

# BETWEEN PAST AND FUTURE: STORIES OF PRE-SERVICE MATHEMATICS TEACHERS' PROFESSIONAL DEVELOPMENT

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*We study the efficiency of a pre-service teachers' education method that is based on a theory-informed analysis of teaching-learning processes, design of tasks for pupils and subsequent creation of fictional classroom discussions focused on the same tasks. A key element of the method is the request, to pre-service teachers, of writing down, after each session of the course in which the method is implemented, accounts of the session, under the guide of suggestive questions. In the contribution we analyse such accounts in order to study the evolution of pre-service teachers' attitude towards mathematics and mathematics teaching and the development of their identity as future teachers.*

## INTRODUCTION AND THEORETICAL BACKGROUND

In this contribution we focus on a method for primary school pre-service mathematics teacher (in the following, PMT) education, designed with a special focus on affect. This choice is in tune with what Hodgen and Askew (2011) advocate, stressing that teachers' affect plays a crucial role in their professional development, thus it should be considered already in teacher education programs. We rely on the work by Di Martino et al. (2013), who study the link between the past experiences of PMTs as students and their future perspectives of becoming mathematics teachers and describe the phenomenon of the "desire for math redemption", i.e. "*the desire to face the "challenge" of teaching mathematics, starting from a personal reconstruction of the relationship with the discipline*" (p. 226). Such a redemption can be achieved by means of specific interventions, such as the education program for PMTs designed by Morselli and Sabena (2015), which is based on problem solving activities and on narrative reconstruction of PMTs' "affective pathways" during problem solving. They point out that PMT education should act in two ways: "in continuity with respect to the need for redemption [...], but also in discontinuity with the widespread procedural view of mathematics" (p. 1232). In this contribution, we present a method for PMT education and we propose the use of two theoretical lenses to discuss the efficiency of this method in fostering such *continuity* and *discontinuity*. The first theoretical lens is the construct of identity, that in the last years has gained increasing interest among researchers in teacher education, as evidenced by the recent overviews and systematic reviews of research in the field (Lutovac & Kaasila, 2018; Graven & Heyd-Metzuyanin, 2019). We refer to the definition of identity by Sfard and Prusak (2005, p.1): "Identity is a set of reifying, significant, endorsable stories about a person". According to the narrator, the referee and the recipient, it is possible to distinguish between AAA stories (told by oneself, about oneself, to oneself), AAC

stories (told by oneself, about oneself, to another recipient), BAC stories (told by a narrator, about another person, to a third recipient). The second theoretical lens is the construct of attitude, defined by Di Martino and Zan (2014) by means of a model made up of three interrelated dimensions: *emotions* toward mathematics, *vision* of mathematics, *perceived competence* in mathematics. The model, initially theorized for students' attitude, was adapted to study PMTs' attitude towards mathematics and its teaching (Di Martino et al., 2013).

## OUR METHOD FOR PMT EDUCATION

We rely on the method introduced by Cusi and Malara (2016), that encompasses the use of theoretical tools for both the design of classroom activities and the a-posteriori analysis of teaching-learning processes. We adapted this method to the case of PMTs by designing a PMT education course characterized by the following kind of activities (see also Cusi & Morselli, 2018): 1) sharing and study of theoretical tools (concerning teaching-learning processes and the roles played by the teacher during classroom discussions); 2) analysis of tasks for students and of videos from classroom activities, by referring to the theoretical tools; 3) design of tasks for pupils and creation of fictional classroom discussions focused on the same tasks, by referring to the theoretical tools; 4) sharing and comparison between the different tasks and fictional classroom discussions created by PMTs; 5) individual reflections, after each session of the course, to be shared with the teacher educator (one of the authors) in the form of a written reports. Individual reflections were guided by some questions suggested by the teacher educator at the end of each session. Suggested questions varied according to the content of the sessions. However, recurrent questions were: "What are the aspects that struck you more? What have you learnt? What have you discovered?".

## RESEARCH AIM AND QUESTION

In a previous work (Cusi & Morselli, 2018) we focused on activity 3, showing that the specific activity of creating fictional classroom discussions promoted a change of perspective, from university students to future teachers, and led PMTs to appreciate theoretical lenses as a support for creating discussions, but also as relevant guidelines for their future practice as teachers. In this paper we focus on the following research question: *Is the method adopted during the course efficient in fostering a continuity with respect to the PMTs' need for redemption and a discontinuity with respect to the procedural vision of mathematics?* To address this question, we focus on the data collected through activity 5, that is on the individual reflections that are performed after each session of the course, and analyse them in terms of attitude towards mathematics teaching and learning and development of teacher identity.

## RESEARCH METHOD

The course on which this study is focused involved a group of 80 primary school PMTs attending their first university year (5 years totally; practicum starts in their second year), and lasted 32 hours. Totally, we collected 10 accounts for participant. In our

analysis, we looked at such written accounts produced during the course as a collection of stories told by PMTs about themselves and directed to the teacher educator as the final recipient (AAC stories). We initially selected parts of the written accounts where the PMTs speak about themselves, that is parts that could represent *reifying* stories, referring to Sfard & Prusak (2005)'s definition. In a second moment, among the reifying stories, we identified sub-stories that are recurrent, i.e. the PMT treats them more than one time in her written accounts. This characteristic makes the selected stories also *significant* for the narrator. Moreover, we focused on sub-stories that are proposed spontaneously by the narrator, without a direct request by the teacher educator, that is on *endorsable* stories. Once selected the sub-stories, we analysed them in terms of attitude towards mathematics and its teaching and learning. Investigating the development of the sub-stories throughout the whole course, we came to reconstruct a story about each PMT, which is a CAD story, since it is our way of narrating about the PMT to a third recipient (the reader of this paper). We outline that the themes of sub-stories may vary from PMT to PMT. Our narration brings to the fore the prevailing themes for one PMT, thus contributing to characterize her identity as a future teacher. In this contribution we confine to two stories of development so as to start our reflection on the efficiency of the method. Our work will be later integrated with the analysis of problematic stories, so as to understand in which cases PMTs' participation in the course does not promote their professional development.

## DATA ANALYSIS

We present and discuss the sub-stories of two PMTs, Zelia and Ella, narrating them by means of relevant excerpts and analysing them through our theoretical lenses.

The first prevailing theme in Zelia's sub-stories is "mathematics and its teaching". In the following excerpt from her 3<sup>rd</sup> written account, she highlights the fact that the classroom activities proposed during the third lesson are designed to support pupils in making their reasoning process explicit. Reflecting on the fact that too often, in mathematics teaching, the product and the application of rules are considered more important than the process, Zelia explains that she is reconsidering her *vision* of mathematics. She asks herself if her love for mathematics is a simple infatuation, associated to an incomplete imagine of this discipline:

I do not hate math. On the contrary, this subject has become enjoyable year after year. But I think that this course is instilling in me the doubt that I've never really loved it...I ask myself if the mathematics that I thought to love is the real mathematics, or if I simply loved the being able to perform exercises, using rules (Zelia, 3<sup>rd</sup> written account).

Zelia's awareness that positive emotions toward mathematics could be connected to procedural *visions* of the subject is also proposed in her 4<sup>th</sup> written account. Discussing on a teaching episode analysed during the fourth session, Zelia reflects on the role played by the teacher, which was very different from the approach that her upper secondary school teacher used to adopt. Zelia declares that she used to prefer

traditional lessons, where the teacher explained contents at the blackboard, to lessons focused on problem solving, and calls again her *vision* into question:

I am trying to discover if my vision of mathematics, under a veil of positivity, is only “mathematics as rules to be applied” (Zelia, 4<sup>th</sup> written account).

In the same written account, Zelia narrates an exchange between herself and another PMT, concerning her colleague’s doubt if mathematics really opens the mind or not:

I answered her that mathematics could help in reasoning and in fostering understanding. I am quoting this experience because I am asking myself if I am myself expressing a prejudice, that is if I am not reflecting enough about it. Maybe I convinced myself that mathematics opens the mind, while I am continuing using mathematics in a ‘mechanical’ way (Zelia, 4<sup>th</sup> written account).

After session 6, Zelia reflects on her way of approaching problems (looking for symbolic expressions to represent relations between variables) and recognizes her difficulty in appreciating alternative solutions; once again, she connects this difficulty to her poor *vision* of mathematics:

The fact that I am not able to find out other strategies makes me reflect on my way of approaching mathematics and on my fear that my answer is always “not enough mathematical”... I am not used at verbalizing my resolutions. I think it could be due to two possible reasons: my approach has become an automatism (it is a problem if it prevents me from elaborating other strategies), or my vision of mathematics focuses only on the product and does not care of the process...It makes me reflect on the fact that some approaches are so well-established that I need to continuously reflect on them (Zelia, 6<sup>th</sup> written account).

Referring to the three-dimensional model of *attitude*, we may say that the course promoted Zelia’s reflection on her attitude towards mathematics: from the beginning she reports *positive emotional dispositions* towards the discipline, but throughout the course she starts questioning her *vision* of mathematics. When she faces difficulty in performing process-oriented activities, she does not stick in a *low perceived competence*, rather she feels more motivated to work on a more elaborated *vision* of the discipline. We may note that Zelia not only reflects on her *past* as a student, wishing to improve her vision of mathematics; Zelia is also aware of the fact that the *vision* of mathematics could influence the teacher in planning her teaching approach. This leads to the second theme, “roles of the mathematics teacher”. The first excerpt refers to session 2, where the discussion with the teacher educator and her mates made Zelia reflect on her role-model teacher and compare her with other kinds of teachers, referred to as “lazy teachers”, who contributed to her mates’ experiences of failure in mathematics:

He is among the models of teacher [...] I take when I imagine me as a future teacher, and that at deeper level maybe gave me the desire to teach and to be for my pupils what he was for me. Conversely, in my colleagues’ accounts I recognized the lazy teacher, ready to

label students, that can contribute the student's failure, aspect that is not so far from my experience as a primary student. (Zelia, 2<sup>nd</sup> written account).

In her 5<sup>th</sup> written account, Zelia reports that the activity of analysis of teaching episodes enabled her to become aware of the importance of teacher's flexibility in managing classroom discussions, and of the necessity of an accurate design of each lesson.

I was struck by the way the teacher was ready to create the metaphor [to make the student's reasoning clearer]. This makes me wonder in which way the teacher had prepared the lesson. I wonder whether the teacher took some time to make hypotheses in the students' difficulties, or the metaphor was already known and she was able to recall and use it at the good moment. (Zelia, 5<sup>th</sup> written account)

Reflecting on session 8, devoted to the presentation of a theoretical construct aimed at characterizing the roles played by the teacher during classroom discussions, Zelia realizes that some of these roles are fundamental in supporting pupils in overcoming a "static" *vision* of mathematics.

We can highlight the importance of whole classroom discussions, since it is from the crash/encounter of different thoughts, approaches, strategies, that we can grasp the richness of thinking and overcome the traditional static vision of mathematics, according to which, for each problem, there is only one solution and one way to find it (Zelia, 8<sup>th</sup> written account).

In reference to the second theme ("roles of the mathematics teacher"), Zelia realizes that the teacher has a role in influencing students' *attitude* towards mathematics (2<sup>nd</sup> written account, reference to her mates' experiences of failure). Afterwards, Zelia recognizes the importance of specific roles concerning planning and managing class activities, thus enriching the three components of her *attitude* towards mathematics teaching in terms of *vision* (she values specific roles such as planning, managing discussions), *emotional disposition* (she is positively struck by the teaching episode!) and *perceived competence* (she realizes that class discussion can help her in proposing students meaningful and "non static" lesson, as she wished).

The second PMT we refer to is Ella. Her first theme concerns "mathematics and its learning". In the account after session 2 (where Ella and her mates were proposed a task of conjecture and proof), Ella recognizes that she never experienced such rich mathematical activities when she was a student, and this lack made her develop a poor *vision* of mathematics, based on procedures rather than on argumentation and reasoning. Moreover, she reports a *negative disposition* towards mathematics (algebra in particular), coupled with a constant fear of making mistakes.

My approach to mathematics, in my experience as a student, led me to underestimate the goals of learning, to internalize isolated concepts; even worse, to provide mechanical solutions, often without conscious argumentations. [...] Fear of making mistakes. [...] The feeling of having a dangerous relationship with the discipline, always on the edge between the desire to move beyond and the sensation of falling down, step into the wrong calculation and into my limits. (Ella, 2<sup>nd</sup> written account)

Throughout the course, Ella reflects on the proposed examples of teaching activities and recognizes that such activities are improving her *vision* of mathematics:

I never thought about the great potentialities of the discipline in such a perspective. Working for the construction of our mathematical thinking, starting from primary school. Learning to “speak mathematically”. Experience mathematics as a language. (Ella, 6<sup>th</sup> written account).

In the final account, Ella recognizes some improvement in her *attitude* towards mathematics, with reference to the *vision* of the discipline. She speaks again about mistakes, but finally she is keen to accept mistakes as an unavoidable part of the process of doing mathematics.

I bring with me my past as an afraid and insecure student. [...] I learnt to hate mathematics, even before looking it in the face. I became able to hide behind an exercise, to circumvent questions, to repeat minimal operations, avoiding the overall vision and the search for meaning. For this reason, the biggest difficulty during this course was to become the protagonist. [...] To ask questions I had never dared to share. [...] to make mistakes, above all. To learn to make mistakes. To desire and to allow myself to make mistakes. Because in my former non-experience as shy and unsecure student, the mistake was not allowed. (Ella, Final written account).

Referring to the three-dimensional model of *attitude*, we may say that thanks to the course Ella moved from an *attitude* towards mathematics characterized by *negative emotional disposition* (fear, danger) and poor *vision* of the discipline (mechanical procedures, emphasis on the final product without mistakes) to a more positive one, characterized by a new *emotional disposition* (to dare to ask questions and make mistakes) and a new, richer *vision* of the discipline (mathematics as language) characterized by argumentation and search for meaning.

The second theme refers to the “roles of the mathematics teacher”. After session 2, Ella reflects on the proposed activity (solving a task of conjecture and proof) and on the crucial role of the teacher educator in the collective discussion on the task. In particular, Ella points out a new way of conceiving mistakes as resources for the teacher:

[...]. I highly appreciated the way the teacher [educator] was able to guide the reasoning of the group without interfering, not judging, using mistakes as resources for the reasoning that was in construction. (Ella, 2<sup>nd</sup> written account)

After session 3, Ella reflects on the fact that the teacher needs to be flexible and adapt her lesson plan to the students’ interventions. Ella expresses the interest for learning how to manage class discussions in a fruitful way.

It seems to me that, in this sense, the teacher's art is very close to that of the master craftsman. And I would like to experiment and I would like to experience firsthand [...] possible techniques of design and presentation to the class. (Ella, 3<sup>rd</sup> written account)

The 6<sup>th</sup> written account, where Ella reflects on a session focused on the analysis of classroom activities, contains an interesting reflection on the role of the teacher who asks questions to the pupils, but also to her/himself.

What strikes me [...] is the interactive learning and the cooperative climate that the teacher stimulates through the acquisition of specific roles. Children learn to confront themselves in group, to argue their own reasonings and strategies, to change their minds [...]. The teacher learns: [to be an] equilibrist in search of questions to ask students and to ask herself, bearer of an idea of transparent teaching, which replaces the question, research and thought as nourishment for the individual and the community to the imposition of univocal solutions. (Ella, 6<sup>th</sup> written account).

In reference to the second theme (“roles of the mathematics teacher”), we may find in Ella’s accounts instances of a positive *attitude* towards mathematics teaching. During the course, the *vision* of mathematics teaching becomes richer and richer, with reference to the crucial roles of the teacher in managing class discussions, guiding students’ reasoning without imposing a strategy, using mistakes as resources. Ella also expresses a positive *disposition* towards her future role and declares herself ready to learn and experiment how to plan and implement meaningful classroom activities. This good will and optimism concerning her future as a teacher may be interpreted in terms of good *perceived competence*.

## PRELIMINARY CONCLUSIONS

This contribution was aimed at discussing the efficiency of a method for PMT education, with a special focus on affect. We adopted a double theoretical lens (identity and attitude) to analyse written reports of two PMTs (Zelia and Ella) throughout all the course. The two reported stories, and their swinging between the *past* and the *future*, show the development of their *identities* as future teachers. The stories of Zelia and Ella reveal differences in the two PMTs’ relation with the *past*: Zelia focuses on *teaching*, reflecting on a positive example of teacher she experienced, while Ella reports her own difficulties in *learning* mathematics. Concerning *future*, both PMTs show an increasing awareness and appreciation of the *roles* they’ll have to play as teachers. Interestingly, the reflection on the roles of the teachers that is promoted during the course is efficient in bridging the two PMTs *from the past to the future*: Zelia recognizes that by playing such roles she will be able to act as the teacher she had when she was a student; Ella thinks that by playing such roles as a teacher she will be able to help her students learn in a better way in comparison to her experience as a student.

Data analysis shows the evolution of the PMTs’ *attitude towards mathematics*, encompassing a more elaborated *vision* of mathematics, thus acting in discontinuity with the *past*. We also found evidences of improvement in *attitude towards mathematics teaching*, both in terms of *vision* of mathematics teaching and in terms of *positive disposition* and *perceived competence*. Such an improvement is linked to a

projection towards the *future* work as teachers and takes place in continuity with the need for “mathematical redemption”.

Although the method for PMT education is put in action in the whole sequence of activities of the course, the analysis of the PMTs’ stories enabled us to identify some activities that seem particularly effective: the analysis of tasks and of videos of classroom activities, the sharing of theoretical tools, the reflections in small groups on the design of specific tasks, and the active participation to laboratory workshops. The written accounts also proved to be effective, because they allowed the creation of a free space to reflect on the course (the *present*) and connect it with their experiences as teacher (their *past*) and their forthcoming role as teachers (their *future*).

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