Teachers' emotions during a professional development program based on lesson study

Le emozioni degli insegnanti durante un programma di formazione professionale basato sullo *lesson study*

Emociones del profesorado durante un programa de desarrollo profesional basado en el estudio de clase (lesson study)

Laura Muñiz-Rodríguez e Luis J. Rodríguez-Muñiz
Department of Statistics and O.R. and Mathematics Education, Universidad de Oviedo, Spagna.

Abstract. *Lesson study is a method of professional development with considerable benefits for teachers. This paper aims at exploring teachers' emotions during a professional development program based on a two-cycle lesson study. In this exploratory study, a sample of 41 elementary education teachers was considered. Two versions of a questionnaire were applied, and the answers were quantitatively analyzed. Despite several negative emotions appeared during the first implementation cycle, the results evidence a substantial change in teachers' perceptions towards curiosity, engagement, and relief.*

Keywords: lesson study, professional development, teachers' emotions.

Sunto. *Il lesson study è un metodo di formazione professionale con notevoli benefici per gli insegnanti. Questo articolo si propone di esplorare le emozioni degli insegnanti durante un programma di formazione professionale basato su un lesson study in due cicli. In questo studio esplorativo è stato considerato un campione di 41 insegnanti di scuola primaria. Sono state somministrate due versioni di un questionario e le risposte sono state analizzate quantitativamente. Nonostante diverse emozioni negative comparse durante il primo ciclo di implementazione, i risultati evidenziano un sostanziale cambiamento nelle percezioni degli insegnanti verso la curiosità, l'impegno e la tranquillità.*

Parole chiave: lesson study, formazione professionale, emozioni degli insegnanti.

Resumen. *El lesson study es un método de desarrollo profesional con considerables beneficios para el profesorado. El objetivo de este trabajo es explorar las emociones de los docentes durante un programa de desarrollo profesional basado en un lesson study de dos ciclos. En este estudio exploratorio se consideró una muestra de 41 docentes de educación primaria. Se aplicaron dos versiones de un cuestionario y se*

analizaron cuantitativamente las respuestas. A pesar de que aparecieron varias emociones negativas durante el primer ciclo de aplicación, los resultados evidencian un cambio sustancial en las percepciones del profesorado hacia la curiosidad, el compromiso y la tranquilidad.

Palabras clave: lesson study, desarrollo profesional, emociones del profesorado.

1. Introduction and theoretical framework

Mathematics teachers' professional development (PD) is a key issue in educational research. Transforming teachers' prior knowledge, experiences and beliefs into professional competences is one of the main purposes of PD (Alsina & Mulá, 2019). To accomplish this goal, Alsina and Mulá (2019) stand up for a PD model based on education for sustainability and reflective learning. Reflection in teacher education fosters collaboration and self-regulation, helps to understand teachers' own competences and beliefs, and provides strategies to improve teachers' practice (Korthagen, 2001). However, reflective learning is also a challenge for teachers, that requires awareness of their own knowledge, experiences and beliefs, and willingness to adopt alternative professional practices (Korthagen & Vasalos, 2005). In this sense, exploring teachers' emotions during professional training is crucial to understand the impact of PD methods in view of competence acquisition, teachers' beliefs, and expectations (Funghi, 2022; Sutton & Wheatley, 2003).

Lesson study is a PD method for teachers initiated in Japan, with varying degrees of success and challenges in other countries (Fernandez, 2002; Fernandez & Yoshida, 2012; Murata, 2011). Formally, it consists of one or more cycles composed of several elements: based on prior exhaustive research on classroom materials, teachers design a lesson focused on problem-solving, which is taught by one teacher under the observation of others, followed by a group discussion to judge whether the lesson accomplished the purposes (Clivaz & Takahashi, 2018). In practice, individual interpretations of this method have led to adapted implementations (Ní Shúilleabháin, 2017; Ponte et al., 2017; Winslow et al., 2017), but they all concur on a process that encompasses lesson planning, observation, and reflection, being the latter component one of the most effective for the development of teachers' professional competences (Alsina & Mulá, 2019). According to research, lesson study has considerable benefits for teachers, since it improves teaching and learning, explores effective ways to implement alternative teaching practices, among others (Clivaz & Takahashi, 2018; Funghi, 2022; Lewis, 2002).

As mentioned before, contextual differences might derive in deviations regarding the implementation of a lesson study (Ramploud et al., 2022). Also, according to Alsina and Mulá (2019) teachers' competence and expertise are context dependent. In this sense, Mellone et al. (2021) conceived the cultural transposition framework, referring to the implementation of didactic practices

coming from foreign cultures in a particular context. Despite implementation differences, lesson study showed to have potential as a PD method for teachers (Funghi, 2022; Ramploud et al., 2022).

Emotions can be described according to two dimensions: valence (positive or negative) and activation (activation and deactivation) (Pekrun, 2017). On the one hand, positive emotions are pleasant feelings that make one feel good and happy, whereas negative emotions are unpleasant feelings that can include anger, fear, sadness, disappointment, and shame. On the other hand, activation refers to the process of triggering or intensifying a particular emotion in oneself or others, while deactivation applies to the process of reducing or suppressing a particular emotion in oneself or others. The study of teachers' emotions in mathematics education has been extensive in the last decades, moving from a positivistic paradigm to an interpretative one (Coppola et al., 2012). Despite the case of prospective primary teachers has been analyzed in-depth and in-service teachers' emotions inside the classroom are also quite well-documented, Saunders (2013) states that: "we know very little about the emotions teachers experience when they make such changes [about their pedagogical and instructional practices] as part of PD programs" (p. 304). Even when emotions and PD have been analyzed in-depth, it is not frequent to find research about emotions during PD programs (Gaines et al., 2019). According to Saunders (2013), lesson study produces changes in teachers' emotions. Kadrron and Inprasitha (2013), when analyzing the adaptation to Thailand of the Japanese model of lesson study, prove how teachers' values about teaching mathematics changed. Mellone et al. (2021) studied a cultural transposition experience of PD and checked how it provoked positive affects in the two participant teachers. Taxer and Frenzel (2015) pointed out that, to avoid emotions faking: "decreasing the experience of negative emotions and increasing the experience of positive emotions could be done, for example, through improved classroom management skills, which can already be taught within teacher education programs" (p. 86). Vermunt et al. (2019) showed how a lesson study-based PD reduced the prevalence of the so-called teachers' *problematic* learning path (Bakkenes et al., 2010), that is, teachers who:

> struggled with the educational innovation, experienced many frictions between how they wanted to teach and how that worked out in practice, often had no idea how to teach in another way, did not know how they might learn to teach in another way, had many negative emotions and sometimes avoided learning about the innovation at all. (Bakkenes et al., 2010, p. 64)

After the lesson study, these teachers realized about more different ways to teach than the one they knew, and then, reduced their negative emotions and increased their willingness to change. Finally, Cross Francis et al. (2020) conducted several coaching sessions analyzing class videos with mathematics teachers to show that emotions often are revealed in a mixed or blended way and that considering more general emotional experiences and not only feelings

about teaching mathematics "provides insight into the complexity of the emotional experiences of elementary teachers in relation to mathematics" (Cross Francis et al., 2020, p. 15).

The aim of this paper is to explore what teachers' emotions are and how they changed after a PD program designed on a video-based adaptation of the lesson study model. From the previous literature we can raise three research questions: (RQ1) What teachers' emotions arise during and after the PD program? (RQ2) Do teachers combine positive and negative emotions at the same time? (RQ3) Did the PD program change teachers' emotions?

2. Methodology

2.1. Context

We briefly describe the context of Andorran school, where lesson study was implemented. The Principality of Andorra is a very small country landlocked in the Pyrenees with over 77,000 inhabitants. In the country three school systems live together: the French, the Spanish, and the Andorran ones. The Andorran school is organized by the Ministry of Education, and it consist of eight schools (grades K-6) and four high schools (three for grades 7^{th} to 10^{th}, and one for grades 11^{th} and 12^{th}). Vehicular languages for all the subjects (including mathematics) are Catalan and French (alternating in odd and even grades).

In 2010-2011 the Ministry started a program called PERMSEA (Ministry of Education, 2022), acronym from Strategic Plan for the Renewal and Improvement of the Andorran Educational System in the original Catalan. The PERMSEA has made a strong commitment to the competency model. Particularly, in elementary mathematics, three competences are addressed: solving mathematical problems and applications to contexts of daily life; applying mathematical reasoning to situations contextualized with mathematics; communicating concepts, processes, and mathematical results through a diversity of representations. These competences organize all the assessment instruments, and they are achieved by several mathematical contents organized into four blocks: numbers, operations, and calculus; space and shape; measurement; and statistics and probability.

In 2019-2020 and 2020-2021 the authors elaborated an internal diagnostic report about the situation of mathematics education in the Andorran school, after conducting class observations and interviews with all the involved agents (teachers, principals, Ministry, etc.). In the interviews, elementary school teachers expressed that they felt rather insecure about their mathematical pedagogical knowledge and competences, presumably because of their initial training, since part of them held a degree in humanities, philology or law, i.e., did not have a background related to mathematics education, some even not in education. Nevertheless, they had followed extensive teachers' continuous training programs organized by the Ministry. One of the recommendations in

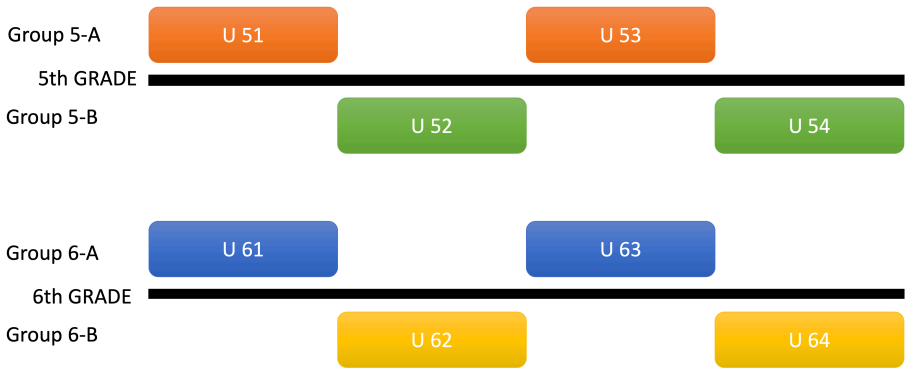
the report was to reinforce the PD of elementary teachers by following a training-in-action program (Kyei-Blankson, 2014). A transposition of lesson study to the Andorran school was designed (Capomagi et al., 2022; Rodríguez-Muñiz et al., 2023), named Andorran Lesson Study (ALS) and it was undertaken during the academic year 2021-2022, aiming at supporting teachers' role during the implementation of the new lesson units to be deployed in that academic year. Thus, teachers are considered as the crucial agent in the curricular reform (Coles et al., 2023).

2.2. Population

This was a census study, since all the population was part of the sample. The population consisted of all the teachers of 5th and 6th grades (i.e., they teach 10-11 and 11-12 years old students) of elementary education in the Andorran school. There were 21 teachers in the 5th grade and 20 in the 6th grade, belonging to eight different schools in the Principality. In order to organize the lesson study, each group of teachers in one grade was divided into two subgroups (named 5-A, 5-B, 6-A and 6-B, respectively) and it was assigned with two (out of four) lesson units, so that, at the end, each teacher participated in the recording and analysis of two alternate units in the academic year 2021-2022, as illustrated in Figure 1. Thus, each group of teachers participated in a two-cycle lesson study, each cycle consisting of the implementation and recording of a lesson unit, followed by a group discussion.

Due to logistic limitations, several adaptations of the original lesson study model were adopted for this research. The main differences were the fact that the observation was done by means of a video recording of the participant teachers, and that the discussion sessions were held after the full unit was taught, instead of after each lesson.

Figure 1
Organization scheme of the lesson units (own elaborated)



At the end of each unit, researchers and teachers held a discussion meeting to deal with the obstacles that arose during the implementation of the unit, as well as to share good practices identified by the researchers in the videoclips, and to point out limitations found in the recordings (in this last phase, the videos were not shown, to avoid teachers feeling publicly singled out). The distribution of teachers in each group is shown in Table 1. The discussion sessions were held, respectively, in November 2021, February 2022, April 2022, and June 2022.

Table 1
Distribution of teachers in groups

Group	Number of teachers
5-A	10
5-B	11
6-A	9
6-B	11

2.3. Instrument

After each cycle, teachers were asked to fill in a questionnaire in which several questions about their emotions during the process were posed. After the first cycle (that is, after units 51, 61, 52 and 62) teachers were asked to answer the following questions:

Q1. Indicate how confident you were, before starting the training, that it would help you in your PD. [Choose only one option: None – Scarce – Indifferent – Quite a lot – A lot].

Q2. Indicate if you had any of these emotions during the recording process (You can mark as many as you consider necessary): Discomfort, Bother, Discouragement, Anxiety, Uncertainty, Excitement, Confidence, Motivation, Engagement, Burden, Curiosity, Worry, Relief.

Q3. And during the discussion phase? (You can mark as many as you consider necessary): [same options as in the Q2].

Q4. Do you consider that a secure discussion has been achieved regarding the possibility of feeling lost, insecure or of being wrong mathematically? [Choose only one option: Yes – No – Doubt].

Q5. Indicate, from 1 (minimum) to 5 (maximum), the level of confidence you felt during the discussion.

Q6. Indicate, from 1 (minimum) to 5 (maximum), the degree of confidence and security that the person who led the discussion has inspired in you.

Q7. Indicate, from 1 (minimum) to 5 (maximum), how useful you think this training program will be for you.

Q8. Indicate the degree of confidence you have, after completing this first cycle, that it will serve you for your PD. [Choose only one option: None – Scarce – Indifferent

– Quite a lot – A lot].

After the second cycle (that is, after units 53, 63, 54 and 64) teachers were administered another version of the instrument in which the former Q1 was substituted by the following one:

Q1*. What is your degree of satisfaction with the first cycle of the training? (Very low – Low – Medium – High – Very high)

A question about their perception of change about several emotions was also added:

Q9. If you participated in the first cycle, indicate if you consider that, in this second cycle, you have felt (regarding mathematics and its teaching and learning) more or less: Confident, Secure, Motivated, Overwhelmed, Anxious, Prepared, Uncomfortable, Engaged, Excited, Worried, Calm. [Options for each emotion were: Less – Similar – More].

All the participant teachers answered the questionnaires. After units 51, 61, 54 and 64 the questionnaire was administered in paper form. After units 52, 62, 53 and 63, the discussion was held online, and the questionnaire was administered using Microsoft Forms®.

2.4. Analysis

The data was analyzed using descriptive statistics with Microsoft Excel® and Google Sheet®. Graphics were rendered with Google Sheet®. Descriptive analysis was performed considering aggregate data. Since anonymity among participants was respected, it was impossible to focus on individual data changes.

3. Results

Since every group of teachers filled in the questionnaire twice (after each discussion session), we gathered the results after the first discussion (held in November 2021 for groups 5-A and 6-A, and in February 2022 for groups 5-B and 6-B), and after the second discussion (held in April 2022 for groups 5-A and 6-A, and in June 2022 for groups 5-B and 6-B).

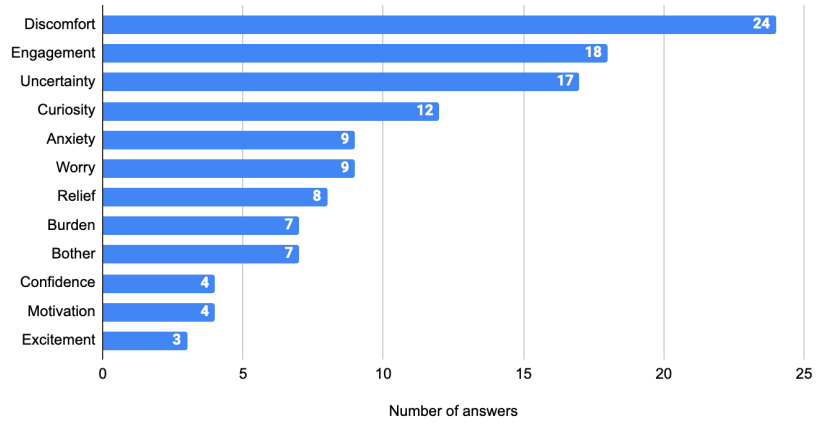
3.1. Results after the first discussion session

In the answers to Q1 about how teachers initially perceived how helpful the training was going to be for their PD, 72.5% of the teachers thought it was going to be quite helpful, 2.5% were indifferent and 25% thought it was going to be scarcely helpful.

Figure 2 shows the emotions while recording the videoclips (Q2). Discomfort was the most frequent emotion, followed by engagement and utility, but many activation and negative emotions (Posner et al, 2005 appeared quite

frequently (anxiety, worry, burden, bother), whereas positive ones were less represented (motivation, confidence, and excitement).

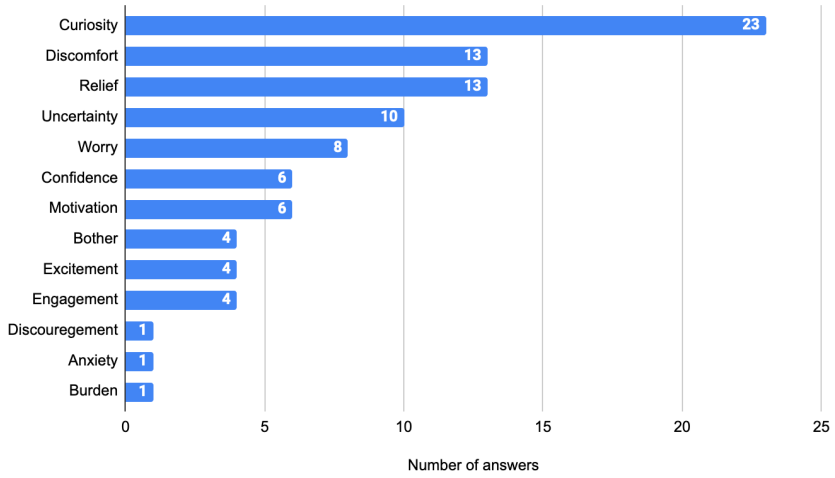
Figure 2
Emotions while recording the videoclips (Q2), after the first discussion (own elaborated)



Since Q2 was multiple choice, it is also interesting to analyze the associations between emotions. The most common pair was discomfort-engagement (appearing 10 times), followed by discomfort-uncertainty (9), discomfort-anxiety (7), uncertainty-engagement (7), and uncertainty-curiosity (7). Discomfort-curiosity, anxiety-uncertainty, anxiety-engagement, and curiosity-engagement appeared 6 times each.

Figure 3 shows teachers' emotions during the first discussion (Q3).

Figure 3
Emotions during the discussion (Q3), after the first discussion (own elaborated)



As we can see, more positive emotions than in Figure 2 appeared, being curiosity, by large, the most frequent, and other positive and deactivation emotions as relief or confidence increased. On the other hand, negative emotions as anxiety or burden were considerably reduced. The most frequent was curiosity-worry (7 times), followed by curiosity-relief (6) and discomfort-curiosity (5).

Most of the teachers considered that a secure discussion was held (85.9%), while 9.8% doubted and only 4.9% felt it was not secure (Q4). Table 2 shows the average and median Likert-scores (from 1 to 5) for questions 5, 6, and 7, as well as the standard deviation. The discussion made the teachers felt confident and it created a good climate with the trainer.

Table 2

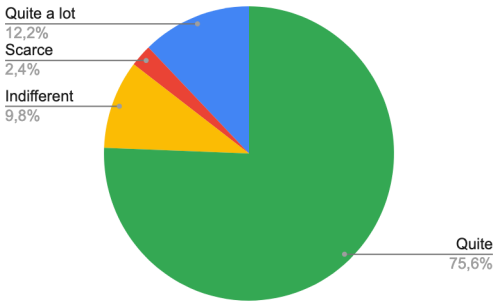
Average, median and SD of scores in Q5, Q6, and Q7 after the first discussion

Question	Average	Median	SD
Q5. Level of confidence you felt during the discussion	3.6	4	.79
Q6. Degree of confidence and security that the person who led the discussion has inspired in you	4	4	.97
Q7. How useful you think this training program will be for you	3.7	4	1.05

Finally, Figure 4 shows the distribution of answers to Q8, about the confidence in the utility of the training for their PD after completing the first discussion. Answers to Q8 are coherent with those to Q7, and we can see that, compared to the results in Q1, the discussion improved the level of confidence, since now 12.5% of the teachers answered 'Quite a lot', and there was a considerable reduction of skepticism.

Figure 4

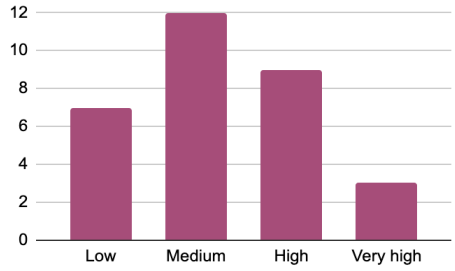
Confidence in the utility for PD, after the first discussion (own elaborated)



3.2. Results after the second discussion session

Figure 5 shows that the degree of satisfaction with the training after the first cycle (Q1*) was moderately high.

Figure 5
Degree of satisfaction with the training after the first cycle (own elaborated)



Regarding the emotions while recording the videoclips (Q2), Figure 6 illustrates that there were still some negative emotions as discomfort (frequency 17), being engagement, by large, the most frequent (21). This fact is also evidenced when analyzing the associations between terms, being the pair engagement-relief (8 times) the most frequent, followed by engagement-curiosity (7), discomfort-engagement (6), discomfort-burden (5), discomfort-worry (5), confidence-engagement (5), and motivation-relief (5).

When comparing the emotions while recording the videoclips during the first and the second cycles (Figure 7), we notice a considerable reduction of discomfort and uncertainty, which were the two most frequent emotions in the first cycle, a general reduction of the negative and activation emotions (bother, burden, anxiety, worry), and a noticeable increase of relief (positive and deactivation).

Figure 6

Emotions while recording the videoclips (Q2), after the second discussion (own elaborated)

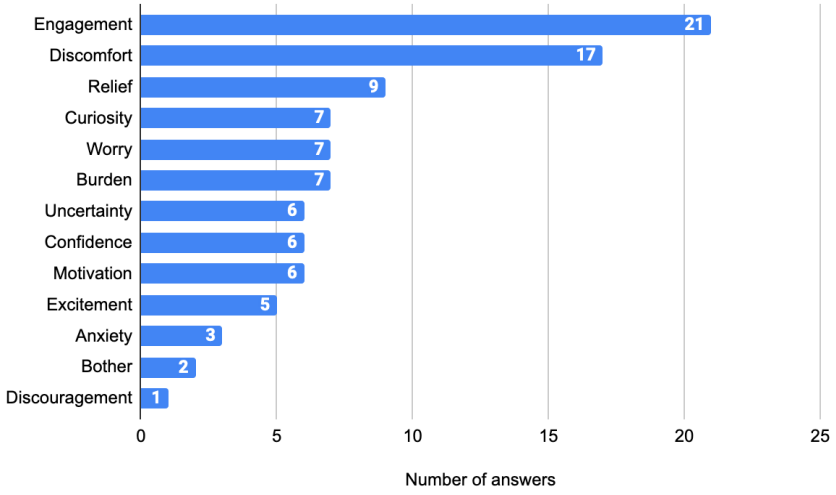


Figure 7

Changes in the emotions while recording the videoclips (Q2), between the first and the second cycles (own elaborated)

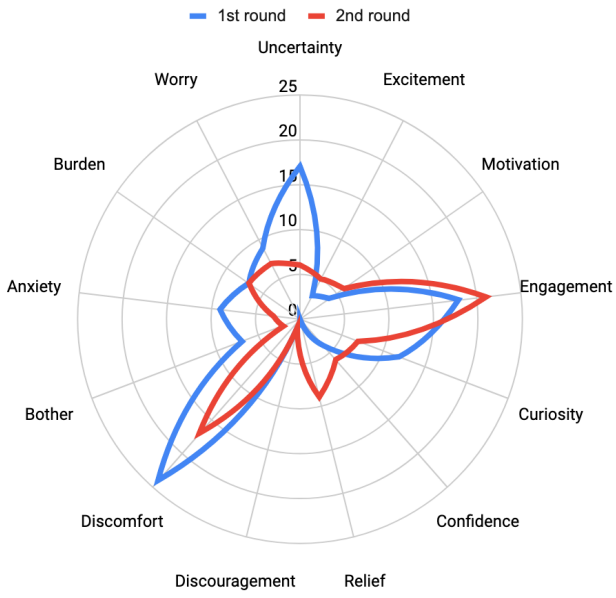


Figure 8 shows the analysis of the emotions during the second discussion (Q3), with a decrease of negative emotions and a clear increase of positive ones with respect to the first cycle. Also, the associations varied, being curiosity-relief (12

times) the most frequent, followed by far by curiosity-engagement (7) and engagement-relief (5). The change in the emotions is much clearly evidenced when comparing term by term between the two cycles (Figure 9), where we can see the reinforcement of positive emotions, and the reduction of negative ones.

Figure 8
Emotions during the discussion (Q3), after the second discussion (own elaborated)

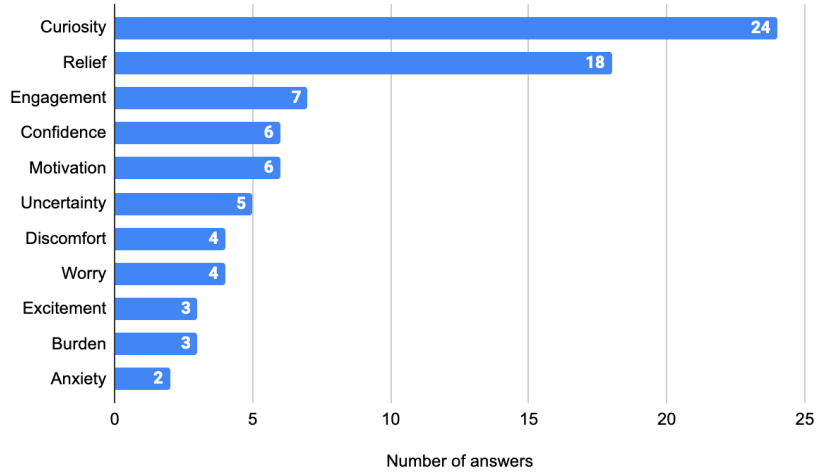
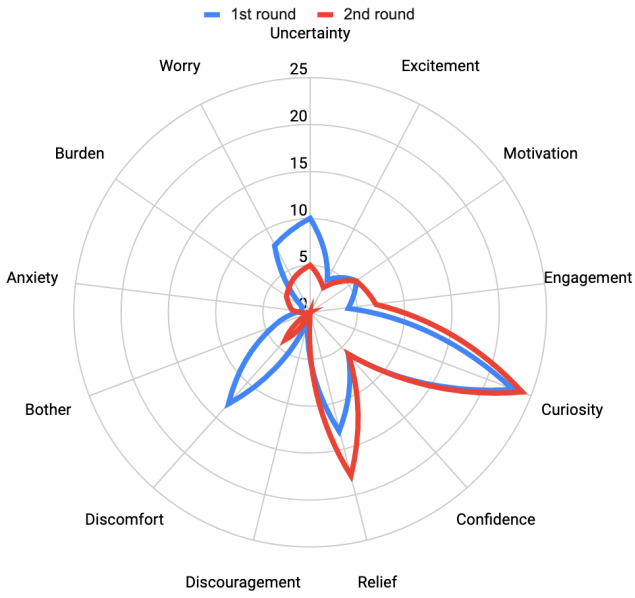


Figure 9
Changes in the emotions during the discussion (Q3), between the first and the second cycles (own elaborated)



Regarding the comfort during the second discussion (Q4), as in the first cycle, most teachers considered it was a secure session (77.8%), with 13.9% doubting and 8.3% considering it was not secure. In Table 3 the average, median and standard deviation of Likert-scores for questions 5, 6, and 7 are displayed. As in the first cycle, these values evidence a good climate during the second discussion, as well as moderately high perception of the utility of the program.

Table 3

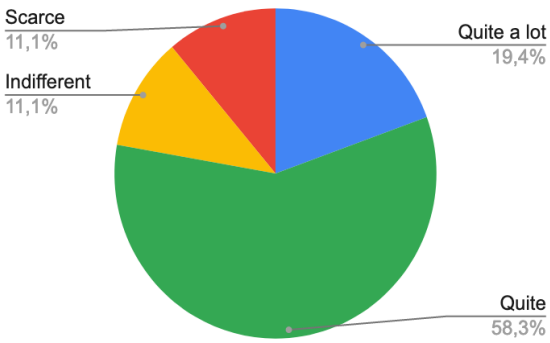
Average, median and SD of scores in Q5, Q6, and Q7 after the second cycle

Question	Average	Median	SD
Q5. Level of confidence you felt during the discussion	3.7	4	.6
Q6. Degree of confidence and security that the person who led the discussion has inspired in you.	4	4	1
Q7. How useful you think this training program will be for you	3.4	4	1

In Figure 10 we display the distribution of the answers to Q8, about the confidence in the utility of the training for their PD after completing the second discussion. Even when 'Quite a lot' increased compared to the first cycle, there was also a moderate increase of skepticism about the utility.

Figure 10

Confidence in the utility for PD, after the second discussion (own elaborated)



Finally, when analyzing Q9, we can see in Table 4 that the reduction of negative emotions is again supported by the data, as well as noticeable increase of positive ones. However, results show a tendency in teachers to judge themselves to feel the similar emotions when asked one by one, in contrast with the analysis of the data displayed in Figures 7 and 9, which evidenced much more the increase of positive emotions and the decrease of negative ones.

Table 4
Answers to Q9 (how have you felt in the second cycle compared to the first one?)

Emotion	Less	Similar	More
Confident	5.7%	57.1%	37.1%
Secure	2.9%	51.4%	42.9%
Motivated	11.4%	54.3%	34.3%
Overwhelmed	48.6%	45.7%	5.7%
Anxious	54.3%	42.9%	2.9%
Prepared	-	65.7%	34.3%
Uncomfortable	51.4%	42.9%	5.7%
Engaged	-	80.0%	20.0%
Excited	11.4%	71.4%	17.1%
Worried	42.9%	57.1%	-
Calm	-	57.1%	42.9%

4. Discussion

Regarding the first research question (RQ1: What teachers' emotions arise during and after the PD program?) results show an initial quite positive expectation about the helpfulness of the PD. That expectation is consistent with the preliminary report, in which it was pointed out that teachers acknowledged the challenges that they had when implementing the PERMSEA regarding their specialized knowledge. They were committed teachers who recognized and identified their own limitations, which represents a quite good basis for any PD program.

Negative and activation emotions prevailed while recording the videoclips during the first cycle, together with engagement and uncertainty. This is a natural result since classroom observation was very traditional in the Andorran school, but teachers were not used to be recorded. The latter explains, on the one hand, emotions as discomfort, anxiety or worry, and, on the other hand, the uncertainty about how the recordings were going to be used later. Engagement can also be explained due to the compulsory nature of the PD program. The emergence of negative emotions is consistent with Cross Francis et al. (2020), who pointed out that the use of videos increases the "insight into the complexity of the emotional experiences of elementary teachers" (p. 15), making more evident teachers' emotional fluctuations. On the contrary, this finding is not consistent with Taxer and Frenzel (2015), who underlined that more positive

than negative emotions are experienced during a classroom observation. This point shows, in our opinion, that the process of recordings is mediating the type of emotions that teachers felt.

The emotions during the discussion session in the first cycle were different, even when discomfort and worry were still present (it was the first time they held such a discussion around classroom recordings), more positive emotions arose: teachers were more used to hold discussions in previous trainings, but not around a classroom videoclip. Again, the recordings act as mediators in the emotional dimension of the PD.

When considering the results from the second cycle, during the recording of the classrooms and, especially, during the discussion more positive emotions appeared, noticeably the engagement becomes the modal emotion while recording and curiosity while discussing. Yet some negative emotions appeared, but this was not necessarily an indicator of negative consequences, Gaines et al. (2019) pointed out that unpleasant emotions can positively influence teachers' conceptual growth after an in-practice PD program, in other words, if the PD becomes superficial, it does not mobilize negative emotions. To this extent, also Saunders (2013) underlined the importance of negative emotions, as worry or anxiety when teachers have to face their peers' views within PD programs.

Answers to questions 5 to 8 after both cycles showed a quite good reception of the program: a high degree of confidence in the facilitators (the researchers) and in the utility of the PD program. Answers to Q1* show that the reception of the first cycle was considered moderately satisfactory.

As regards the second research question (RQ2: Do teachers combine positive and negative emotions at the same time?), teachers combine both positive and negative emotions and activation and deactivation ones (discomfort-engagement, curiosity-worry, engagement-relief, etc.). These findings endorse previous literature as in Scott and Sutton (2009), who claimed that "teachers often made both strongly negative and strongly positive statements when reflecting on professional development" (p. 166) moving along a continuum. Saunders (2013) also identified what she names "mixed emotional patterning response", ranging from "worry, anxiety, uncertainty, disappointment and anger to happiness, enjoyment, confidence and enthusiasm" (p. 327). This combination of emotions reflects the complexity of thinking about the way we teach mathematics and the reasons why we do it in a certain way, as Cross Francis et al. (2020) already remarked.

The last research question (RQ3: Did the PD program change teachers' emotions?) can be clearly answered in an affirmative way. Emotions considerably changed during and after the PD program. Figures 7 and 9, together with Table 4, evidence a substantial change from the first to the second cycle in emotions, both while recording the videoclips and during the discussion session, significantly moving from a more negative to a more positive general scheme. In Figure 7 it is also noticeable the increase of uncertainty from the first

to the second cycle. We interpret this as an effect of the PD program: after the teachers discussed about the videoclips during the first cycle and interacted with the facilitators, they started thinking about their own practices while recording the clips for the second cycle. That is, as Vermunt et al. (2019) pointed out, once teachers become aware of some problems in their teaching, they realize that their usual way to teach maybe does not suffice. Figure 9 endorses our interpretation of the process of the PD program: after the second cycle, the teachers already knew what the discussion was going to be about, and, thus, a relevant decrease in discomfort but also in the uncertainty, together with an increase in the relief is noticeable.

It is also relevant the slight decrease in the security that teachers felt during the discussion (Q4 in the questionnaire), which was reduced from 85.9% to 77.8%. We think this is related to teachers' high expectations after the first cycle, that maybe led them to assume that in the second cycle everything was going to be more controlled (as the *problematic* profile in Vermunt et al., 2019), but we can only hypothesize about this fact. The answers to questions 5, 6, and 7 did not vary substantially, but it is interesting to underline changes in the answers to Q8: there was an increase in the percentage of teachers who considered the program quite a lot useful for their PD (from 12.2% to 19.4%) but also an increase in those who considered it scarcely useful (from 2.4% to 11.1%). While it is likely that the *problematic* profile is still related to this fact, we also interpret it in terms of Gaines et al.'s (2019) remark about a view of PD as a tool to provide concrete and immediately applicable practices to be used in the classroom, rather than a transformation program, as we conceived the PD, following Zeichner (2012), since a practice-based-only PD highly likely leaves out other relevant aspects of teaching. That is, our design for the PD was grounded on practice (classroom recordings) but aiming at transforming teachers' specialized knowledge, practices, and emotions. In fact, in the academic year 2022-2023 we continued with the PD program but focusing on training about certain aspects as mathematical generalization and problem-solving strategies which are not directly linked to any lesson unit, as a way for complementing the previous training.

These findings regarding teachers' emotional aspects in the PD program have been transferred to the Andorran Ministry of Education, who shares with the authors the need to act based on empirical results, and to acknowledge emotional experiences of teachers at the core of their PD (Saunders, 2013).

Several implications for theory and practice arise from the previous findings. Research about teachers' emotions during PD programs is still scarce. Therefore, this research study holds significant value in its support of the limited existing results on this topic, expanding the knowledge in this area. As mentioned before, lesson study is a PD method with substantial implementation differences and varying degrees of success. In this sense, this research study is pioneer in the context of Andorra, but also in the Spanish context, in considering

emotions during a great-scale lesson study PD program. Besides, it offers the possibility to trigger analogous studies in other countries to subsequently compare data.

Before concluding, the limitations of this study must be pointed out. These findings are highly particular to the context of Andorra, which may differ significantly from other countries. As a result, the research may only be partially applicable on a global scale. Nevertheless, it is feasible to initiate similar studies in other countries to compare data. In connection with the previous limitation, this lesson study was implemented in a trilingual context. Participant teachers were Catalan and French native speakers, whereas researchers were Spanish native speakers. Consequently, the research instrument had to be applied in a language other than the mother tongue of the teachers or researchers. Since the questionnaire was designed by the researchers, it was applied in Spanish, but this decision might have caused misunderstandings regarding the intention of some of the questions. Even when most participants, further than Catalan and French, were fluent in Spanish, there could be nuances in the meaning of some of the verbs and adjectives in the questionnaire. The PD program was compulsory for teachers, a condition that might be particularly disadvantageous for teachers (Clivaz & Takahashi, 2018). Still, the results reveal that this PD method led to improved conditions in teachers' perceptions and in the Andorra education system. The last limitation comes from the structure of the instrument, we used closed-ended lists of emotions, because we already had used open-ended questions during the interviews to write the initial report, thus, we already had some previous information. However, this structure could hide other possible emotions. In a forthcoming paper, we are analyzing the answers to open-ended questions in the instrument in which those emotions could arise.

Acknowledgements

This research was funded by the Andorran Ministry of Education. Authors want to express their gratitude The authors also want to acknowledge the participation and collaboration of the participant teachers and administrative staff of the Ministry.

References

Alsina, Á., & Mulá, I. (2019). Advancing towards a transformational professional competence model through reflective learning and sustainability: The case of mathematics teacher education. *Sustainability, 11*(15), 4039. https://doi.org/10.3390/su11154039

Bakkenes, I., Vermunt, J. D., & Wubbels, T. (2010). Teacher learning in the context of educational innovation: Learning activities and learning outcomes of experienced teachers. *Learning and Instruction*, *20*(6), 533–548.

https://doi.org/10.1016/j.learninstruc.2009.09.001
Capomagi, G., Benvenuti, S., & Rodríguez-Muñiz, L. J. (2022). *Il lesson study come strategia di ricerca: un esempio presso il Principato di Andorra* [Conference presentation]. La Formazione Docenti di Matematica tra continuità e innovazione: il Lesson Study, Torino (Italy).
Clivaz, S., & Takahashi, A. (2018). Mathematics lesson study around the world: Conclusions and looking ahead. In M. Quaresma, C. Winsløw, S. Clivaz, J. P. da Ponte, A. Ní Shúilleabháin, & A. Takahashi (Eds.), *Mathematics lesson study around the world: Theoretical and methodological issues* (pp. 153–164). Springer. https://doi.org/10.1007/978-3-319-75696-7_9
Coles, A., Rodríguez-Muñiz, L. J., Chee-Mok, I. A., Ruiz, A., Karsenty, R., Martignone, F., Osta, I., Ferretti, F., & An Nguyen, T. T. (2023). Teachers, resources, assessment practices: Role and impact on the curricular implementation process. In Y. Shimizu & R. Vithal (Eds.), *Mathematics Curriculum Reforms Around the World* (pp. 291–321). Springer. https://doi.org/10.1007/978-3-031-13548-4_18
Coppola, C., Di Martino, P., Pacelli, T., & Sabena, C. (2012). Primary teachers' affect: A crucial variable in the teaching of mathematics. *Nordic Studies in Mathematics Education, 17*(3-4), 107–123.
Cross Francis, D. I., Hong, J., Liu, J., Eker, A., Lloyd, K., Bharaj, P. K., & Jeon, M. (2020). The dominance of blended emotions: A qualitative study of elementary teachers' emotions related to mathematics teaching. *Frontiers in Psychology, 11*, 1865. https://doi.org/10.3389/fpsyg.2020.01865
Fernandez, C. (2002). Learning from Japanese approaches to professional development: The case of lesson study. *Journal of Teacher Education*, *53*(5), 393–405. https://doi.org/10.1177/002248702237394
Fernandez, C., & Yoshida, M. (2012). *Lesson study: A Japanese approach to improving mathematics teaching and learning*. Routledge. https://doi.org/10.4324/9781410610867
Funghi, S. (2022). *Cultural transposition of lesson study: Primary pre-service teachers' beliefs after a workshop* [Conference presentation]. 28th International Conference on Mathematical Views (MAVI28), Gijón (Spain).
Gaines, R. E., Osman, D. J., Maddocks, D. L. S., Warner, J. R., Freeman, J. L., & Schallert, D. L. (2019). Teachers' emotional experiences in professional development: Where they come from and what they can mean. *Teaching and Teacher Education, 77*(1), 53–65. https://doi.org/10.1016/j.tate.2018.09.008
Kadroon, T., & Inprasitha, M. (2013). Professional development of mathematics teachers with lesson study and open approach: The process for changing teachers values about teaching mathematics. *Psychology*, *4*(2), 101–105. http://dx.doi.org/10.4236/psych.2013.42014
Korthagen, F. A. (2001). *Linking practice and theory: The pedagogy of realistic teacher education*. Lawrence Erlbaum Associates.
Korthagen, F. A., & Vasalos, A. (2005). Levels in reflection: Core reflection as a means to enhance professional growth. *Teachers and Teaching*, *11*(1), 47–71. https://doi.org/10.1080/1354060042000337093
Kyei-Blankson, L. (2014). Training math and science teacher–researchers in a collaborative research environment: Implications for math and science education.

International Journal of Science and Mathematics Education, *12*(5), 1047–1065. https://doi.org/10.1007/s10763-013-9444-6

Lewis, C. (2002). *Lesson study: A handbook of teacher-led instructional change.* Research for Better Schools.

Mellone, M., Pacelli, T., & Liljedahl, P. (2021). Cultural transposition of a thinking classroom: to conceive possible unthoughts in mathematical problem solving activity. *ZDM Mathematics Education*, *53*(4), 785–798. https://doi.org/10.1007/s11858-021-01256-z

Ministry of Education [Andorra]. (2022). Pla Estratègic per a la Renovació I Millora del Sistema Educatiu Andorrà. https://www.educacio.ad/sistema-educatiu-andorra/permsea

Murata, A. (2011). Introduction: Conceptual overview of lesson study. In L. Hart, A. Alston, & A. Murata (Eds.), *Lesson Study Research and Practice in Mathematics Education* (pp. 1–12). Springer. https://doi.org/10.1007/978-90-481-9941-9_1

Ní Shúilleabháin, A. (2017). Enacting curriculum reform through lesson study in the Irish post-primary mathematics classroom. In M. Quaresma, C. Winsløw, S. Clivaz, J. P. da Ponte, A. Ní Shúilleabháin, & A. Takahashi (Eds.), *Mathematics lesson study around the world: Theoretical and methodological issues* (pp. 65–85). Springer. https://doi.org/10.1007/978-3-319-75696-7_4

Pekrun, R. (2017). Emotion and achievement during adolescence. *Child Development Perspectives, 11*(3), 215–221. https://doi.org/10.1111/cdep.12237

Ponte, J. P. D., Quaresma, M., Mata-Pereira, J., & Baptista, M. (2017). Fitting lesson study to the Portuguese context. In M. Quaresma, C. Winsløw, S. Clivaz, J. P. da Ponte, A. Ní Shúilleabháin, & A. Takahashi (Eds.), *Mathematics lesson study around the world: Theoretical and methodological issues* (pp. 87–103). Springer. https://doi.org/10.1007/978-3-319-75696-7_5

Posner, J., Russell, J. A., & Peterson, B. S. (2005). The circumplex model of affect: An integrative approach to affective neuroscience, cognitive development, and psychopathology. *Development and Psychopathology*, *17*(3), 715–734. https://doi.org/10.1017/S0954579405050340

Ramploud, A., Funghi, S., & Bartolini, M. G. (2022). Chinese lesson study: Critical aspects of transfer from China to Italy. *International Journal for Lesson & Learning Studies*, *11*(2), 147–169. https://doi.org/10.1108/IJLLS-04-2021-0031

Rodríguez-Muñiz, L. J., Aguilar-González, Álvaro, Alonso-Castaño, M., García-Honrado, I., Lorenzo-Fernández, E., & Muñiz-Rodríguez, L. (2023). Explorando nuevas estrategias de formación del profesorado de matemáticas: un enfoque ampliado del Lesson Study para el desarrollo profesional en la Escuela Andorrana. *Revista Interuniversitaria de Formación del Profesorado*, *98*(37.2), 35–54. https://doi.org/10.47553/rifop.v98i37.2.99131

Saunders, R. (2013). The role of teacher emotions in change: Experiences, patterns and implications for professional development. *Journal of Educational Change*, *14*(3), 303–333. https://doi.org/10.1007/s10833-012-9195-0

Scott, C., & Sutton, R. E. (2009). Emotions and change during professional development for teachers: A mixed methods study. *Journal of Mixed Methods Research, 3*(2), 151–171. https://doi.org/10.1177/1558689808325770

Sutton, R., & Wheatley, K. (2003). Teachers' emotions and teaching: A review of the literature and directions for future research. *Educational Psychology Review, 15*(4),

327–358. https://doi.org/10.1023/A:1026131715856

Taxer, J. L., & Frenzel, A. C. (2015). Facets of teachers' emotional lives: A quantitative investigation of teachers' genuine, faked, and hidden emotions. *Teaching and Teacher Education*, *42*, 78–88. https://doi.org/10.1016/j.tate.2015.03.003

Vermunt, J. D., Vrikki, M., van Halem, N., Warwick, P., & Mercer, N. (2019). The impact of lesson study professional development on the quality of teacher learning. *Teaching and Teacher Education*, *81*, 61–73. https://doi.org/10.1016/j.tate.2019.02.009

Winsløw, C., Bahn, J., & Rasmussen, K. (2017). Theorizing lesson study: Two related frameworksand two Danish case-studies. In M. Quaresma, C. Winsløw, S. Clivaz, J. P. da Ponte, A. Ní Shúilleabháin, & A. Takahashi (Eds.), *Mathematics lesson study around the world: Theoretical and methodological issues* (pp. 123–142). Springer. https://doi.org/10.1007/978-3-319-75696-7_7

Zeichner, K. (2012). The turn once again toward practice-based teacher education. *Journal of Teacher Education, 63*(5), 376–382. https://doi.org/10.1177/0022487112445789