Cognitive dissonance that different mathematics teachers report feeling in their classrooms

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Abstract: The research shows the continuous presence of affective processes that influence and are influenced by cognitive processes, behaviours and, in the case of our mathematics teachers, by interactions with students. We analyse from a qualitative perspective the processes of cognitive dissonance that occur when teaching mathematics at different educational levels. The main objective is to describe these processes from the experience of our cases and relate them to the mathematical content, the didactics of mathematical content and classroom management. The results show the amount of psychological discomfort that mathematics teachers have to deal with on a daily basis and how some of these processes are not solved and remain a long-term concern for teachers. It also shows examples of how our cases manage situations of dissonance, which can enable us to become more aware of what we feel, why we feel it and how we can reduce or even eliminate cognitive dissonance. Reflecting on these processes is essential to mitigate teachers' discomfort, thus reducing the risk of burnout and professional attrition.

Keywords: cognitive dissonance, mathematics teachers, affect system, beliefs, tensions.

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1 Introduction

Teaching is a profession characterised by a combination of cognitive and emotional components, both of which are important for achieving teaching goals and good learning outcomes (Kariou et al., 2021). Moreover, researchers in mathematics education have recognised that affect plays a fundamental role in teaching and learning phenomena, increasing the interest and importance of research in this field of study (Andrà et al., 2023). On the one hand, the continuous interactions between teachers and students make inevitable the presence of socio-affective variables that, from more or less complex processes, will influence their corresponding processes of teaching and learning mathematics. Bearing this complexity in mind, in this study, we adopt a dynamic affect systems perspective by considering its study from a "dynamic affect system", in which its constructs are related in a dynamic way, influencing both the individual and his or her behaviour and the decisions taken in the classroom (Pepin & Roesken-Winter, 2015).

On the other hand, teachers need more reflection and knowledge of the affective and emotional processes that take place in the classroom. Inadequate emotional management continues to be one of the main reasons why teachers leave the profession (Fried et al., 2015). According to Chang (2009), to alleviate this emotional exhaustion, it is important to increase studies that promote understanding of the emotional process, starting from the previous assessments that trigger these emotional processes and learning how to regulate them. We are aware of the great emotional work of teachers, but there is a lack of time for reflection, identification and analysis of these emotional and affective processes. Moreover, teachers are constantly exposed to criticism from students, parents, colleagues and superiors, and must manage these situations without failing to be a role model for their pupils (Silbaugh et al., 2023).

This study is part of a broader research project that focuses on the affective systems of mathematics teachers through the study of cognitive dissonance. In the first part, a questionnaire was used to get teachers to reflect on their teaching practice. The discrepancies between the actions that teachers considered important and the frequency with which they were used in the classroom were analysed (Marbán de Frutos et al., 2024). Based on these responses, we began this study that seeks to identify the cognitive dissonances that appear in our case studies, all of them mathematics teachers. Specifically, we posed the following research questions: What type of cognitive dissonance do we find based on the dimensions that have been raised in the previous questionnaire? How is the psychological discomfort or distress that occurs in the situations identified managed?

2 Theoretical framework

The theory of cognitive dissonance comes from social psychology, was developed by Festinger (1957) and is still the basis of much research today, with the field of teaching and learning being an area in which to further explore this theory (McGrath, 2020). According to Festinger (1957), human beings seek to achieve and maintain consistency between what they know or believe and what they do, the problem arises when this balance is broken, and cognitive inconsistency or dissonance appears. Cognitive dissonance is thus defined as the existence of cognitions that do not agree, with "cognition" being understood as any knowledge, opinion, or belief about the environment, about oneself or about one's behaviour (Festinger, 1957). A contradiction between two elements of knowledge is a separate mental state with its own emotion

of cognitive dissonance (Bonniot-Cabanac et al., 2012). The characteristic of cognitive dissonance is that it generates a discomfort or unpleasant state that motivates the individual to do something to eliminate or reduce this discomfort. Festinger's theory of cognitive dissonance falls within the cognitive approach, which assumes that emotions are triggered by a special type of cognitive activity (Marbán, 2022).

Previous studies in mathematics education have discussed situations that can be related to the process of cognitive dissonance. They mention tensions related to professional dilemmas that elicit strong emotions (Andrà et al., 2019), or tensions around what and how to teach best, how to manage situations with students, colleagues, administrators and parents (Liljedahl et al., 2023). Teaching is characterised by a great deal of emotional work in the management of all these situations and interactions. Often such decisions conflict with our goals, attitudes and values, resulting in a state of affect characterised by discomfort, tension and distress (McGrath, 2017). Once these tensions arise, as with cognitive dissonance, the teacher will try to resolve or manage them to the point where the discomfort diminishes and a balance is reached below the threshold that generates the dissonance. Cognitive dissonances involve specific emotions related to the knowledge instinct, which drives the mind to adjust mental representations to cognitive experiences and to resolve contradictions (Bonniot-Cabanac et al., 2012).

One of the most important consequences of deciding is the existence of dissonance, discomfort appears when rejecting something that was attractive and the restructuring process begins to reduce it (Festinger, 1957). If there is something characteristic of the teacher's work in the classroom, it is continuous decision making, in each situation and with each interaction with the students, an evaluation is produced which, passing through the affective system, generates a reaction or response. With this statement, we position ourselves in a "dynamic affect system" (Pepin & Roesken-Winter, 2015), which allows us to relate and interpret the connections between these elements and the behaviors of teachers. Similarly, cognitive dissonance is related to specific emotions generated by teachers' appraisals based on their values, beliefs and attitudes. It is a system and its components are better understood in the context of the relationships between them than in isolation (Pepin & Roesken-Winter, 2015). Thus, it should be noted that to reduce the discomfort generated by acting contrary to our beliefs and opinions, we may try to rationalize or justify our actions to ourselves and others. In fact, dissonance can be reduced by eliminating dissonant cognitions, adding consonant cognitions, reducing the importance of

dissonant cognitions (Festinger, 1957), or increasing the importance of consonant cognitions (Harmon-Jones & Mills, 2019). Bearing in mind that dissonance acts as an impulse or necessity we point out here the importance of analyzing these processes and reflecting on the situations teachers encounter in the classroom, so that they are aware of their own affective processes. Within the previously mentioned dynamic system of affect, we will analyse what circumstances generate the emotions of dissonance, the appraisals and their beliefs and how they balance some of the cognitions involved in the process, seeking balance to reduce discomfort. However, we cannot forget that people lie, to themselves and to others (Schoenfeld, 2015), there may be circumstances in which the individual behaves in a way that is opposite to their cognitions or affirms something they do not believe in (Festinger, 1957). In the case of teachers, this may be due to external pressures from the educational community or internal pressures from the model of the teacher they ideally want or believe themselves to be. Thus, more conscious work at the affective level will enable mathematics teachers to question and challenge their identity as mathematics teachers (Grootenboer & Edwards-Groves, 2019). Only by reflecting on and analyzing these affective processes will we be able to use them for the teachers' own benefit and the improvement of mathematics teaching and learning processes.

3 Methods of analysis

This research follows a qualitative methodological approach as it fits the description given by Hernández-Sampieri and Mendoza (2018), examining how individuals perceive and experience phenomena from their point of view. The main objective focuses on the identification and analysis of cognitive dissonances, but with the exploratory purpose of understanding both their origin and teachers' responses to them. The research is based on a cross-case study that allowed us to identify discrepancies in each of the case studies based on a questionnaire on good practices in mathematics education (Marbán de Frutos et al., 2024). In this first stage of the research the answers to the questionnaire show us the differences between the actions that the participants in the study consider important in the classroom and the frequency with which these actions are carried out in their classroom. In addition, we hope that these responses will provoke a first reflection of these discrepancies in these study teachers.

The cross-case study design is of great interest when different units of analysis, each of which constitutes a case, are to be compared. The cases were chosen based

on three variables: gender, educational stage and teaching experience. Taking these characteristics into account, the research team contacted active teachers, who were informed of the involvement and aims of the research, and their informed consent was obtained, and the study and data collection began.

We present here the second part of the research, in which the instrument used to obtain the data is a semi-structured interview that seeks to delve deeper into the discrepancies identified through the previous questionnaire and their possible generation of dissonances. On the other hand, the interview has been designed to generate a propitious environment in which the subjects can identify other dissonances and for joint reflection on them. Thus, the interview is organized in four blocks: the first focuses on establishing a relaxed atmosphere for dialogue, as well as to learn more about the academic and professional background of the case; the second explores the cognitive dissonances generated from the questions in the previous questionnaire; the third expands on the search for tensions and discomfort with any other aspect of teaching practice; and finally, the fourth block is oriented towards a final reflection. It should be noted that the interview was validated and piloted before being used with the cases in our sample. Moreover, in accordance with the criteria of rigor in all qualitative research, after the transcription of the interview, it was sent to the corresponding participant for review, who could propose changes, clarifications, suppressions and even the incorporation of experiences or opinions that had not arisen during the live development of the interview itself.

The participants are the same as in the first stage, 16 in-service teachers representing four educational stages (Primary, Secondary, University-Education Degree and University-Mathematics), with different levels of experience (Junior: 5 or less years and Senior: 6 or more years of teaching experience) and of different gender (Female and Male). All of them were interviewed after being asked again for informed consent and told the purpose of this second part of the study. In addition, when setting the interview date, they were asked to review the questions and answers from the previous questionnaire as these would be discussed in the interview. The interviews lasted between 60 and 120 minutes and were conducted in seven cases via “Teams” and in the other nine cases face-to-face. The interviews were all recorded and subsequently transcribed in their entirety, except for one interview in which the audio could not be retrieved due to a malfunction of the device used. Due to the impossibility of recovering the audio and working with the transcript as in the

other cases, we decided to eliminate the information from this case (Senior/Male/Mathematics Degree) from our analysis.

From the collected data we will carry out a content analysis (Krippendorff, 2019). As a starting point, the three main categories into which the initial questionnaire was organised were considered: mathematical content, didactics of mathematical content and classroom management. These three categories make it possible to narrow down the problem of identifying elements, as was the case in POEMat.es (Joglar et al., 2021), the observation guideline used to create the questionnaire. In each of these, subcategories were added, most of which were present in the questionnaire, to organise and detail the type of dissonances that emerged in the interviews. The models behind these categories and subcategories are: Mathematical Knowledge for Teaching (Thames & Ball, 2010), and Mathematics Teachers' Specialised Knowledge (Carrillo-Yañez et al., 2018). As the interview leaves room for participants to expose other teaching situations that cause them discomfort, new subcategories emerge that were not in the previous questionnaire. Table 1 shows the categories and subcategories presented in our analysis. These will be complemented in the analysis with concrete examples and the information given by each case.

Table 1. Categories and subcategories present in the analysis carried out in the study

Dissonnances related to mathematical content	Use different representations register/strategies Mathematical concepts: connections, examples and counterexamples Working on or from mathematical errors
Dissonnances related to didactics of mathematical content	Use of manipulative materials Setting research tasks to construct new knowledge Student protagonism
Dissonnances related to classroom management	Learning difficulties Student behaviour Time management Use different resources (textbook, slides, notes, photocopies)

Note. Categories and subcategories used in our analysis. Source: own elaboration.

In terms of the analysis of cognitive dissonance it is important to consider these situations that show decisions made by teachers that conflict with their attitudes, values and goals (McGrath, 2017). Moreover, we allow participants to show current situations that generate discomfort for them and that may not have been shown in the previous questions or not yet managed. The cases' explanations of these

situations will allow us to gather information about the participants' management of cognitive dissonance in terms of the cognitions that constitute them, which we will analyze in the following section.

4 Analysis and results

In this section we will identify cognitive dissonances in each of the categories we have indicated and the explanations of these dissonances by the teachers interviewed. These explanations or justifications made by each of the cases will allow us to demonstrate the management carried out by the teachers interviewed, adding/removing cognitions or increasing/decreasing the importance of some cognition. In this way, the participants will reveal how they manage situations of discomfort by seeking a balance in the cognitions that make up the dissonance. The literal comments made by the participants, both about the cognitive dissonance and its management, will be written in italics. In addition, the information about the specific case to which the fragment corresponds (Experience/Gender/Educational level) will be indicated after the dissonance and in brackets.

4.1 Dissonances related to mathematical content

4.1.1 Display/use different representation registers/strategies

- In this case, it was a new situation that arose in the classroom when the students asked him if they could solve the exercise in a different way: "*I had a conflict and I said: no, no, please, do it this way*" (Junior/Male/Secondary).
  To manage it, he tries to reduce the importance of his beliefs: "*you think you have the only truth in the way to solve things [...] then I thought about it now, why not*". He also adds consonant elements: "now they are commenting in the Evau that they accept that way". On the other hand, he tries to justify the decision not to accept other strategies: "I like to guide them and tell them that I want it like this, this way, because I think it is much better".

4.1.2 Mathematical concepts: connections, examples and counterexamples

- "*I do find it difficult, specifically, to link concepts; because there are concepts that are very abstract (decimals or fractions)*" (Junior/Male/Secondary).

In this case, he feels insecure about the mathematical content and justifies his discomfort by referring to his previous education: "*we should be taught much more about everyday life situations and problem solving. And especially about concepts*". He also adds didactic elements that he considers he has not had either: "*you miss certain strategies on how to teach it, something more didactic*". Management in the classroom is by reducing importance: "*if there is something I don't know or I'm not sure, I tell them, I don't know, but I look at it*" and seeking the support of the students: "*or look for the information too and tell me, let's see if you agree or if I made the mistake*".

- "*It has happened to me in mathematics, some concepts I don't know how to explain in another way and I get frustrated*" (Junior/Male/Education Degree).
  As in the previous case, he tries to diminish the importance of the dissonant elements by focusing on the education received: "*I didn't have those tools, I didn't have that necessary training*". In addition, he adds consonant elements that have helped him manage discomfort: "*On my own, a lot of reading, asking people, through social networks, because there are groups on Twitter for didactics of mathematics*".
- "*Fear of not knowing what to say or getting it wrong; I felt that I was inferior because I am neither an expert in mathematics nor in didactics*" (Junior/Female/Education Degree).
  We observe a decrease in the importance of the dissonant element, while at the same time an increase in the importance of the consonant element: "*I take comfort in knowing that they know less than I do and even if I don't know everything, I know what I'm going to explain and I'm going to do my best*".

4.1.3 Working on or from mathematical errors

- "*We don't go into why it's wrong, my fear is that they will stick with the mistake*" (Senior/Male/Secondary).
  In this case the error causes him discomfort and he tries to avoid such situations and give importance to what he believes that is consonant with what he does: "*My belief is that by working on the error, in the end, you can insist on the error [...] I don't want to teach them what is wrong, I don't want to insist on that*".

4.2 Dissonances related to the didactics of mathematical content

4.2.1 Use of manipulative materials

- "*I like the manipulatives a lot, but I can't use them every day because there is a lot of mess with the children*" (Senior/Female/Primary).
  Consonant elements are added in management: "*there are material limitations because there aren't enough materials for everyone", "the classroom is small*". The importance of dissonant is also diminished: "*it is not always the ideal time, at the end of the day it is difficult to work with them manipulatively*".
- "*It is true that in 4th year I could perhaps do more*" (Senior/Female/Secondary).
  A consonant element is added which is the amount of mathematical content to be completed: "*how can I do anything here if there is not enough time to see all the things they have to learn*". The importance of the dissonant component is also diminished: "*I don't always believe that having done the manipulative first will make things clearer for you*".

4.2.2 Setting research tasks to construct new knowledge

- "*You can't do it with the curriculum, because there are activities that I would like to do that take up a lot of time*" (Senior/Female/Secondary).
  Already in the way he expresses it, he adds an element consonant with his decision, the curriculum, which he also reinforces with social pressure: "*parents, the school and everyone asks you what you have given and if you have finished the curriculum*". Also focusing on this social pressure reduces the importance of the dissonant element: "*no one asks if children know how to think*".
- "*In some units I have tried to carry out learning situations to see how it goes and I am finding that they don't want to do it, it is something I feel a bit uncomfortable with*" (Senior/Male/Secondary).
  In this case there is no management of the dissonance but rather the existence of discomfort due to the attitude of the students who do not agree with his beliefs or value his work: "*tell me how far I have to go and that's it, that's all I'm going to give you, I'm not going to give you any more*", "*you devote a lot of time in your personal life to it, and then the result is practically nothing*".

4.2.3 Student protagonism

- "*During the lectures I feel very pressed for time [...] that often means that you don't give enough time for people to talk*" (Senior/Male/Education Degree).
  In the answer he already introduces time as a consonant element that reinforces the decision taken and repeats it again later: "*to save time, because I get nervous, because I have to give this, this and this*". On the other hand, he minimizes the importance of dissonant elements: "*You ask the question, and nobody answers immediately, so..., telling someone to speak seems a bit disruptive to me*".

4.3 Dissonances related to classroom management

4.3.1 Learning difficulties

- "*Students with needs have a lot of doubts, they come and then you cannot attend to several at the same time [...] that frustrates me the most*" (Senior/Male/Primary).
  In his discourse a consonant element is added: "*I can't split myself*", and the importance of another dissonant element is diminished: "*I want to help you, but I'm with this one and you have to wait*".
- "*I see that I have no idea, and I don't know if I'm doing it right, if I'm doing it wrong, it makes me feel insecure*" (Senior/Female/Secondary).
  This teacher expresses a situation that "*makes her very angry*" with a special needs pupil with whom she considers that she is not doing enough and justifies this by blaming the system and the support teacher: "*But if you add to that the fact that the other teacher doesn't give him material for him to develop, I think this system is shit*", "*For some special needs, half of the time in class and the other half outside, I don't know to what extent that helps the student*".

4.3.2 Student behaviour

- "*With the young ones there is a lot of interference, sometimes you get frustrated, and you say: I wanted to give this and I don't get there*" (Senior/Male/Primary).
  In this case dissonance is managed by increasing the importance of consonant elements: "*the calculation is very important, there are some minimums that I*

have to fulfil". Related to this discomfort, he also points out that he would like to show interest in every doubt they may have, but he is unable to do so: "*Jo, I have so much to teach that I can't stop at every explanation*". He justifies his decision to move forward by stressing the importance of the agenda: "*I stop, but then I'm going to fail to give this and this*".

- "*It's always unpleasant when you're talking to someone and they're on WhatsApp*" (Senior/Male/Education Degree).
  Consonant elements are added for dissonance management: "*because I consider my time to be important as well*" and the importance of these is increased: "*not knowing how to behave is a lack of respect*".

4.3.3 Time management

- "*I plan an activity, I schedule it, I think it is going to take me a certain amount of time and then the reality is that it does not happen*" (Senior/Male/Primary).
  For management, the participant minimizes the importance of dissonant cognition: "*they come and then you can't attend to several at once*", "*explaining in two different ways is not easy*"; at the same time he adds other consonant elements and increases their importance: "*I send them to work as a team, to be helped by a partner, which also works very well for me*".
- "*We have to try to give all the material, as I saw that I couldn't make it, it overwhelmed me a lot*" (Junior/Female/Secondary).
  In this case the consonant element that is added is the social support of her colleagues who said to her: "*it's fine, that usually happens, there is no problem*".

4.3.4 To use different resources (textbook, slides, notes, photocopies)

- "*In general, the book disturbs me a lot*" (Senior/Female/Primary).
  Consonant elements are added and the importance of those already present is increased: "*I don't like the problems at all, and I don't like some of the explanations either*". It also dismisses the importance of dissonant cognitions: "*it's fine, we will do the book, but it's a support*", "*having to work with the book and only in the way the book offers seems to me to be very limited*".
- "*It is a booklet that from my point of view is horrible because it mixes up everything*" (Junior/Female/Primary).

In this case, she justifies her decision to use the workbook and adds consonant elements: "*guides me because I have never been in first grade, and I have never been teaching mathematics*". It also minimizes the importance of dissonant elements: "*use it in such a pattern just because they have bought it*" and increases the consonant element: "*I don't like it because I think that each child has his or her own rhythm [...] there are children who would need to reinforce other things*".

5 Final reflections

The main contribution of our study is to shed light on the process of cognitive dissonance which, as we have seen, appears in classroom actions and decision-making. First, it is important to mention that we found cognitive dissonances belonging to the three main categories into which the previous questionnaire used is organized. The participants think about these actions when answering the questionnaire and in the interview, they justify their discrepancies by referring to previous experiences, so that their discourse helps us to identify situations of discomfort characteristic of cognitive dissonance. This is the reason why some authors speak of emotions of cognitive dissonance related to the instinct of knowledge (Bonniot-Cabanac et al., 2012). Precisely the analysis shows us such mental elaborations and the adjustments that the participants make to resolve situations in which the decision taken causes certain cognitions to enter conflict, provoking discomfort. The analysis has shown us how these affective processes influence the behavior of the teacher and the relationship between the teacher and students (Keller et al., 2014), being part of a system that influences and is influenced by students' outcomes, including the emotions, cognitions and behavior of students (Frenzel et al., 2021).

Although space is limited, the analysis reflects the participants' comments on the treatment of cognitions to favor the reduction or elimination of dissonance. Different strategies are observed in eliminating or reducing the importance of dissonant cognitions or the opposite process with consonant cognitions (Festinger, 1957; Harmon-Jones & Mills, 2019). In this way teachers justify the decision taken and manage the conflict that has caused them tension or discomfort. Thus, we can affirm that teachers' emotions are inseparable from their moral goals and ability to achieve them (Hargreaves, 1998), as well as the instructional choices they make (Hannula, 2015).

Our study has made it possible to show the mental elaboration underlying the affective processes related to cognitive dissonance in specific situations in the mathematics classroom, as well as its management. These are common situations that generate discomfort, so normalizing them and showing how to manage them seems to us to be very important for promoting well-being in the classroom. This reflection gave them tools to live with tensions that had not yet been resolved (Liljedahl et al., 2023), or that even if they are not fully resolved their management will help teachers find the balance that allows them to deal with the situation in the future. Repeated experiences related to unpleasant emotions can lead to teacher burnout (Chang, 2009). It is therefore important to learn how these affective processes work and how we can improve their management.

Finally, it should be noted that due to space limitations we cannot show all the cognitive dissonances that have been found, nor more elements of their management or patterns between the different cases studied. For future studies, it seems important to us to deal with each case in depth and to complement it with observation and treatment of the dissonance as it occurs, so that management is more in line with reality and each one of the cognitions involved can be better analyzed.

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