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LEARNING, PARTICIPATION AND LOCAL SCHOOL MATHEMATICS PRACTICE*

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Abstract: This paper reports on a study whose aim was to examine students' learning in terms of participation in collective mathematical discussions. Our basic theoretical assumptions are based on a combination of situated learning perspectives and a framework that links social and psychological approaches of mathematical activity and learning. The research was carried out in a Year-8 classroom (students were aged 12 to 13), and the mathematical subject under investigation was area measurement. Data are presented to illustrate possible correspondences between 'signs' of learning and 'local' changes of participation. We conclude by discussing some pedagogical implications resulting from the study.

Keyword**s:** classroom discourse; communities of practice; local practices; mathematical learning; psychology of learning; sociological approaches;

Introduction

In the context of mathematics education participation during the classroom interactions has been examined by distinct approaches and foci. These have strongly indicated that factors like the affective domain, the other participants (especially their power relation to the person), the means of communication (especially language), the artefacts involved and the physical surroundings influence the process of participation. For example, Tatsis and Rowland (2006) argue that the participants are engaged in an interpretive process during their interactions; while they may wish to fulfil the purpose of the interaction (e.g. to solve a problem), at the same time they are interested in maintaining their face. Back and Pratt (2007) examine a student's participation in an online discussion board; their work demonstrates the significance of the medium of communication (in their case written speech) in participation and identity formation. McVittie (2004) has used discourse analysis, particularly Wegerif and Mercer's (1997) categorisation, to describe the regularities found in students' talk. According to this scheme, students use three different kinds of

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talk – depending on the task and the discourse community they are involved – disputational, cumulative and exploratory talk. These different kinds of talk are used to signify different participation patterns or, in other words, different selves. Williams and Clarke (2003) focus on patterns of participation in dyadic and triple collaborative interaction aiming at solving mathematical activities. The authors suggest that in both interactions the communication among the students is characterised not only by the sharing of the meanings of the mathematical terms they exchange during the interaction, but also by some pre-existing (but not always stated) established modes of particular participation of each dyad/triple. Jaworski (2007) extends the concept of participation into engagement, which denotes active participation and mental inclusion; she uses this concept – together with the concept of community of inquiry – to examine the ways in which teachers engage in their school community, align with its practice and exercise imagination to achieve their own professional goals. Frade, Winbourne and Braga (2006) examine students' participation in terms of crossing boundaries between different disciplinary school practices. From interdisciplinary work carried out by secondary mathematics and science teachers, the authors conclude that it was mainly the activity of these teachers that enabled the crossing of the boundaries between their disciplines: they have translated for each other their specific discipline codes, worked together to prepare and organise their collaborative work and shared their goals and purposes with the students.

Cobb, Stephan, McClain and Gravemeijer (2001) offer a framework that links social and psychological approaches of mathematical activity and learning. In doing so, they attempt to see participation as a coordination between the establishment of common mathematical practices (social perspective) and the individuals' reorganisation of mathematical reasoning during the evolution of these practices (psychological perspective). This attempt to address to any coordination between the social and the individual in studies of participation is shared, in some way, with other researchers. Indeed, from a situated perspective of learning, Wenger (2007) says that as long as we enter, engage with and leave communities of practice, learning – in these communities – is a social journey as well as a cognitive process. In developing a *discursive participationist* view of learning, Sfard (2006) emphasises the interrelationship between what she calls 'collective and individual editions': developmental transformations are the result of two complementary processes, that of *individualization of the collective* and that of *collectivization of the individual*. For her, these two processes are in a constant dialectical flux between both individual and collective forms of doing.

Lave and Wenger (1991) describe participation by following a movement from the 'peripheral' to the 'central', i.e. the process of becoming a member of a particular community of practice. This movement, adapted accordingly for the classroom context, can be used to analyse the students' participation and identity formation during an extended period of time. However, teachers also need to evaluate students in smaller periods of time, e.g. during a single lesson or even an activity. Motivated by this and based on Lave's (1993) discussion of practice, Winbourne and Watson (1998) have introduced the notion of *local community of practice* (LCoP) for everyday school mathematics. Grounded on a combination of this situated theoretical construct and that of Cobb et al. above-mentioned, our study aims at providing a possible way of analysing students' learning in terms of participation (something we could also discuss in terms of identity formation, though that is beyond the scope of this paper) during a specific classroom activity: a collective mathematical discussion. In doing so we will also look for the evolution of sociomathematical norms, as Yackel and Cobb (1996) put it and, particularly, how these norms influence participation and the establishment of a LCoP. Our basic theoretical assumptions will be presented firstly, followed by our methodology and analysis of the data.

Theoretical Background

Situated learning perspectives are fundamentally characterised by two main epistemological premises: i) learning means changing participation and formation of identities within communities of practice (e.g. Lave 1988; Lave and Wenger, 1991); ii) cognition is seen as a process situated in practices, and so always changing or transforming individuals – including teachers and students, activities and practices (e.g. Frade, Winbourne, & Braga, 2006; Lerman, 2001;). These very features are thoughtfully expressed by Lave and Lerman as follows:

(Quotation 1 here)

(Quotation 2 here)

Concerning school practices these mean a shifting of teacher's focus on individual differences, and an abandonment of comparative notions, for instance, 'good' or 'bad', 'more' or 'less' learning, among students groups. This is challenging or, at least, unusual, for it demands other way of thinking from the teacher's part. Learning now should be seen as occurring socially; collectively in activities which the students develop in specific, situated practices. Student and learning environment are closely connected, and the student's performance is strictly linked to his/her participation and identity formation in learning practices.

The most expressive elaboration of the concept of participation is offered by Wenger (1998). For him, participation is a process related to social experiences "in terms of membership in social communities and active involvement in social enterprises" (p. 55). In elaborating this concept Wenger (1998) differentiates participation from mere engagement as the former has the potential of mutual recognition. In doing so, he explicitly takes into account people, interaction, community, identity, and so on. Participation includes talking, doing, feeling and belonging; it is treated as learning in terms of distinctions between kinds of enterprises rather than distinctions in qualities of human experience and knowledge.

As indicated in the introduction, the movement from the 'peripheral' to the 'central' to describe the process of becoming a member of a particular community of practice (Lave & Wenger, 1991) can be used to examine the students' participation during an extended period of time. This can be done by adapting the concept of 'legitimate peripheral participation' (Lave & Wenger, 1991) to school mathematics practice as proposed by the first author of this paper in her doctoral thesis; it can be thought of as the ways the students fit their experiences in order to engage in such a practice, or their intention to preserve a collective fruitful environment for learning. According to Frade (2003) it does not make sense to say that peripherality has to do with a necessary distance from full participation aiming at the mastery of a profession. Peripherality in classroom practices is a mode of participation, which is associated with the students' commitment (more or less intensive) to their learning. In other words, the movement from the 'peripheral' to the 'central' in school mathematics context should be associated with motivation and predisposition for learning. Interpreting this movement as such, the aspects 'non-voluntarism' and 'not aiming at being a mathematics teacher or a mathematician' that make difficult the direct translation of Lave's and Wenger's ideas to classrooms cannot be obstacles to regard a classroom as a particular community of practice. In fact, these aspects, says Frade, do not necessarily imply that students will construct an identity of non-participants in school mathematics practice, or yet, that they will not wish to develop possible trajectories or to invest in themselves.

Having said this, let us return to our exploration of students' learning in terms of participation, considering smaller periods of time, e.g. a single lesson or a specific activity. Based on Lave's (1993) discussion about local practices, Winbourne and Watson (1998) have introduced the notion of *local community of practice* (LCoP) for everyday school mathematics:

(Quotation 3 here)

This notion of LCoP it is clearly compatible with both Wenger's concept of participation and Frade's (2005) adaptation of the movement from the 'peripheral' to the 'central' to classroom contexts. Also, it is very important for our research purpose, for it provides a situated background for us to talk about learning and 'local' changes of participation (as well as on identity, as we said before) during a single lesson, in particular where the students were involved in a whole-class discussion.

From this notion, Winbourne and Watson have proposed a helpful tool consisting of six characteristics, which allow us to identify whether a local community of practice is constituted in classroom:

(Quotation 4 here)

Taking a closer look to these characteristics, one could see that they refer to two aspects of the activities; on the one hand we have the social aspect (2, 4 and 5) and, on the other hand, the personal aspect (1, 3 and 6), though the one cannot be thought without the presence of the other. Or yet, these characteristics allude to something that we could call 'collective cognition' to emphasise the dynamic character and the indissolubility between the social and individual facets of an interaction that emerges from a certain practice. This has led us to look for a theory that could somehow combine these aspects – or explain a collective cognition event – in order to provide a full account of the classroom practices. Cobb et al.'s (2001) framework offers this possibility[1]:

(Quotation 5 here)

The idea of participation above can be viewed as a 'local mode' of talking, doing, feeling and belonging when restricted to a classroom microculture, or else, to a LCoP as Winbourne and Watson put it. Another idea that proved useful in our analysis was that of the norm, particularly the social and the sociomathematical norm. The social norms refer to regularities in classroom activity that are jointly established by the teacher and the students (Cobb et al., 2001), while sociomathematical norms are "normative aspects of mathematics discussions specific to students' mathematical activity" (Yackel & Cobb, 1996, p. 461). These norms regulate the classroom's practice and play a part in shaping the participants' acts. Based on these ideas we analysed the interactions that took place in a whole-class discussion, taking participation in such a practice as involving sharing of purpose, ways of interpreting and arguing, and forms of mathematical reasoning and argumentation, in relation to the suggested classroom norms. At the same time we have looked to this whole-class discussion as a LCoP.

The basic elements of the context of our study, together with our methodology are presented in the following section.

The study

Research context and data collection

The study was carried out in a Brazilian urban secondary school and was part of a wider research project whose general aim was to investigate the development of area measurement knowledge of 28 students (11 girls and 17 boys) of a Year 8 mathematics class (ages approximately 12 to 13). This class was not a multiethnic class, though we can say that it was characterized by a cultural diversity concerning the children's socio-economical position. The context of the study refers to two sequential lessons (50 minutes each) dedicated to the collective correction of a diagnostic questionnaire the students had answered in order for the teacher-researcher – the first author of this paper – to start working on the subject. She was an experienced teacher who had been teaching in this school for eighteen years. She had also been teaching in this class since Year 7 when her students were introduced to area measurement by prioritising their daily-life and school previous knowledge, the basic concept and some informal procedures for calculating area. During the research she worked professionally both as a regular teacher fully involved in the routine of the classroom work, and as a researcher, having that classroom as her research setting. At this time two undergraduate students who had done their teaching practice in her class for the period of one month prior to the beginning of the research were asked to help the teacher-research in the data collection. They promptly agreed and stayed in the class during all data collection under the teacher-researcher supervision. Before starting the data collection the teacher-researcher gave them instructions on how to collect data and to help the students. If requested by them the two undergraduate students could offer explanations about the activities proposed in the questionnaire, working with the students in a similar way they both had done previously during their teaching practice.

The day in which the diagnostic questionnaire was applied the students sat individually. The day after the students had answered the questionnaire the teacher-researcher allowed them to sit in small groups to discuss it collectively. On this day the teacher-researcher walked around the classroom all the time, picking out students who were contributing to the discussion. Sometimes the teacher-researcher addressed to some students asking them to respond to a specific question; other times she addressed to the whole class asking volunteers to talk about their answer. Such practices had been typical of the culture of this classroom from the year before. With the help of the two undergraduate students data were collected by video, audio and students' questionnaires.

The questionnaire consisted of seven questions. For our research purposes we opted to mention just one question from it. This question presented ten alternative situations to the students and asked them to mark with an 'x' those which contained the concept of area measurement. These situations were:

a) to calculate the quantity of paint needed to paint a wall

b) to compare the quantity of water of two reservoirs

c) to decide about the size of a carpet to be put in a living room

d) to measure the distance from your house to the nearest bakery

e) to decide in which of two wardrobes you can put more clothes

f) to calculate the quantity of wood needed to cover the floor of a house

g) to measure the height of a building

h) to decide which umbrella protects more from rain

i) to calculate the quantity of wire needed to surround a terrain

j) to decide which of two gardens is the biggest.

Due to the rich collective discussion that occurred during the correction of this question we restrict our analysis to the first situation: to calculate the quantity of paint needed to paint a wall. It was expected that all students had marked this alternative with an 'x'. The particular or 'local' discussion lasted seven minutes and was chosen because it explicitly demonstrates some of the students' doubts concerning volume and area measurement and how the discussion has evolved to reach a common understanding.

Methodology

For our analysis we adapted Cobb et al.'s (2001) methodology to fit our research purposes; we have tried to locate the forms of participation that were legitimate in this discussion. This led us to develop conjectures "both about the ways of reasoning and communicating that might be normative at a particular point in time and about the nature of selected individual students' mathematical reasoning" (p. 128). By focusing on students' utterances we were able to view them as constituting the classroom practices and at the same time their own forms of participation. These two aspects of the same activity were then tested against Winbourne and Watson's characteristics to see if a local community of practice has been established. In relation to these characteristics (C1, C2, …, C6), the criteria we have used to produced evidence of them are shown in table 1. We note that we have rephrased C3 and C6 into one characteristic, namely C3,6; for the latter looks like to us the same as the former plus the teacher's participation. The reliability of the criteria used was achieved by the two authors' agreement.

Characteristics	Criteria
C1. pupils see themselves as functioning mathematically and, for these pupils, it makes sense for them to see their 'being mathematical' as an essential part of who they are within the lesson	Self-reflexive statements related to mathematical processes
C2. through the activities and roles assumed there is public recognition of developing competence within the lesson	Utterances of appraisal or expressions of satisfaction towards one's own work
C3,6. participants see themselves as engaged in the same activity, working purposefully together towards the achievement of a common understanding.	Procedural utterances (used to assist the regular flow of the discussion) or prompts for actions needed for common understanding (as it is perceived by the speaker)
C4. there are shared ways of behaving, language, habits, values, and tool-use	Regularities in the discussion and common assumptions revealed in the discussion; the social and sociomathematical norms are the core theoretical constructs related to this characteristic
C5. the lesson is essentially constituted by the	Requires an holistic approach to the activity and

active participation of the students	can be identified by observing the significance of each student's contribution and the number of students that participated

Table 1. Local Community of Practice characteristics and identification criteria

Having done this, we decided on how to refer to these characteristics and the respective criteria in our analysis in such a way that they would not blur our main analytical purpose: to build possible correspondences between 'signs' of learning and 'local' changes of participation. So, utterances in the discussion were coded when they indicated to us evidence of the above characteristics; this coding was used additionally to support or to withdraw our claims for the existence of a local community of practice. We note that this evidence was produced by analysing the discussions related to the whole questionnaire, during the two sequential lessons.

Analysis

The discussion that was transcribed took place between the teacher and some students, and among students. The sign (…) indicates that some utterances or parts of an utterance were omitted. Our notes are in brackets. Next to each turn there is a code that refers to the characteristics mentioned before; this is done for all codes except C4 and C5 which can be identified in a sequence of verbal exchanges and not in single utterances as we show in the analysis that follows. The duration of the discussion was seven minutes and all students' names are pseudonyms.

01 Teacher: Children, pay attention now (…) we are going to discuss [an exercise] and if needed you should make it over again, okay? (…) Among the alternatives below, mark with an 'x' the situations in which the mathematical concept of area measurement is involved (…) the first alternative is 'to calculate the quantity of paint needed to paint a wall'. Hands up those who marked this (…). [Most students raise their hands. After observing the raised hands the teacher invites the students who did not mark this alternative to speak]

02 Marcelle: I don't know.

03 Paula: Why don't you know?! [C3,6], [C4]

04 Teacher: Don't you? What did you think here? [addressing Marcelle] (…)

05 Marcelle: I thought it was…oh, I thought it was to measure the paint litres.

06 Teacher: Then you thought that the litre has nothing to do with area measurement.

07 Stephanie: I also thought this… The same thing she [Marcelle] thought.

08 Teacher: Felipe, why didn't you mark this? Do you remember?

09 Felipe: I forgot, Miss; I don't know why I didn't mark it.

10 Teacher: You don't know why. Didn't anybody else mark? [some students raise their hands] Amanda, why?

11 Amanda: Likely, liquid has nothing to do with area. How do I measure...

12 Teacher: Okay, you thought that litre, the quantity corresponding to a litre has nothing to do with area measurement. Now let's see who has marked this alternative (…)

13 Paula: Let's suppose that I am going to buy, to paint my house. Let's suppose that I am going to buy ten cans of paint, but I don't know how many square metres my house is. How would I know how many litres of paint I would need? (…) [C1]

14 Calvin: I did.

15 Teacher: And does your justification coincide with [that of Paula]?

16 Calvin: The same thing. (…)

17 Lucas: Oh, I have marked it like this. Let's suppose that he needs paint to paint, to paint five square metres like this. So he has to measure how many square metres there are in order to know what to paint. (…)

18 Livia: See, I haven't thought in this way. You gave me the, the example of the room. But I haven't thought about the room. I have thought, for example, about a football field. [The teacher hears the student carefully] I would know the length, I mean, the width if it had been a square. But it is not a square, it is a rectangle. Then I have to know the length and the width of it. I would know the area of the field for me to cover it with grass. [C1]

19 Teacher: Hum, but I am thinking about the first exercise, to calculate the quantity of paint.

20 Livia: Then, this classroom is an example of this. I have to know the area. For example, I am going to paint just one wall in one colour. I have to know the area of the wall for me to paint it; for me to see how much paint I am going to buy. [C1]

21 Teacher: Okay. (…) Felipe [who had already said to the teacher that he didn't know why he didn't mark it] (…) what do you think now, after? [this discussion]

22 Felipe: I think I should have marked it.

23 Teacher: Sorry?

24 Felipe: I should have marked it.

25 Teacher: Why?

26 Felipe: Because knowing the size of the, knowing how much paint I am going to need to paint the wall I don't need to buy a lot of paint. [C1] [C4]

27 Teacher: So, it was enough for you to know what about the wall?

28 Felipe: The square metres.

29 Teacher: The size of the wall. Okay, that's fine. Did you mark, Mateus? [C2]

30 Mateus: I did (inaudible) like this, you, I am going to paint a wall, don't I? So I calculate the quantity of paint I have, so I paint just with was not enough (inaudible) So a bit of the area of the wall rests without painting. This is because I didn't calculate. I have to calculate how much I am going to spend to paint.

31 Teacher: Okay. That's fine kids (…) Wait! Yes, Amanda? [Amanda calls the teacher] [C2]

32 Amanda: Let me ask a question. Which one is correct?

33 Teacher: Kids, see! [The teacher asks for silence to hear Amanda]

34 Amanda: Because like this. I don't know how many, how many like this, one paint can I can paint?

35 Teacher: You do.

36 Amanda: How?

37 Teacher: It [the quantity] is written on the paint can.

38 Amanda: Is it?

39 Teacher: Yes, it is.

40 Herbert [and some others]: It is always written. [C3,6]

41 Teacher: The quantity of paint is written, but the painter or even you, you can buy one litre of paint [referring to a paint can]. Even if it were not written on the container, you could go there and hold a small can of paint. So, you calculate more or less. Say in this way: observe that that little can was enough to paint this area. Then how many cans am I going to need to paint the whole area? Then you have to know the whole area of the wall. This means, the concept of area measurement is involved for you to know how many litres of paint you need. Otherwise, you won't know, okay? [C3,6]

42 Barbara: So, whoever marked [an 'x'] is right. Whoever marked it is right?

43 Teacher: So, whoever marked it is right [some students exclaim happily 'Yeah!'].

Valuing the practice of sharing and comparing the students' responses the teacher asks the students who have marked the 'x' to put their hands up aiming at an evaluation of the consonances and dissonances, and decides firstly to involve the students who have not marked the 'x', i.e. the 'wrong' responses. When Marcelle says that she does not know why she did not put the 'x' Paula intervenes immediately suggesting that Marcelle should know. Encouraged by Paula the teacher asks Marcelle what she had thought and she immediately explains her interpretation of the question. In utterance 06 the teacher conjectures about Marcelle's reasoning and completes her thought; by doing that she scaffolds her students' thinking as she formulates in a clear and comprehensible way the idea that volume ("litres") does not seem to be related to area. Moreover, she encourages three more students to express their opinion. Felipe says that he does not remember, whereas Stephanie and Amanda confirm the teacher's conjecture. Amanda goes a bit further in her participation when she gives clues about their mathematical reasoning and interpretation of the question (11). Note that the teacher does not intervene in the students' responses concerning their inappropriateness.

In utterance 12 the teacher repeats the proposition that "the litre has nothing to do with area measurement" and decides to listen to the responses of the students who marked the alternative. This time she encourages six students to talk about their responses (note that in a classroom with 28 students, eleven have demonstrated public participation in the task by this time) despite their difficulties in making their utterances intelligible or clear. In particular, Livia participates with an analogical reasoning between the situation under discussion and a 'football field' situation. The teacher did not intervene in the students' responses because she wanted to promote a learning practice in which the students may uncover for themselves the dissonances or inconsistencies in their responses. The students' utterances up to this point do seem to agree with the reason they have marked the 'x'. On the other hand, these utterances may serve to mark disagreement, and to raise the discovery and exploration of dissonances between responses of the participants, teacher and students.

Utterances 21, 23, 25, 27 and 29 reflect the teacher's intention to check if meanings were negotiated and some knowledge was co-constructed during the conversation. Utterances 22, 24, 26 and 28 are evidence that Felipe has negotiated meanings and has constructed a 'new' knowledge for him (perhaps for others as well, but not in the same way) since he assumes that he should have marked the 'x'. Moreover, he is aware now that if he does not know how much paint he needs he can run the risk of buying more paint than necessary. Up to this point the teacher did not make any straight suggestion about which students are right: those who marked the 'x' or those who did not. The way in which the teacher guides the discussion was intentional, for she valued the negotiation of meanings and co-construction of knowledge between the students-participants. Indeed, she supports the establishment of the sociomathematical norm of clarity of expression (utterances 27-29) by assisting Felipe to express his thoughts. Until now, twelve students have participated publicly in the activity.

The utterances 32-40 demonstrate Amanda's attitude in wanting to confirm/test after all which responses are correct. This is related to a sociomathematical norm, according to which a question is validated by its answer. Utterance 33 shows that the teacher asks the other students to pay attention to their classmate's doubt. This action may configure a social classroom norm, according to which a query is expected to be discussed and evaluated by the whole class and not solely by the teacher. However, Amanda's doubt is related to a convention that paint manufacturers should provide clear information for their clients; she wants to be sure about the quantity of paint there is in a can. Utterances 37, 39 and 40 show that both the teacher and Herbert were able to allay her doubt. At this stage, the number of students who have participated publicly is fourteen, so we can claim that the lesson is essentially constituted by the active participation of the students (characteristic C5 in Table 1). The teacher has not yet said anything about which responses are right or wrong.

Finally, the teacher decides to summarise the discussion trying to reach a collective agreement concerning the meanings constructed by the participants. In doing so, she extends the discussion of the alternative in question to a situation of how many paint cans one needs in order to paint a specific surface, and concludes that this involves the concept of area measurement. In her final response, when she agrees about "who was right", Barbara shows some awareness of what she has learned. Finally, the teacher agrees with Barbara and makes an 'indirect' synthesis of the situation: "…whoever marked it is right".

Throughout the excerpt one can see the sociomathematical norm of justification, i.e. that one is expected to justify his/her opinion. It is evident from the beginning in Paula's question (03) and then it is re-expressed by the teacher (04, 08). Students' participation structure is based on this norm, since we see them during the whole episode trying to explain their choice, and when their explanation is not accepted (18) elaborating it (20). Another interesting norm revealed is that mathematics seems to be closely related to everyday practice; contrary to other research findings (Tatsis and Koleza, 2008). Paula and Livia enrich the initial question with 'everyday' examples in order to make the problem more comprehensible, thus more easily solved.

Conclusions

Regarding our research objective – to build possible correspondences between 'signs' of learning and 'local' changes of participation – we take Felipe and Amanda's participation to claim that there was a correspondence between leaning and changing participation during the collective discussion. Indeed, we have established which forms of participation were expected in such a practice. In doing so, we could identify Felipe and Amanda's forms of participation, according to the classroom norms suggested, as well as how their forms of participation changed during the event (Felipe: 09, 22-29; Amanda: 11, 34-38). From a situated perspective this participation has constituted some learning (something we could also discuss in terms of identity formation, though that is beyond the scope of this paper). In fact, it is very reasonable to say that 'bits' of Felipe and Amanda are not the same as before, for the practice clearly afforded transformations in their way of thinking. On the other hand, Felipe and Amanda's participation contributed to the regeneration of the practice as they afforded the participation of both the teacher and their classmates. Amanda's unexpected doubt "…I don't know how many, how many like this, one paint can I can paint?" revealed that such kind of practices include emergent phenomena that overlap already-established/expected ways of reasoning and communicating into which students are suppose to be inducted (see Cobb et al., 2001).

From the video recording of the two sequential lessons (50 minutes each) dedicated to the collective correction of the diagnostic questionnaire and the analysis of these lessons as a whole, we can say that a LCoP was constituted during the particular activity. The degree of the students' participation – as we took participation above – was very significant. We have identified an expressive number of students exposing their interpretation of the questions, their reasoning and argumentation, based on the relevant norms established. These norms and especially the justification norm proved very important in the structuring of the participation, by helping students establish some shared ways of understanding each other and of evaluating each other's contribution (the most characteristic case is Paula's question towards Marcelle in 03, asking her to justify her opinion). Another common assumption established was that the problems posed can be integrated into everyday situations (coming from the students' everyday experience) in order to be more effectively dealt with. This assisted their purposeful participation towards the achievement of a common understanding. The discussion took place not only between the teacher and the students, but also among the students: many of them addressed their classmates to question or comment about their responses, which reveals the social norm of collaboration towards a common end. Also, the intensity of the students' participation was so high in certain moments that the teacher-researcher had to do interventions likely "Children, please! I think it's great that all of you are excited to participate, but we don't need to do this by shouting so much and at the same time! I still have to teach until 5:30 p.m.!".

We suggest that the main pedagogical implication of this study points to the teachers' role in guiding a collective discussion and scaffold the students' thinking. Also, teachers should be clear and transparent with students about which ways of participation they expect and value in classroom practice in order to support and evaluate their learning. This does not mean that students' participation should be constrained; it means that the teacher should be able to frame the students' actions according to the established norms and at the same time be flexible in the establishment of new norms and practices. Moreover, if the teacher is able to identify the 'small' changes in each student's participation, s/he will be able not only to better monitor the evolution of the activity but also to perform his/her interventions in the most effective way.

Quotations

1. …learning is an aspect of changing participation in changing "communities of practice" everywhere. Wherever people engage for substantial periods of time, day-by-day, in doing things in which their ongoing activities are interdependent, learning is part of their changing participation in changing practices. (Lave, 1996, p.150)
2. As a person steps into a new practice, in social situations, in schooling, in the workplace, or other practices, the regulating effects of that practice begin, positioning the person in that practice… Even if a person withdraws from a practice after a short time, she or he has been changed by that participation. (Lerman, 2001, p. 98)
3. Such communities are local in terms of time as well as space: they are local in terms of people's lives; in terms of the normal practices of the school and classrooms; in terms of the membership of the practice; they might 'appear' in a classroom only for a lesson and much time might elapse before they are reconstituted… (p. 94)
4. C1. pupils see themselves as functioning mathematically and, for these pupils, it makes sense for them to see their 'being mathematical' as an essential part of who they are within the lesson;
   C2. through the activities and roles assumed there is public [from the participants] recognition of developing competence within the lesson;
   C3. learners see themselves as working purposefully together towards the achievement of a common understanding;
   C4. there are shared ways of behaving, language, habits, values, and tool-use;
   C5. the lesson is essentially constituted by the active participation of the students;
   C6. learners and teachers could, for a while, see themselves as engaged in the same activity. (p. 103)
5. … normative activities of the classroom community (social perspective) emerge and are continually regenerated by the teacher and students as they interpret and respond to each other's actions (psychological perspective). Conversely, the teacher's and students' interpretations and actions in the classroom (psychological perspective) do not exist except as acts of participation in [and constitutive of] communal classroom practices. When we take a social perspective, we therefore locate a student's reasoning within an evolving classroom microculture, and when we take a psychological perspective, we treat that microculture as an emergent phenomenon that is continually regenerated by the teacher and students in the course of their ongoing interactions. (p. 122)

References

Back, J., & Pratt, N. (2007). Spaces to discuss mathematics: Communities of practice on an online discussion board. *2nd Socio-cultural Theory in Educational Research and Practice Conference, University of Manchester, U.K.* Retrieved March, 24, 2008 from: http://www.lta.education.manchester.ac.uk/ScTIG/papers/Jenni%20Back.pdf

Boaler, J. (2002). The development of Disciplinary Relationships: Knowledge, Practice and Identity in Mathematics Classrooms. *For the Learning of Mathematics*, 22, 1, 42-47.

Cobb, P. (1994). Where Is the Mind? Constructivist and Sociocultural Perspectives on Mathematical Development. *Educational Researcher, 23 (7),* 13-20.

Cobb, P., Stephan, M., McClain, K., & Gravemeijer, K. (2001). Participating in classroom mathematical practices. *Journal of the Learning Sciences, 10,* 113-164.

Frade, C. (2003). *Componentes Tácitos e Explícitos do Conhecimento Matemático de Áreas e Medidas* (Tacit and Explicit Componenets of Area Measurement Knowledge). Belo Horizonte: Faculdade de Educação-UFMG. Tese de Doutorado não publicada (Unpublished Doctoral Thesis).

Frade, C., Winbourne, P., & Braga, S. (2006). Aline's and Julia's stories: Reconceptualizing transfer from a situated point of view. In J. Novotná, H. Moraová, M. Krátká & N. Stehliková (Eds.), *Proceedings of the 30th Conference of the International Group for the Psychology of Mathematics Education*. Prague, Czech Republic: PME, vol. 3, 97-103.

Jaworski, B. (2007). Theory in developmental research in mathematics teaching and learning: Social practice theory and community of inquiry as analytical tools. In *2nd Socio-cultural Theory in Educational Research and Practice Conference, University of Manchester, U.K.* Retrieved March, 24, 2008 from: http://www.lta.education.manchester.ac.uk/ScTIG/papers/Barbara%20Jaworski.pdf

Lave, J., & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation.* New York: Cambridge University Press.

Lave, J. (1993). The Practice of Learning. In S. Chaiklin & J. Lave (Eds.), *Understanding Practice: Perspectives on Activity and Context*. New York: Cambridge University Press, 3-32.

Lerman, S. (2001). Cultural, Discursive Psychology: A Sociocultural Approach to Studying the Teaching and Learning of Mathematics, *Educational Studies in Mathematics, 46,* 87-113.

McVittie, J. (2004). Discourse Communities, Student Selves and Learning. *Language and Education, 18 (6),* 488-503.

Sfard, A. (2006). Participationist discourse on mathematics learning. In J. Maaß & W. Schlöglmann (Eds.), *New mathematics education research and practice.* Rotterdam, The Netherlands: Sense Publishers B.V., 153-170.

Tatsis, K., & Rowland, T. (2006). Vague language in Greek and English mathematical talk: A variation study in face-work. In J. Novotná, H. Moraová, M. Krátká & N. Stehliková (Eds.), *Proceedings of the 30th Conference of the International Group for the Psychology of Mathematics Education*. Prague, Czech Republic: PME, vol. 5, 257-264.

Tatsis, K., & Koleza, E. (2008). Social and Sociomathematical Norms in Collaborative Problem Solving. *European Journal of Teacher Education, 31 (1),* 89-100.

Wegerif, R., & Mercer, N. (1997). A dialogical framework for researching peer talk. In R. Wegerif & P. Scrimshaw (Eds.), *Computers and Talk in the Primary Classroom.* Clevedon: Multilingual Matters, 49-61.

Wenger, E. (1998). *Communities of Practice: Learning, Meaning and Identity.* Cambridge, UK: Cambridge University Press.

Wenger, E. (2007). Learning for a small planet: Agency and structure in the constitution of identity. In *2nd Socio-cultural Theory in Educational Research and Practice Conference, University of Manchester, U.K.* Retrieved March, 24, 2008 from: http://www.lta.education.manchester.ac.uk/ScTIG/2007conferencekeynotespeakerabstracts.html

Williams, G., & Clarke, D. (2003). Dyadic Patterns of Participation and Collaborative Concept Creation: 'Looking In' as a Stimulus to Complex Mathematical Thinking. Paper presented as part of the symposium *"Patterns of Participation in the Classroom"* at the Annual Meeting of the American Educational Research Association, Chicago, April 21-25, 2003.

Winbourne, P., & Watson, A. (1998). Participating in Learning Mathematics through Shared Local Practices in Classrooms. In A. Watson (Ed.), *Situated Cognition and the Learning of Mathematics.* Oxford: Centre for Mathematics Education Research, University of Oxford. Chapter 7, 93-104.

Yackel, E., & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education, 27 (4),* 390-408.

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[1] Sfard's (2006) discursive participationist view of learning could be another possibility. However, given that we are using the notion of LCoP as our background, and the discursive interactions are, in our opinion, contemplated in it (characteristic number 4) as well as in Cobb et al.'s framework (part of normative activities in classroom practices), we believe that the latter allows us to talk about learning as local changes of participation within a LCoP more flexibly.