenced by past experiences as math-students. The goal of the analytical process is identifying and describing the relationships among the different components of the model (emotional disposition, view and perceived competence), with a particular attention to

the links among past experiences as students, present and future perspectives as future teachers.

Results and discussion

Emotional disposition

At first we focused on the relationship between the participants' emotional disposition towards mathematics and towards its teaching, in relation with their past experiences as math-students (Coppola et al., 2012). As regards mathematics, from the answers to Question 4 we detected a strong predominance of negative emotions. However, comparing the attitude towards mathematics with the attitude towards its teaching, we find out that

- positive relationship or positive emotions towards mathematics are always combined with positive emotions towards the idea of having to teach it; *but*
- negative relationship or negative emotional disposition towards mathematics, are *not* always combined with negative emotions towards the idea of having to teach it .

In some cases the negative emotions, strictly linked to negative past experiences, appear to be the origin of rooted and precise beliefs influencing negatively the perspective of teaching mathematics. However, in many cases respondents declare negative emotions towards mathematics or a negative relationship in the past with it, *and* positive feelings related to the perspective of having to teach it.

These relationships emerge if we compare the answers to Question 4 (about emotions that students associate with mathematics), Question 5 (about their past relation with mathematics), and to Question 10 (students' emotions about the idea of having to teach math). In particular, among those respondents who write negative emotions and declare to have negative experiences with mathematics, 40% declares to have positive emotional disposition towards the idea of having to teach mathematics, whereas 30% declares to be scared by this perspective (*ibid*.). FIN QUI

View

Considering Questions 1, 2, 3, 6, 8, 9 we can have information about respondents' views on mathematics. In particular, focusing on the analysis of the answers to Question 9, it seems that three main categories of views of

mathematics come into sight. We called them "instrumental" view, "formative" view and "cultural" one.

By the "instrumental" view we mean a view of mathematics mainly linked to computation and practical problems. As an example, a protocol belonging to this category is the one of sbu: "*we need mathematics in the everyday life, how you could know if you got the right change in a supermarket?*". The "instrumental" view is absolutely the prevailing one with respect to the other two (47% of the answers).

Nevertheless also the "formative" view is quite frequent (43%), we find it in answers such as "*mathematics is important for the developing of capabilities regarding logic reasoning*". The "formative" view category regards mathematics as a discipline that helps the individual in his/her development, in particular supporting his/her cognitive development.

The "cultural" view category regards math as a scientific discipline, evolved in the course of history, that contributes to the cultural background of citizens. Very few respondents show to have a cultural View of mathematics: only 10%. None of them refers to specific features such as proving or defining, since they refer to more general aspects or impact of Math in society, such as ada n: "*mathematics is the basis of the operation/implementation of the main findings-innovations that are part of the cultural heritage of our Western societies*".

Analysing the mutual relationships between the view of math and the emotional disposition towards math and towards it's teaching, it emerges that the instrumental view prevails (60%) in the cases in which negative past experiences are associated with a negative emotions towards the idea of having to teach mathematics. Instead, when there is an upsetting from negative past experiences to positive emotions towards the idea of having to teach mathematics, the formative view is more frequent and also the cultural one appears. In particular, the only case in which formative and cultural views go over the instrumental one is when there is an ambivalent (which often means more negative than positive) past relationship with mathematics associated with positive emotions in the perspective of having to teach it.

Perceived competence

Considering Question 7 we can gain information on the perceived competence in mathematics. Almost one third of respondents (31%) declares to have the necessary qualities in a good measure, whereas one fifth (20%) feels to be insufficient with this respect. In not a few cases (22%) respondents specify those qualities they possess that can help them with mathematics ("positive qualities") and those that prevent them to be sufficiently good in math ("negative qualities"). Considering this view emerging from respondents, we analysed Question 6 and Question 7 together in order to identify what are the qualities perceived as important by future teacher for succeeding in math.

As a result, we find a mixture of controllable and uncontrollable aspects: the most quoted are in fact reasoning and logical skills (26%), engagement (20%), patience (19%), concentration (14%), perseverance (11%), predisposition for math (10%). The same categories appear lacking in those who declare not to be competent in math, but two new categories emerge: the lack of passion for the discipline (10 respondents), and anxiety (2 respondents). In other words, a negative emotional disposition towards math appears linked to low perceived competence in math, and considered by future teachers one of the causes of such low competence.

From the analysis of the answers to Question 11, it emerged that many difficulties future teachers expect to meet in math teaching are linked to their low perceived competences. In particular, most of the respondents influenced by low perceived competences (answers to Question 7 and 11) expresses negative feelings towards the idea of having to teach mathematics (Question 10) and declares a fluctuating relationship with the subject as student (Question 5).
But in many other cases what emerges is a chance of "redemption" and hope for future teaching, also when respondents declare a fluctuating past relationship with mathematics (for a further discussion on this topic see Coppola et al., 2012).

Conclusion

The obtained results are a first validation of the TAMT model, which we introduced in our research. Considering the relationships between the components in the model (see Figure 1), we want to underline the links between the view of mathematics and the emotional disposition towards future mathematics teaching. From our data analysis it seems to emerge that

an instrumental view of mathematics, strictly linked to computation, to practical problems of everyday life, does not support a positive change of disposition towards the idea of having to teach mathematics.

We are convinced that a global vision on mathematics, that includes the cultural aspect along with the instrumental and the formative ones, is a necessary frame for teachers' Specialized Mathematics Content Knowledge (Shulman, 1986). This aspect is highly relevant with respect to our aims as teacher educators. Teacher Education courses which focus mainly (if not only) on mathematical contents, even if complemented with didactic discussions, risk to fail with future teachers that have such narrow - and in our opinion distorted - view of mathematics. As teacher educators, we claim that it is urgent that we include this kind of dimension in our work with future teachers.

The interviews that we carried out after the questionnaire constitute a first step into the route to deepen the study on the links among the past experiences, the personal relationship with mathematics and the future perspective of having to teach math. At the same time and not less important, they constitute a little step also in entering into dialogue with future teachers about their attitude towards mathematics and it's teaching. We share the conviction that dialogue is not only a pre-condition but also a means to provoke changes into people, including teachers, future teachers, and researchers.

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