

WHAT CONTRIBUTES TO POSITIVE FEELINGS TOWARDS MATHEMATICS?: EXAMINING MATHEMATICS AUTOBIOGRAPHIES

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In this paper, we present how the participants in our study (post-secondary students) described what contributed to fostering their positive feelings towards mathematics. Drawing from mathematics autobiographies completed by the participants, we present some of the contexts wherein participants described positive feelings toward mathematics. We discuss a) encounters with teacher dispositions and pedagogical practices, b) experiencing the joy of engaging in mathematics, and c) external validation from teachers and parents, and consider whether each of these contexts sustained participants' positive feelings towards mathematics.

Keywords: Affect, Emotion, Beliefs, and Attitudes

Literature Review and Theoretical Framework

The interplay between the affective domain (beliefs, attitudes, and emotions) and teaching and learning mathematics has been explored over the past 30 years. Many of the studies investigating affect and mathematics in the field of cognitive psychology tend to focus on negative aspects, such as “math anxiety,” associated with mathematics (e.g., Ahmed, Minnaert, Kuyper, & van der Werf, 2012; Young, Wu, & Menon, 2012). Also, when conducting large survey-based studies on the affective domain of mathematics learning (e.g., Vandecandelaere, Speybroeck, Vanlaar, De Fraine, & Van Damme, 2012), treating emotion as fluid, dynamic and changing becomes a methodological challenge so the construct tends to be portrayed in static ways and as an attribute of an individual. As Di Martino and Zan (2011) maintain, the mathematics education community tends to treat emotion in a more holistic way by considering a wider range of emotions and the importance of social aspects. For example, researchers in the mathematics education community pay close attention to the conditions and instructional contexts in which students' emotions towards mathematics can be changed (e.g., Evans, Morgan, & Tsatsaroni, 2006; Hannula, 2002). However, such investigation is still often limited to single case studies.

Our study further extends these earlier investigations by analyzing a large number of autobiographical narratives from Kindergarten to post-secondary level students. In this paper, we focus in particular on the data from participants enrolled in post-secondary level education, in order to give us a longer-term view of the contexts that influenced students' feelings about learning mathematics in schools and the factors that helped them to sustain positive feelings into their post-secondary years. Because the majority of research on emotions and mathematics, especially when drawing from a psychological paradigm, focuses on negative emotions, we hoped to examine other aspects of emotions, such as positive feelings and a change in feelings.

This research is framed by enactivism, a theory of embodied cognition that emphasizes the interrelationship of cognition and emotion in learning (Maturana & Varela, 1992). Enactivist thought reorients us to the significance of this mathematical milieu in shaping not only what students learn in school but also their emotional connections with the discipline.

Method

This study is part of our larger project, which investigates students' experiences learning mathematics in Canadian K-12 schools and post-secondary institutions. The data we present here were gathered by using an online submission form. We asked participants (ages 18 and older) to submit mathematics autobiographies, wherein they described their histories of learning mathematics

and their relationships with the discipline of mathematics. We also asked participants to contribute demographic information including age, gender identity, education history, and current profession. To date, we have analyzed 70 submissions, 48 of which were submitted by pre-service teachers, and 26 are multimodal autobiographies using visuals, sounds, and videos. Our data collection and analysis are still ongoing. The analysis of this paper focuses on positive feelings towards mathematics described by participants. Positive feelings were coded when linguistic markers to describe positive emotions (e.g., “like” “love” “enjoy”) were used.

Findings

In this section, we present how the participants described the factors that contributed to fostering their positive feelings towards mathematics. Mainly, participants described a) an encounter with particular kinds of teacher dispositions and pedagogical practices, b) experiencing the joy of engaging in mathematics, and c) external validation from a teacher and parents.

Encounters with Teacher Dispositions and Pedagogical Practices

One of the recurring themes was how teachers made an impact on participants’ feelings towards mathematics. Many participants acknowledged teachers who appreciated various ways of solving mathematical problems rather than strictly following a set of predetermined procedures. For example, a participant said: “The best teachers I had for math taught to my learning style (and this happened rarely). For me, math is highly intuitive, and I loved the idea that math answers could be arrived at using different methods.” Other aspects of teaching that changed participants’ disposition towards mathematics were teachers’ commitment to students’ success and providing sufficient help when needed. A participant recalled high school mathematics classes and said, “At lunch one could frequently find students from both classes crammed into his (the mathematics teacher’s) classroom, clamouring for help.”

Teachers’ dispositions toward mathematics can also influence students’ feelings. The following description, by a participant who considered herself to be “math anxious,” is informative in showing how teaching approaches can make a difference in students’ feelings.

Specifically, I LOVED algebra!... I remember when Ms. W. spoke about algebra. She reminded us throughout the unit that doing algebra is like doing a puzzle; have fun with it!... Ms. W. had always given us extra time to complete tests, which I needed being the ball of nerves I was and still am. I, the former math anxious student, received the highest grade in the class (92%). More importantly, I approached the test as a puzzle, something I needed to take time with and figure it out. I was given that time. Time to play around with letters and numbers. Time to experiment with math!

This quote shows the significance of a teacher’s dispositions towards mathematics—the importance of communicating the joy of mathematics and validating the time in which students “play around with” and “experiment with” mathematics. While many participants acknowledged great teachers, they also described encounters with a good mathematics teacher as a rather rare experience.

Experiencing the Joy of Engaging in Mathematics

In contrast with findings from our Kindergarten to Grade 9 student dataset where very few participants reported liking mathematics because of an intrinsic appeal (Hall, Towers, Takeuchi, & Martin, 2015), a third of post-secondary participants reported an intrinsic love of mathematics itself. Interestingly, the descriptions of the internal joy of engaging in mathematics described by these participants painted two very different portraits of “mathematics.” Some participants conceived of mathematics as a discipline consisting of a set of procedures and correct answers to be discovered and it was this apparently “one right answer” vision of mathematics that they found compelling. The

following quote represents this stance: “I liked that I was given a formula to follow and that there was always only one right answer to each question. Everything was straight forward and to the point in my eye.” These participants appreciated how the mathematics with which they engaged at school was “simple” “reasonable” and “concrete.” Notably, those who perceived mathematics as a set of procedures did not further pursue a post-secondary degree that heavily involves mathematics.

Others perceived mathematics to be like a “puzzle,” “an elegant language,” “something beautiful,” and “patterns.” Many of these participants further pursued a post-secondary mathematics education through the degrees in the areas of engineering, astrophysics, biology, chemistry, and computer sciences. For example, the following quote is one representation of this group of participants: “I have associated mathematics with puzzles.... To me it is a game, with each level of increasing difficulty add[ing] another layer of beauty and technique.” For these participants, mathematics was much broader than a set of procedures to follow. Another participant described the joy of mathematics as: “I actually really like doing math; it is an elegant language and I wish I could speak more of it. When I hear the word ‘mathematics’ I see the Universe and all of the matter within it.” It is noteworthy that we observed quite opposite ways of describing the joy of engaging in mathematics among the participants.

External Validation from Teachers and Parents

External validation, appraisal, and positive evaluations received from teachers and parents contributed to participants’ positive feelings to some extent. For example, a participant said, “When we had “mad minutes” (a minute to complete a sheet of multiplication questions) in grade three, I always tried to be the first one done.” For some participants, the speed with which they could operate computation was rewarded in school and that contributed to their positive feelings towards mathematics. But the feelings of excitement were inconsistent for these participants. For example, the same participant said, “in Grade two, I couldn’t understand at first how to subtract numbers and ‘borrow’ ones...I was just about in tears and felt really stupid.” This participant associated her confusion with her identity. Similarly, when participants were relying on external validation from others, positive feelings towards mathematics could be easily swung to become negative ones.

As a mathematics student in elementary school I remember liking mathematics because I liked solving problems and I was quite good at it. In junior high, I liked math even more because my family was amazed that I was able to get quite good marks in math.... I kept persisting in achieving high marks because I liked the acknowledgement that I received from teachers and my family.

This participant’s grade dropped in Grade 12 and she received 65%. She said she “was very ashamed of this grade” and “I discovered that math no longer had a purpose in my life, so the hard work needed to get through the class didn’t feel worth my time anymore.” As clearly described in this case, positive feelings about mathematics backed up merely by external validation could be drastically changed to negative feelings towards mathematics as soon as the external validation of good marks and acknowledgement from others disappeared.

Discussion and Implications

Our analysis adds to the existing literature by detailing some of the factors contributing to students’ positive relationships with mathematics. This analysis adds to earlier investigations on the complexity and dynamics of emotion (e.g., Evans, Morgan, & Tsatsaroni, 2006; Hannula, 2002) by demonstrating that an encounter with a mathematics teacher, who embodies the joy of mathematics and encourages students to explore and experiment with mathematics, can affect students’ feelings towards mathematics in a positive way. However, we also came to learn that such an encounter was described as rather rare. In addition, our study suggested that positive feelings backed up merely by

external validation from teachers and parents could easily shift to negative feelings in the absence of such validation. This finding suggests the significance of teacher education where teachers can foster a wider range of mathematical dispositions and teaching methods that can positively influence students' relationships with mathematics.

Our study also suggests the importance of attending to the details and contexts when participants describe positive feelings towards mathematics. For such investigations, participants' autobiographical narratives provided contextualized accounts of how participants' feelings have changed over time and whether participants pursued mathematics-rich further education and careers. Our analysis revealed that those who enjoyed mathematics because it was perceived as straightforward, simple, and a set of procedures, did not further pursue post-secondary mathematics education. In contrast, those who were attracted by its beauty, challenge, and elegance further pursued mathematics. This is an important finding that should be further explored by mathematics education researchers.

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