

Evolution of preservice primary teachers’ attitudes towards mathematics and its teaching

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Abstract. This paper reports on an ongoing action research project aimed at investigating the evolution of preservice primary teachers’ attitude towards mathematics and its teaching and at testing the effects of specifically planned interventions on this evolution. Data from students are collected in three significant moments of their “Teaching for the elementary level” bachelor studies (DFA-SUPSI, Switzerland) through an initial, an intermediate and a final questionnaire. These instruments are designed to investigate emotional disposition, perceived competence and vision about mathematics and its teaching, following the three-dimensional model of attitude developed by Di Martino and Zan (2011). In this article, some preliminary analyses are presented.

Résumé. Nous présentons un projet de recherche-action en cours visant à étudier l’évolution de l’attitude des futurs enseignants du primaire envers les mathématiques et leur enseignement et à tester les effets d’interventions spécifiquement conçues sur cette évolution. Les données sont recueillies à trois moments significatifs de la licence en « Enseignement pour le niveau primaire » (DFA-SUPSI, Suisse) à travers trois questionnaires : initial, intermédiaire et final. Ces instruments sont conçus pour investiguer la disposition émotionnelle, la compétence perçue et la vision des mathématiques et de leur enseignement, selon le modèle tridimensionnel de l’attitude développé par Di Martino et Zan (2011). Dans cet article, quelques analyses préliminaires sont présentées.

1. Introduction

This paper reports on an ongoing action research project aimed at investigating the effects of specifically planned didactic interventions, in the context of a teacher training, on the evolution of preservice primary teachers’ attitudes towards mathematics and its teaching. The research began in the academic year 2017/18, following the 72 students who were starting their bachelor’s degree in “Teaching for the elementary level” provided at the SUPSI’s Dipartimento formazione e apprendimento, in Locarno (Switzerland). The students enrolled at this teacher training generally come from very different school backgrounds and their mathematical knowledge is often limited. For many of them, school experience with mathematics has been extremely negative, with an impact on their attitude.

This worrying phenomenon is well known to all mathematics teacher educators and spread in many countries, as documented by international research (Wood, 1987; Hannula et al., 2007; Di Martino & Sabena, 2011). Preservice primary teachers’ negative attitude towards mathematics risks having a double effect: it might affect how they approach the teacher training, as well as their identity as mathematics teachers and therefore their future choices in the classroom (Coppola et al., 2012; 2013). Hence, it appears crucial that mathematics teacher education takes responsibility for this phenomenon, creating the conditions to reinforce or to rebuild a positive relationship with mathematics. In our project, we are designing and experimenting specific interventions, while

developing observation tools to analyze and interpret any changes in attitudes towards mathematics and its teaching during the training.

2. Theoretical framework

Since the mid-1980s, mathematics education research developed a specific interest in studying students' beliefs about mathematics. This trend was born with the aim of interpreting, within problem solving activities, phenomena that are difficult to explain in purely cognitive terms (Schoenfeld, 1983). In particular, Schoenfeld (1992) highlights how students view and conceptualize differently mathematics and how this vision influences their behavior in problem solving. In the same period, drawing on the studies of Thompson (1992), an important research trend emerged with a focus on studying teachers' beliefs about mathematics. The assumption behind these studies is that the vision of mathematics can influence teachers' didactic choices (Calderhead, 1996; Sbaragli, 2006; Hodgen & Askew, 2011) and teacher-student interactions (Buehl et al., 2002). For instance, teachers who tend to consider mathematics as a static body of knowledge to be learned could be more inclined to adopt approaches that emphasize technical training and memorization.

The studies focused on students' and teachers' beliefs were the first step to go beyond the purely cognitive approach in mathematics education, assuming the influence of affective factors (emotions, values and attitudes in addition to beliefs) in the process of teaching-learning (McLeod, 1992). In this frame, attitude is considered as the more stable affective construct: in the model developed by Di Martino and Zan (2011), attitude towards mathematics is defined as a three-dimensional construct including emotional disposition, beliefs, perceived competence and their mutual relationships.

Recent studies used this theoretical model to analyze the preservice primary teachers' attitudes towards both mathematics and the idea of teaching it (Coppola et al., 2012). As the authors underline, this field is still little explored: so far, mathematics education research on teacher education has devoted much energy to determine the disciplinary and didactic knowledge that preservice teachers need, but little attention to the crucial aspect of their relationship with the discipline.

In the Italian context, Coppola et al. (2012; 2013) confirm the worrying spread, among preservice primary teachers, of strong negative (unpleasant) emotions towards mathematics. Nonetheless, they highlight an interesting phenomenon: the desire for a "math-redemption", accompanied by positive (pleasant) emotions related to the possibility of redeeming oneself from past experiences by becoming a good teacher. This desire needs for an important teacher education support in order to be fulfilled.

Drawing on these studies, we developed our project in three phases: 1) collection of incoming data and analysis of the initial situation; 2) design and implementation of didactic interventions aimed at promoting a positive attitude towards mathematics according to the picture emerged in phase 1, collection of intermediate data, and design of observational tools to analyze the students' attitude evolution; 3) collection of final data and analysis of the final situation.

One of the main objectives of the entire project, indeed, is to compare the initial and the final attitudes – described in terms of emotional disposition, vision of mathematics and perceived competence (Di Martino & Zan, 2011) – of the individual students and analyze if and in what dimension(s) they have changed, also thanks to the designed didactic interventions. In this paper, we provide a preliminary analysis of preservice primary teachers' incoming emotions towards both mathematics and the idea of teaching it, drawing on data collected at the beginning of their training, with some hints at their attitudes at the halfway.

3. Methodology

It is important to premise that data have been collected through questionnaires, built and sent online. In fact, we wanted to leave the students as free as possible to participate in the survey and not to impose them the filling of the questionnaire during the lesson hours in classroom. For this reason, the number of students composing the sample will vary from questionnaire to questionnaire, depending on the students who decided to send their answer. Let us consider the different phases of the project from a methodological point of view.

First phase (September - November 2017). In the initial phase of the project, we designed and administered a questionnaire to students in order to collect data on their incoming attitudes. This questionnaire was composed of three sections, one for each attitude dimension:

- *Emotional disposition* was investigated through open questions regarding mathematics, such as “Write the first emotion you associate with the word ‘mathematics’. Explain why you associate this emotion with mathematics”, “How would you define your relationship with mathematics?” accompanied by the description of a significant episode; and concerning mathematics teaching, namely “What emotion do you feel at the idea that one day you will teach mathematics? Explain why you think you feel this emotion”.
- Students’ *vision of mathematics* was explored by asking to indicate a good and a negative aspect of mathematics, with argumentation.
- Regarding the *perceived competence*, we measured the sources of self-efficacy in the specific context of mathematics learning through a validated measure (Ulsher & Pajares, 2009), composed by 24 items, response format on a 5-point Likert scale, ranging from 1 “Totally not true” to 5 “Totally true”.

Second phase (November 2017 - May 2019). In the intermediate phase of the project, in mathematics and in mathematics education courses, students were encouraged to change or widen their beliefs regarding their relationship with the discipline, and constantly guided to analyze and reflect on their possible choices as mathematics teachers in a metacognitive perspective. In addition, some meetings have been devoted specifically to workshops and discussions in order to make students verbalize, argue and become aware of the aspects related to their attitude towards mathematics and to their representation of the professional identity as mathematics teachers. While at the beginning of the project the great part of them had never been in a classroom, at the halfway of their training, they have had their practical internship with pupils in the classroom every week for an entire day and once a semester for a longer period of three weeks. To foster the reflection on this teaching experiences and to monitor the evolution of attitudes towards mathematics and its teaching, an intermediate questionnaire was proposed in January 2019, with the following open question: “What emotion do you feel when you think back on the mathematical activities you have proposed in your internship in the classroom? Explain why you feel this emotion”. This questionnaire was followed in presence by a group and, then, a collective discussion, both organized around questions about emotions:

- a. Compared with the beginning of the training, do you feel the same emotions towards math and towards the fact that you will teach it?
- b. If they are different, in which way they changed? According to you, what made them change?
- c. Do you think that the courses and/or the internship had an impact on these emotions?

Third phase (May 2019-August 2020). In the closing phase of the project, a final questionnaire has been designed and proposed to students (May 2019). It is composed of three sections, one for each attitude dimension, as the initial one. Some questions remain the same in order to facilitate comparison while other ones are specifically centered on the preservice teachers’ experience as

university students. Moreover, some additional questions are asked about their vision of mathematics teaching and their sense of self-efficacy as future mathematics teacher.

The participants have been assigned an anonymized identification code, so that we can make a longitudinal comparison of the collected data.

As mentioned before, in September 2017, the students enrolled at the first year of the bachelor's degree were 72: 78% of them were women, they were between 18 and 31 years old, and came from different school backgrounds, as shown in Figure 1:

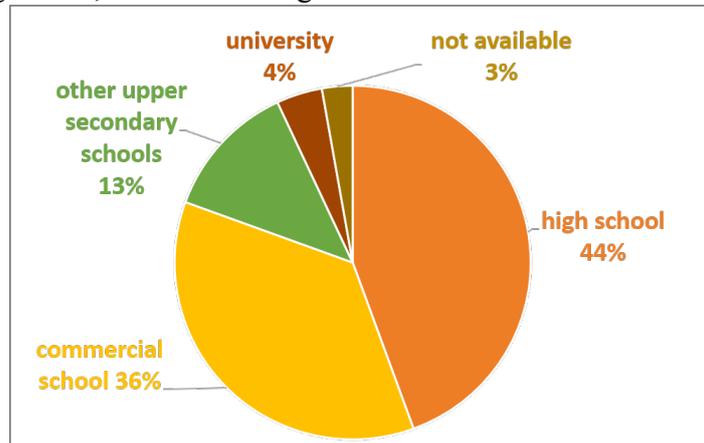


Figure 1. School backgrounds of the participants

4. First analyses

We analyzed the data emerging from the initial questionnaire, in particular those related to the students' emotional dispositions, which turned out to be very heterogeneous. Using Pekrun and colleagues' categories as analysis lenses, we identified *achievement emotions* (Pekrun et al., 2007), related to both activity and outcomes, and *epistemic emotions* (Pekrun et al., 2017), related to the knowledge-generating qualities of cognitive activities. We analyzed such emotions in terms of *valence* (positive/negative) and *activation* (activating/deactivating).

Regarding the emotion associated with mathematics (Figure 2), we identified:

- 39 negative emotions (54%): 31 activating (e.g., anxiety); 8 deactivating (e.g., hopelessness);
- 24 positive emotions (34%): 21 activating (e.g., enjoyment); 3 deactivating (e.g., relief);
- 3 contrasting or intermediate emotions (4%) (namely, enjoyment/shame and enjoyment/anxiety as contrasting, while indifference as intermediate);
- 6 non-classifiable answers (8%) that do not refer to a specific emotion.

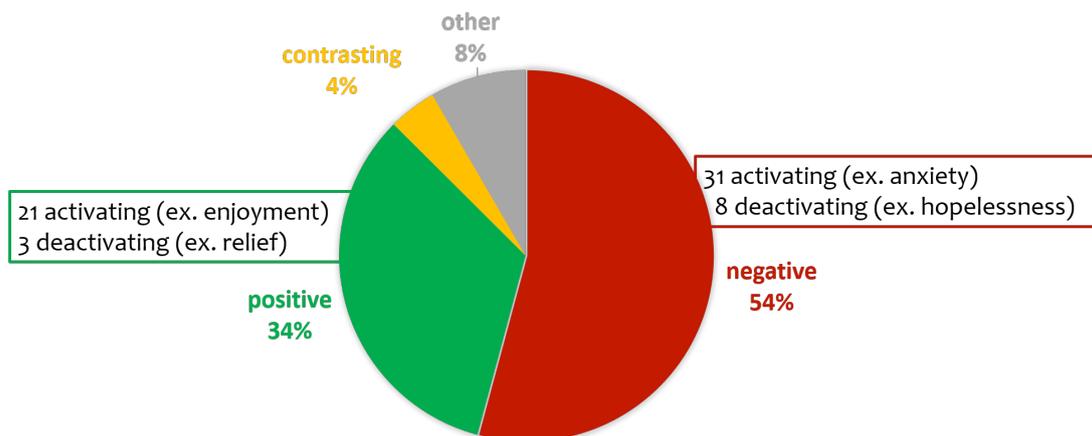


Figure 2. Students' initial emotions related to mathematics

It is worthwhile noticing that negative emotions are strong and mostly activating, such as anxiety, fear and anguish.

Concerning the emotions towards the future teaching of mathematics (Figure 3), data are more encouraging:

- 47 positive emotions (65%): 44 activating (e.g., hope); 3 deactivating (namely, calm);
- 5 activating negative emotions (7%) (namely, fear and anxiety);
- 17 contrasting emotions (24%) (e.g. enjoyment/fear);
- 3 non-classifiable (NC) answers (4%) since they do not refer to a specific emotion.

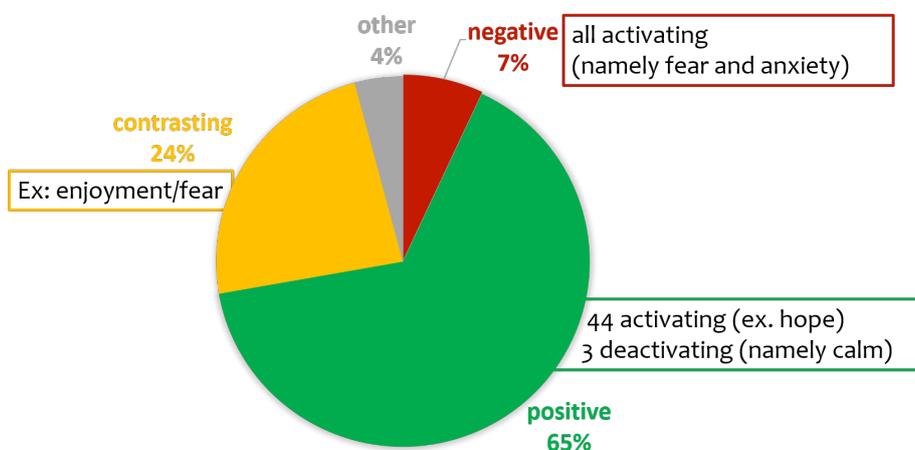


Figure 3. Students' initial emotions related to mathematics teaching

We remark that 16 of the 22 contrasting emotions towards mathematics teaching are declared by students whose attitude towards the discipline is linked to negative emotions. That is why it is interesting to cross the two dimensions in the data analysis: the emotions towards mathematics and the emotions towards its future teaching. Various profiles can be identified (see Table 1 for details):

- students whose emotions have the same characterization (positive or negative) with respect both to the discipline and to its future teaching;
- students for whom the emotion is slightly different or varies greatly, even changing from negative to positive, if expressed in relation to the discipline or to its future teaching.

Table 1. Different students' profiles according to emotions towards mathematics or its teaching.

		Emotion towards the math teaching			
		Positive	Negative	Contrasting	NC
Emotions Towards math	Positive	19 students	1 student	4 students	0 students
	Negative	21 students	4 students	12 students	2 students
	Contrasting/Intermediate	3 students	0 students	0 students	0 students
	NC	4 students	0 students	1 student	1 student

5. Discussion and perspectives

The first analyses we carried out show a prevalence of unpleasant emotions towards mathematics that can negatively influence the students' attitude towards the discipline and its teaching. Preservice primary teachers need support not only on the disciplinary and didactic sides, but in parallel they should also be helped reflect upon their relationship with the discipline and upon their being mathematics teachers in the classroom. We consider essential to foster their metacognitive reflection upon what they were able to do and what difficulties they encountered, both as adult students of mathematics and in relation to their internship in the classroom, while teaching mathematics to pupils. Identifying and sharing difficulties and how they have coped with them is promoted as an important activity in their training.

Students' preparation, in fact, without a specific work on attitudes, could be undermined as soon as negative emotions, twisted beliefs or a weak sense of self-efficacy regarding mathematics and its teaching prevail.

For example, one of the students, in the initial questionnaire, associated the emotion of anxiety with mathematics. However, the emotion she expressed at the idea of teaching mathematics one day was contrasting: a mix of anxiety, fear and calm. This case shows how important is to analyze the justifications that each student gave with respect to the emotions expressed. To this purpose, we are analyzing all the students' open answers to find reasons for specific emotions. The above-mentioned student, for instance, justified her anxiety towards mathematics as follows: *"I had teachers in high school who made me feel this way every time I entered the classroom"*. At the same time, concerning emotions towards mathematics teaching, she wrote: *"I feel a bit of anxiety anyway, because of my 'bad' past with this subject, but on the other hand the fact that I will teach in a primary school calms me down, because it is not the mathematics I had difficulty with (which was high school mathematics). However, there is a part of me that is a little bit scared because I want to be able to teach it well, so that my future pupils will not find themselves in the same situations as me (suffering because I did not understand anything)"*. Notice that her attitude towards mathematics was clearly influencing her attitude towards mathematics teaching. Negative emotions towards mathematics were mixing with her desire of a math-redemption (Coppola et al., 2012).

In this regard, concerning the evolution of students' attitudes especially in the emotional dimension, which is the object of this paper, we already have some promising data from the intermediate questionnaire that has been sent back by 32 students. Our analyses are ongoing, but we can identify a generally positive trend regarding the emotions towards mathematics teaching. Anyway, there are also some non-negligible cases in which the trend is slightly negative (see Table 2 for details).

Table 2. Emotions towards mathematics teaching in the intermediate questionnaire compared to those of the initial questionnaire.

	Initial emotion	Intermediate emotion	Number of students
14 stable cases	Positive	Positive	13
	Negative	Negative	1
10 positive trends	Contrasting	Positive	7
	Negative	Positive	2
	Negative	Contrasting/Intermediate	1
8 negative trends	Contrasting	Negative	1
	Contrasting	Contrasting	1
	Positive	Contrasting	5
	Positive	Negative	1

The reported trend is encouraging for our research project. Moreover, in the discussion meeting held after the intermediate questionnaire, some students confirmed that something has been changing. They also provided reasons of this evolution; for instance, one of them claimed that her vision of mathematics teaching has been changing, and she made explicit reference to the courses: *“[The change has happened] with the courses we have done here. The aspects of the a-didactic and laboratory situations, in which children build their knowledge, leads us to have a more open vision and not to consider mathematics as mechanics. Here we have been offered many ideas and we have been able to realize some of them in our internship”*.

Feedback of this kind are important for us, since with our action research we expect to have an influence on the teacher education courses offered by our Department: not only for the bachelor’s students involved in the project, but also for future pre- and in-service teachers, with indirect effects on their pupils. Our ambition, in fact, is to succeed in intervening significantly, at least at a local level, in the dangerous cycle that transforms students with a negative attitude towards mathematics into future teachers with a negative attitude towards mathematics and its transposition into the classroom, with harmful consequences for their pupils. After all, already in the ‘70s, Mihalko (1978, p.36) wrote: “[Mathematics teachers] cannot be expected to generate enthusiasm and excitement for a subject for which they have fear and anxiety. If the cycle of mathophobia is to be broken, it must be broken in the teacher education institution”.

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