

Crossed Critical Reflections as a Way of Promoting Teachers' Awareness and Improving Their Professional Development

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Introduction

Current research points to the socio-constructive teaching as the most suitable in compulsory school to raise pupils' interest in mathematics and promote in them a *meaningful* conception of the discipline.

This has notable implications for the teachers. They cannot be simple knowledge conveyors any longer but they assume the more complex character of *decision makers*. In particular they have: to plan teaching trajectories that foster the students' conceptual constructions; to create an environment that enables the development of the pupils' argumentation and the sharing of ideas; to choose the communicative strategies to be adopted in classroom interaction. Moreover they have to acquire the ability: to make hypotheses about the possible development of the students' constructions; to preview students' reactions; to improvise in front at unforeseen classroom situations.

Some scholars highlight the macroscopic effects which are consequent to the bifurcation in the dynamics of a classroom caused by micro-decisions (Artigue & Perrin-Glorian 1991); so teachers must not only acquire pedagogical content knowledge, in Shulman's sense (1986), but also knowledge of interactive and discursive patterns of teaching (Wood 1999).

Several scholars underline the importance of the teachers' critical reflection on their own practice (Mason 1998, 2002; Jaworski 1998, 2003, Ponte 2004, Shoenfeld 1998). In particular, Mason highlights the role of the teacher's reflection onto classroom activity in order to develop awareness and self control in action. He recommends to train 'the discipline of noticing', as well as the creation of a social practice where the teachers can speak of their experience.

In the last decade several studies have been realized both with and for teachers, in order to make them get aware of their way of being with the pupils and of the incidence of their decisions in the development of the classroom process. These studies show many different approaches, but in general they all aim at fostering the teachers' critical review of their own conceptions of mathematics and of its teaching, so that they can become aware of the complexity of the classroom work, as well as acquire new and more appropriate conceptions and models of behaviour (Borasi et al. 1999, Ponte 2004, Potari & Jaworski, 2003). Our studies are framed within this trend of studies; still, they deal with questions concerning the renewal of the teaching of algebra through a linguistic approach in the sense of early algebra (Malara & Navarra 2003).

Our research experience made us aware of the difficulties the teachers meet in the design and management of a socio-constructive teaching. We have observed how, despite the good intentions, in the development of discussions, teachers do not make pupils be in charge of the conclusions to be reached and tend to ratify the validity of productive interventions without involving pupils in the evaluation process. Moreover, often teachers tend to let interesting contributions drop if they diverge from the plan they have previously outlined, or rather are not able to recognize potentialities of certain pupils' interventions (Malara 2003, 2005).

For this we consider extremely important that teachers (not only perspective teachers) undergo some training about the dynamics involved in the teaching and learning processes and particularly about aspects that influence decisional processes. In the same time we believe that this work has to be intertwined with the reading of meaningful research papers so that the teachers can arrive to conceive the study as an essential component of their professional development (Malara & Zan, 2003).

Our Methodology

Our studies have always been realized in a strict co-operation with teachers and concern the design and experimentation of innovative didactical projects, in the frame of the Italian model of research for innovation (Arzarello & Bartolini Bussi, 1998). With time, our methodology of work has gradually become more and more refined. Though having its roots in the above-said model, it represents an important and complex evolution of the model itself. It fits in with the model of co-learning partnerships by Jaworski (2003), although it differs from it as to elements concerning the study of the pupils' ways of learning, the relationship with the teachers and most of all the conceptions underlying the roles played by the partners.

In tuning with the international trend (Sfard 2004), in last few years our research has shifted towards the teachers, with the precise aim of finding out methodologies and tools that can promote their development about the mathematical/pedagogical competencies necessary to face a socio-constructive teaching.

Today, our studies are devoted to *the analysis of classroom processes* and have a double aim. On one hand, we want to offer to the involved teachers the possibility of having a more and more precise control on their own behaviour and ways of communication and of observing the impact on classroom interactions of micro-variables linked to individual attitudes or to emotional-relational dynamics. On the other hand, we want to realize tools for the teachers education at large, to be used directly or in e-learning (about this last point see, for instance, Malara & Navarra, to appear).

These aims are pursued through the critical reflection on the transcripts of classroom processes, focusing on the interrelations between the knowledge built by students and the teacher's behaviour in guiding students in their constructions. This process develops along the following steps: the teacher's autonomous reflection; the teacher and researcher's joint reflection; the teachers' common reflection; the teachers' reflection in interaction with the researchers.

In the first phase, concerning the autonomous reflection on what happened in the classroom, teachers are asked to transcribe the recorded classroom discussions¹ and to write explicit comments about the moments they consider problematic. This forces them to observe their action with detachment, in order to monitor the consequences of their ways to communicate with pupils, to ask questions, to give hints and to make decisions. In the second phase, after a careful reading of the teacher's transcripts, the researcher writes his/her line-by-line and general comments, then sends them by e-mail to the teacher. A joint analysis is done on a specific meeting. The researcher induces the teacher to make local reflections by asking him/her to explain the meaning/the reasons of some interventions, (s)he indicates potential strategies for overcoming dead-ends and gives explanations about (sometime subtle) mathematical questions arisen. (S)he also triggers global reflections on what has been done and objectifies significant steps in the development of the mathematical construction. This joint analysis provides an opportunity to make the teacher's habits, stereotypes, beliefs, misconceptions explicit and to disclose possible conceptualisation gaps in his/her mathematics knowledge. This moment turns out to be of particular importance for the teacher's awareness of his/her way of being in class and for a first assessment of his/her decisions (didactical choices, interventions/silences, word turns to the pupils, reintroductions, timings, etc).

The third phase, consisting of an exchange involving all teachers, represents a moment of free sharing of the events, useful to express any possible fear or doubt, as well as to look for the roots of

¹ Transcribing the sessions is hard work for teachers, but they are strongly motivated by: the sense of belonging to the research group; the acknowledgement of their work both by the school (which sometimes gives them some financial support) and by the Ministry of Education and the related institutions (which promote and finance this kind of projects); last but not least, the fact that they live in small towns of Northern Italy, where life-long professional refinement and, more generally, cultural growth, are socially shared values.

possible common questions. This phase is also characterized by a cross reading of diaries related to their classroom processes and an initial getting aware of the divergences of the individual action developments. This leads to further reflections on one's actions and to the formulation of some possible hypotheses. In the fourth phase, the whole group reflection, a global revision of the teachers' transcripts is made and this turns out to be the climax of the whole experience. Sharing transcriptions and gathering the different classroom discussions arisen about the same problem situation, allows to spot out and objectify the reasons that have determined them. By comparing one's own developmental path with what colleagues did in the same steps of a teaching sequence, each teacher detects important distinctive elements and reflects on the effectiveness or limitations of his/her work (personal hasty and decisive interventions, little attention to listening, not understanding potentially fruitful interventions, scarce ability to orchestrate voices, difficulty in managing leaders or minimising effects of tacit alliances, etc).

All this leads teachers to acquire deeper awareness of their way of being in the classroom, to better control their behaviour, to conceive new insights on their teaching and, possibly, to *assume a new identity* over a lengthy time.

Some comments on this methodology

In countries with a long tradition in mathematics education, video recordings of classroom processes are used in order to make teachers reflect on their own decisions and actions in the classroom and to compare them to the ones of the colleagues involved in the same class work (Jaworski & Gates, 1987). Recently, some scholars have pointed out how the video is an efficient tool for understanding teachers' beliefs underlying their decisions and actions in the class (Sherin 2004; Kuntze & Reiss 2005).

However, in our country videos still aren't used in mathematics education and are only marginally used in Italian research (due to laws protecting individual privacy).

Of course, videos of classroom processes are important for teacher education, mainly because they might help teachers analyze the use and incidence of non-verbal language, as well as the participation of the whole class. Nevertheless, we believe that watching the video as such does not enable teachers to fully capture details, relate them to one another and to the context in which they actually take place. Transcripts, instead, are able to crystallize interactive processes: this way, the single expressions used can be analyzed line by line, related to one another and checked globally. In our case, the fact that one or more researchers involved in the study make written comments on the formulation of the questions asked, on the expressions used by the teachers or on their lack of action as to specific interventions by the pupils (some of which are successful, whereas some are obscure and difficult to interpret) allows to 'freeze' a wide range of considerations and deepenings that reveal and magnify several aspects of the teachers' professionalism: their pedagogical and mathematical knowledge, their conception of teaching, their ways of relating with the pupils, the adopted didactical contract, the possible digressions or hurriedness, even their affectivity.

It is a real 'x-ray photography' of the teacher in front of which, by possible distortions, he/she might undergo a healthy moment of crisis, usually followed by a positive reaction of challenge towards his/herself, which makes him/her act in order to re-convert his/her professionalism.

These studies highlight two crucial issues: one concerning *the teacher's language* in communication, often characterized by slang, superficiality and incorrectness, full of metaphors that are not always appropriate; the other concerning their *conception of mathematics*, which is too often *operative* in that 'calculating' prevails over 'representing', 'thinking', 'reflecting'.

During the workshop we would like to present some fragments of a multi-commented transcription and to show the variety and the typologies of the comments emerged. The analysis of such comments clearly reveals the epistemology of the researcher that has produced them, owing to the prevalence of certain types of comments. Both the similarities and the divergences of the arising

points of view turn out to be fruitful for the teacher: the former strengthening the comment, the latter enriching in their being complementary.

Of course, this methodology is sharply dependent on teachers' involvement and cannot be used at large, for instance in short refreshing courses. Nevertheless, our hypothesis is that it is possible to promote the spreading of these ideas and methods through the direct influence of the teachers involved in the project on their colleagues at school, according to a 'wave'-style model, adopted for the renewal of teaching in our country since the Seventies.

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