EMOTIONAL KNOWLEDGE OF MATHEMATICS TEACHER

CONOCIMIENTO EMOCIONAL DE DOCENTES DE MATEMÁTICAS

María S. García González
Autonomous University of Guerrero, Guerrero, Mexico
msgarcia@uagro.mx

Emotions come into play as teachers make decisions, act, and reflect on the different purposes, methods, and meanings of math teaching. In order to learn more about the emotions of mathematics teachers, this paper shows the emotions experienced by 81 Mexican teachers who teach mathematics in middle school and high school. Emotions are contextualized by the theory of the cognitive structure of emotions, narrative and drawings were used to express their emotions. According to the results, three frequent and common emotions were identified in the teachers, happy-for, satisfaction, and disappointment. Fear was the only frequent emotion in high school teachers; it occurred at the beginning of their teaching, due to the lack of pedagogical content knowledge.

Keywords: Emotion, Teacher Educators.

Emotions and Mathematics Education

In recent years there has been a growing interest in the study of emotions in education (Graesser, 2020). In particular, the field of mathematics education classifies the emotions of teachers into two groups: negatives and positives. Negative emotions imply unpleasant experiences during the teaching moment; stress, demotivation and burnout syndrome are among these emotions. Burnout syndrome is an emotional disorder caused by job stress which leads to experience anxiety or depression (Schutz & Zembylas, 2009; Rodríguez, Guevara & Viramontes, 2017). Experiencing high levels of intensity of this group of emotions could even lead to abandoning the profession (Hannula, et. al, 2007). The most frequent negative emotion experienced by mathematics teachers is mathematics anxiety (Fennema & Sherman, 1976; Brady & Bowd, 2005; Bekdemir, 2010). On the contrary, positive emotions imply pleasant experiences when leading a class; some of these emotions are enthusiasm, joy, satisfaction, and interest (Di Martino & Sabena, 2011; Anttila, et. al, 2016).

According to the results of the investigations, there are two triggering situations for negative emotions in mathematics teachers: (a) emotional experiences as students: generally, those who experienced negative emotions related to mathematics continue to experience them after they become mathematics teachers, retaining the belief that mathematics is difficult (Coppola, et. al, 2012); and (b) the knowledge of the academic discipline: many of the teachers in charge of teaching mathematics are not specialists in the contents of the school curriculum (Philipp, 2007).

In order to expand and communicate what teachers feel while teaching mathematics, this paper presents 81 cases of mathematics teachers who communicate their emotions through narrative and drawings. This communication was carried out collectively in four different workshops, coordinated by the author; these workshops were held outside the teachers' working hours. The aim of the workshop was to create a place where the mathematics teachers could talk about their emotions during teaching with colleagues from other places and from the same or different school levels. Feeling heard and listening to other teachers, they find similar emotional histories and are allowed to reflect on how emotions affect their teaching.

OCC Theory and Emotional Knowledge

Because language is a functional means to talk about emotions, this work makes use of the Theory of the Cognitive Structure of Emotions (Ortony, Clore & Collins, 1987), also named OCC theory after the initials of the authors, to study emotions. OCC theory analyzes emotions from the narrative of a person about their emotional experience; it ignores completely the behavioral and physiological evidence that are also recognized as sources to investigate emotions. OCC theory defines emotions as "valenced reactions to events, agents or objects, with their particular nature being determined by the way in which the eliciting situations is construed" (Ortony, Clore & Collins, 1987, p.13). This definition implies that an emotion appears when a person values a specific situation; this situation is recognized as a triggering situation, and the appraisal is expressed by an emotion word.

The analysis of emotions in OCC theory is not only focused on the emotion words, although linguistic evidence is taken into account, but also considers the triggering situations. This is because daily language has several words that could be used to refer to different aspects of the same type of emotion. For example, the word distress refers to a moderate fear, while the word panic gives evidence of an intense level of fear, but they definitely refer to same type of emotion, fear. The OCC considers some emotion types (OCC typology of emotions, Table 1), and gives a generic definition for each of them, focusing on the triggering situation and the emotion word. In this way, the analysis of an emotion depends on its interpretation based on the proposed definition.

Table 1. Emotion types according to the OCC theory.

Class	Group	Types (sample name)
Reactions to events	Fortunes-of-others	Pleased about an event desirable for someone else (happy-for)
		Pleased about an event undesirable for someone else (gloating)
		Displeased about an event desirable for someone else (resentment)
		Displeased about an event undesirable for someone else (sorry-for)
	Prospect-based	Pleased about the prospect of a desirable event (hope)
		Pleased about the confirmation of the prospect of a desirable event (satisfaction)
		Pleased about the disconfirmation of the prospect of an undesirable event (relief)
		Displeased about the disconfirmation of the prospect of a desirable event (disappointment)
		Displeased about the prospect of an undesirable event (fear)
		Displeased about the confirmation of the prospect of an undesirable event (fears-confirmed)
	Well-being	Pleased about a desirable event (joy)
		Displeased about an undesirable event

		(distress)
Reactions to agents	Attribution	Approving of one's own praiseworthy action (pride) Approving of someone else's praiseworthy action (appreciation) Disapproving of one's own blameworthy action (self-reproach) Disapproving of someone else's blameworthy action (reproach)
Reactions to objects	Attraction	Liking an appealing object (liking) Disliking an unappealing object (disliking)
Reactions to events and agents simultaneously	Well-being /Attribution	Approving of someone else's praiseworthy action and being pleased about the related desirable event (gratitude) Disapproving of someone else's blameworthy action and being displeased about the related undesirable event (anger) Approving of one's own praiseworthy action and being pleased about the related desirable event (gratification) Disapproving of one's own blameworthy action and being displeased about the related undesirable event (remorse)

Ortony, Clore and Collins (1987).

On the other side, Emotional Knowledge is a construct that refers to the information teachers have about their own emotions while teaching mathematics (García-González, 2020). This emotional knowledge is developed, as the mathematical and didactic knowledge, and the development implies the following abilities:

1. Recognize that we feel, because emotions are part of our human nature.
2. Be able to recognize the emotion we experience in a specific situation.
3. Put a name to the emotion; this is knowing the emotion word that clearly represents what we feel.
4. Recognize the triggering situation for what we feel.
5. Distinguish the negative emotions from the positive ones.
6. Regulate the emotions we experience, being able to act in consequence.
7. Be capable of helping others, like our students, on their self-knowledge emotionally.

In this paper, the focus is on the first five abilities of emotional knowledge.

Methodology

This study involved 81 Mexican teachers who teach in middle school (students from ages 12 to 15), and high school (from ages15 to 18). These teachers attended voluntarily four different virtual workshops carried out from July 2020 to November 2021. Attendance to the workshop was as follows: workshop 1, 30 teachers, workshop 2, 15 teachers, workshop 3, 15 teachers, and workshop 4, 21 teachers. The data collection was carried out through two techniques, drawing

and narrative, both of which have been tested for their functionality to express emotions through written and pictorial language (García-González & Martínez-Padrón, 2020).

Teachers are asked to draw, individually, a drawing of an emotional experience while teaching mathematics, but this drawing should not include emotion words. Then, they show it to other teachers who will identify the emotion expressed. After the observers talk about the emotion in the drawing, the teacher that draws should say if it was the actual emotion he or she wanted to communicate. Most of the times the observers match the correct emotion. Finally, the teacher that draws is asked to write the emotion word associated to the drawing, and to describe the situation that triggered the emotion. In other activity, teachers are asked to take considerable time to write their histories as mathematics teachers. Each one of them reads it in an intended session; from this narrative the listeners should comment on a positive or negative emotional experience. Both techniques were carried out in the workshops to develop emotional knowledge.

The drawings were collected in drive files for later analysis. The teachers were asked to authorized the dissemination of their products for research purposes, taking care of anonymity.

According to OCC theory, a type of emotion is identified by 2 specifications: 1) Concise phrases that express all the eliciting conditions of the emotional experiences. The evidence highlights these phrases in bold. 2) Emotion words that express emotional experience. The emotion words are highlighted in italics.

Therefore, emotion words and triggering situations were identified in the drawings and narratives. Then, with the help of the OCC typology, a reinterpretation of the evidence was carried out based on the definitions of the emotions, and the emotion type that better describes the evidence was selected.

The teachers are listed from 1 to 81, and it is highlighted whether they are male (M) or female (F). In the evidence, the code T1-M means male teacher listed with number 1, and T48-F means female teacher listed with number 48.

Results

Figure 1 shows twelve emotions identified along with their frequency (number of teachers having that emotion), the same teacher experienced several types of emotions. No distinction is made between educational levels because fear was the only emotion experienced just by the high school teachers and not by the middle teachers. Table 2 shows the triggering situations of these twelve emotions.

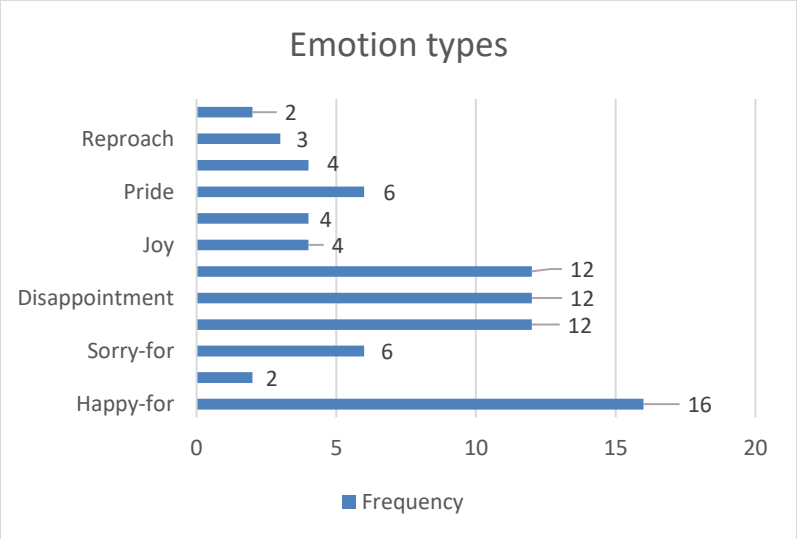

Figure 1. Teachers' emotions.

Table 2. Triggering situations of the emotions.

Emotion type	Triggering situation
Happy-for	Students' learning, Scores/text, concept understanding.
Resentment	Problem solving.
Sorry-For	Students' indifference to the understanding of concepts, internet access, students' problem-solving
Satisfaction	Students' problem-solving, participation/paying attention in class, appropriate teaching resources.
Disappointment	When students' learning is not achieved, the lack of students' paying attention/participation online, low students' scores, excess of work in virtual mode.
Fear	Lack of pedagogical content knowledge.
Joy	The management of the classroom, the attention of students.
Distress	The resolution of the test by the student.
Pride	Acknowledgement of the work of the teacher, students attending to recommendations, achievement of personal academic goals.
Self-reproach	The lack of pedagogical content knowledge, students' lack of understanding.
Reproach	Distraction in virtual class, dissatisfaction with the score, the unwillingness of students.
Liking	Teach using technology, the application of mathematics.

Below it is focused the presentation of results on the two most frequent emotion types, satisfaction and fear.

Satisfaction

All teachers have expectations of their students. Two expectations were identified in the participants, solving problems and participation or attention in class. When these expectations become real, teachers experience the emotion of satisfaction (pleased about the confirmation of the prospect of a desirable event). In addition to their expectations of students, also were identified expectations for themselves, such as those associated with online teaching. With respect to students' problem-solving the drawing of T48-F expresses her happiness (pleased) because the student solved the problem; it can be noted the smile that is drawn on her face.

T48-F: *I feel happy* when the **student managed to solve the problem** (Figure 2).

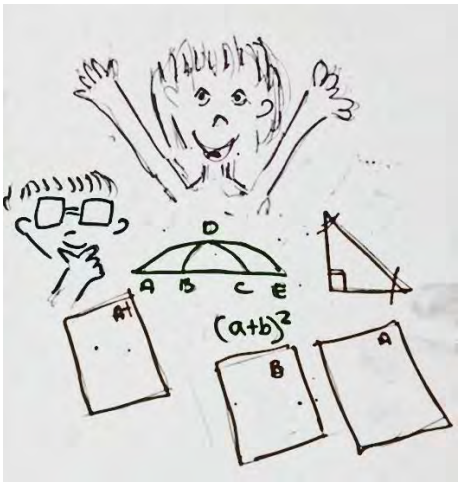

Figure 2. Satisfaction emotion-problem solving. T48-F.

Fear

Fear is defined as being "displeased about the prospect of an undesirable event". This emotion was only identified in high school teachers, and it was a consequence of the lack of Pedagogical Content Knowledge (PCK, Shulman, 1987) at the beginning of their teaching practices. The teachers were surprised when they recognized that teaching mathematics required more than just knowing mathematics (T15-M).

> T15-M: I felt a bit of *fear* when I knew that **I was in charge of a large number of students (50),** *I was uncertain* if **I would be able to control them,** … *I was attacked by the fear of knowing* if **my ideas and my way of teaching could be correctly understood and assimilated by my students,** … I thought I had a huge advantage: I knew mathematics, but my didactic was weak.

Discussion and Conclusions

Figure 1 shows the range of emotions that a teacher can experience when teaching mathematics, and is made up of positive and negative emotions. The case of the emotions of reproach and self-reproach is striking, where the agents that trigger them are the teacher himself, in the case of self-reproach, due to low PCK, and the student is reproached for his distraction in class, and his unwillingness to learn. Recognizing what we feel, putting a name to the emotion, and knowing the situation that triggers it, account for our emotional knowledge.

Previous studies have documented mathematical knowledge as a triggering situation of negative emotions in a Mexican middle teacher (Diego's history García-González & Martínez-

Sierra, 2020) due to his teaching training. In this case, were identified PCK as the triggering situation of fear in high school teachers; we can also explain it from teacher formation. In Mexico, most of the high school teachers have a strong mathematical training because they study for a mathematical career or a related college degree as physics or actuaries. However, PCK is not always part of the curriculum for these degrees.

Fear was triggered at the beginning of their teaching practices by their poor PCK. This group of teachers recognized their extensive mathematical knowledge but they felt powerless regarding to the teaching part. So, they had to look at how to change this triggering situation by means of courses and their own practice, which gave teachers more confidence, as T15-M said.

Having emotional knowledge becomes as important as having mathematical knowledge and PCK, because emotions guide the actions of the teachers. For example, teachers who are afraid because of their lack of PCK may, in the worst case, abandon their teaching labor. On the other hand, the results make us reflect on the need to develop emotional knowledge in their training, as the mathematical and didactic knowledge is developed. In this sense, Marbán, Palacios & Maroto (2020) underline the need to establish specific mathematics affective intervention programs and incorporate them into the didactic training process of pre-service teachers.

The previous excerpts confirm that teaching mathematics requires not only mathematical knowledge but specialized knowledge to teach it, in the words of Carrillo-Yañez, et. al (2018). This matches with Pekrun (2021) who points out that teachers need more than knowledge in the discipline to teach, referring specifically to the emotion and motivation of the teacher. With regard to this result, it is relevant to mention that the lack of mathematical knowledge triggers negative emotions in primary educators because many of the teachers in charge of teaching mathematics are not specialists in the contents of the school curriculum (Philipp, 2007). The data on this study point out that the triggering situation of negative emotions in high school is the PCK and not the mathematical knowledge; as mentioned earlier, these cases can be associated with the formation of both groups of teachers.

References

Anttila, H., Pyhältö, K., Soini, T. & Pietarinen, P. (2016). How does It feel to become a teacher? Emotions in teacher education". *Social Psychology of Education*, 19(3), 451-47

Bekdemir, M. (2010). The pre-service teachers' mathematics anxiety related to depth of negative experiences in mathematics classroom while they were students. *Educational Studies in Mathematics*, 75(3), 311–328. http://doi.org/10.1007/s10649-010-9260-7

Brady, P., & Bowd, A. (2005). Mathematics anxiety, prior experience and confidence to teach mathematics among pre-service education students. *Teachers and Teaching: Theory and Practice*, 11(1), 37–46. http://doi.org/10.1080/1354060042000337084

Carrillo-Yañez, J., Climent, N., Montes, M., Contreras, L., Flores-Medrano, E., Escudero-Ávila, D., Vasco, D.,Rojas, N., Flores, P., Aguilar-González, P., Ribeiro, M. y Muñoz-Catalán, C. (2018) The mathematics teacher's specialised knowledge (MTSK) model. *Research in Mathematics Education*, 20 (3), 236-253, DOI:10.1080/14794802.2018.1479981

Coppola, C., Martino, P. Di, Pacelli, T., y Sabena, C. (2012). Primary teachers' affect: a crucial variable in the teaching of mathematics. *Nordic Studies in Mathematics Education*, 17(3–4), 107–123.

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

Fennema, E., & Sherman, J. A. (1976). Fennema-Sherman mathematics attitude scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *JSAS: Catalog of Selected Documents in Psychology*, 6(2), 31.

García-González, M. S. (2020). Desarrollo del conocimiento emocional en matemáticas. *Uno. Revista de didáctica de las matemáticas*, 88(1), 17-23.

García-González, M. S. y Martínez-Sierra, G. (2020). The history of a teacher's relief of his mathematics anxiety: The case of Diego. *Educational Studies in Mathematics*, 103(2020), 273-291. DOI: 10.1007/s10649-020-09941-8.

García-González, M.S. & Martínez-Padrón, O. J. (2020). Conocimiento emocional de profesores de matemáticas, *Revista Educación Matemática*, 32, 1. DOI: 10.24844/EM3201.07.

Graesser, C. (2019). Emotions are the experiential glue of learning environments in the 21st century. *Learning and instruction*, 1-5. https://doi.org/10.1016/j.learninstruc.2019.05.009

Hannula, M. S., Liljedahl, P., Kaasila, R., & Rösken, B. (2007). Researching relief of mathematics anxiety among pre-service elementary school teachers. In J.-H. Woo, H.-C. Lew, K.-S. P. Park, & D.-Y. Seo (Eds.), *Proceedings of 31st Annual Conference for the Psychology of Mathematics Education, vol. 1* (pp. 153–156). Seoul, Korea.

Marbán, J. M., Palacios, A., & Maroto, A. (2020). Desarrollo del domino afectivo matemático en la formación inicial de maestros de primaria. *Avances de investigación en educación matemática*, (18), 73–86. https://doi.org/10.35763/aiem.v0i18.286

Ortony, A., Clore, G. L., & Collins, A. (1987). *The cognitive structure of emotions*. Cambridge, UK: Cambridge University Press.

Pekrun, R. (2021) Teachers need more than knowledge: Why motivation, emotion, and self-regulation are indispensable. *Educational Psychologist*, 56(4), 312-322. DOI: 10.1080/00461520.2021.1991356

Philipp, R. A. (2007). Mathematics teachers' beliefs and affect. In F. Lester (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 257–315). Charlotte, NC: Information Age Publishing.

Rodríguez, J., Guevara, A. y Viramontes, A. (2017). Síndrome de burnout en docentes. *IE Revista de Investigación Educativa de la Rediech*, 7(14), 45-67.

Schutz, P., & Zembylas, M. (2009). Introduction to advances in teacher emotion research: The impact on teachers lives. En P. Schutz, M. Zembylas (Eds.), *Advances in teacher emotion research*. New York: Springer

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57, 1–22.