

A EUROPEAN PROJECT FOR PROFESSIONAL DEVELOPMENT OF TEACHERS THROUGH A RESEARCH BASED METHODOLOGY: THE QUESTIONS ARISEN AT THE INTERNATIONAL LEVEL, THE ITALIAN CONTRIBUTION, THE KNOT OF THE TEACHER-RESEARCHER IDENTITY

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The European project (PDTR)¹, which this paper deals with, is aimed at the development of research based methodologies for teacher training to promote new classroom approaches in the sense of PISA competences. After a short description of the Project, we present in some details the cultural choices, the work methodology and the outcomes of the Italian teams. Some reflections are made about the main problems involved, in particular on the intense attempts to clarify the meaning of the figure of the teacher-researcher, the true core of the Project. In a few final remarks we discuss the validity and the potentialities of the Project.

Key-words: European cooperation. Teachers’ professional development. Educational methodologies. Teacher-Researcher figure.

INTRODUCTION

The PDTR is a project finalized to induce in teachers structured view and knowledge of mathematics, in coherence with new pedagogical approaches and social needs, and to promote, by means of suitable classroom practices, motivation and sense-making in students involved in mathematical activities. A key idea of the project is that of *Teaching-Research*, based on the principle of inseparability of classroom practice and educational theory in the context of the action aimed at the improvement of learning. The intention is to build a formation and teaching path where instruction, research and professional development mutually support each other. The underlying hypothesis is that the involvement of teachers in “mentored” collaborative study within a research team and a familiarity with theoretical studies increase their awareness as school teachers, and bring them to change their beliefs, to conceive their professional development as a life-long process and to assume a scientific inquiring approach in their classroom pedagogy.

The central aim of the Project has been to initiate a process of transformation of the ways to teach mathematics, while respecting the standards and contents of national curricula. The main specific goals have been: a) introducing Teaching-Research into daily classroom practice, with special emphasis on the integration of mathematical and didactic knowledge; b) developing instructional research based materials, which improve students’ understanding and mastery of mathematical competences as

assessed by the OCSE-PISA tests, while, at the same time, increase their enjoyment of mathematics; c) promoting in teachers the attitude to give more weight to students' process of thinking than to formal skills and knowledge.

The Project has lasted three years: the first one mainly devoted to the study of general methodological-curricular choices, that be coherent with the approach to mathematical competences in OCSE-PISA tests; the second one centered on designing, implementing and analysing didactic experiments and producing shared materials; the third one devoted to a critical review and refinement of experimentations, and to the production of reports to be published. An additional task has been the study of the English language, to favour exchanges among participants.

THE ITALIAN CONTRIBUTION WITHIN PDTR

In Italy, many research projects were promoted by the National Research Council since the seventies, for the renewal of mathematics teaching. This implied the birth in several universities of the '*Nuclei di ricerca didattica*' (that is, groups formed by university and school teachers of all levels, working jointly) and contributed to the emergence of a new "bivalent" figure of teacher: the '*insegnante-ricercatore*'. Such a figure can be considered the result of a slow evolution of a motivated and able teacher through *stages of active involvement at different levels*, stages which can be said the steps of a *process of training to research*. This process, starting from simple experimentations, brings gradually the teacher to collaborate in the formulation of research hypotheses and in the theoretical analysis of research data, until to be able to autonomously realize a research project and to write scientific papers. This national frame constitutes the background of our cultural and methodological choices within PDTR, and of our way of conceiving the participants as *perspective teachers-researchers*, novice in research.

The two Italian (Modena and Naples) teams share not only this general framework, but also common research themes and a long habit of mutual collaboration. Therefore their work has been done along the same lines. Here, we want to report in some details three aspects of our activity: the theoretical and laboratorial work, the conduction of teaching experiments, the production of the final reports.

The work at theoretical level and the laboratory-based activities

We worked at three levels, facing: theoretical questions concerning mathematics education, with particular reference to the teacher figure; questions related to mathematical contents and questions devoted to a renewal of classroom practice.

We have taken inspiration from two related models of teacher, as *resonance mediator* (Guidoni, Iannece & Tortora, 2005) and as *decision maker* (Malara & Zan, 2002). In our view, teachers are influenced by important factors that the research should not neglect, such as knowledge, beliefs and emotions. Thanks to close contacts with Math Education ideas and theories, they can become more and more aware of all these components and to be able to possibly change them. For this reason we have

devoted special sessions to introduce teachers to selected literature samples, in order to clarify our theoretical reference framework. These include epistemological studies, mathematics oriented papers, and papers focused on didactic-methodological aspects and on classroom practices.

For what concerns didactic and methodological aspects, we have assumed a socio-constructive approach, with particular emphasis on studies about the mathematical discussion, the didactic contract and the classroom norms. A particular importance is also assigned to reflections on class processes, and to the role of teachers (and of their beliefs, actions, wordings, ...); for this we refer to Mason studies (see for instance Mason, 1998). Moreover, we have taken into account the linguistic and communication dimensions, as described by Pimm (1987) and Sfard (2000).

As to mathematical content we worked in Shulman's sense (1986). We privileged the arithmetic-algebraic field, directing our attention towards the competences promoted by the PISA tests.

For the renewal of classroom practice, we studied the units of the ArAl Project, which can be seen as models for socio-constructive teaching, and some protocols of classroom processes on them, highlighting the incidence of different variables in the process (teacher's behaviours, students' participation, affective relationships, gender issues).

The work related to teaching experiments and the methodology adopted

The work with teachers has been carried out in small groups and has been structured through: design and planning of teaching sequences, experimental setting in the classes, critical analysis of the enacted didactic processes, editing of reports for dissemination. The chosen themes concerned: a) problem solving, according to the theoretical framework of the PISA tests and with reference to the development of proportional thinking; b) the approach to the algebraic language as an instrument to represent relations, to interpret graphs, to solve optimization problems and to solve proof problems. Teachers were engaged in teaching experiments for at least two years, and in the second year the experiments were broadened and refined on the basis of the initially implemented ones. They involved students of school grades between 6 and 11, with a high concentration of grades 6-8.

In order to implement a given teaching sequence, we faced: a joint study of selected research papers on the chosen theme for the clarification of didactic key points and hypotheses to be tested; the construction (or adjustment) of tasks constituting the main steps of the path and the *a priori* analysis of pupils' potential difficulties. This work was not easy, due to: a) the need to combine the progressive development of the mathematical set of questions with curricular time constraints; b) the analysis of the difficulties of the tasks from both linguistic and mathematical points of view; c) the planning of discussions related to questions to be tackled and solved collectively.

In the classroom the teachers worked constructively, stimulating and orchestrating pupils' interventions, promoting reflections on what was gradually being carried.

They promoted verbalisation, by always inviting the pupils to write down their ideas, conjectures, reasons for their procedural choices, etc. Moreover, they (video) recorded classroom discussions, transcribed them, adding local and general comments on classroom processes.

The driven analysis of classroom processes and the birth of the ‘multi-commented diaries’

We carried out a complex activity of critical analysis of the transcripts, looking at the relationships between the knowledge constructed by students and the teacher’s behaviour in guiding them to such achievements. Our main aim has been to lead teachers to get a higher and finer control over their own behaviours and communicative styles and to observe the incidence of a critical analysis on both classroom processes and pupils’ behaviours and learning. This critical and reflective activity, based on the classroom transcripts commented by the teachers (shortly called diaries) developed along different moments of comparison between: the pair ‘teacher-mentor’; the teachers involved in the same teaching sequence; the whole team (teachers, mentors and the leader). Within some projects – due to participants’ different locations and therefore to the difficulty to meet – the diaries have been commented by at least three people: the mentor assigned to the teacher; the co-ordinating mentor; the head of the project. The diaries, so enriched by a multiplicity of written comments, reflect a variegated range of points of view and interpretations, which highlight crucial points of the process as well as critical elements in the teacher’s behaviour.

They allowed us to identify five key areas of teachers’ weakness concerning: *beliefs on cultural and/or educational issues*; *pedagogical content knowledge*; *bifurcation between theory and practice* (e.g. difficulties in realising what has been studied or planned, and in working on the basis of relational thinking); *linguistic issues* (massive use of operative linguistic expressions coming from the received model of teaching; difficult balance between colloquial language and language of scientific teaching; scarce attention to word paraphrases in view of an algebraic translation); *management of classroom discussions* (dialogues mainly between teacher and pupil; widespread prompting; yes/no questions; lack of attention to the development of ‘social intelligence’ in the classroom). But two issues seem to be crucial and dramatic at the same time: *the teacher’s language* in communication, often imprecise, not correct, full of slang expressions and rich in not always appropriate metaphors; *the conception of mathematics*, too often *operative*, where ‘calculate’ and ‘find’ often prevail over ‘represent’, and ‘do’ over ‘reason’ and ‘reflect’ (for more details see Malara’s contribution, in Czarnocha, 2008).

The reports editing

In the third year of the project teachers were asked to produce written report about their teaching experiments following the rules of the Mathematical Education community. This phase of teachers’ work turned out to be a true pivot toward the

acquisition of a *researcher behaviour*. In fact, teachers are used to report their classroom experiences within their own community, but this kind of “internal” communication, having its focus on students’ performances, leaves behind any information about one’s own role in the process and about the choices made for its development. In the first version of the report, almost all teachers applied this model of communication to the new situation, in spite of the attitude, developed in two years of participation in the project, to reflect on the influence of their own role in the development of a discussion, and more in general, on the relationship between teacher and pupils, with a special focus on the impact of their own knowledge, beliefs and emotions on the process itself (see next Section). The experts faced the problem, trying to change this communication praxis. Several individual and collective comparisons were needed to lead teachers to become aware they had to change their usual point of view and to include, in their writings, themselves as determinant components of the process itself. This way, by means of successive approximations, always mediated by interaction with the experts, teachers succeeded in writing their reports. Then these reports were reviewed by international reviewers before being accepted for publication (in the books edited within the project²).

From the point of view of the research training, this final phase has been crucial to attain project aims: the necessity of communicating lead teachers to make explicit for other people, but for themselves too, the key points of change in their classroom behaviours.

Reflections on the project spin-off for teachers

The project turned out to be a great opportunity for teachers to engage with a new way of conceiving and teaching mathematics and to reflect on their own conceptions and ways of being in the classroom. Teachers met major difficulties in transposing in their practice what they had learned at theoretical level, especially concerning the didactic-methodological aspects.

Here is a list of the main problems concerning the role of the teacher in managing class-based activities, in particular discussions: the problem of the language used, often misleading for the pupils; the problem of the pertinence and consistency of the indications provided at crucial moments of the discussion; the problem of listening to pupils and being unable to grasp the potentiality of interventions that diverge from predicted ones (especially when they come from pupils who are not viewed as leaders); the problem of a real social knowledge construction: the issue of sending back ideas to the class so that they might be validated and shared, the issue of institutionalizing knowledge, the issue of individual learning (the teacher often took for granted that pupils had understood or intuited something, only on the basis of reassuring ‘yes’ in chorus); the problem of checking that participation is actually collective (discussions often developed with the contribution of a few pupils and there were no interventions aimed at involving everybody).

Nevertheless, at the end of three years, several appreciable improvements can be noticed in teachers' classroom practice, as well as changes in their beliefs and a better awareness of their professional role. All this is also witnessed by the teachers themselves within their final essays. In the Appendix we will report a few excerpts from these essays.

THE INTERNATIONAL ACHIEVEMENTS. THE FIGURE OF THE TEACHER-RESEARCHER

At the international level, the Project did not fully meet our expectations. Many substantial disagreements emerged along the common work, concerning first of all different views about Math Education research contents and methodology, between Eastern and Western countries and, as a consequence, disagreements emerged on the way to conceive a teaching experiment. Therefore, only in the last year a first true international collaboration, a bilateral teaching project between Italy and Hungary, occurred (see Navarra, Malara & Ambrus, 2008).

The main points of difference concerned: variables to be observed (students vs the pair "teacher-students"); time (short vs long term experiments); types of intervention (simple proposals of PISA question vs insertion of suitable PISA problems into didactic paths designed for the whole year workplan); way to refine a teaching experiment (proposals of 'corrective tasks' for students vs critical analysis of classroom processes with/for teachers); and, *dulcis in fundo*, the figure of the teacher-researcher.

The question of defining what the word "(mathematics) teacher-researcher" means is by no means a rhetorical one and, well beyond the limited range of the Project, is of deep interest for the whole Math Education research community. Indeed, for some authors, the two domains of academy and school are incommunicable worlds, and therefore the unique possible concern of the teachers is their school-practice (Crawford & Adler, 1996). For others the two roles are still separate, even if there are teachers who are able to investigate about their practice; but it is very rare that a teacher can identify by himself a research question (Jaworski, 2003; Brenn quoted by Peter-Koop, 2001). Some other authors believe that the teachers can become true researchers, provided they frequent for enough time an academic environment (Malara & Zan, 2002).

One of the, so to call, side achievements of the project PDTR, but, in our opinion, a valuable one, has been that of trying to share a common view on this question, naturally arisen in order to achieve the main goals of the Project. So here we want to report some conclusions about it, reached at the end of several discussions and collaborative work, together with some reflections of ours. The question has received several interpretations and answers by the members of the PDTR staff, due to their different views deeply dependent on different theoretical frameworks and social and cultural traditions.

Moreover, the following related questions have arisen: “How do the double roles of teacher and researcher acting simultaneously in concrete situations accord to each other? How can the possible conflicts between the two roles, each embodying its own objectives and its own ethics rules, be managed? How can one harmonize the two roles in the different real situations or perhaps in the different phases of the work?” Of course, all the above questions are open ones. But the wide debate developed has given some contribution to them, witnessed by specific papers devoted to these items in the two books edited within the Project. It seems to us that they well represent the variety of positions.

The main task remained of reconciling the different views about the crucial point: when a teacher can be identified as a teacher-researcher. A shared conclusion has been that of recognizing some steps by which a teacher can become a teacher-researcher. Teachers teach following textbooks and external indications. Good (or excellent) teachers utilize natural skills and their own intuition to obtain good results from their students, following textbooks and other resources filtrated by their personality. A teacher-researcher adds to this a *personal aspect*: the habit to reflect upon one’s own teaching action and to utilize such reflections to interpret and to improve practice (one can also recognize this habit in a reflective teacher); and a *social aspect*: the readiness to face a matching, comparing one’s own actions with others’ actions, to identify and to clearly formulate research questions, to be able to communicate with other people according to the rules of an evolving scientific community. In particular, what surely characterizes teacher-researchers and distinguishes them from, may be, excellent teachers, is the capability to share ideas within a scientific community. This implies to follow some general and specific rules, for example to put well identified research questions into a general theoretical framework, to utilize experience and materials in order to argue about some well declared thesis, to accept criticism and to be continuously well disposed to changes.

We believe that to fix some minimal condition that characterize a teacher-researcher is necessary in order to satisfy the standard of a scientific community: in this sense it is important to have shared criteria to carefully distinguish an acceptable contribution for a research journal, from more freely written, though interesting, accounts of a teaching activity. At the same time we are aware that pretending to strictly satisfy those requirements as a necessary goal of the enterprise of forming reflective teachers or perhaps teacher-researchers could entail the risk of discouraging willing young teachers from realizing their urges for improving their professional behaviour. This recommendation has been one of the main points of discussion in the Project.

SOME FINAL REMARKS

The outcomes of the international meetings allowed us to understand the depth and the multiplicity of problems to be overcome, in order to achieve an effective collaboration between researchers belonging to different cultures. A necessary condition for such a collaboration goes through: *a real willingness of sharing*

problems; listening to others and taking into account the working and operating conditions of a certain group (in order to understand and to search for solutions after common studies and efforts).

In our opinion, the main result of the project might be considered *a deeper awareness of the problems that make an effective collaboration between Eastern and Western countries difficult*. By making these problems explicit, we might help others to overcome the rigid barriers we met. It is not an easy task, due to the weak common background, which makes actual interests often diverge.

NOTES

1. The Project PDTR (*Transforming Mathematics Education through Teaching-Research Methodology*) has been realized in 2005-2008 under the leadership of S. Turnau (Rzeszów University, Poland), with the help of B. Czarnocha and the expertise of H. Broekman, J. Mason, N.A. Malara. It has involved seven teams of mathematics teachers, apprentices in the craft of “teaching-research”, from Hungary, Italy, Poland, Portugal and Spain.
2. The two books (Czarnocha, 2008) and (Turnau, 2008) are downloadable from <http://www.pdtr.eu/index2.php>

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APPENDIX

Excerpts from the teachers' final global reflections revealing the impact of the project on them

NG (Primary school teacher). Thanks to PDTR project I have understood that my professional growth is still at the beginning, and it is a process that has never to be considered concluded. To sum up, in these three years I have learned to reflect on: cognitive processes (How have I done? How does my mind work when I learn? How does children's mind work when they learn? etc.); metacognitive activities of control (I have learned how to carry out this activity... I have used these strategies... such strategies allowed me to... Which structures or models do my pupils construct? How do they use these structures?...); the disciplinary structures on which I've been working with my pupils (above all arithmetical structures and “proportional thought”).

RF (Middle school teacher). Transcriptions, that have demanded time and energy, allowed for a self-evaluation of my own professionalism, a critical meta-reflection on my own way of managing collective discussions, on my way to send pupils' suggestions back to the class, to intervene and direct the discussion itself. After this process I got to a higher professional awareness: I became aware of the need to refine my capacity of grasping immediate feedback by pupils in a meaningful way, always keeping in mind the aims of the route I undertook. I also reached a higher awareness of the need for a careful control of didactic methods and of knowledge about the discipline. This has led an empowerment of my professional awareness on the pedagogical sensitiveness that needs to be used in order to favour pupils' cognitive, relational and affective increase.

MP (Middle school teacher). Through the training activities I actually saw the relevance of linguistic obstacles, which make the interpretation of texts with a mathematical content problematic well before their translation into the most typical languages of this discipline (numerical, algebraic, tabular, graphic). For many students this process implies an extremely hard move from a narrative context to a logical relational one. This aspect is often neglected in the ordinary mathematics

teaching activity, whereas it would require an in-depth reflection by teachers. ... Since the whole teaching sequence was video recorded, the careful analysis of the recordings strongly highlighted the main features of my *modus operandi* in the classroom. It is embarrassing and instructive at the same time to see yourself during the class, to find out that you did not grasp immediately the opportunities offered by students to guide the lessons towards fertile grounds for a discussion.

MB (Secondary school teacher). The *a-posteriori* analysis of my lessons sometimes meant realizing the inefficacy of my own didactical methodologies and behaviours. During this project of research on our own practice we had the possibility to learn to consider failures, not as negative events to be cancelled without trying to find a remedy, but as “launching pads” to bring ourselves into question. During this phase, the work with the mentor particularly helped me. The numerous pre and post class activities meetings and the crossed analysis of excerpts of class discussions represented a further source of reflections. Cooperating with the mentor gave coherence to my work, aimed at reaching prearranged objectives: the didactic ones, those related to the relationship to be established with my students and those correlated with the research on my practice. In these three years I gradually acquired more confidence in the tutoring-relationship with the mentor, who initially was an “uncomfortable” presence and quickly became an important reference.

SD. (Secondary school teacher). The relationship with the mentor and the coordinator must be particularly taken into account because, with their experience, they helped us in keeping the coherence between the path we planned and the objective of the project. Their advices concerned not only the theoretical framework of reference, but also the planning of the different phases of the path, the organization of the methodology of work in our classes and the *a priori* and *a posteriori* analysis of class activities. Thanks to this collaboration, I understood the importance of considering the didactic action as a set of measured choices of contents, proposals, methodologies and teacher’s behaviours. In this perspective, students’ contributions are interpreted as a resource, rather than a dreadful unforeseen event... Numerous aspects have made my participation in the Project significant, even if I am aware that I have only taken a little step in the professional development of a teacher, which is full of shades and potentialities.