Mathematics teacher change in a collaborative environment: to what extent and how

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Abstract: This article reports on a study into how collaborative contexts influence the professional development of an early-career primary teacher, Julia. We describe the process of change by which Julia manages to make her planning to teach mathematics more flexible so as to adapt to student difficulties, and we analyse the role that joint reflection plays in promoting this change. In order to understand the *how* of this influence, we carried out an analysis of the interactions within the group from Julia's point of view, following a dialogical approach to discourse. We believe that it is in and through the interactions that Julia constructs her interpretation of the opinions, critiques and suggestions expressed. This interpretation conditions the extent of her involvement and moulds the influence of the context on her professional development. The presence of skilled collaborators (Day, 1993) proved decisive in promoting this development.

KEY WORDS: professional development, teacher change, collaborative environments, early-career primary teacher, interactions, dialogical approach to discourse, mathematics education.

Introduction

This article[1] forms part of a broader study which focuses on the professional development of an early-career primary teacher participating in a collaborative research project (PIC). The participants in the project include two experienced teachers, two recently qualified teachers, two university researcher-trainers and a novice researcher. Each participant has their own interests and expectations, closely bound to common objectives that have been reached by consensus: the professional development of each member, and research into both classroom practice and teacher training. The group, in which open debate and reflection are encouraged, meets for three hours every fortnight and centres its interest on exploring ways that a problem-solving approach can be beneficial to mathematics learning in the primary classroom. We would characterise the

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PIC as a collaborative environment for interaction (see Climent and Carrillo, 2002 for further details), joint reflection, participation of teachers in the analysis of data, differentiated roles and shared objectives (Feldman, 1993).

This article considers one of the more notable changes in Julia's professional development: the introduction of a greater degree of flexibility into her lesson planning. Our interest in understanding this development lies not only with the *what*, but equally with the *how* of this change, as her classroom performance receives support through her participation in the PIC. An analysis of Julia's interactions within this group – carried out via an 'interactions instrument' created expressly for the purpose – provides clues as to how the meanings that Julia constructs in the interaction mediate the potential for professional development offered by the PIC. We discuss the extent to which this might be a lasting change in relation to the circumstances which brought it about and the obstacles threatening its consolidation as part of her practice.

Theoretical framework

The study approaches professional development from the perspective of social constructivism (Ernest, 1996). We understand that teachers develop through processes affecting the individual and through their interactions with others, in a process of constant interpretation of socially constructed knowledge.

Our conceptualisation of professional development recognises both context ("any opportunity for teachers to meaningfully interact with content, teaching or learning", Nipper & Sztajn, 2008, p. 335, in our case the PIC), and process (aimed at a deeper understanding of one's own practice, Krainer, 1999). Our analyses focus on this process and on the change in key dimensions such as the teacher's conceptions, knowledge and practice (or lesson planning as a product of practice). Such changes in the teacher's thinking and practice allow us to track their process of development and to analyse it.

In the course of this analysis, reflection becomes both the medium and the descriptor (Climent, 2005; Llinares & Krainer, 2006). Teachers' reflections mirror the languages they use to describe reality, their interpretative systems, their theories and the context in which they work (Schön, 1983).

Reflection within a collaborative environment enables teachers to engage in a reflective dialogue with their practice, with the aim of deconstructing it (breaking it down into relevant excerpts and sifting out contradictions and ambiguities, and the personal

theories underpinning them), so as to later reconstruct and improve them. This reconstruction is undertaken in the light of certain theoretical frames, advancing the development of practice knowledge (Goffree & Oonk, 2001).

In collaborative environments such as the PIC, joint reflection plays a crucial role (Ticha & Hospesová, 2006), enabling teachers to develop sufficient competency for self-reflection. In the case of early-career primary teachers, joint reflection is crucial, given the difficulties they encounter in reflecting on their practice (Goodell, 2006). For more experienced teachers, joint reflections can provide the skills they lack, guiding them towards a fuller analysis of classroom situations and acting as models of reflective practice.

Joint reflection becomes a cognitive and relational practice in nature, in that cognition and communication are dialogically interlinked. The dialogue, which proceeds through interactions and is semiotically mediated, is not a sequence of individual discourse acts, but a sequence of activities with the aim of establishing mutual understanding of the topics under discussion. The study of Julia's interactions within the PIC from a dialogical conception of discourse (Linell, 2005) (developed in the following section) allowed us to focus on her construction of meaning within the frame of shared construction. Our focus, then, is not on the result of this social construction, but rather the individual processes of construction contributing to it.

Methodological approach

Our aim is to understand the professional development of an early-career teacher, Julia, through scrutiny of the way she interprets situations and what meanings she attaches to these (Denzin & Lincoln, 2000).

Julia started working as a tutor to the first-grade class in the same year that we initiated our project, and she joined the PIC with enthusiasm. Her development as a teacher took place in two different contexts: her school, embodying a traditional view of education, and the PIC, founded on a Problem Solving approach consistent with an investigative tendency (Carrillo & Contreras, 1994). Her teaching was characterised by a heavy dependence on the textbook.

We collected information (from the PIC and her lessons) over the course of the two first years of Julia's teaching, using a variety of techniques and instruments. Audio recordings of the PIC sessions (in which participants considered video recordings of

lessons) provided the principal source for focusing on the 'how' of Julia's development. With respect to the 'what' of her development, we drew from video recordings of three 'teaching units', her teaching diaries and a post-teaching unit interview.

Analysis of the PIC sessions focused solely on Julia's utterances and took the interventions of the other participants into account only where these were relevant. We devised an instrument, IMDEP, for analysing these interactions (Muñoz-Catalán et al, 2010) based on a dialogic approach. From this a summary was compiled in which we interpreted both the interactions and the content of Julia's contributions in the context in which they were produced.

IMDEP emerged during the research in close relation with the data. In this article, we focus on one aspect of the interaction, that concerning the meaning of each contribution: the nature of the action. This attempts to capture the communicative function of each contribution to the discourse, that is, the use to which the interlocutor puts each word, phrase, sign or symbol of his or her discourse, expressing the meaning they wish to transmit or is being constructed at each moment of the interaction (Godino & Llinares, 2000) as interpreted by the researcher. By this means, each contribution was assigned to its corresponding function in the discourse, designated by an appropriate verb. An inventory of these speech acts was compiled from which the most suitable meaning of Julia's contributions could be selected (see Muñoz-Catalán et al, 2010). The instrument was applied to the transcriptions of the PIC sessions, in which the researchers participated, and considered to be complementary data to the verbal, along with the history and culture of the group and the individuals.

We based the study of interactions on the dialogical perspective developed by Linell (1998, 2005), which he describes as "a bundle, or a combination, of theoretical and epistemological assumptions about human action, communication and cognition" (p. 6). We apply the approach mainly to the epistemological component of the relational processes, following Linell, in contrast to Bakhtin's (1986) perspective, which stresses the ontological dimension of human relations.

Dialogism considers that language, cognition and communication are constructed in the reciprocity between oneself and the other. It represents the speaker as 'in dialogue with' their interlocutor(s) and the varying contexts, both local (specific situations) and global and abstract (the cultural and socio-historical context) in which they participate. Given that discourse and dialogue do not consist of the enunciation of individual utterances,

but an attempt to establish a shared understanding of the topic in question, discourse and dialogue are considered to be shared activities, coordinated between all participants and mutually dependent (Linell & Marková, 1993). All communication is oriented towards shared knowledge (intersubjectivity), assuming the existence of asymmetries in the knowledge of the participants (alterity). The dialectical perspective assumes that the tendency of dialogue is to achieve equilibrium and conceives of differences as contradictions to be overcome (Wegerif, 2008). Dialogism, nevertheless, "also provides space for differences of perspectives and opinions, asymmetries and argumentation, competition and conflict, as well as misunderstandings and misalignments" (Linell, 2005, p. 25), therefore considering dialogue as never-ending and incompletable.

Group reflection develops through dialogical discourse. This discourse is not solely a language oriented towards a representation of the world, but rather a language in action (understood as communicative intervention), because it is in the action that the speaker interprets the voices of others and establishes a mode of conduct to achieve social or cognitive ends amongst others (Godino & Llinares, 2000). The minimum unit of discourse is the utterance ("a link in a very complexly organized chain of other utterances", Bakhtin, 1986, p. 69), and its meaning is created within a specific dialogue, in narrow dependence on the preceding contributions to which it responds, and the subsequent ones which it anticipates (sequential environment, Linell & Marková, 1993). Thus, the meaning of an utterance is not reduced to the intention of the speaker or the reply of the interactant, but emerges between the two (Wegerif, 2008). The words which are uttered do not usually derive from the dictionary, but from the voices of the interactants who have used them previously.

Julia's change

In order to understand the nature of Julia's professional development and to increase our theoretical sensitivity to this process (Strauss & Corbin, 1994), we decided to take the most notable changes in her practice as reference points pointing out the direction of her development. We describe the process by which Julia began to consider the planning of her teaching in a more flexible and complex manner, incorporating a new variable – her pupils' difficulties, in terms of both before and during her classroom practice.

Signs of change in Julia

From the start, Julia adopted the textbook as the fundamental tool of her teaching: “Me, what I normally do is the book” [first PIC session, reviewing a video – L7 (Ln stands for the n^{th} recorded lesson) of her teaching]. This reliance was largely due to her perception of parental pressure to finish the textbook within the school year, and it impinged upon her lesson planning and execution, dominating the reflections recorded in her teaching diary (Muñoz-Catalán, Carrillo & Climent, 2006). With regard to her planning, she stuck closely to the units presented in the textbook and always followed the teacher’s guide. She would think about how best to get through each worksheet, and which activities would help its successful completion, but she did not appear to consider the most appropriate activities for a specific topic, the possibility of coming up with alternatives, nor indeed the subject matter in general and the wider objectives concerning learning.

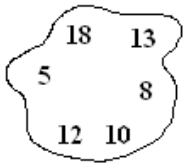
Julia experienced several episodes early on in which she insisted that the pupils finish a worksheet within the allotted time, irrespective of the difficulties arising: “OK, look at the textbook everyone, look at the textbook; I know you’re all tired and me too, but look at the textbook” [L3]. In her subsequent reflection (teaching diary), she limited herself to making a note of the difficulties encountered, with suggestions for overcoming them that never materialised, such as: “Don’t do activities that require so much continuous attention because they are still not ready for it” [Teacher’s diary corresponding to L1]. A significant situation can be found in L7. On the spur of the moment, Julia asked her students (6 years old) to give her a definition of a rectangle. The precision she demanded led her to spend nearly an hour eliciting attributes associated with a rectangle such as parallelism and perpendicularity. Pondering her dissatisfaction, she blamed the children’s restricted image of what a rectangle should look like: “What really strikes me is that, for them, a rectangle necessarily has to have its sides aligned vertically and horizontally with the longer sides always on the horizontal”. As a means of overcoming this mental block, she recommended “not always presenting geometric figures in the same position” [Teacher’s diary corresponding to L7]. Of the two PIC sessions dedicated to analysing L7, S7 (the first) focused exclusively on encouraging Julia to reflect on her performance in this episode (see next section). From this moment onwards, changes began to be seen. At the end of the first academic year, Julia implemented a series of activities on the decomposition of numbers, based on a problem-solving approach designed collaboratively in the PIC. One of these activities

('The same, more, or less', see table 1) turned out to be extremely difficult for her students, which Julia became aware of from the beginning of the class (L26). Foreseeing the difficulty that the activity was going to entail, Julia, somewhat doubtfully, sounded out the best way of introducing it:

> "Now I'm going to take a different number to these; you are all going to think […] listen; now I'm going to say a number and you have to think: here inside there are some numbers, from these numbers that are here inside on the board you have to think which numbers, any ones […] ssh. Come on listen" [L26].

A) Select the numbers which add up to:

a) 27
b) 36
c) 43



B.1) Is the addition of 23 and 15 greater than 20? Than 30? Than 40? 50? (Repeat with 'less than'). B.2) Is the addition of 23 and 32 greater than 20? Than 30? Than 40? 50? (The same with less). B.3) Is the addition of 19 and 32 greater than 20? Than 30? Than 40? 50? (The same with less)

Table 1. The activity 'the same, more, or less'

When Julia went over the first of the two tasks (A) with the whole class, she asked the students to explain the reasoning each had employed to arrive at the solution with the result that only the most able students were able to answer. This required around 40 minutes. By the time they came to the second activity (B) most pupils were tired and only a few could follow. Julia opted to do the activity with the whole class and although she eventually covered the three estimations, she did not go into much detail with the last two. Nevertheless, she reported being left with the impression that she had left the activity half done: "I see that the problem is that they normally solve almost everything successfully, and this time it began to be a bit frustrating (…) and we had to finish without fully completing the activity" [PIC session analysing L24, at the end of the first year.] Her decision not to see the activity through as planned would seem to show a greater willingness to take the students' learning difficulties into account when these arise and to treat the original plan with more flexibility as the lesson unfolds.

A year later, the possibility of Julia repeating the activities on decomposition came up in the PIC. Recalling her experience the first time around and taking into account the level of her current pupils, Julia considered it reasonable to reuse the material in a modified form.

> “So, I don’t know, maybe I’d have been wrong and I’d have got a pleasant surprise, but as last year was far from being productive, I thought: where’s the point of wasting an hour by repeating the experience?” [Interview in which she reflects on the final lesson recorded, L32, at the end of the second year]

She replaced the activity ‘the same, more, or less’ with another from a bank of activities from the PIC, making sure that the same mathematical area was covered. In addition to the sense of failure experienced the previous year, she felt that the source of the difficulty lay in the degree of abstraction required on the part of the students to do mental arithmetic without a given context.

This episode highlights how Julia was now able to consider the potential learning problems facing her students at the planning stage itself and to respond accordingly. At the start of the process, we saw how her individual reflection, as evidenced in her teaching diary, was limited to merely recording events. Her reflection in the group, by contrast, seems to have played a different role, as could be seen by her increased awareness of the importance of suiting one’s pedagogical intentions to the needs of the students at both the planning and implementation stages. The following section provides further detail about the process of joint reflection in the PIC with the aim of determining what tools provided Julia’s critical analysis and questioning of her practice, and how she began constructing a new understanding of the situation through the interactions. Nevertheless, we are fully aware that we cannot claim that the PIC was the only cause of the change in Julia.

How her change came about

In previous studies (Climent & Carrillo, 2002; Carrillo et al, 2007; Muñoz-Catalán, et al, 2007) we have highlighted the role of collaborative contexts in promoting professional development. Here, we would like to take a step further in studying the interactions arising between Julia and the other PIC members with the aim of understanding how the group reflections influenced her understanding of and response to her practice.

Julia’s processes of constructing meanings occurred in and through the interaction and were mediated by various factors, some inherent in Julia herself, others characterising the PIC and its members, but all acting in concomitance with others arising in the interaction and determining it. It was in the interaction that Julia's role in the group was defined, along with the degree of trust she felt for each member, the image she held for

each of them and they for her, and so on, aspects influencing how Julia accepted the opinions, suggestions and critiques about her practice. It is our belief that the processes of interaction determined the extent of Julia's involvement in the group, and as such mediated and modulated the role that the PIC might enjoy in her reflection and professional development.

The last section described how joint analysis of L7 (definition of a rectangle) played a key role in bringing her to question her practice. We analyse this session (S7) below from the perspective of the interactions, identifying the interpretations which Julia assigns to the utterances of the other PIC members. The joint analysis of recordings of lessons given by the teachers is particularly valued in the group in that it is seen as an opportunity to pass a critical eye over one's practice with a view to improving it. Moreover, joint analysis constituted a key feature of the PIC, playing a crucial role in promoting the exchange of views between new and experienced members and so establishing a common language with which to work. Videos of other (experienced) teachers (both within and without the PIC) were also given one or sometimes two, sessions for review, according to the interest they generated. The heterogeneous nature of the group in this analysis plays a key role, the primary teachers supplying their background experience and the teacher-educators offering their theoretical knowledge. Both areas of expertise, theoretical and experiential, are highly valued by all members and are interwoven in the interpretations and proposals for improvement (Carrillo & Climent, 2009). The experienced teachers, Pilar and Inés, assumed responsibility for encouraging Julia's reflection during the course of analysing L7, each with their own role and style. Pilar had been given the task of doing a preliminary analysis of the extract and organising the group proceedings, which consisted in watching the video and reflecting upon it as a group. Pilar openly expressed her disagreement with Julia's decisions. During this excerpt of the interaction, the nature of the action that is predominant in Julia's contributions is that of *explaining* how the session unfolded, *agreeing* with statements supporting her position, *disagreeing* with those that did not offer support, and *reasserting* her original arguments. Table 2 below offers an excerpt from the session, albeit qualified by our awareness of the limitations of isolating an extract of interaction from the context in which it acquires its meaning, with the nature of the action assigned to each of Julia's contributions, based on our own participation in the interaction, indicated in the right-hand column.

Excerpt from transcription	Nature of the action
Julia: Not one of the pupils gave the definition…… I don't know, it's just that they often have the wrong idea about what it is … they've seen that a rectangle has to be like that, and that's it.	**Explains** why she feels the activity was positive.
Pilar: But it's not because they've got the wrong idea, it's because they see the whole thing, they're not yet able to focus on the specifics.	
[…]	
Julia: But personally, I went home satisfied... in the sense that some had tried to follow a line of reasoning a little longer than usual... they had taken part in the discussion, they had learnt something new. I think they shed some preconceptions [about] the shape of a rectangle ... So, at least it was my intention that that should happen.	**Reasserts** her satisfaction with what she was able to contribute to the pupils' learning.
Pilar: They might have amplified their mental representation of a rectangle, but that's all. I could be wrong, but I wouldn't claim anything beyond that.	
Julia: No, my idea wasn't that, no way do I expect that six-year-olds [arrive at a definition] based on an explanation ... but it was a little so that they started looking at specific characteristics. It was probably too much for them, and none of them really got it, but if it was good for anything, it'll be that they'll look back and it will help them to reason things out, to look at things another way, to look more closely at things [so I'm satisfied with that]…	**Disagrees** because she did not expect the pupils to learn the definition, and insists that the activity was valuable.
Pilar: …but what if, for example, one of them arrived at the exact definition. Would that be of any use?	
Julia: Would it be of any use of they got the definition? Of course it would.	**Reasserts** the usefulness of the activity.
Pilar: You think so? I don't.	
Julia: Well, I think it would be of use, not learnt [by heart].	**Reasserts** that the activity is of use to the pupils.
Pilar: It would be of use to the extent that they had been able to memorise the definition in the words you'd given them, but it wouldn't be of any use beyond that.	
Julia: Well, of course…. if they know it only because I'd told them and they'd memorised it, it's of no use at all; but if they know it because they've managed to work it out, well of course that strikes me as absolutely useful.	**Explains** why she feels it is useful to memorise a definition.

Table 2. Excerpt from transcription of the interaction between Julia and Pilar, with analysis

As can be seen in this interaction, Julia holds firm in her arguments, laying emphasis on the positive aspects of her performance, as, to a certain extent, she feels her practice as a teacher is being called into question. Seeing the unlikelihood of Julia understanding what is at the root of Pilar's contributions, Inés takes responsibility for bringing Julia to question her posture and to delve into the real reasons behind her actions, in order for her to become aware of them and to be able to govern them. She opens her intervention by noting Julia's sound knowledge of mathematics and presenting her with one possible explanation for her actions (see Table 3):

Excerpt from transcription	Nature of the action
Inés: What does stand out is that you know maths ... and that you like maths …I noted that you gave priority in what you were doing to the conceptualisation and the subject matter, so to speak ... and quite possibly you gave less importance to what you yourself said, that for example, most of the children be able to follow what you were saying. You could see that that was secondary; it was clear that at that moment you gave more importance to the concept, the academic work, than to pedagogic issues, wouldn't you say? Julia: There were a few who managed to follow all the time, but the majority were drifting in and out ... I think they went away happy. It is important that they learn, if not to speak perfectly, then ... to be a bit more precise when they speak because I think they generalise too much.	**Evades directly responding** (avoids an awkward question or one to which the addressee lacks a reply) to Inés' interpretation. **Reasserts** belief that although many switched off, they did learn something.

Table 3. Excerpt from transcription of the interaction between Julia and Inés, with analysis (I)

In this latter contribution, Julia avoided responding to Inés' suggestion that she had prioritised mathematical considerations over pedagogic ones. In evading the question, Julia shows her unwillingness to accept Inés' interpretation and although other members of the group develop the conjecture in more detail, she *reasserts* her satisfaction with the lesson because she considered that, although not everybody had followed the class to the end, at least the lesson had promoted a certain degree of mathematical thinking. In her attempt to make Julia aware of what had happened, Inés then changes her strategy. She proposes that the group consider which aspects of the events had been productive for the students' learning, which could do with being improved and what suggestions for improvement would be appropriate. She suggests that it should be Julia who starts the analysis so that subsequent discussion focuses on the areas she feels were most lacking. Julia shows her dissatisfaction with the excessive amount of time spent on the activity and explains that it would have been interesting to have put the children to work in groups: "working that way doesn't promote full class participation. It would have been better to make groups and then afterwards talk about it, giving their conclusions" [S7]. Inés feels that Julia is still being evasive in her answers and is not able to see more deeply into events, and so begins to formulate part of the anticipated answers within her questions (see Table 4):

Excerpt from transcription	Nature of the

	action
Inés: You don't think it was because you wanted to get somewhere and you saw that they weren't getting there? Julia: Well, no, it wasn't completely like that**.** There was a moment when I saw it was too much for them… and I said: come on, let's stop there because it didn't seem right. Inés: My question is why do they have to get to that point? Why did you insist that they get that far? Julia: Because it doesn't seem right to me not to finish things. […]	**Agrees** with Inés' explanation, but softens the interpretation. **Explains** her difficulty with leaving tasks half-finished
Inés: No, what happens, Julia, is that sometimes we get involved in something and we have to be able to realise that for whatever reason even if we've planned everything out […] you put your foot in it because there were some details that escaped you. And secondly, knowing how to go back over something, in the sense of saying, 'OK, for whatever reason, this isn't working out, and it's OK if this doesn't work out,' and you say, 'OK, we'll have another go at this tomorrow.' […] Because the one who knows everything is you and the children don't know anything. So, the one who goes away with the sense that things haven't been finished is you, but not the children, […] I saw the determination in you when you said, 'This has got to work out.'	

Table 4. Excerpt from transcription of the interaction between Julia and Inés, with analysis (II)

This is a key moment in the group refection because it is as a result of this that a change in the nature of Julia's contributions could be seen. Gone are the reaffirmations of her original arguments, and in their place is an acceptance of the interpretations and observations of the others. The verbs *recognise*, *agree with* and *disagree with* predominate, these latter two with a very different meaning to that while Pilar directed the discussion. Now Julia *agrees* when she recognises the validity of the argumentation put before her (S7. 90), and *disagrees* when she demurs the attribution of a personal quality (S7. 104). Some examples of this new attitude are now provided, with emphasis on the last (S7. 116), in which she now *agrees* with the interpretation of Inés which she had originally rejected (see Table 5).

Excerpt from transcription	Nature of the action
Researcher 1: I think you expected them to say at least [that the sides of a rectangle are] equal and parallel ... Because in fact, when you give the definition of a right-angle, you start using their terminology and say 'corner' [marked in Spanish for diminutive]; you realised then that you couldn't do it. Julia: Yeah, I thought, 'How can I put it?' ... and I was on the point of saying, 'That's enough,' and leaving it there. (S7. 90)	**Agrees with** the explanation given of events.

Pilar: Also, I see that … you've got a lot of patience because I'd have been driven to screaming by one child. Julia: No, I can also see that I don't have that much either. If, instead of telling him to sit down, I'd said, "What's the matter? C'mon, we'll sort it out..." But I do see everything that you are all pointing out, yeah. (S7. 104) […] Inés: I think what you said about the session is the key thing, too much time was spent on it, but it was because of that. What I thought, and what I hoped was that you would realise that it took too long because you wanted it to take too long. Julia: Yes, it was my fault; the poor little angels were already saying, "Let's do the textbook!" (S7. 116)	**Disagrees** as she feels she does not have so much patience. **Agrees** that responsibility for the episode taking so long was hers.

Table 5. Excerpt from transcription of the interaction between Julia and Inés, with analysis (III)

It seems that Julia starts to perceive the critical comments of the other group members from a new perspective aimed at her professional development, and becomes much more receptive to their guidance.

In the collaborative context of the group, there was no predetermined information or knowledge that was to be assimilated by Julia. Rather, she participated in the joint construction of meaning which took place through the interaction, and which she assimilated through a new personal interpretation. Julia gradually constructed her interpretation in and through the interaction, from the suggestions, critical observations and knowledge brought into play. In this particular case, the interpretation promoted a development in one facet of her professional repertoire, that of flexibility at the planning stage. Additionally, the general reflection brought about an increase in her pedagogical content knowledge, so far as the learning capacities of first-year students was concerned, in that she came to appreciate the difficulty involved in setting six- and seven-year-olds the task of arriving at a formal definition of a rectangle, requiring, as it does, a capacity for analysis and for breaking the shape into parts which is beyond most. The analysis of interactions gave us access to the meanings which Julia assigned to her colleagues' utterances. It allowed us to identify which issues seemed of most importance to her and which challenged her perspective, providing clues to understanding how group reflection influences the understanding and putting into action of one's own practice.

Rarely was any suggestion or critical comment that Julia had rejected during a session put into practice by her, nor could those she accepted always be seen to influence her practice. The PIC was one of the contexts which exerted a direct influence over

professional development, it being one of the objectives of the group to promote development in all participants. Nevertheless, there were other contexts and conditioning factors which influenced the process of translating what had been learned into what could be done in the classroom. From our perspective, we can only affirm that the analysis of interactions has provided us with clues as to how the PIC has brought an influence to bear on her professional development.

To what extent?

It is reasonable to expect that the principles which originally promoted the changes in Julia's approach would go on to be thoroughly interiorised and integrated into her day to day classroom practice. In a subsequent interview (conducted a year later), we found that the textbook remained her point of reference and her overriding objective was that the students should fully complete every worksheet. When she foresaw certain difficulties, she thought of pedagogical strategies that would aid assimilation as much as possible, and when she saw that these were also ineffective, she resorted to getting through the exercise as quickly as possible. Although it might appear that Julia had taken a step backwards, we consider that it is more a question of having stagnated, as her conversation indicated that she still valued the importance of adaptive lesson planning and of avoiding following the plan too rigidly. She found herself hedged in by certain restrictions from her context, most notable of which was the pressing need for the students to have fully completed their textbook by the end of the school year. This process of stagnation under the influence of the context, was made evident by Fernandes and Vale (1994).

Discussion

We accept that changes within the sphere of professional development cannot be understood in a general sense nor in an absolute manner, but from Julia's characteristics, her pace of development and the conditions of the context in which they came about. The increased flexibility in her planning, described above, arose in the context of activities that were jointly designed in the PIC. However, this does not represent a change that can be extrapolated to activities deriving from the textbook. The obligation she felt to complete the textbook inhibited both her teaching and her professional development, in stark contrast to her form of participating in the PIC, which far from limiting her development, promoted it. Potari and Georgiadou-Kabouridis (2009) also recognize the role of the context on teachers' development.

Nevertheless, Julia felt very satisfied by her participation in the PIC and noted the changes she had experienced in her classroom management:

> "The first thing I'd like to underline is that my everyday classroom management has also changed a lot, I think, since the start of the year to now, because of the way we've reflected on things in the group and my own reflections which I've been making every day" [Entry in diary, in which she wrote her general reflections about putting into action the final teaching unit recorded in the first year, which was developed in the PIC.]

From an overall perspective, and applying the four dimensions that Krainer (2004) foregrounds to analyse teachers learning systems, we notice that Julia, through joint reflection with others (reflection-networking) and acting and reflecting on her practice (action-autonomy-reflection), gained additional competence and self-confidence in autonomous planning and interaction (autonomy and action) and in capacity to reflect on mathematical teaching practice and to reflect with other colleagues and communicate and take advantage of their ideas (reflection-networking). The autonomy she displayed was highly dependent on the activities developed by the PIC. However, this, we believe, was not due solely to the need for an external authority to provide support for what she did in the classroom. The pressure she felt to complete the textbook, combined with limited time and the additional effort dedicated to the profession and to her development, meant that it was difficult for her to design or adapt teaching materials more independently.

The collaborative environment of the PIC contributed decisively to Julia's professional development. Within this environment, the work of the group proceeds in a dialogical fashion through interaction. We could identify the type of dialogue which takes place in the PIC as 'cumulative talk' (Wegerif, 2008). Although this term is applied to conversations between students, we could extend its coverage to the PIC given that both contexts have a clear educational purpose of constructing shared knowledge, in the students' case, of mathematics itself, in the case of the PIC, additionally of professional knowledge regarding the teaching of mathematics. Within the PIC, each member identifies with the group and with the objectives of the dialogue arising within it, and this bestows group solidarity and an acceptance of the challenges being raised through critical exchanges. In such a context, dialogue takes the form of explicit exposition of one's reasoning and by "the willingness of group members to change their minds, reflectively criticise ideas that they themselves had put forward and admit their lack of

understanding". In other words, the members identify themselves "with dialogue as a process of shared inquiry" (Wegerif, 2008, p. 356).

This study focused in particular on Julia, the early-career teacher of the group. We also highlighted the role of one of the experienced teachers, Inés, who became the guiding force during the analysis and was considered by Julia as a 'skilled collaborator' (Day, 1993), that is, someone in whom you can place your trust, a critical friend, in possession of special qualities of interpersonal relations, such as energy and the experience of having reflected on their own practice. When she intervened, she showed herself to be more understanding than Pilar and deployed a variety of tactics and arguments which, backed up by the other members of the group, stimulated Julia's questioning of her practice. The main strategy she used was that of "hard questions" (Jaworski, 1998), that is, questions which strike at the root causes of a specific action and which reveal the personal theories in play.

The analysis of interactions gained us access to the *how* of the PIC's influence upon professional development. In and through the interactions, Julia gradually constructed her interpretation of the arguments articulated by her colleagues, which eventually led her to admit the truth of the comments and critiques of her practice. The observed changes with respect to the greater degree of flexibility she incorporated into her planning are closely related to the changes in the nature of Julia's utterances during the course of the group reflection. This change in attitude towards the utterances of the others emphasised a newly acquired understanding of her own practice, giving her the confidence to make her own decisions about it. It would seem that Julia develops insight into students' difficulties with mathematics and this insight influences her classroom practice (similarly to the case reported in Norton and McCloskey (2008) concerning students' mathematics).

With respect to our own learning, our work with the PIC and particularly Julia's case has led us to change our perspective and attitude towards the analysis of teachers' beliefs. We now are in agreement with Leatham (2006) that inconsistencies between declared and in-action teachers' beliefs could derive from the researcher's lack of expertise, as we assume that the teacher's system of beliefs is sensible. This assumption is not only important when analysing teachers' beliefs, but when working with teachers, because it helps create a fairer and more sincere atmosphere. Moreover, in the context of pre-service teacher education, we have introduced various tasks and reflections from

this in-service context, which have proved very helpful in bridging the gap between these two usually isolated contexts (Carrillo & Climent, 2009). The experience of following a teacher through their first year of practice underlined how much more support the newly-qualified teacher requires in comparison with their more experienced colleagues in order to reflect on their practice effectively and to develop in their chosen profession. Besides shared reflection, he or she needs the benefit of support which is specifically oriented to their teaching context. We agree with Norton and McCloskey (2008) that more explicit support is required to help teachers manage constraints, and far more in the case of novice teachers. Additionally, with respect to the role in professional development played by the participants, a variety of profiles is to be valued for the different forms of contribution and authority they bring to the group. A reflective and empathetic veteran is an invaluable resource for the novice, not least because of the model they provide. We should also note the importance of the role of the trainer-researcher, whose expertise in research can provide relevant issues drawn from the literature, and who has a role to play in other situations of collaborative learning (such as those requiring a basis in theoretical models of analysis or in mathematics content itself).

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