LUMAT-B
International Journal on Math, Science and Technology Education

Conference paper

Why do you want to be a mathematics teacher?
Stories "in the middle"

Gabriella Pocalana[1] and Peter Liljedahl[2]

[1] Università degli Studi di Pavia, Pavia, Italy
[2] Simon Fraser University, Burnaby, Canada

Abstract: This paper aims at studying the affective aspects of the relationship with mathematics of prospective middle school mathematics teachers, enrolled in a master's degree in Natural Sciences focused on secondary mathematics and science education. According to the principles of narrative data collection, the 10 prospective teachers of our sample have been asked to answer two open prompts: "Me and maths" and "Me as a maths teacher". Data analysis has been conducted according to the dimensions holistic vs categorical and content vs form. The results reveal that the participants' relationship with mathematics, as well as their grades, can be described as fluctuating. Their motivations to become mathematics teachers are not very strong, but they declared a marked willingness to empathize with their future students' difficulties in mathematics.

Keywords: affect, middle school teachers, narratives, teacher professional development

Correspondence: gabriella.pocalana@unipv.it

1 Introduction and theoretical framework

Middle school is often considered a "middle-earth" for different reasons. It is "in the middle" between primary and high school, and it is attended by students "in the middle" between childhood and adolescence. This study stemmed from the awareness that, in Italy, also the mathematics teachers working in middle schools can be, in a way, considered "teachers-in-the-middle": they are not non-specialist teachers like in primary schools, but they can have (and usually have) a degree in a scientific discipline different from mathematics and they teach both mathematics and science.

Due to this peculiar situation, the relationship with mathematics of prospective middle school teachers deserves to be studied, taking into account specific affective aspects. Affect, indeed, influences cognitive processing in several ways: it conditions attention and memory, and activates action disposition. Moreover, affective aspects are seen to have a key role in human coping and adaptation (e.g. Evans, 2000; De Bellis and Goldin, 2006; Hannula, 2002). In the last decades, research on mathematics teacher affective aspects has been mainly focused on prospective and in-service primary teachers (Martinez Sierra et al., 2021). The results obtained from these studies proved that many of

them have developed a negative relationship with mathematics during their school experience (Hannula et al., 2007). This negative relationship seems to influence their emotional disposition towards the perspective of teaching mathematics and their efficacy beliefs with respect to mathematics teaching (Di Martino & Sabena, 2011). Indeed, teachers' emotions towards mathematics and towards the perspective of having to teach it "seem to be two different faces of the same medal" (ibid. p. 91).

Carotenuto et al. (2022) focused their attention on affective aspects in the professional development of prospective secondary school mathematics teachers, enrolled in a master's degree in mathematics. They revealed a complex relationship with mathematics, marked by turning moments, failures and stories of redemption. The most common factors influencing these turning moments are failure experiences, associated with negative emotions and a lowering in their perceived competence in mathematics. Their mathematics teachers seem "to play a primary role in determining the turning moments" (ibid. p. 105).

A research gap remains to be filled, regarding the affective dimension of the relationship with mathematics of prospective middle school mathematics teachers, enrolled in a master's degree different from mathematics. Therefore, this paper aims to address the study of these kinds of affective aspects in the case of 10 students enrolled in a master's degree in Natural Sciences, especially addressed to students who want to become mathematics and science teachers in middle schools. This paper addresses both the affective aspects of their relationship with mathematics throughout their school career and of their choice to become mathematics teachers.

2 Methodology

The methodology adopted in the study is that of an instrumental case study (Stake, 1995), in which the case serves to provide an insight into a general issue.

2.1 Data collection

The sample of our case study consists of 10 prospective middle school teachers enrolled in a master's degree in Natural Sciences with several courses devoted to teaching methods, both for science and mathematics, in an Italian University. They are 6 females and 4 males of different ages, ranging from 22 to 37 years old. Among them, there are 3 working students who want to change their job and 2 students who are already currently teaching at school and would like to obtain a qualification for a permanent position. This sample represents almost the totality of the students attending the course of mathematics education, led by the first author (only one student of the course did not accept to participate in the study).

In research, much of the studies on affective aspects have been conducted through narratives such as essays, diaries, questionnaires with open questions and interviews (Karsenty and Vinner 2000; Hannula 2002; Kaasila 2007; Di Martino and Zan 2011; Pocalana et al., 2023). In line with the method of narrative data collection (Kaasila,

2007), the prospective teachers of our sample were asked to answer two open prompts, during the first lesson of the course: “Me and math” (Di Martino & Zan, 2010) and “Me as a maths teacher”. Indeed, according to Kaasila (2007): “During teacher education it is important to listen to the voices of pre-service teachers talking about themselves as future mathematics teachers” (p. 4). Their narratives were collected in an anonymous way.

The goal of the narrative approach adopted in this study is to get the respondent to tell stories about things that are important to her/him, feeling free to express her/his emotions and memories, reporting those that s/he considers central in her/his own experience. Moreover, using open prompts, respondents are not forced to align their opinion on a ready-made list chosen by the researcher.

2.2 Data analysis

To analyse the collected narratives, we referred to two main independent dimensions, holistic vs categorical and content vs form (Lieblich et al.; 1998). In a holistic approach, the narrative is analysed as a whole, and each part is interpreted in the context of the other parts. The categorical approach is useful to analyse a phenomenon common to a group of people. In each narrative, sections or even single words belonging to a defined category are collected from different texts produced by a number of narrators (Lieblich et al. 1998). The combination of a holistic and a categorical approach, as well as the combination of an analysis of the content and of the form of the narratives, allows for a deeper and differentiated understanding of the narratives (Carotenuto et al., 2022). Accordingly, it is more appropriate to apply the classification made by Lieblich et al. (1998) as “an analytical bridge: the ultimate purpose can be to integrate the approaches into a whole” (Kaasila, 2007, p.5).

We conducted a first round of analysis with a holistic approach, to identify the general sense of the narratives regarding the relationship of the prospective teachers with mathematics (prompt “Me and maths”) and regarding the choice to teach mathematics (prompt “Me as a maths teacher). For the content/form dimension, the content was the main focus of our analysis, however, the recurrence of some peculiar expressions, specific for each of the two prompts, was considered as an important indicator. In the second round of analysis, we adopted a categorical approach. We identified recurrent themes in the narratives related to the prompt “Me and maths”, grouping them in 3 categories, and recurrent themes in the narratives related to the prompt “Me as a maths teacher”, grouping them in other 3 categories. This process of analysis was conducted in a first phase separately by both the researchers and finally discussed using a researchers’ triangulation method.

3 Results

3.1 Holistic analysis

As an example of holistic analysis of the prospective teachers' narratives, we will present the answer to the prompt "Me and maths" provided by Max (pseudonym). It has been chosen as an emblematic example of the main characteristics common to almost all (9 out of 10) the participants: the ups and downs in the relationship with mathematics, the intermediate or inconstant results in terms of school grades and a fluctuating passion. Max clearly highlights the turning moments (Carotenuto et al., 2023) of his school experience with mathematics, mainly connected with the transition from one school level to another and with the change of mathematics teacher. Starting already from the title "My fluctuating relationship with mathematics", Max immediately clarifies the general meaning of his narrative, which is a succession of ups and downs. The narrative covers all school levels, always connecting his relationship with mathematics to the teacher, the topics covered and his results in terms of school grades.

As far as primary school is concerned, he reports a good relationship with mathematics and good results in terms of school grades: "Although the teacher was relatively strict to the eye of a primary school child, I almost always managed to bring home full marks. Math was fun, with the colours of units, tens and hundreds, and the red exercise book." At the middle school, his relationship with mathematics started to change, becoming more fluctuating, as well as his grades. He says: "And here we come to the first disaster... middle school", "I started to see math as a potentially dangerous subject, except for geometry, which was wonderful.", "I had a huge drop in performance on algebra, which matched my growing hatred of the subject". Also with regard to high school, the relationship with mathematics is described as fluctuating, but globally worsened in respect to middle school, especially due to his teachers' faults: "High school was the peak of my failure", "The teacher of the first two years explained in a boring way and every moment of the lesson was able to make controversy about anything", "If for the first two years of high school my relationship with the subject was in an abyss, and in the third and fourth years it had recovered, well... in the fifth year it is as if it had been killed", "The teacher was not interested in us learning", "The tests were awkward because the marks were given away". As a consequence of his school path, Max reports that he arrived at the university with law self-confidence and low perceived competence in mathematics: "At the university, I found myself really unprepared [...] I no longer liked doing mathematics and I felt unable to face it, due to lack of preparation".

For each phase described in his narrative (except for University), Max attributes a grade to mathematics, which helps us to clarify the globally descending trend of his relationship with the subject: "Overall, at primary school, I liked mathematics and I found it very good. Grade to mathematics: 9" "Overall, at the middle school, I liked mathematics until the letters were added. Grade to mathematics: 7 (the part on solid geometry raises it)", "Grade to mathematics at the high school: 5/6". The narrative ends with a global evaluation of mathematics which is intermediate, coherently with the overall description, not too low but not too high either: "Overall grade to mathematics: 6/7".

Max's narrative in response to the prompt "Me as a maths teacher" is equally emblematic, because it contains the characteristics common to almost all (8 out of 10) participants: teaching (particularly in the middle school) not as a first job choice, the fear of not being good enough to teach mathematics, and the willingness to be a teacher who helps students appreciate mathematics. Max says: "I had never taken the idea of becoming a teacher seriously", "Being a middle school teacher was not my first choice, and I ended up seeing myself as a middle school mathematics teacher for fear of not being able to explain in higher institutions with a higher degree of difficulty. I still plan on enrolling in a mathematics refresher course this year just to be safe", "The goal would be to be able to make learning mathematics fun".

3.2 Categorical analysis

Through a categorical analysis of the 10 narratives related to the first prompt "Me and maths", we identified 3 main categories: *Fluctuating relationship with mathematics*, *Intermediate and/or inconstant mathematics grades*, and *Moderate passion for mathematics*. The first category encompasses themes related to the fluctuations in the relationship with mathematics over time, with an emphasis on the ups and downs that occur during the school years. The third category, instead, includes themes related to a moderate appreciation of mathematics, without a fluctuation over time.

In the following table (Table 1), we report the number of narratives in which the aforementioned categories were retrieved and examples of excerpts coded in each category.

Table 1. Examples of excerpts coded in the 3 categories for the first prompt

Category	**N.**	**Excerpts**
Fluctuating relationship with mathematics	9	Mary: "**Love and hate**, that's how I would define my relationship with mathematics." Marcy: "It's **not always rosy** in life, and it wasn't even with this subject" Jack: "I would define my relationship with mathematics as **fluctuating**. This is because since the first grade he has undergone a **continuous ups and downs** of affectivity." Giusy: "My relationship with mathematics has always been **a bit fluctuating**: there have been moments in which I really liked it, moments in which I ignored it and, finally, moments in which it intrigued me. Marty: "Math and I have had **ups and downs** []. It hasn't been a linear relationship."
Intermediate and/or inconstant mathematics grades	9	Mat: "The grades from excellent became **sufficient or little more**" Jack: "I was **never the fastest or smartest** at solving exercises, but I was **still among the best**" Giusy: "I **wasn't even remotely a genius** and so I recognized my limitations on certain topics"
Moderate passion for mathematics	8	Sarah: "Mathematics has always fascinated me **but, at the same time**, a little intimidated."

		Chris: "**After all**, it has always fascinated me **a little**" Mat: "My relationship with this subject is **not particularly** happy" Mary: "Mathematics is **not my first passion**, I have always preferred living organisms to numbers" Lety: "It was certainly **never my favourite** subject but, **all in all**, it was also fun"

As a general trend, it emerged that the participants' relationship with mathematics has been fluctuating but globally declining. The first moment of decline can be situated at the middle school for 4 participants and at the high-school for other 4 participants (2 of them do not specify this aspect).

From the point of view of the analysis of the form of the narratives, we identified words or expressions (in bold in Table 1) indicating a fluctuation, a non-constant relationship with mathematics (for example, *love and hate*, *ups and downs*, *not always rosy*, *fluctuating* etc.). We also identified words or expressions indicating a perceived intermediate competence in mathematics (for example, *sufficient or little more*, *never the fastest or smartest*, *I wasn't a genius,* etc.), and words or expressions indicating a moderate love for mathematics (for example, *not my first passion, never my favourite subject, all in all it was fun,* etc.).

Through the categorical analysis of the 10 narratives produced in response to the second prompt "Me as a maths teacher", we identified 3 main categories: *Not the first choice*, *Fear of not being good enough*, and *Desire to be a caring teacher*. In the following table (Table 2), we report the number of narratives in which these categories were retrieved and examples of excerpts coded in each one.

Table 2. Examples of excerpts coded in the 3 categories for the second prompt

Category	**N.**	**Excerpts**
Not the first choice	8	Mat: "The reason why I enrolled in this course is due to a need to work, to have a "**plan B**" in case the "plan a" does not work." Chris: "I have to say, sincerely, that my greatest interest is in the teaching of science in the high school; therefore, the teaching of mathematics remains a sort of **plan B**." Lety: "I'm not yet clear what I want to do in the future; I have many dreams in my drawer and, for this reason, I didn't want to deny myself the possibility of being able to teach mathematics, even if **it is not my only goal.** Jack: "Ideally, the teaching job would be more of an option to '**plug the holes**', waiting (and hoping!) to find a job more similar to my interests and passions. Giusy: "Honestly, being a teacher is not the only possible choice I see in my future but **a possibility**, [...] it's simply an **open door** that I keep until my future is clear".
Fear of not being good enough	7	Mat: "I have always thought and still think that there is a need for suitable knowledge that **I have never attributed to myself**".

		Lety: "Mathematics not being 'my' subject makes me a little insecure and from here another **fear** arises which is that of **not being able** to answer hypothetical questions, doubts or perplexities from students". Max: "[] fear of **not being able** to explain in higher institutions with a higher degree of difficulty". Jack: "**As I am not particularly gifted** for the subject in question, it becomes more difficult for me to communicate it in a precise way, with a suitable and easily understandable language."
Desire to be a caring teacher	8	Sarah: "**Having myself had problems** in high school with this subject, **I know the discomfort** it can sometimes create and I would like to try to **make everything pleasant** even for those who may have difficulties and to **convey trust** just like a teacher". Paul: "I want to provide a **stimulating and positive learning environment** for students, in **which they can feel comfortable** and able to ask questions and seek answers". Chris: "I would like to be able to convey method and concepts in an 'attractive' way, which is able to **arouse interest even in those who do not like the subject**". Giusy: "I would really like to be able to connect with students and **understand their point of view**, be able **to build a relationship** that goes beyond the transfer of concepts".

As far as the analysis of the form of the narratives is concerned, we identified words or expressions (in bold in Table 2) indicating that teaching mathematics at the middle school was not the first choice of the respondents (e.g. *plan B*, *open door*, *it's not my only goal*, *plug the holes*, etc.). Furthermore, we identified words or expressions indicating fear due to low perceived competence in mathematics (for example, *fear of not being able*, and *I am not particularly gifted*, etc.), and words or expressions indicating the desire to be a teacher who cares about all her/his students (e. g., *make everything pleasant*, *convey trust*, *understand their point of view*, *arouse interest* etc.).

Discussion and conclusion

The results reveal that the relationship with mathematics of the middle school prospective teachers of our sample can usually be described as "in the middle". Mathematics is not and, in many cases, it never was their favourite subject; their school grades in mathematics were not terribly bad, but usually not brilliant either, in any case, they were fluctuating. Many of them express the need to recover a good relationship with this subject, often compromised by past failures and by teachers recognized as not very capable or not very empathetic. The reasons motivating their choice to become middle school mathematics teachers can also be interpreted as "reasons-in-the-middle", because, in many cases, this was not their first choice, but a "plan B", or even a "plan C". In addition, many of them do not feel very confident about being able to be a good mathematics teacher, due to a lack of proficiency in this discipline.

Three elements, emerged from the data, deserve to be taken into consideration by teacher educators as possible point on which to leverage. One is the participants' strong

awareness of the limits of the mathematics teachers that they met in their school path. This can be a starting point for a reflection to be conducted during the courses for prospective middle school mathematics teachers on how they would be more effective than their own teachers. Another element that can be exploited to nurture their self-confidence and self-efficacy sense are their memories of when they felt good at mathematics and they had a positive relationship with this subject. The third very promising point is the participants' propensity to empathize with the difficulties of their future students and their declared willingness to help all students love mathematics and trust that they can understand it. Further research can be conducted to study bigger samples of prospective middle school mathematics teachers, enrolled in master's degrees different from mathematics, in other universities in Italy or in different countries with a comparable institutional system.

Research ethics

Author contributions

G.P.: conceptualization, investigation, methodology, formal analysis, writing—original draft preparation, writing—review and editing.
P.L: supervision, writing—review and editing.

All authors have read and agreed to the published version of the manuscript.

Informed consent statement

Informed consent was obtained from all research participants.

Conflicts of Interest

The authors declare no conflicts of interest.

References

Carotenuto, G., Coppola, C., Di Martino, P., & Pacelli, T. (2023). Turning moments: The crossroads of the prospective secondary teachers' attitude towards math. In C. Fernández, S. Llinares, A. Gutiérrez & N. Planas (Eds.), *Proc. 45th Conf. of the Int. Group for the Psychology of Mathematics Education* (Vol. 2, pp. 99–106). Alicante, Spain: PME.

DeBellis, V.A., Goldin, G.A. (2006). Affect and meta-affect in mathematical problem solving: Representational perspective. *Educational Studies in Mathematics, 63*, 131–147.

Di Martino, P. & Sabena, C. (2011). Elementary pre-service teachers' emotions: Shadows from the past to the future. In K. Kislenko (Ed.), *Current state of research on mathematical beliefs XVI* (89–105). Tallinn University.

Di Martino, P., & Zan, R. (2010). 'Me and maths': Towards a definition of attitude grounded on students' narratives. *Journal of Mathematics Teachers Education, 13*(1), 27–48.

Evans, J. (2000). *Adults' mathematical thinking and emotions: A study of numerate practices*. Routledge Falmer.

Hannula, M. S. (2002). Attitude toward mathematics: Emotions, expectations and values. *Educational Studies in Mathematics, 49*, 25–46.

Hannula, M., Liljedahl, P., Kaasila, R., & Rösken, B. (2007). Researching relief of mathematics anxiety among pre-service elementary school teachers. In J. Woo, H. Lew, K. Park & D. Seo (Eds.), *Proc. 31st Conf. of the Int. Group for the Psychology of Mathematics Education* (Vol. 1, pp. 153¬156). Seoul, Korea: PME.

Kaasila, R. (2007). Using narrative inquiry for investigating the becoming of a mathematics teacher. *ZDM, 39*(3), 205–213. https://doi.org/10.1007/s11858-007-0023-6

Karsenty, R., & Vinner, S. (2000). What do we remember when it's over? Adults' recollections of their mathematical experience. In T. Nakahara & M. Koyama (Eds.), *Proc. 24th Conf. of the IGPME* (Vol. 4, pp. 451–458). Hiroshima, Japan: PME.

Lieblich, A., Tuval-Mashiach, R., & Zilber, T. (1998). *Narrative research. Reading, analysis and interpretation.* (Vol. 47) Sage. http://dx.doi.org/10.4135/9781412985253

Martínez-Sierra, G., Arellano-García, Y. & Hernández-Moreno, A. (2021). Which situations trigger emotions of secondary school mathematics teachers?. *International Journal of Science and Mathematics Education*. 1–21. https://doi.org/10.1007/s10763-021-10158-1

Pocalana, G., Robutti, O., & Liljedahl, P. (2023). Inquiry activities are not for everyone: Teachers' beliefs and professional development. *International Journal of Mathematical Education in Science and Technology*. https://doi.org/10.1080/0020739X.2023.2176795

Stake, R. (1995). *The art of case study research*. Sage