Introduction

This paper focuses on an ongoing action-research project (September 2017-August 2020) on attitudes towards mathematics and its teaching involving a cohort of students of the bachelor’s degree in “Teaching for the primary level” provided at the SUPSI’s Dipartimento formazione e apprendimento, in Locarno (Switzerland). The theoretical frame of this research is the three-dimensional model of attitude towards mathematics, developed by Di Martino and Zan (2011), which includes emotional disposition, beliefs, perceived competence and their mutual relationships. The attention for affective factors in mathematics education emerged in the mid-1980 when several studies underlined that the vision of mathematics can influence students’ performance in mathematics (Schoenfeld, 1983), teachers’ didactic choices (Calderhead, 1996; Hodgen & Askew, 2011; Sbaragli, 2006; Thompson, 1992) and teacher-student interactions (Buehl, Alexander, & Murphy, 2002). In the same period, other studies highlighted the role of other affective factors (emotions and attitudes) in the teaching-learning process of mathematics education (McLeod, 1992): it emerged the need to go beyond the purely cognitive approach in the research field of mathematics education.

These studies have also an impact in the research on teacher professional development: in particular, preservice primary teachers represent an interesting sample for research about affective factors. In fact, several studies (e.g., Hannula, Liljedahl, Kaasila, & Roesken, 2007; Di Martino & Sabena, 2011) show how negative emotions towards mathematics prevail over positive ones and negative attitude towards mathematics can affect future teachers’ emotional disposition towards mathematics teaching.

Such results are interesting for teacher educators: affective factors seem to influence how preservice teachers approach the teacher education programme and, consequently, their well-being in this educational context, as well as the development of their identity as mathematics teachers and their future choices in the classroom. In their studies in the Italian context, Coppola, Di Martino, Mollo, Pacelli and Sabena (2013) highlight an interesting phenomenon among future teachers with negative experiences with mathematics: the desire for a “math-redemption”, accompanied by positive emotions related to the possibility of redeeming oneself from past experiences by becoming a good teacher.

It appears crucial that any education programme for preservice primary teachers takes these aspects into account, creating the conditions to reinforce or to rebuild a positive relationship with mathematics, with desirable effects on students’ well-being.
Research questions and objectives
The project aims at investigating the evolution of preservice primary teachers’ attitude towards mathematics and its teaching, and at testing the effects of specific didactic interventions on students’ attitude.
Our overall research questions are:
• What is the attitude of preservice mathematics teachers towards mathematics and its teaching at the beginning of the education programme?
• Does their attitude evolve during the teacher education programme in relation to specific didactic interventions?

Methodology, methods and sample
The sample is composed of 72 students. Age varies between 18 and 31, 78% are women and have different school backgrounds. The project develops in three main phases, each accompanied by analysis of the collected data and dissemination of the results.

In the first phase (September 2017-November 2017), a questionnaire was designed and administered to investigate students’ attitudes towards mathematics and its teaching at the beginning of the education programme. It was composed of 3 sections, one for each attitude dimension:
• Emotional disposition was investigated through open questions 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 “What emotion do you feel at the idea that one day you will teach mathematics? Explain why you think you feel this emotion”.
• Students’ beliefs about mathematics were 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”.

In the second phase (November 2017-May 2019), we designed and implemented specific didactic interventions, integrated into the courses regularly attended by the students, with the aim of promoting and supporting a positive evolution of students’ attitude towards mathematics and its teaching. More precisely, in mathematics education courses, students are constantly encouraged to analyse and reflect on their possible choices as mathematics teachers in a metacognitive perspective. In addition, some meetings are devoted to workshops and discussions to make students express their representation of the professional identity as mathematics teachers. To monitor the evolution of attitudes towards the discipline and its teaching, in January 2019 we proposed this open question: “What emotion do you feel when you think back on the mathematical activities you have proposed in your apprenticeship in the classroom? Explain why you feel this emotion”, considering that, parallel to university courses, students have a continuous apprenticeship in the classroom.

In the third phase (May 2019-August 2020), designed to investigate students’ attitude after two years of education programme, we administered a final questionnaire composed of 3 sections, one for each attitude dimension, as the initial one. Some questions remain the
same in order to facilitate comparison and other ones are specifically centred on the preservice teachers’ experience as university students.

Each student is assigned an anonymised identification code to answer the three questionnaires, in order to make longitudinal comparison on the collected data.

Analyses and results
In this section, we present results from the initial questionnaire and some preliminary results from the intermediate questionnaire focusing on emotions towards mathematics and its teaching. The declared emotions are analysed in terms of valence (positive/negative) and activation (activating/deactivating) according to Pekrun and colleagues’ research (Pekrun, Frenzel, Goetz, & Perry, 2007; Pekrun, Vogl, Muis, & Sinatra, 2017). These authors identify achievement emotions, which are related to both the activity and the outcomes, and epistemic emotions related to the knowledge-generating qualities of cognitive activities.

**Emotional disposition – initial questionnaire.** With respect to mathematics, we can identify:
- 54% negative emotions: 31 activating (e.g., anxiety); 8 deactivating (e.g., hopelessness);
- 34% positive emotions: 21 activating (e.g., enjoyment); 3 deactivating (e.g., relief);
- 4% intermediate or contrasting emotions (e.g., enjoyment/anxiety);
- 8% non-classifiable answers that do not refer to a specific emotion.

Notice that the recurring negative emotions are strong and activating. They are mainly related to students’ outcomes in mathematics or to specific teachers, namely at secondary school.

Concerning the emotions towards the future teaching of mathematics, data are more encouraging:
- 65% positive emotions: 44 activating (e.g., hope); 3 deactivating (namely, calm);
- 7% activating negative emotions (namely, fear and anxiety);
- 24% contrasting or intermediate emotions (e.g. enjoyment/fear);
- 4% non-classifiable answers since they do not refer to a specific emotion.

We deepen this analysis for each student, identifying if and how the valence and activation of the emotions vary with respect to the discipline or to its teaching. We remarked that most of the contrasting or intermediate emotions towards mathematics teaching are declared by students who feel negative emotions towards the discipline. For example, one student who associates anxiety to mathematics (“because I had teachers in high school who made me feel this way every time I entered the classroom”) feels a contrasting emotion thinking about mathematics teaching: “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 [...]. However, I am a little bit scared because I want to manage to teach it well, so that my future pupils will not feel as I did (suffering because I did not understand anything”).

**Emotional disposition – intermediate questionnaire.** For the students who answered both the initial and the intermediate questionnaires, we can identify a positive trend regarding the emotions towards mathematics teaching.

Among the 32 comparable cases,
- 13 express stable positive emotions;
- 10 shift from a contrasting or negative emotion to a positive one (mainly pride) or from a negative emotion to a contrasting one;
in 9 non-negligible cases the trend is negative, when anxiety, stress or fatigue, related to
time or material issues, influence students’ emotional disposition.

Discussion
Our first analyses show a prevalence of negative emotions towards mathematics that can
negatively influence the students’ attitude towards the discipline and its teaching. Espe-
cially students who feel contrasting emotions towards mathematics teaching or those who
have had a negative relationship with the discipline needs support to reconcile with it and
feel self-confident and positively motivated about their future teaching. They need support
not only on the disciplinary and didactic sides, but simultaneously through specific work-
shops and discussions they should also be helped identify and share the strong and the
critical points of their disciplinary and didactic choices.
Preservice primary teachers’ 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
prevail. With this action-research project, we expect to intervene 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.
We are aware of the limits of this project: our interventions, although ad hoc designed, are
limited to sporadic meetings, over two years, and mainly addressed to the whole group of
students, while each student has individual needs and evolution patterns. For this reason,
a perspective of the study is to collaborate with the educators of the professional accompa-
niment seminar that is offered by our department, in order to target our interventions by
working in smaller groups.

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