

COMMUNICATION IN THE CLASSROOM: PRACTICE AND REFLECTION OF A MATHEMATICS TEACHER

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Abstract. *This paper discusses the conceptions, practices and reflections about practices of a basic education mathematics teacher in Portugal with respect to communication in the mathematics classroom. It also addresses their change through her work on a collaborative project. The case study of this teacher was carried out as part of a long term (one year and a half) collaborative project involving a researcher and three mathematics teachers. The case provides evidence of the relevance of such a project to develop the teacher's understanding of communication processes in her classroom, putting practices under scrutiny and developing richer communication patterns between teacher and students.*

1. INTRODUCTION

Communication in mathematics classrooms has become an element of especial interest with curriculum reform movements. Particular attention has been paid to the role of classroom interactions and to the negotiation of meanings. The analysis of communication structures and their development in the classroom is the theme of the collaborative project inside which this paper was born. The focus of the paper, however, is placed on the work of the teacher. It discusses a teacher's conceptions, practices and reflection on her own practices with respect to communication in the classroom and how they changed through a collaborative project. We begin providing a brief characterisation of communication phenomena in the specific context of the mathematics classroom, describe the case of a teacher involved in the project, and, finally, point out issues for future work.

2. THE TEACHER AND CLASSROOM COMMUNICATION

Communication in the mathematics classroom. Several authors underline the relevance of communication in the mathematics classroom (Bishop & Goffree, 1986; Ponte & Santos, 1998; Voigt, 1995; Yackel & Cobb, 1998). Communication is viewed as a social process along which participants interact, sharing information and constraining their mutual evolution. It concerns not only the heterogeneous set of interactive processes evolving in a classroom but also their contexts, underlying denotations and expressive resources. Such a perspective includes in the study of communication in the mathematics classroom two issues

clearly identified in the literature (Ponte, Boavida, Graça & Abrantes, 1997): (i) *continuous interaction* between the actors in a classroom, and (ii) *negotiation of meanings* understood as the processes such actors set to share their own ways of making sense of mathematical concepts and procedures, and their evolution and relation to the formal curricular contents. Actually mathematical learning requires a stepwise construction of a reference framework through which students construct their own personal account of mathematics in a dynamic tension between old and newly acquired knowledge. Bishop and Goffree (1986) point out negotiation of meanings decreases with the increase in teacher's control over the classroom dynamics.

Such a progressive visibility is achieved along the countless interaction processes happening in the classroom. Of especial import are the interactions between students and teacher, which simultaneously constrain and are constrained by the kind of lesson. For example, in a learning context in which the teacher stresses exposition and exercise solving, he/she tends to control the whole process. In other contexts he/she may assume instead the role of a coordinator. The nature of questions is particularly relevant, leading to the development of communication and reasoning skills (Barrody, 1993). On the other hand, the role of interactions among the students in the classroom can not be underestimated. In general, such interactions, with smaller formal contents, become essential to stimulate discovery and critical reasoning, as well as to foster personal appropriation of common meanings.

Research provides evidence that student-student interaction in lessons involving projects, investigations or problem solving in groups, provide deeper experiences than interactions during exercise solving (Alro & Skovsmose, 2002; Ponte et al., 1998; Yackel & Cobb, 1998). Students feel more comfortable talking in small groups (Lester, 1996), in “non-threatening” ambient (Buschman, 1995) where they progressively master the mathematical way of expressing. Inversely, when interactions only take place in whole class, students become more reserved, placing themselves out of discussions if they are unsure about how their voice is considered by the colleagues and the teacher (Alro & Skovsmose, 2002).

The role of the teacher. It is widely recognised the fundamental role teacher plays either in enabling or limiting communicative processes within the classroom (Barrody, 1993; Lappan & Schram, 1989; Pimm, 1987). Such a role makes itself explicit from the outset, for example when selecting challenging tasks or encouraging students to express and sustain their own views (Lampert & Cobb, 2003; Ponte & Santos, 1998), or else when resorting to tasks and educational materials that put the focus of the lessons on mathematical ideas, conjectures or intuitions, instead of calculations and procedures.

The teacher is also responsible for creating an atmosphere of self-esteem and mutual respect, so that students feel comfortable to participate. Teachers have also an important role in structuring the classroom discourse, namely through asking questions. Love and Mason (1995) distinguish three main kinds of questions: *focussing*, *confirmation* and *inquiry*. The first aims at focussing student's attention into a specific issue. Confirmation questions test plain knowledge. Finally, inquiry questions are the "real" ones, the teacher asks what he/she does not know. Dealing with questions in the classroom often fall into what is called the 'triadic sequence' (Lemke, 1990), involving three steps: *initiate*, *respond*, *assess*. Such an interaction scheme is quite common, usually regarded as a convenient way not only to "keep speech control", but also to "go around or ignore a number of answers" (Pimm, 1987, p. 64). It is accepted that the triadic sequence may involve more students in the class (Lemke, 1990), even if their participation is limited to short, reactive answers, and, as Alro & Skovsmose (2002) remark, it emphasises the role of authority in the classroom.

On the other hand, to promote a communicative dynamics in the classroom, the teacher is expected to stimulate students' interest and ability to enrich their mutual interactions. Steffe and Tzur (1996) underline the teacher's role in bringing to light the independent activity of each student. Authority should therefore be decentralised: students must have the power to assess what is correct or fake in an argument (Alro & Skovsmose, 2002). This entails the need for ways and opportunities for students to put themselves under question, even if the opposite attitude is still rather common (Ponte & Santos, 1998).

3. METHODOLOGY

The project involved the researcher and three mathematics teachers. From a methodological point of view, this is a qualitative study, with interpretative character and based on a case-study design (Yin, 1989). Data gathering and analysis was based on two semi-structured interviews, group meetings, a number of lessons selected by the teacher herself to be observed and recorded by the researcher (the first author of this paper), and finally, the researcher's field notes. Maria was interviewed before joining the group (E1) and again by the end of the academic year (E2). The researcher made transcripts of all meetings of the collaborative project (R1 to R25) and of all interviews.

4. MARIA

Introduction. Maria is 52 years old and counts 31 years as a teacher. She is married and has two children, already grown up. She assumes work with professionalism and

commitment. For 6 years she served as a school director and is still active in the trade union. Maria concluded a bachelor degree in chemical engineering in 1974. Becoming a teacher was not her first option; only later, she completed another degree on teaching natural sciences. This background may explain her main concern as a mathematics teacher: to provide evidence of the usefulness of this content. Her lessons, as she says, follow a traditional format: she writes down the summary of the previous lesson and recalls its subject, reviews homework, jumps to a new topic, suggests a few exercises and, finally, sets the new homework.

Conceptions and practices about communication. To Maria, a *pleasant atmosphere in the classroom* is fundamental. As she puts it: “Yes, I always try to avoid giving orders, but say instead ‘I’ve asked you to do...’” (E2). Her interest on group work increased along the project. In the first interview she stated that this was not a priority for her. Later she expresses a different concern: “To plan [for the following year] a lot of group work, (...) discovery tasks, with manipulatives (...) with little guidance, eventually written”. Moreover, she considers that if a more active role is assigned to students, lessons become more interesting. She prizes students’ participation in the classroom and always tries to get all of them involved, resorting either to direct questions or open sentences which students are expected to complete.

She tries to get everybody involved, even if sometimes participation is residual: “I do not restrict myself to above average students. Often I confront students with difficulties even if I know they will limit themselves to a humble ‘I don’t know’” (E2). Usually, students ask a lot of questions during lessons: “Normally it is like this: ‘I didn’t understand’. (...) But a few of them would ask ‘Can’t this be made like this?’ I answer: ‘Come to the blackboard and show us’” (E2). She also values the emergence of different strategies for a given problem. She compares and discusses them, because students tend to be more involved when their way of solving problems is under scrutiny: “I say: ‘Please come here to compare our work’. And that’s it: there are no unique or best approaches to a problem” (E1).

In the initial interview Maria explained a strategy to enable everybody’s participation: “I say: ‘write it in the air!’ They find it funny. Some of them try to simulate writing carefully so that I can understand their input” (E1). This shows Maria’s commitment to systematically propose confirmation questions, trying to help students for whom participation is often difficult and providing clarification as soon as she sees that the students are confused. Her concern in identifying, discussing and correcting errors or misunderstandings tells a lot about her own perception of a teacher’s role: to signal the correct route in the map: “My reaction is to fix it straight away (...) ‘Look! Are you following me?’” (...) they say ‘Yes’, but I often wonder if the lesson is learnt. (E1).

Maria also values student’s *autonomy*, but is aware of its difficulties: “Certainly all of these small steps help students to build Mathematics. My question is: is there enough time? Which percentage of a lesson can be used for discovery, for building insight?” (R18). She is also aware that students prefer to be proposed open tasks and that excessive teacher’s control makes lessons rather dull: “They like this sort of tasks, in which they do not have to guess. The way they follow to solve the problem is what they see as fundamental” (R17).

Reflection on practices. Maria’s communication practices and the reflections she makes on them can be discussed starting with a set of lesson episodes from the statistics unit in a grade 5 class. Such unit was largely planned in the project meetings. In all of them students work in groups, starting with a brief discussion of what has been achieved in the previous session and defining the work to follow. By the end, Maria discussed with each group its work and plan for the following lesson. Each group chose a leader to report conclusions.

Lessons	
1	Introduction to Statistics. Reading and interpretation of newspaper fragments, in group. Discussion in the classroom of the emerging (different) interpretations. Introduction to the working theme: water consumption. Each group prepares 2 to 3 questions on water consumption (as homework students gathered relevant information to answer them).
2	Each group analyses answers to the part of the inquiry assigned to it.
3	Data organisation concluded. Each group prepares a slide with its conclusions.
4	Slide preparation concluded. Results from 3 groups are presented and discussed.
5	Results from the remaining 4 groups are presented and discussed.

Along the project Maria’s critical sense and ability to question herself became more and more visible. Facing a discussion, a text or an episode, she always tries to provide illustrations from her own practice, to make comparisons and even to place herself in the role of a student. For example, when discussing the *sort of questions* proposed to the class, she recognises that, in group work, inquiry questions emerge more naturally than in a conventional lesson: “sometimes I have to ask further, because it is myself the one who don’t understand what they want to achieve and how (R22). She reflects on the increased student’s commitment to the class and suggests that this kind of lesson is *intellectually more attractive* to them.

Maria is concerned about her own language in the class. For example: “Some of my sentences are incomplete... How can they understand what I said if I do not complete my own reasoning?” (R22). She recognises the triadic pattern is dominant in the first lesson of this sequence as well as in the group presentation in the end. And wonders: “I ask myself: is this unavoidable? Or just difficult?” (R22). One of her episodes is the following:

Maria: (...) And this group? What did you conclude?

Ricardo: Natural gas, energy and coal.
 Maria: Just this: gas, energy and coal? Any more information? (...) Yes, André?
 André: The first page is on employment and unemployment.
 Maria: Where? In China? In Guinea-Bissau?
 André: Portugal
 Maria: Anything to add?
 André: The second [page] is on a loan.
 Maria: Of what?
 André: Money
 Maria: More...
 André: The third one is the rise of oil...
 Maria: Did it go upstairs? [they laugh] Do you think this information is enough for us to understand? Oil rise... If it is not a change in position, what is it?
 André: Price...

Again Maria points out that, although this discussion emerged from the interpretation of the work of the students done in small groups, her questions were traditional: she knew all the answers. She recognizes that the discussion was focussed on herself and was “quite brief”. But, on the other hand, she comments the episode below saying: “Here the triadic pattern was not overwhelming” (R22).

Maria: (...) My question is: if I show such a result to another class, without showing them the question (...) just saying “most frequent answer is 10 minutes”, would it be possible for them to understand the issue?
 Ana: I do not think so.
 José: Yes, it is.
 Maria: Do you think nothing more is required?
 Marta: They need the question!
 Maria: If, for some reason, this is unavailable, will there be a second way...?
 André: We explain better.
 Maria: ... so that whoever looks at the results of your work, could say: ah! This result is about that! If they fail to ask... what to do?
 Ricardo: I think the number of people and minutes involved should not be given in the end but in the beginning.
 Maria: Would that be better?
 Ana: It's the same.
 Maria: Agree? (silence) I think there is another alternative.

With respect to *negotiation of meanings* Maria acknowledges she is more attentive to it with her work in the project. She illustrates this with the following episode:

Paula: 4% have a proper bath (written in the slide).
 Pedro: This is not a percentage!
 Paula: But 4 students make 4%.
 Pedro: In the whole they are 28... (Maria approaches the group).
 Paula: (addressing Maria) 4% , isn't it?
 Maria: Why do you think it is 4%?
 Pedro: Can't be! I've already told her.
 Maria: Can you explain, Pedro.
 Pedro: 4 out of 28 does not make 4%.
 Maria: Why?
 Pedro: It has to be 100.

It is relevant to note that the concept of percentage is part of the official program for the grade 6 curriculum. Later, Maria comments: “If we had not talked here [in the project group] my answer to those students would most probably be something like ‘we’ll talk about this next year’ and go ahead” (R22).

Influences. The project experience was recognised as a source of “added value”. The project group makes it easier to plan, implement and assess new experiences. Moreover, “this forces us to think”. And later, “I love this work! But did I learn anything really new? No. Most of it we already knew... but were unable to put in practice. (...) This work put myself in question” (R23). She adds: “Our lessons are planned the way we get used to from our earlier experiences. (...) without a possibility to share, to review, to criticise, the years go on and we stay close to the starting point” (R25). How relevant the project was with respect to the development of her own communication skills within the classroom is witnessed by her own words in the analysis of this lesson: “Now I pay more attention to what students say. My own comments became more succinct and crisp” (R22).

In a number of occasions Maria provided evidence that this project has meant a lot to her in several regards: (i) becoming aware of communication difficulties – “The starting point to think about communication is to recognize that problems exist” (R25); (ii) experiencing new communication strategies, namely in conducting group work – “I discovered the relevance of students taking notes and reporting a group work for improving communication” (E2); and (iii) discovering the relevance of sharing with other teachers – “To change things we cannot be alone we need to share” (E2).

5. CONCLUSIONS

The case of Maria provides some evidence on how important this project and the collaborative work were for her own practice. Having the possibility to plan, review and assess new teaching experiences made her understand the relevance of seeking new forms of work in the classroom. Before the project, she was likely to speak most of the time in a lesson, strictly controlling its dynamics. Her concern to keep students interested and to go until the end of the official curriculum, explains the sort of direct questions she used. In the project Maria learnt how to carry out more autonomous and “creative” teaching strategies, without compromising the curriculum. Along the project, she brought to the classroom a more accurate perception of her role in the communication dynamics of a class, in particular her concern to listen carefully each student. She became an enthusiastic of group work and got convinced that this way her own communication with students became more natural and effective.

For future work it would be important to study how this sort of collaborative work can be integrated in the daily routine of the school, reducing, or even dispensing, the structuring role of an external researcher. Another question concerns the identification of the elements that constrain the evolution of a teacher in such projects; in particular the reasons why this project was so successful with Maria and less so with some of the other teachers involved.

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