IN-SERVICE MATHEMATICAL TRAINING FOR PRIMARY SCHOOL TEACHERS: A PORTUGUESE EXPERIENCE

Alexandra Gomes
CIFPEC/LIBEC
Universidade do Minho

Abstract: The role played by primary school teachers is crucial in what concerns the introduction of basic but fundamental mathematical contents and the initiation of a process of mathematical learning, where every stage is highly dependent on the previous. Therefore, the mathematical training of primary school teachers deserves a careful attention. In spite of this, in Portugal, the mathematical training of these teachers has been neglected for an extensive time by the scientific community. More recently, and particularly due to the persistent bad results in mathematics achieved by Portuguese students, either in international studies (PISA and TIMSS) or in national tests, not only the scientific community but also the government have began to show some concern related to the mathematical training of teachers, especially, primary school teachers.

Last year the Ministry of Education decided to launch a national in-service mathematical training programme intended for primary school teachers. My institution is one of the 18 higher education institutions involved in this programme. In this paper I will start by enunciating some ideas about mathematics teacher training that support the way our programme is conceived. Then I will describe our in-service mathematical teacher training and finally I will illustrate it with some of the tasks proposed.

INTRODUCTION

The idea that elementary mathematics is “easy” or easy to teach is often mistakenly assumed. As Ma (1999) refers, elementary mathematics is fundamental mathematics in the sense that it is:

- Foundational (will support the mathematical constructions);
- Primary (is the first contact of the children with mathematics);
- Elementary (is presented in an elementary format).

In this sense, primary school teachers play a key role in introducing children to basic but fundamental mathematical ideas and initiating a more or less lengthy path of mathematical learning. Consequently, the mathematical training of primary school teachers deserves a careful attention. In spite of this, in Portugal, the mathematical training of these teachers has been neglected for an extensive time by both the government and the scientific community. However, for the past few years and because of the persistent bad results in mathematics achieved by Portuguese students, either in international studies (PISA and TIMSS) or in national tests, an increasing attention is being devoted to the mathematical training of teachers, especially, primary school teachers.
MATHEMATICAL TEACHER TRAINING: SOME IDEAS

The fact that teachers’ knowledge has a great influence on what is done in class and on what pupils learn seems unquestionable.

Another unquestionable fact is that if one wants to change the teaching practices in order to ensure an efficient teaching of mathematics, teachers should have a solid basis of mathematical knowledge.

However, according to Askew et al (1997), an adequate knowledge to ensure an efficient mathematical teaching not only depends on a sound mathematical knowledge but also on the nature of that knowledge. The most competent/efficient teachers are the ones that have a better understanding of the inter-connections between concepts. Brophy (1991) also refers that, when teachers knowledge is more explicit, better connected and more integrated, they will tend to teach the topics more dynamically, to represent them in various ways and to completely answer their students’ questions and comments.

Therefore, when dealing with primary school teachers we need to consider not only the mathematical knowledge they possess but also the way they possess it and use it in their teaching. Our challenge is then to prepare teachers who, besides mastering the mathematical contents, know how to use them efficiently, that is, in order to help all their students to learn.

Facing this same problem, Deborah Ball (2000) enumerates 3 questions that one can pose to mathematical teacher training:

1. identify the mathematical contents relevant for teaching;
2. understand how that knowledge should be acquired;
3. know what is necessary to teach the mathematical contents.

We shall try to answer these questions given that they reflect our concerns.

1. Identify the mathematical contents relevant for teaching;

There are numerous opinions concerning this question. There are those who defend a strong training in education and methodologies, neglecting the mathematics; and there are others who defend a strong mathematical training, trivializing the methodological aspects (Wittman, 1998).

In the training of primary school teachers, mathematical knowledge is often considered unimportant when compared to the emphasis on the educational knowledge. However, several research studies show that teachers have an unsatisfactory knowledge of mathematics, especially primary school teachers.

For example, Ponte, Matos & Abrantes (1998) referring to the investigation done in Portugal about teachers’ mathematical knowledge, conclude that:

*The elements that it [investigation] gives suggest that the mathematical knowledge of future teachers is inadequate, being, in some cases, strongly deficient. The mathematical knowledge of primary school teachers seems generally weak.* (pp. 218-219)

Also Gomes (2003) in her research involving (future) primary school teachers, in Portugal, states that:

“Teachers and future teachers reveal a worrying lack of mathematical content knowledge. This ignorance reflects on their professional work and interferes negatively in the classes taught by them.”
Very often it is assumed that teachers should only know the contents they will have to teach. This perspective is deceiving. On one hand the complete analysis of the school curricula would produce a lengthy list of contents to be studied, some of them unnecessarily because they are already mastered and some insufficiently in account of their intrinsic difficulty. On the other hand, this approach wouldn’t contribute for a better teaching of mathematics.

2. Understand how that knowledge should be acquired

The majority of teachers didn’t have, as students, opportunities to do relevant and meaningful mathematics so they end up teaching the way they were taught, in a, so-called, traditional way. They are unable to establish connections between topics and to move away from teaching topics in “compartments”. Therefore we have to provide them experiences that will allow the construction of a new model for mathematics teaching.

As Shulman and his colleagues state, a better mathematical knowledge will allow teachers to make connections between topics, emphasize the conceptual understanding and consider problem solving as central in mathematics teaching (Brown & Borko, 1992).

Liping Ma (1999) claims that if teachers don’t have a deep understanding of mathematics, they are unable to promote a meaningful teaching even if they believe in it.

3. Know what is necessary to teach the mathematical contents

For teachers to be able to propose meaningful activities, listen to children, give them satisfactory answers and help them learn it is necessary that teachers acquire a good understanding of the way children think, learn how to pose questions, how to evaluate and change textbooks, that is, to use their knowledge in classroom environment (Ball, 2000).

First of all, teachers need to break their knowledge into less sophisticated forms in order to expose its basic components (given that they are dealing with the formation/growing of contents).

Then we have to consider a special type of knowledge, called pedagogical content knowledge by Shulman (1986) that consists of a mixture of knowledge that relates subject-matter and pedagogy. This type of knowledge is exclusive of the teacher and different from the kind of knowledge necessary for a mathematician. This doesn’t mean, of course, that it is weaker or less demanding. Our answers provide the framework to create and develop the mathematical training programme in our institution.

THE IN-SERVICE MATHEMATICS TEACHER TRAINING PROGRAMME

As already been said, for the past years, Portuguese students have persistently attained bad results in mathematics, forcing the Ministry of Education to adopt concrete measures in order to change the situation. In particular, the Ministry initiated last year an in-service mathematical training programme designed for primary school teachers, with the final purpose of improving the mathematical learning of primary school children and to develop a positive attitude towards this area of knowledge.

The main goals of this programme are:
- To deepen the mathematical, pedagogical and curricular knowledge of the teachers;
- To promote experiments of curricular development;
- To develop a positive attitude towards mathematics;
- To create dynamics of collaborative work.
This is a two years’ programme, involving all public higher education institutions (universities and polytechnics) responsible for the training of primary school teachers. Each institution had to gather a team of mathematic trainers, ideally teachers with experience in primary school and a deep understanding of elementary mathematics, to work with the teachers. Although the programme is not compulsory, teachers were encouraged to enrol. An official national committee has been empowered to set up the core guidelines of the “curriculum” for this programme and to draw the way it should be structured.

The training involves two kinds of work: (1) joint sessions were each trainer works with a group of 8 to 10 teachers for 3 hours, every fortnight; and (2) classroom observation/supervision where each trainer goes to a classroom to observe/participate alongside the teacher. Every week, the trainers’ team meets to discuss the progresses and to organize tasks.

The mathematical themes that should be approached in the training are related with the ones present in the primary school curriculum, that is, number and operations, shape and space, measurement and data analysis. Teachers’ assessment is based on a portefólio developed throughout the year.

From these general characteristics, each institution developed its own programme. This implies, in particular, that one can find a wide range of “programmes”, depending on the institution and on the ideas they have about mathematics education.

OUR PROGRAMME

The programme developed by our institution is based in the official guidelines and in the framework discussed earlier. We also consider teachers’ needs and difficulties.

We will briefly describe the programme in terms of the mathematical themes addressed and the nature of the tasks.

Relating to the mathematical themes, we point out the development of some themes linked with:

- Numbers and operations, where we intend to deepen teachers’ knowledge concerning number systems, positional value, number sense, operations’ meanings and algorithms;

- Shape and Space, giving special emphasis to the clarification of geometrical concepts, definition and classification of geometrical figures and geometrical transformations;

- Measurement, where notions of magnitude and measure are deepen and some magnitudes such as length, area, volume and capacity are explored. We also propose to highlight the relations between magnitudes and the geometrical concepts involved;

- Data analysis, where gathering processes, organization, representation and interpretation of data are explored.

Relating to the nature of the tasks we privilege problem solving and investigation tasks, debating not only the aspects connected with these topics and relevant to their understanding but also giving teachers experience in this kind of tasks.

We try to develop/adapt tasks that can enrich teachers’ mathematical knowledge and at the same time allow them to work certain types of activities that they are not used to work with (even though recommended in the National Curriculum). Therefore it is our intention that teachers begin to change their practices by focusing on problem solving, investigations and even games.
We believe that the fear of making mistakes is minored since they already worked those activities at a profound level, during the joint training sessions.

In what follows, there are two examples of tasks we worked with teachers during the training sessions:

Task 1

- Suppose you want to pave a corridor that is 2 meters wide and length indeterminate. You can use rectangular tiles that measure 1 metre wide and 2 metres long. How could you do it? In how many different ways can you do it?
- Below there is an example of the possible pavement for a 5 meters long corridor:

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  1 1 1 1 1
  1 1 1 1 1
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Task 2

- Take a square of paper. Enumerate some properties about the square.
- Draw a line connecting one vertex to the middle point of the opposite side (How would you define vertex of the square? And middle point of a segment?); Cut through the line.

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- Observe the 2 shapes obtained. Identify them and register all the properties you know about them.
- Find out as many shapes as you can by joining two congruent sides of the 2 shapes. Draw and characterize them.
- What would have happened if you had cut through the diagonal of the square? Without making the cut, can you find out what shapes could you get?

More examples can be found at www.fcmbraga.com.

**SOME CONSIDERATIONS**

This programme is still in progress. Nevertheless it is already possible to draw some considerations based on the joint training sessions and especially on the observations we make in the classrooms.

During the exploration of the tasks, teachers became aware of their own difficulties and their lack of mathematical knowledge. This was a good thing because they were able to discuss their doubts with their colleagues and clarify them.

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1 Adapted from the work of the group on Geometrical Reasoning commissioned by the Qualifications and Curriculum Authority (UK).
We noticed that most teachers adapt tasks proposed during the joint sessions to work with children. They feel more confident in trying “new” approaches because they already worked on them intensively. We also have groups of teachers that started to work collaboratively, in their schools, planning together their lessons.

We found that it is very important and useful to discuss and share the work done by the teachers with the children. These discussions help them to realize what went well, what went wrong and how can they improve but also help us, as trainers, understand how teachers “read” our proposed tasks and especially what mathematical learning children build/consolidate from them.

We have verified that teachers began to be more aware of children work and to listen to them; they are becoming more sensible to proposing meaningful activities and using some manipulative and games in their classes.

Children are also responding very well to this programme. They are positively surprising their teachers that were reluctant in proposing certain tasks and doubted on their capacities. They also appear to be very happy every time they have a “supervised” math lesson.

Nevertheless there are still some difficulties observed in classroom. For example, we noticed that some teachers still have a dominant role guiding the activities leaving little space for discussion between children;

They also miss opportunities that could enrich the class based on children’s suggestions, questions or interventions, probably because they tend to stick to a rigid planning or/and they feel scientifically/pedagogically insecure.

Some teachers try to avoid working in groups or in other learning situations that causes interaction because they fear that these situations will lead to some noise and indiscipline, getting out of control.

We observed that teachers tend to propose a lot of closed activities/exercises (too many), that children should do in very little time, not allowing a deep exploration nor the establishment of connections between different contents.

Changes take time and of course we can not say that there are lots of changes or improvements. Nevertheless there are some evidence that show that something is changing and we believe its for better…

REFERENCES


Alexandra Gomes

magomes@iec.uminho.pt