

THE EDUCATION OF MATHEMATICS TEACHERS AND A LEARNING ENVIRONMENT (*)

Ana María Redolfi Gandulfo

Universidade de Brasília - Brazil

Abstract

The mathematics teachers are impelled by the changing social and cultural environment and also, by the restructuration of the educational programs, to renew their teaching practice and to look forward mathematical and didactical knowledge. The education of the mathematics in-service teachers, their motivation and perseverance, is a very important educational goal. Considerably efforts and creativity are necessary to face the dilemmas confronted in this action. The Mathematics Teaching Laboratory is a useful tool to succeed in these tasks.

(*) This work was partially supported by FINEP, MCT.

INTRODUCTION

The important role of mathematics in people's life, motivated for their changing cultural, social, economic and scientific environment, foster new challenges and responsibilities for mathematics teachers. Their educational work takes place in a determinate geographical site and time and should include the physical neighborhood and its local history, cultural and ethnic values, as pointed out by the Ethnomathematics.

The pedagogic propose of the Ethnomathematics is to make of the Mathematics something alive, concerned with real situations in time (now) and space (here) and question the sense of here and now; making these, we dive into the cultural roots ...
(D'Ambrosio 2001, p. 46)

The mathematics educators are impelled to understand these necessities, to review the concepts with new perspectives and to provide the appropriate models of teaching for the pre-service and the in-service teachers.

Also, new tasks appeared in mathematics teaching with the restructuration of the educational programs at the different levels around the world, like the Parâmetros Curriculares Nacionais in Brazil (PCN 1998), which brought new emphasis in the development and excellence of capacities and competences of the students. The teaching of mathematics from these perspectives, assumes a special dimension in the formation of students.

In this context, the mathematics educator needs adequate mathematics and psycho-pedagogic knowledge and familiarity with teaching methodologies. Great importance is given to the integration between the scientific instruction, the intellectual development and the improvement of cognitive and socio-cultural skills that will enhance the personality and behavior of the future citizens.

IN-SERVICE TEACHER EDUCATION

The implementations of the curricular reforms open new ways in the form of the necessary adaptation to new models of teaching and bring different school teachers to the University looking for mathematical knowledge and different methodologies to improve their practice.

The education of the in-service mathematics teacher begins with mathematics courses and the creation of an adequate learning environment for mathematical activities of exploration and experiments together with problem solving and generalizations. We aim to teacher education and professional development that includes knowledge and cognitive aspects and also personal and social dimensions.

Professional development involves the gradual maturing of the potentialities of each teacher, the construction of new knowing and bears the mark of the underlying social and collective contexts. On the other hand, didactics has essential contributions to make to the professional activity of the teacher. It suggests useful concepts for understanding educational situations and supplies resources for professional practice.(Ponte 2001, p. 62)

Very often we found that school teachers lack the necessary preparation and are too insecure to try new approaches or to implant new pedagogic strategies in the classroom. They keep the poor formation acquired in their student days and by diverse circumstances, mostly economical, they find themselves in situations where their knowledge is insufficient for their teaching.

The school work demands on teachers includes professional knowledge, teaching skills, competences and very important, they must improve constantly their professional growth.

The motivation of the in-service school teacher is a challenge for mathematics teacher educators and spends considerably efforts to find the proper strategies to overcome the important goal of providing them with the mathematical, educational and didactical requested skills.

The geometry topics as a starting point in the mathematical studies for in-service teachers makes an appropriate subject for the initiation of the activities (Coxeter 1971, Dodge 2004, Heath 1956, Martin 1982). Geometry opens the educator an enjoyable and beautiful road to mathematical discoveries plenty of activities of modeling and visual representations, hand-on explorations, investigations and testing, conjectures and verifications, problems resolution and real world applications.

The van Hiele (1986) model of geometric thought, the learning development (Hoffer, 1981) and the signifying learning of Ausubel(1978), are part of the psycho-pedagogic instruction. The epistemology of Piaget (1979) and Vigotsky (1987), the model of teaching oriented by the educator and centralized on the student's discoveries, the work of Freudental (1973) and the cooperative learning (Bassarear and Davidson 1992) provide strategies to be implemented by school teacher educators with in-service school mathematics teachers.

The invention, to look for the relations, the disagreement of ideas, the security and the confidence in herself, the acceptance of his conclusions, the exploration of different ways, the creation of rules, all are variables that belongs to the formation of learning. (Huete 2006, p. 182)

The practices and appropriate use of different techniques and methodological teaching approaches is a subject of reflection and questioning that contributes significantly in the preparation of school teachers and bring up the complexity of the teaching work,

...where is necessary to promote several attitudes: open mindedness, curiosity, critical and strategic thinking, flexibility, integrative and progressive autonomy. (Alsina 1998, p. 173)

It also challenges teachers to incorporate teaching of mathematical concepts from new perspectives, problem solving and cooperative learning, promote classroom discussion and the development of communication skills. These achievements result in a more confident attitude regarding the professional work.

The Mathematics Teaching Laboratory (MTL) provides an adequate environment to implement these tasks. In this way, the in-service school teachers of all levels are involved in the process of acquiring mathematical knowledge through exploratory activities in a dynamic perspective and it gives them good reasons to persevere in their studies. In this context they revise the mathematics topics and acquire methodological methods in an experimental environment.

Since the pedagogic models of the MTL have low costs, the school teachers can build these materials in workshops offered during their studies and provide similar ones at their respective school for teaching activities. The richness of this approach is that teachers can study mathematics and practice teaching methods in an environment they can recreate for their teaching. In the processes of learning, the in-service teachers construct and also they reconstruct their knowledge of mathematics and teaching.

Interdisciplinary projects must have a place in the in-service education curriculum and they proved to be important parts of it. Cooperative/collaborative investigations, designing activities and strategies, making conjectures and proofs, data collection, reflecting, analyzing and (re)organizing all the work, demand unity from all the members of the group to add personal contributions to reach the task.

Closely related to the idea of investigation is the idea of project (...) In a project, a teacher, or a group of teachers, identify an objective regarded as important and develop a set of activities to reach it. The actors are the essential protagonists, and they both are transformed by the process they live and contribute to the transformation of the involving situation. (Ponte 2001, p. 64)

The course of action recommended here was developed at the Mathematics Department of the University of Brasilia during the last 10 years. The implementation of the project included the following steps:

- Education of the pre-service school teachers (as university graduate students) by means of several disciplines and the implementation of the MTL.
- Education of the in-service school teachers. Annual mathematics courses were offered as previously described.
- Periodical workshops for the construction of pedagogical models.
- The didactical materials from the MTL are used by the pre-service teachers in short courses for their teaching practices in public schools.

In the last three years we applied a new program with graduate students that included more hours of teaching practice and educational work at five public schools registered in the Program: SCIENCE FOR ALL. Several teachers from these schools attend courses of mathematical education offered by the Mathematics Department of the University of Brasília.

PRESERVICE TEACHERS EDUCATION

The mathematical program of the pre-service school teacher has specific disciplines that include teaching practices and enables pupils to be involved in the school teaching activities. This teaching work has to be carried through with the orientation of a University professor and the assistance of the school teacher from the corresponding local public school where the practice is performed. The graduate student should have the opportunity to gain in-service practice in a guided way, reinforced with the experience of the in-service mathematics teacher.

Previously, this school practice involves observation of the teaching work of the in-service teacher and preparation and planning of classes. Discussion about mathematical concepts, teaching approaches and assessment strategies programs are part of the weekly meeting with the supervising professor.

The pre-service teacher offer extra class tutoring work at the school, where they help student's learning by the explanations of concepts, encouraging them to reason mathematically by developing small group activities and by posing related problems. This pre-service teacher-to-student interaction contributes significantly and brings tangible benefits for both of them. The students, with the extra help, feel encouraged and are better able to successfully study and learn. The pre-service teachers have the opportunity to employ several strategies, a variety of approaches and gain intellectually and personal growth using mathematics as a tool for communication.

As part of the graduate program, the pre-service teachers develop workshops at the school that consist of structured presentations, where they teach the concepts with multiples visual models and works a wide variety of experiences and activities. Each presentation, using the classroom as a laboratory, is carefully prepared and revised with the advisor. The student response to this class is very satisfactory, since they engage very easily in the activities with the innovative approach using different kind of models, in the process of the exploratory activities and the mathematical discovery.

The undergraduate students, during their studies, create and construct different models and mathematical games and they prepare several projects about mathematical concepts and models to be used in the teaching-learning activities. This involves investigative work about the subjects and the materials, opportunity for creative work, developing strategies and testing ideas, making conclusions and writing about them. The project includes the oral presentation to their colleagues, where they have to submit and defend their work; here take place discussions about further applications of the models and suggestions for improvement.

The realization of mathematical investigations by the students, can contribute in a significant way to their learning of Mathematics and to develop the taste for this discipline. (Ponte 2006)

Also, as part of their teaching experience with the laboratory models they participate in workshops for the teachers of the local schools presented in a dynamic and interactive way, about different mathematical topics that include activities, experiences, problem solving and construction of manipulative pedagogic material for the classroom activities. These activities involve a qualitative evaluation of the topics presented and of the manipulatives by the participants teachers, with later analysis of the results. Many of the models and mathematical games constructed by the graduate students become part of the MTL.

The manipulative materials of the MTL are tools of the teaching and learning activities that take the pupil from intuition to the understanding of the concepts. This process of passing

from the concrete to the abstract is centered in their own actions, and they have the opportunity of engage in different experiences and discoveries.

The motivation for the investigation and further construction of models for the MTL result from the study of the mathematical concepts of the school curriculum and from books that illustrate and/or defend the use of pedagogical models in the teaching-learning activities (Alsina 1989, Garner 2002, Ghyka 1977, Holden 1991, Kappraff 1991, Luckiesh 1965, Weyl 1997, Stewart 2004).

IN-SERVICE TEACHER: PROFESSIONAL DEVELOPMENT

The in-service teacher participants of the workshops offered by the pre-service teacher get involved in the dynamics of the school teaching work developed in a laboratory environment and the preparation required from the mathematics teacher for these activities and in the activities of evaluation of the new pedagogical materials (constructed at the MTL) and their use in teaching activities as visual and experimental tools. Several of these teachers try to insert laboratory activities and pedagogical materials in their school class and they return to attend courses and other workshops, looking for professional and educational development.

Some of the most motivated in-service teachers attended formation courses and participated in the interdisciplinary project, and are still active in the group and have established a regular meeting schedule to continue with the study-research activities related to their project. They discussed new concepts related with the theme, new pedagogical models and experimental methods to use, and they have recorded their work. This group work is collaborative in the sense that

In the collaboration, everybody works together and they support each other mutually, to drive to attain a common objective negotiated by the collective contribution of the groups. (Fiorentini p. 52).

The studies carried out by the collaborative teams of school teachers with a university professor involve mathematics contents, contextualized and accompanied with experience activities and with important level of didactical work. The final version of these projects was presented by the school teacher members of the groups, in the form of short-courses and workshops for in-service school teachers at congress of Mathematical Education in Brazil. This was an educational opportunity to further develop their skills professionally and personally.

The conception of professional development is founded in the supposition that the teacher is the agent of his own knowledge; the necessity of being in constant formation comes from him. (Nacarato p.15).

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