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ORIGINAL PAPER

# Processes of subjectification: positioning, power, and emotions in the mathematics classroom

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**Abstract**
During teaching-learning activities, students and teachers engage in complex interactive and intersubjective processes in which both co-position each other. These processes, which, in the theory of objectification, are called processes of subjectification, are conceived as agentic processes of a cultural-historical nature. From these processes, teachers' and students' verbal and corporal language and emotions emerge in close relationship with how knowledge and cultural values promoted by the school are manifested. In this article, we analyze the processes of subjectification of a group of Mexican high school students during a sequence of mathematics classes in which the concept of motion is taught. The video data from the lessons were transcribed and analyzed using a semiotic multimodal dialectical methodology. Our findings provide a deeper understanding of the dialectical relationship between students' emotions, power, and other various agentic devices that teachers and students resort to in their teaching-learning activity.

**Keywords** Theory of objectification · Subjectivity · Emotions · Social relations · Positioning · Power

## 1 Introduction

In the last decades, the concept of subjectivity has attracted particular attention in mathematics education as well as in other disciplines (see, e.g., Brown, 2008; Fischbach, 2012). We want to argue that this increasing attention is a token of the difficulties that have arisen in trying to come to terms with what Adorno (2001) calls *the estrangement of the subject*. The estrangement of these roots lies in the impossibility to overcome the duality of the individual and the social, expressing in many guises the inherent antinomy of bourgeois society since the inception of modernity until today, where "human beings have increasingly made the world in their own image, and the world has become progressively theirs. At the same time, however, the world has increasingly become a world that dominates them" (Adorno, 2001, p. 115). Adorno contends that modernity, with its capitalist forms of production, brought forward an idea of the world based on a "commodity character" (p. 115):

> Thus we have these two concepts, namely, subjectivization, the dissolving of the world into the activity of the subject, on the one hand, and the reification, objectification of the world as something contrasted with the subject, on the other. (Adorno, 2001, p. 115)

By multiplying and complexifying the world's commodity character, global capitalism has exacerbated the problem of the dichotomy of the individual and the social. The result has been an increasing emphasis on subjectivization in terms of free individuality (Russon, 2017) and an accruing reification of the social that appears now as a mere space of constraint—a space that in no way is constitutive of the individual (Balibar, 2014).

In the field of education, this capitalist ideology that reifies the social has been championed by the Organization for Economic Cooperation and Development (OECD). Subjectivization appears emphasized through the construct of agency, understood as a sense of responsibility and the capability to set goals and take action, as opposed to merely

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responding to external influences. "It is about acting rather than being acted upon; shaping rather than being shaped; and making responsible decisions and choices rather than accepting those determined by others" (OECD, 2019, p. 2).

In the case of teaching and learning, the efforts made in understanding subjectivity have often led to questions about gender, race, and power. For example, drawing on positioning theory, Wagner and Herbel-Eisenmann (2014) demonstrate how authority structures in the mathematics classroom are embedded in discursive speech patterns and grammatical scripts, highlighting the ways participants' positionings relate to teacher authority. Quintos et al. (2024) also employ positioning theory to analyze how power dynamics in the classroom shape students' rights and responsibilities, revealing that these roles are continuously negotiated. Valoyes-Chávez et al. (2023) highlight how Black immigrant students in Chile face forms of epistemic violence that position them as "non-knowers" of mathematics due to racial stereotypes that limit their participation in class discussions. Byun (2024) examines how interactional practices in the classroom can either facilitate or restrict the participation of minority students in mathematical discussions.

Our paper is inspired by the aforementioned literature, but looks at the students from a different angle. Adopting a processual dialectic approach, it focuses on the makings of subjectivities in the mathematics classroom. Its goal is to investigate the students' processes of subjectification through the prism of the interplay of agentic dimensions (e.g., emotions, power, and authority relations) as they appear and are transformed in intertwined dialectical manners during classroom activity. Our approach is theoretically framed by a neo-Vygostkian perspective—the theory of objectification (Radford, 2021). In the next section, we present a brief outline of the problem of subjectivity from neo-Vygotskian approaches; this outline is followed by a discussion of the concept of subjectivity in the theory of objectification. Then, we move to an exposition of the method and analysis of our data. Our results shed light on the co-production of subjectivities in the classroom and its link to the students' understanding of, and participation in, the mathematics activity.

## 2 Theoretical framework

### 2.1 Neo-Vygotskian approaches

Neo-Vygotskian scholars have drawn on Cultural-Historical Activity Theory and its monist stance to understand subjectivity. Drawing on Vygotsky's (1994) insights, one of the key concepts in contemporary Vygotskian research on subjectivity is perezhivanie, that is, "a common name for direct psychological experience [in which] we distinguish [...] an activity related to the appearance of certain Perezhivanie [and] the content, the composition of what is experienced" (Varshava and Vygotsky 1931, p. 128; cited in Veresov, 2017, p. 48). As Mok (2017, p. 19) notes, the concept of perezhivanie "unifies emotion and cognition, and the individual with their environment, in a single unit." For example, in this line of thought, Ng (2021) has investigated the way students' lived experiences in mathematics relate to subject choice plans and decisions.

However, re-imagining the social beyond the traditional dualistic Western tradition has proven to be one of the most enduring problems in education and the social sciences. It requires in particular to move to a different ontology of the world—a "relational/process ontology" (Stetsenko, 2019, p. 255)—whose theoretical understanding leads to prioritizing some concepts rather than others. A. N. Leont'ev, for instance, is often interpreted as prioritizing the link between the individual and the social in practical, material activity, instead of following Vygotsky's idea of perezhivanie understood "as a word-meaning-based intellectual process" (Mok, 2017, p. 39).

Despite theoretical differences, neo-Vygotskian scholars are moving away from an earlier understanding of internalization as the link between the social and the individual. This is the case of González Rey (2021), a Cuban psychologist who studied with Lidia I. Bozhovich, herself one of Vygotsky's students. In her investigations of the social in child development, Bozhovich (2009) insisted that to understand the child's development one needs to distinguish between external and internal factors or positions, since internal positions condition "the structure of their [children's] attitude toward reality, toward those around them, and toward themselves" (p. 81). She went on to assert that "every moment, the effects coming from the environment are refracted through this internal position" (p. 81). In the footsteps of her mentor, González Rey formulated a cultural-historical theory of subjectivity articulated around the axes of subjective meanings and social subjectivity: "The social is producer of a subjectivity that ... has an effect and an organization that integrates ... productions of subjective sense ... It is this level of subjectivity that we have called social subjectivity" (González Rey, 2021, p. 61).

As we can see, González Rey's concept of subjectivity is a semiotic one. As he puts it in an interview, "For me, the constitutive unit par excellence of subjectivity is the subjective sense" (Díaz Gómez & González Rey, 2005, p. 378). Subjectivity is based on the idea of sense, sketched by Vygotsky at the end of his life. Subjectivity is a system "where senses, configurations of senses, and symbolic unfoldings are organized with the repertoires that the subject finds to express themself and to act" (Díaz Gómez & González Rey, 2005, p. 375). In this theory there is an explicit intention to go beyond the meagre views of the social as an ensemble of contractual monads of Western thought (Elias, 1991). However, González Rey's magnificent theorization falls prey to

a subjectivist view of the subject. Despite the repeated acknowledgment of a symbolic cultural-historical sphere that transcends the individual, "The subject," he tells us, "is the individual who takes a particular path of subjectivation and generates his own spaces within the institutional social spaces" (Díaz Gómez & González Rey, 2005, p. 377). Or, "My subjectivity is constituted in a field of *my* action" (p. 382; emphasis added).

Influenced by the 1970s official bureaucratic conception of activity that dominated psychological research in the USSR, González Rey was too quick to dismiss the ontological role of collective activity and shifted the emphasis onto the semiotic significance of the individual's actions and doings. Society became conceived of as an external space to host individual experience—pretty much as in Bozhovich's (2009) theorizing and not much different from how society appears in Piaget's (1967) work, really. Subjectivity and the social do include an important semiotic component; but they also include political and economic components that, all together—and in a dialectical manner—shape the nature of both subjectivity and the social. Thus, instead of being a mere background of human experience, the social needs to be seen, as Fischbach (2015) suggests, as a dynamic whole in constant movement and transformation where the social not only comes to express conceptions about individuals but also where individuals find and enact in creative and subverting ways social relations that link self and other—historical relations that are always tinged with political and cultural valences.

## 2.2 Subjectivity in the theory of objectification

The theorization of subjectivity and processes of subjectification we follow here are guided by the theory of objectification (Radford, 2021)—an educational theory inspired by Vygotsky, Leont'ev, and dialectical materialism. The theory resists the idea that learning consists of receiving knowledge; or that learning is the construction of personal or subjective ideas. In the theory of objectification, learning is conceived as an encounter with cultural-historical knowledge. This encounter takes place in human, practical, sensible activity where knowledge and its cultural logic are revealed through processes of objectification, namely the collective, active, embodied, discursive, symbolic, and material processes through which the students become conscious and critically acquainted with culturally and historically constituted systems of thinking, reflection, and action. Now, by encountering knowledge, the students are transformed. This is why, in the theory of objectification, learning is about both knowing and becoming.

The encounter with knowledge is such, then, that in the activity that mediates learning, we find two interrelated processes: the processes of objectification and the processes of subjectification, the latter being those processes of the making of subjectivities—i.e., unfinished, and unfinishable entities always in transformation. We agree with González Rey about seeing subjectivity in processual terms as a system. However, we see it as a dialectical system of *social relations*. Indeed, what defines us is what we think and feel, what we do, what we say, what we imagine, what we dream of, etc. But all of these components have in their deepest texture a *relational nature*: our thinking, our saying, our doing, are not the thinking of a solipsist ego. They are all rooted in our *relations with others*; that is to say, in social relations. This is what Marx (1998) claimed in his *Theses on Feuerbach*: the individual is an ensemble of social relations. The social relations that define us are what we express in our thoughts, actions, conversations, our projects, etc. They carry with them our dreams, fears, and hopes.

We can reformulate these ideas by saying that a subjectivity is an evolving, unfinished, and unfinishable dialectical system made up of social relations intertwined with diverse spheres, including the spheres of sense, concepts, language, emotion, motion, body, and conscious and unconscious projects of life. Rather than being the product of the self, subjectivities are co-produced as subjects engage with others in activity—activity, however, understood in a cultural-historical sense; that is to say, as something that glues us to others.

Hence, in the perspective sketched here, the subjectivities that continuously emerge in processes of subjectification are relational entities. They are neither the cognitive subjects of rationalist epistemology nor the sensualist subjects of empiricist approaches. They are sentient concrete beings that breathe, transpire, dream, suffer, think, and hope with others.

In the investigation of the processes of subjectification in teaching and learning contexts we pay attention to the activity where these processes are subsumed. This point is important to bear in mind because the processes of subjectification are shaped by the kind of activity in which they unfold. For example, the processes of subjectification that can occur in a teacher-centred pedagogy (direct teaching) are different from those that occur in constructivist (student-centred learning) and other settings. Hence, in the course of our analyses, we identify the kind of teaching-learning activity and pay attention to the ways in which students participate in the activity.

In this line of thought, we distinguish between two general types of activity that the English language collapses into a single term but that the German and the Russian languages keep apart, as their meanings are not the same. The first one is activity in the sense of Tätigkeit (in German) and deyatel'nost' (in Russian). Activity in this sense refers to a dynamic system where individuals interact collectively in a *strong* social sense and are driven to the attainment of a

common object: the object/motive of the activity (Leont'ev, 1978). The second one is activity in the sense of Aktivität (in German) and aktivnost' (in Russian). Its sense is not collective; it is rather subjective or individual, as being busy with something (Roth & Radford, 2011) or as when students learn by themselves (maybe in interaction with others but where this interaction is simply a stimulus to the student's own cogitations), as in socioconstructivist approaches.

The participation of the students in the activity is studied in terms of the theoretical construct of positioning, which we briefly mentioned in the Introduction. Generally speaking, positioning theory presents itself as a new perspective (mainly a method of analysis of discursive focus) to investigate what people experience in interaction. A seminal work is Harré (2012), which defines positioning theory as "based on the principle that not everyone involved in a social episode has equal access to rights and duties to perform particular kinds of meaningful actions at *that moment* and with *those people*" (p. 193; emphasis in the original). The famous question of the dichotomy of the social and the individual is tackled in terms of the link between the individuals' access to cultural resources and the personal use of those resources as clusters of duties and beliefs displayed in storylines. As Herbel-Eisenmann et al. (2015, p. 188) note, "the idea of positioning was offered to recognize the flexible nature of interactions, which are continually negotiated either explicitly or implicitly." The approach leads to an emphasis on an interactionist individual as a kind of negotiator that draws on social and cultural rights and obligations. Our approach to positioning is different: it tries to capture participation in the global project encapsulated by cultural-historical teaching-learning activity, with an emphasis on how students come to participate (or not) in the attainment of the object of the activity (the activity's object of learning, for instance learning to interpret graphs, as in the example we discuss below). It seeks to investigate how students position themselves and others through the enactment of cultural-historical social relations (e.g., relations of power or cooperation; solidarity or antagonism; commitment or disengagement; listening or ignoring; caring or uncaring, etc.) as they appear in the interrelated spheres of sense, concepts, language, emotion, motion, and body.

## 3 Method

### 3.1 Context

This qualitative study was conducted in a mathematics class in a public high school in Mexico City. The teacher and each of six teams of four students (17–18 years of age) were video recorded during three class sessions while solving a didactic sequence related to constant speed motion and the corresponding interpretation of Cartesian position-time graphs.

### 3.2 Data collection strategies

The unit of analysis is the students' development of emotions when solving a didactic sequence on the analysis and description of the movement of two people moving at constant speeds and the analysis of their respective position-time motion graphs. The researchers of this study designed a didactic sequence consisting of three tasks. This didactic sequence was shown to the class teacher for feedback and suggestions, and to get to know the sequence in advance of its implementation. The teacher implemented the sequence, so data were collected through non-participatory observation by the study researchers during three class sessions. The aim of the sequence was to observe how students' mathematical solution is permeated by their own emotions and perceptions. Each class lasted two hours. The video data from the lessons were transcribed and analyzed using a semiotic multimodal dialectical methodology; that is, we analyzed gestures, words, and drawings in order to delve into students' processes of subjectification. In addition to the video and audio, the sequence worksheets were collected and were to be filled out by team consensus. In this paper, we mainly report how the subjectivities of four students (Nancy, Arturo, Fernanda, and Jazmin; pseudonyms) evolved as they positioned themselves in arguing their responses to Task 2 (see Table 1).

## 4 Analysis

It is important to take into account that Arturo, after the teacher finished reading the text of Task 1, pulled the worksheet from the middle of the table and directed it towards himself. He then began verbally expressing his interpretations of Pedro's graph segments. The discussion was guided mainly by Arturo, not only because he had the worksheet and the pencil, but also because he was the one who took the lead in the interpretations of the graph. He wrote:

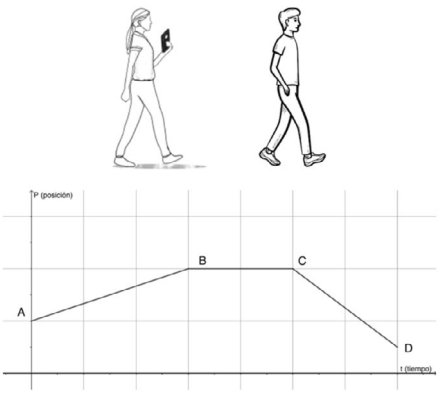
> First of all, it should be noted that between points A and B, there is a distance between Marta and Pedro, then there is no movement between Marta and Pedro from points B and C, and finally, between points C and D, the two come closer, and their distance decreases.

After finishing writing, Arturo returns the worksheet to the centre of the table. Nancy takes it and reads Arturo's writing. The entire team agrees with the answer. The elapsed time between Arturo picking up the worksheet and Nancy finishing reading was approximately 4.5 minutes.

In solving Task 1, the group reached a quick consensus. Task 2, by contrast, took more than 13 minutes, and was characterized by an intense discussion between Arturo and his teammates (and mainly between Arturo and Nancy).

**Table 1** The first two tasks of the sequence

**Task 1.** It was indicated that Marta followed Pedro for a period of time (starting at a distance of one metre), and, with the help of a motion-sensor calculator (hereafter, sensor), she obtained Pedro's movement shown on the right graph (Pedro's graph). Each team had to discuss and describe Marta and Pedro's movements.




a)

**Task 2.** The sensor was indicated to be changed to a fixed location (the post shown in b), but Marta and Pedro performed the same movement as in Task 1. The students were asked to graph the movement of Marta and Pedro in the same coordinate axis system so that the movement of Task 1 was preserved but now seen from another reference system ('the post').

b)

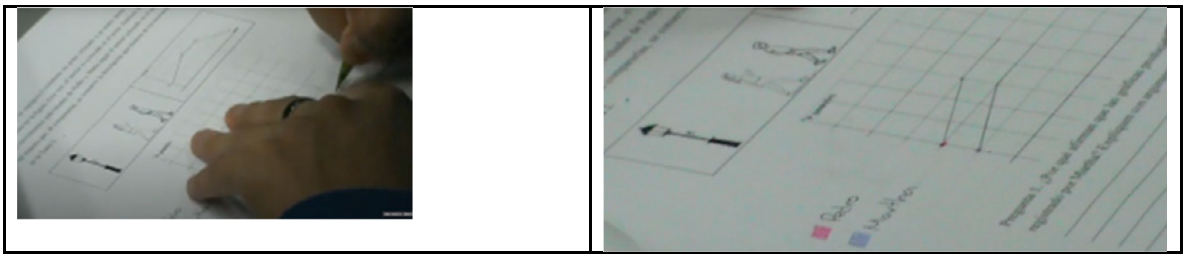


**Fig. 1** Construction of the "parallel graphs". Note: Left: In the answer to Task 2, Arturo draws the points D of the CD segments of the graphs of Pedro and Marta. Right: Partially completed "parallel graphs"

In what follows, we analyze how students position themselves as they interact with others in trying to produce an interpretation of the movement of two objects in motion whose relative distance is represented in a graph. We place special emphasis on the type of emotions that arose when suggesting how Pedro and Marta should move, according to the sensor on the post.

The team's response to Task 2 consisted of two graphs similar to the graph provided in Task 1. Arturo referred to these as "parallel graphs" (see Fig. 1). According to the team, Pedro moves the same as Marta; hence, the graphs are similar (see Fig. 1, right). However, since Pedro is one metre from Marta, Pedro's and Marta's graphs are separated by one unit (one square). This separation is seen in the AB segments of each graph (see Fig. 1, right). Since Pedro is ahead of Marta, Pedro's graph must be "on top" of Marta's graph (see Fig. 1, left).

However, the drawings of the D points of each graph's segments and the graphs' positions caused a long discussion among the four students, mainly between Nancy and Arturo.

**The logic of male dominance** Episode 1 [38:20 – 38:50]

L1 Arturo: Marta, there are two lines, there are two ...

L2 Nancy: [*Interrupts Arturo*] But Pedro should have been below [*She refers to Marta's graph, in the parallel graphs*].

L3 Arturo: [*Interrupts Nancy*] No, your graph should be two parallel graphs since Pedro starts one metre in front of Marta [see Fig. 1, right] [*With his index fingers, he simulates the movement of Pedro and Marta*].

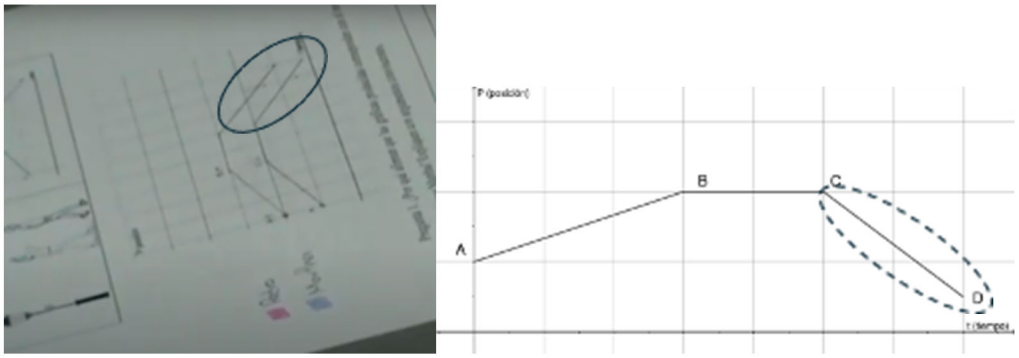



**Fig. 2** "Parallel graphs" completed by Fernanda. Note: The CD segments of each graph "use three squares" (solid oval, left); contrary to the CD segment of Pedro's graph, which uses two squares (dotted oval, right)

L4 Nancy: Then we must change the colours [*She refers to the colours they used in the parallel graphs; see Fig. 1, right*].
L5 Jazmin, Arturo, and Fernanda: Why?
L6 Nancy: I mean the names [*Referring to the names they put on the parallel graphs, see Fig. 2*]. Because you are representing ... This one is supposed to be Pedro [*Points to Pedro's graph*].
L7 Arturo: [*Interrupts Nancy; raises his voice and addresses Nancy*] Wow, wow, baby, enough! Understand, they have the same ... it's the same movement, under the same amount of time.
L8 Nancy: But what about the distance?
L9 Arturo: [*Raises his voice*] It's the same distance under the same amount of time ... only that Pedro starts one metre in front of Marta ... And that's it! [*Makes movement with his hands indicating the end of the conversation*] They are two ... they are two parallel graphs.
L10 Nancy: Oh, I don't know, guys!

The first disagreement between Nancy and Arturo was characterized by a need to understand what each of them was arguing. While Arturo refers to the number of graphs to be drawn in Task 2 (L1 and L3), Nancy refers to the fact that Pedro's graph, in the parallel graphs, should be placed below Marta's (L6). Nancy, ignoring Arturo's comments, insists that the graphs should be interchanged (L4).

Arturo's refusal of Nancy's suggestions (L3) can be understood from his leading role in the response to Task 1. With his accepted interpretation of Pedro's motion, Arturo positions himself as the student who gives the correct answers. His individual positioning is asserted in an argument that is vested with a strong emotional tone. Bijlsma (2014) reminds us that to have an idea or to position oneself in front of a social group is simultaneously to be in an affective state. The discursive-bodily actions that students perform include emotions that cannot be considered as mere concomitant phenomena, but as constituent parts of their action and meanings.

Like each of his peers, Arturo is constituted as a being in constant movement, strengthening his own individuality as social interaction unfolds (Radford et al., 2023; Sánchez, 1977). His individuality is continuously forged and affirmed during the activity through his deeds and voice, but so is the case of the others. Students, in general, position themselves and are at the same time positioned by others in an ever-controversial class context of culture and history (Radford & Santi, 2022). Arturo, however, shuts down the possibility of dialoguing with others.

It seems that he feels that any modification of what he proposes puts into danger the position he intends to acquire within the group. The problem is not just about the validity of the mathematical interpretation; it is also about the key position that the interpretation confers upon him vis-à-vis his teammates. At Nancy's insistence, and with the support of Jazmin and Fernanda, who question Nancy's proposal in L4, Arturo makes sure that his answer is the correct one by raising his voice (L7) and even by an expression that minimizes Nancy's position ("Wow, wow, baby, enough! Understand! . . . "). Arturo's utterance reveals not only tension but power: power as an act of subjecting the other. By expressing himself in this way, Arturo's utterance may have an impact on the others too. His utterance is a bearer of "social contradictions that constitute the very essence of the social relations that we all encounter in society and that form our own transindividual essence" (Radford, 2024, p. 51). In the social relationship with his female teammates, Arturo draws on social relations of a cultural-historical nature: male dominance. This general social relationship finds a singular content in this episode. Nancy did not react directly to Arturo's offense or agree with what he said. In L10 she tries to bring forward the role of distance, "But what about the distance?" But she is not heard.

After this discussion, Fernanda draws the "parallel graphs" suggested by Arturo. In her drawing, Fernanda places the points D of each graph almost at the end of the grid (see Fig. 2, left). Seeing that the end of the CD segment

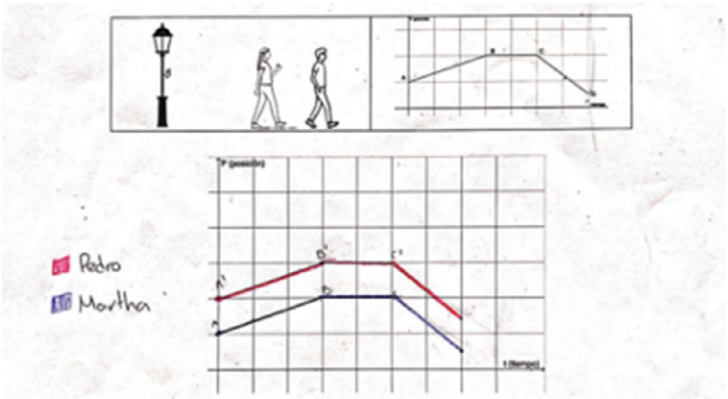



**Fig. 3** Nancy's team's final response to the Task 2 question. Note: Above: Drawing and graph of Task 2. Below, in blue and red, "are the parallel graphs" proposed by Arturo for the Task 2 question. Students named the points on Pedro's graph A', B', and C.' Point D' was not written (Color figure online)

did not coincide with the points previously suggested by Arturo, Jazmin asks why point D of Marta's graph was "so far down," almost touching the time axis. Jazmin's question denotes impatience, and she brings the worksheet closer to her so Fernanda can see it.

In addition, Jazmin observes that the CD segment of the "parallel graphs" covers "three squares" (see Fig. 2, left, solid oval), not two, as in Pedro's graph (See Fig. 2, right). When Jazmin uses the worksheet to count the squares to justify why the CD segment of the parallel graphs should be modified, Fernanda takes the worksheet. She erases part of the CD segment so that the CD segment covers only two squares. The final graph that the team proposes in response to Task 2 is shown in Fig. 3.

Episode 2 [41:09 – 41:43]

L11 Nancy: Jaz is already angry.

L12 Jazmin: [*With a tone of impatience and, simultaneously, laughing*] Well, I just don't see the sense in it ... [*Points to point D on Pedro's graph and explains*] It's just that, otherwise, it wouldn't be the same amount of time, am I clear?

L13 Nancy: That's what I wanted to explain.

L14 Fernanda: Well, if we base it on your logic [Nancy's logic], then it would have to end here [Points to point D of the parallel graphs], because this is as far as the point goes [*Slides her pencil vertically on point D of Pedro's graph*].

L15 Nancy: So, they are upside down.

L16 Arturo: What do you mean they are upside down?

L17 Nancy: Pedro was at the bottom; Marta is at the top.

L18 Jazmin: [Turns to Arturo] Who is this? [*Points to the graph of Pedro and Marta*]

L19 Nancy: [*At the same time as Jazmin. They turn to Arturo*] Who is this?

L20 Arturo: What?

L21 Nancy: [Speaking simultaneously as Arturo] That's what I was telling you, but you don't understand me [*She laughs; she hits the table 3 times with both fists as a sign of triumph*].

L22 Arturo: What do you mean "who is this?"

By listening to Jazmin's tone of voice and seeing her actions on the worksheet, Nancy interprets that Jazmin is angry (L11). Jazmin neither affirms nor denies that she is angry, but her explanation in L12 indicates that her objection to where the CD segment should end is based on the time representing Pedro and Marta's final movement. Although Nancy claims that she meant to explain the same thing as Jazmin (L14), none of her earlier interventions allow us to infer that this is what she intended. The most clear and authentic intention of her intervention is revealed in L15 when she again insists that the placement of the graphs in Fig. 3 should be interchanged. Analyzed separately, the comment "So they are upside down" may be interpreted as a misconception caused by a lack of mathematical knowledge regarding how graphs "should be read." However, analyzed in terms of the gestures, tones of voice, words, and the social relations that had been produced in the team so far, we interpret this comment as a key moment in the students' unfolding process of subjectification, mainly shaped by the way Arturo talked to Nancy at the end of Episode 1. We contend that "So they are upside down" represents Nancy's subjectivity in the making expressing and affirming her desire to be heard and be right. Such desire may also be observed in the fact that Nancy's comment is unrelated to Fernanda's argument (L14), who tried to understand the consequences of moving point D, which Jazmin mentioned previously in L12. In other words, it seems that Nancy did not care about her teammates' mathematical arguments, but rather about positioning through non-discursive devices her own feelings into the teams' discourse. Thus, regardless of the content of Arturo's argument, what Nancy first heard and felt from Arturo was his high tone of voice (L7) and his indifference (L9), respectively. From Nancy's perspective, Arturo's argument remained in the background. Her emotional experiences (perezhivanija) may have driven her persistent critique of the inaccuracies in Pedro and Marta's graphs in Fig. 3. Jazmin does not continue with her argument about the number of squares that the CD segment should cover; instead,

she supports Nancy's observation and, turning to Arturo, guides the conversation about the meaning of the graphs in Task 2 (L18). By echoing Jazmin's "Who is this?" question (L19), Nancy may feel she had the opportunity to fight back against Arturo's earlier comments (L7 and L9). This feeling of revenge can be seen in L21. As in her response to Fernanda, Nancy did not intend to explain the order of Pedro and Marta's graphs to Arturo. Instead, she felt the need to resolve Arturo's question by proving that she is right. The expression "That's what I was telling you, but you don't understand me" (L21), accompanied by a laugh in triumph, is intended to make her teammates see that Arturo's shout in L9 was unnecessary and lacked any basis. The following episode shows how Nancy positions herself as a "winner" in the activity.

**Revenge** Episode 3 [41:44 - 42:11]

L23 Arturo: [*Raises his voice*] What do you mean, who is this? [*Points to Pedro's graph*]
L24 Jazmin and Nancy: [*In a tone of impatience*] It's Pedro!
L25 Arturo: The two . . .
L26 Nancy: [*Interrupts Arturo*] Why? Because, [*With her index finger, she touches Pedro's graph and, at the same time, moves her other hand away from this graph, indicating a separation from Marta*] because Marta had the sensor last time.
L27 Arturo: Aha!
L28 Nancy: [*Hits the worksheet with her index finger repeatedly*] She was not being detected. This is Pedro's graph [*Repeatedly points to Pedro's graph. Along with Jazmin and Fernanda, points to the graph from Task 1*]. We are drawing a new graph, which is Marta's graph. We are replicating Pedro's if you draw the new one, which is Marta's.
L29 Arturo: Let's see [*Drags the worksheet towards him*].
L30 Jazmin: Yes.
L31 Nancy: Which one is Pedro's here? [*Points with her finger to the graph of the parallels*]
L32 Fernanda: Then the other way around it would be Pedro purple and Marta pink [*She refers to the colours of Fig. 3*].
L33 Nancy: Yeah! I won! [*She hits the table excitedly and laughs; see Fig. 4*].
L34 Arturo: But I don't even know what they did.
L35 Jazmin: Evil won! Evil triumphed! [*She laughs*]

In this episode, it becomes more evident that Jazmin's remark about the number of squares in the CD segment has been forgotten by her as well as by Nancy, Arturo, and Fernanda. Now, the discussion is about the meaning of Pedro's graph from Task 2 (L24). However, Nancy is not interested in convincing Arturo. She joins Jazmin to let Arturo know that she was right in saying that Pedro's and Marta's graphs

**Fig. 4** Upper left corner: Nancy slaps her two palms together in a triumphal gesture

from Fig. 3 should be interchanged. Hence, Nancy immediately accepts Fernanda's comment (L32) without asking why Fernanda is not answering the question of which graph belongs to Pedro in the parallel graphs. Nancy's subjectification—her way of positioning her own point of view within the learning activity, the perspective she takes vis-à-vis the others—is characterized by a feeling of *revenge*, for she now sets herself up as the winner (L33). Such triumph was not achieved by convincing Arturo but by echoing Jazmin's question (L19 and L24) and having felt supported by Fernanda in L32. We can see now how the power to be right has been distributed among the team. Nancy shows her power by slapping her palms on the table (Fig. 4).

The way in which the activity has evolved, each students' utterance, and mainly those of Nancy and Arturo, simulates an effort to defeat an opponent; they are competing one against the other. Competition is consistent with our capitalism system (such as where the students live) in which there are strong discourses regarding meritocracy and feeling of triumph.[1] The phrase "I won" belongs to a symbolic cultural sphere in which individual is highly recognized by society and is a sign of an individual's natural growth. These symbolic cultural spheres comprise interrelated cultural ideas about the nature of the world, truth, the nature of the individuals and their relation to others. In the case of Nancy and the other students, "winning" becomes a leading form of social relations and is expressed here with a connotation that operates as a form of individualist competitive superiority. We can contrast this cultural valence of competition with the one of classical Athens, where athletes prepared to compete and tried to win to honour the city. Generally speaking, the purpose of all Greek Games (e.g., Olympian Games) was not to win in order to be praised, but to stimulate and display "human *aretê* [excellence], and this was a worthy offering to the god" (Kitto, 1951, p. 173).

[1] As Jacquemin (1995) notes, in capitalist cultures, individualism and competition are essential elements in the way people understand and participate in the world. People "position themselves, materially and psychologically, in such a way as to discourage or constrain the actions and reactions of actual and potential rivals" (p. 2).

Since Nancy feels like a winner, Arturo must feel like a loser. Such a defeatist feeling is uncomfortable for Arturo, who has seen that his "own creation" of the parallel graphs is in danger of being modified. Thus, Arturo tries to persuade his classmates by raising his voice and reading the problem statement of Task 2 again.

**The agony of defeat** The next two episodes show how Arturo intends to reverse that feeling of defeat.

Episode 4 [43:02 – 43:23]

L36 Fernanda: But what Nancy is referring to is upside down.

L37 Arturo: [*With a tone of impatience*] Why are they upside down?

L38 Jazmin: [*Snatches the worksheet from Arturo and puts it on the table*] According to you, whose graph is this [*Points to Pedro's graph in Task 2*], Pedro's or Marta's?

L39 Arturo: [*He snatches back the worksheet from Jazmin*] This is the movement graph of ... [*He hesitates*] ... it is the same as ... [*He hesitates. He points with all his fingers, and with force, to the original graph*] ... it is the same movement as ... [*He stops; he shows despair and brings his hand to his head*] It's just that ... the movements! [With his palm he hits the worksheet].

L40 Jazmin, Fernanda, and Nancy: [*All laugh*].

L41 Arturo: [*Using his fingertips, he taps the worksheet repeatedly as he speaks*] It's the movements that registered ... that registered the sensor when Marta had Pedro's sensor.

At this point in the conversation, Nancy has convinced Fernanda and Jazmin that the graphs in Fig. 3 should be switched. Now, Arturo must convince not just one of his teammates but three! Based on the subjective position that he himself has provoked, his goal is to make it appear that Nancy's triumph in L33 was only an illusion. In the absence of mathematical arguments based on the analysis of a variation of position with respect to time, Arturo is impatient (L37) and insecure (L39). The pressure of feeling defeated must have increased even more when he hears his female companions laughing at his hesitation (L40). The dimensions of insecurity, impatience, and pressure are ontological statements in the development of Arturo's subjectivity within the framework of a cultural-historical activity that features forms of action marked by an individualistic interest. Furthermore, Arturo's last two interventions of Episode 4 show that he is not interested in understanding why his classmates insist that Pedro and Marta's graphs should be switched. Although there are "others" with whom Arturo interacts, he does not treat them as collaborators in the same teaching-learning activity. Instead, his interest is to overcome his sensation of defeat. From this sensation, his teammates (the "others") are individuals against whom Arturo must fight. He must have interpreted all the laughs as the disappearance of the power he had wielded during his participation in Episode 1 and his response to Task 1. Arturo does not position himself with the intention of tuning in to his teammates "in conceptual and affective layers to collectively reach interactional achievement" (Roth & Radford, 2011, p. 306), but with the interest in not losing his power to maintain control of the conversation.

Seeing that Arturo cannot continue explaining (L41), the researcher (first author) asks the students if they want the teacher to come to their aid. Arturo immediately says yes. Unexpectedly, hope appears on Arturo's horizon. It is worth mentioning that, unlike his constant visits to the different teams in the group, the teacher had not previously visited Nancy's team.

Before the teacher comes to the team, Jazmin takes the worksheet in such a way that only she can read it. After a few seconds of holding it, she places the worksheet on the table and initiates the following conversation:

Episode 5 [43:28 – 44:20]

L42 Jazmin: No, yes, it's right because here [*She reads the initial text of Task 1*] it is saying that Marta is the one with the sensor and this is the graph that represents [*Points to Pedro's graph from Task 1*].

L43 Arturo: [*In a relaxed tone of voice*] I just don't understand what you all are fighting for.

L44 Jazmin: [*Tapping the graph with the tip of the pen*] Arturo, if this graph was Pedro's [*Refers to the original graph*] it would not make sense to put Pedro on top [*Points to the graph of the parallels*].

L45 Arturo: [*Raises his voice more, with an angry tone*] Damn it! Understand! [*He touches the worksheet with force; see Fig. 5, photo 1*] Here [*Hits Pedro's graph with his index finger; see Fig. 5, see photo 2*].

L46 Nancy: Calm down!

L47 Arturo: [*Points, hitting, the original graph*] No, no, no [*Puts his hand to his head in desperation; see Fig. 5, photo 3*] Look, Marta is one metre away from the post [*Points to the drawing of Task 2*].

L48 Jazmin: Yeap!

L49 Arturo: [*Points to the graph*] Starts one metre away from the post. In the previous one [*Refers to the text of Task 1*] it said that Pedro and Marta were one metre away, here is your metre of distance between Marta and the post, and here [*Points to the starting points of the parallel graphs. These points are separated by a square*] is your metre, your two metres of distance between Pedro and the post [*Points to the drawing of Task 2*]. And that's it! [*He looks at Jazmin as a sign to end the conversation; see Fig. 5, photo 4*]

L50 Jazmin: Ah ok! Ya. Yes, there you go.

L51 Nancy: Well, it doesn't matter; I mean ...

L52 Jazmin: [*Waving the pen in the air*] No, yes, no, yes, yes, yes, yes it makes sense. Because Marta is one metre away. If we change it as we had said [*She refers to*

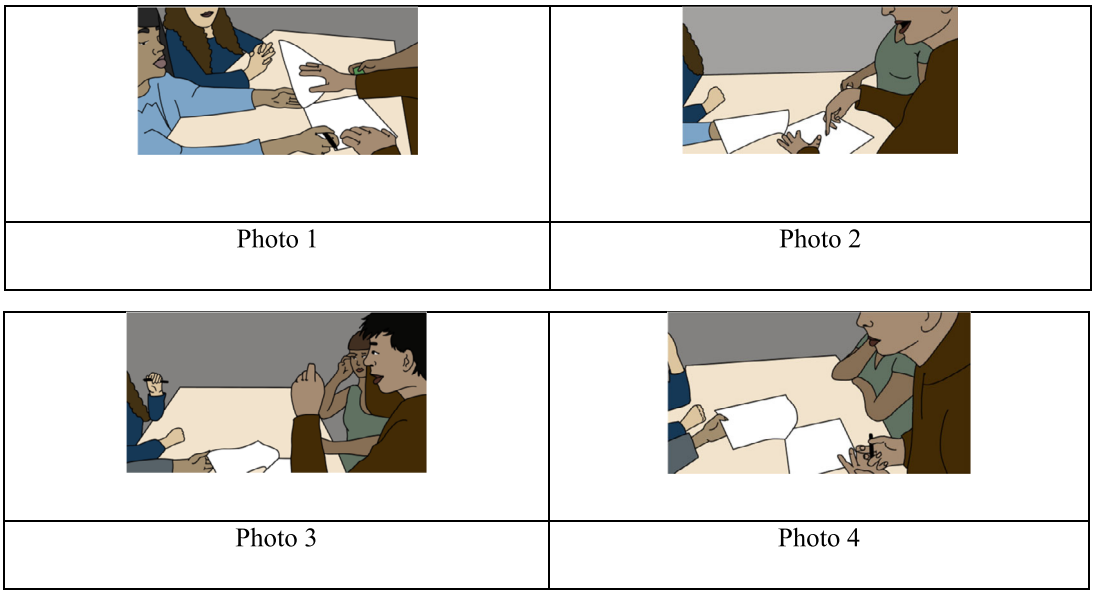



**Fig. 5** Sequence of Arturo's gestures as he was expressing his anger in L45, L47, and L49

> *the order of the parallel graphs*] ... Yes, there would no longer be any logic to what you are asking us [*Slides the pencil several times over the text from left to right*].

Jazmin's comment in L42 is not precise. She is looking at Pedro's graph from Task 1; for this reason, her teammates could not know for sure whom Jazmin was supporting with her comment, "No, yes, it's right." Perhaps Arturo believed that he was the one with whom Jazmin agreed, so he missed what his teammates were discussing previously (L43). Even when his voice denotes calmness, Arturo still interprets his discussion with his companions as part of a fight. This feeling of Arturo's struggle to be right is activated just after hearing that Jazmin, in L44, does not agree with him. Thus, he insists, now more violently, that the parallel graphs should be exchanged. His loud expression, "Damn it! Understand!" is intended to put an end, once and for all, to the discussion regarding the order of the graphs. The raised voice and a decisive "And now!" mark the final blow of a fight with his companions (mainly Nancy) that has been at the centre of the students' subjectification process.

It is important to emphasize that Arturo's explanation is not based on arguments related to the mathematical concepts involved in Task 2 but on the emotions of feeling triumphant in the debate. In the students' processes of subjectification, the sphere of sense and mathematical concepts has been pushed into the background in favour of the spheres of antagonistic relationships expressed through body language, a discourse of exclusion, and confrontational emotional actions. This does not mean that the process of subjectification we see lacks social relations. On the contrary, there are social relations, but they are not bearers of links of true human cooperation (what we see in these episodes are what Fischbach (2015) calls simple associative links). Thus, although Arturo identifies that the separation of one metre between Pedro and Marta, shown in the drawing of Task 2, corresponds to the separation of one unit (one square) between the initial points of the parallel graphs, he does not analyze the graphs in terms of the position of the sensor located on the post nor in terms of the variation between position and time.

Arturo's aggressive intervention had the effect he desired: to convince his classmates that the parallel graphs, as he had initially proposed them, were the correct answer. Jazmin's (L50) sudden acceptance that the parallel graphs had been drawn correctly, Nancy's (L51) quick indifference, and Fernanda's silence were the actions that Arturo interpreted as signs of his triumph. Note how Jazmin, in L52, expresses her agreement with Arturo without using mathematical arguments. Her explanation does not show that she is convinced; in fact, it gives the impression that she wants to mitigate the awkward moment she and her team have just gone through.

As Jazmin finished explaining why Arturo's arguments convinced her, the teacher approached the group without saying a word. Having finished her speech, Jazmin turns to the professor and says, "No, not anymore!" The professor asks, "Not anymore?" and walks away from the team. Nancy, who seconds before had been convinced that the order of the parallel graphs should be changed, turns to the team and says, "Conflicts, but they've been solved." Arturo, in a lower tone than he had shown earlier, says, "Internal conflicts." Arturo is here facing a fundamental situation of the activity: difference. These differences are at the very source of the processes of subjectification and deepen at the

precise moment of the encounter with the Other (Radford et al., 2023). Differences can be understood in various ways. In the case of our students, they are understood as fleeting moments that lead to internal conflicts that may disappear one way or the other. There is still a long way to go to understand conflicts as part of the substance of the truly social, as Fischbach (2015) maintains.

## 5 Discussion and final remarks

Questions of subjectivity and subjectification have recently attracted interest in mathematics education. In this paper, we have followed insights from the cultural-historical school of thought that draws on the work of Vygotsky and Leont'ev.

We focused on a group of four students (17–18 years old) in a public school in Mexico City. We articulated a concept of subjectivity that brings to the fore a dialectical view of the subject and the social world. This concept of subjectivity entails a focus on the cultural-historical social relations to which the individuals resort as they present themselves to others and engage in activity. In their appearance, these social relations are not the mere enactment of something that is already there. They always express the uniqueness and continuously changing subjective core of the individuals—their subjectivity—as they assert themselves cognitively, discursively, corporally, and emotionally. More specifically, we suggested that subjectivity can be considered as an evolving, unfinished, and unfinishable dialectical system made up of social relations intertwined with diverse spheres, including the spheres of sense, concepts, language, emotion, motion, body, and conscious and unconscious projects of life. In other words, subjectivity can only be studied in a process that is framed in the context of social relations. This assertion implies that subjects' encounter with knowledge is not static, but dynamic. It is in this dynamism that subjects' learning is not only about knowledge, but only about how students become.

We contended that subjectivities are co-produced in *collective activity-bound* processes: the processes of subjectification. An important point in our way of theorizing subjectivity is that the nature of a process of subjectification is consubstantial with the nature of the activity that subsumes it. Thus, the way individuals position themselves needs to be comprehended in terms of the individuals' understanding of their activity with others, as this understanding paves the way for how they interact with others.

Our findings suggest that positioning was driven by a particular form of interaction. The interaction was not about building a good mathematical ideal together. Rather, it was mainly driven by a competitive attitude, permeated by the struggle to affirm oneself as the one who is right. In this context, we could see that the different spheres of subjectivity were organized through the pole of power: posture, gestures, language, prosody, and emotions were extensively articulated in Arturo's positioning as a means of subjectification to assert himself in a privileged position vis-à-vis the others.

However, the articulation of these spheres in the students' process of subjectification should not be confined to what is actually happening in the classroom. This articulation should be understood against the backdrop of culture and history. We have stressed that Arturo draws on a general cultural form of being in the world: male dominance. This cultural-historical form takes on a specific content in the classroom activity. By addressing Nancy in a patronizing tone, "Wow, wow, baby, enough! Understand!", Arturo subjugates her (and the others) and imposes his view and interpretation of the problem. We can imagine how difficult the situation is for Nancy.

As the interaction unfolded, we see Nancy putting mechanisms of subversion in place. Following a partisan strategy, she gradually recruits her teammates to undermine Arturo's power. In L33 she exclaims: "Yeah! I won!" Again, the interaction is not about building the best mathematical answer, but about winning. Then, Arturo experiences the agony of defeat. Claiming power as in his utterance, "Damn it! Understand!" no longer has the expected effect since Nancy did not understand the meaning of the parallel graphs Arturo tried to explain. The rare instances where the discussion could have developed into a deep mathematical dialogue disappear immediately, as in L44 and the following lines.

During Nancy and Arturo's quarrel, we were able to observe what Wagner and Herbel-Eisenmann (2014) noted regarding the distribution of power among students. Due to the absence of the teacher in the students' conversation, the knowledge of relative motion shown in the graph of Task 1 was mediated by the feeling of power both Nancy and Arturo wanted to exert over each other, and over Jazmín and Fernanda. In this sense, our findings reinforce Langer-Osuna et al.'s (2020) study in terms of the authority roles (mediated by the tones of voice, gestures, and offenses) played by Nancy and Arturo, which affected the recognition of who assumed the role of owner of mathematical knowledge. This distribution of power characterized a social relationship in which each student's interventions were shaped by their teammate's interventions, and vice versa. It could be said that the distribution of power has a dialectical characteristic. As Elias (1991) points out, human beings are always bound in a very specific way to their interdependence with others. In our analysis, this interdependence appears in dialectical terms, that is, not only does the positioning appear supported by a particular form of interaction with others, but at the same time, it modifies or transforms the interaction itself. In our case, Arturo's positioning provokes positioning in others, particularly in Nancy; these positionings lead to a certain interaction (an antagonistic interaction). And reciprocally, following the guidelines of antagonistic positioning,

Nancy's positioning affects that of Arturo and the others, and the interaction, moving it even farther along the path of antagonism and the logic of the winner.

We are not finished yet. In order to better understand the students' process of subjectivation, we still need to relate it to the type of activity in which such a process unfolded. We mentioned in the theoretical framework section that activities can be distinguished in terms of the social, cultural, and historical significance that the object of the activity has on the way people act and interact to achieve that object. Two students may agree to go to the school library to do some homework together; they may sit next to each other and talk to each other from time to time to get some feedback. Their interaction has only an ephemeral stimulating role. They do the same homework, they pursue the same object, but they do not do it together, in a real *joint activity* (Radford & Roth, 2011). This is therefore not an example of activity in the sense of Tätigkeit, which would require an understanding of collective action as the production of something common together—*une oeuvre commune*, as in the common work of an orchestra playing a piece of music (Radford, 2021).

In our case, the object of the activity was to interpret mathematically the individual movement of two moving bodies from a given graph in relation to the relative position of these two bodies. The classroom activity in our Mexican public high school did not reach the meaning of Tätigkeit.

Indeed, although the students made an effort to use mathematical arguments to orient the object of the activity towards the cultural-historical way of interpreting the motion of objects, each of the students (especially Nancy and Arturo) participated in the activity from an individual position. This individualistic position paved the way for them to position themselves in relation to others. We can conjecture that if the classroom activity had been of the Tätigkeit type, the subjectivation process observed would have taken a different course.

Since the teacher of our study very rarely visited Nancy's team, further research is needed to investigate how the teacher's participation affects the students' subjectification process. This research may shed light on the efforts of other researchers who have reported on the effects of the teacher's role on students' attitudes and achievement (e.g. Domino, 2009; Campbell et al., 2014).

These results encourage us to explore new ways of understanding classroom activities as collective events, deeply connected to authentic cultural-historical social relations. This perspective may foster alternative forms of subjectification aligned with an inclusive, non-competitive, and community-oriented learning approach. In turn, such a vision calls for reimagining the role of schools beyond individualistic frameworks and recognizing their potential in shaping societal transformation.

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