

## AN EXPERIMENT IN DISTANCE IN-SERVICE TEACHER EDUCATION

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*This paper focuses on a distance in-service teacher education “study group” framed in a flexible pedagogy, centered on the notion of mathematical investigation, and based on the notions of collaboration, reflection and exploration and inquiry. We present some evaluation results, showing how teachers adjusted to this new teacher education format and how they reacted to the papers and tasks proposed. Finally, we conclude with a discussion about the potential of distance education as an in-service opportunity for mathematics teachers.*

### Introduction

In Portugal, there are around 12 000 mathematics teachers in grades 5 to 12, about 80% of whom are women. Many hold professional degrees in mathematics or mathematics and science education (about 60%), but there are many with degrees in engineering (about 25%) and in other subjects such as science, business, and pharmacy (about 15%). Middle and secondary school teachers tend to have more years of teaching experience than junior high schools teachers (APM, 1998)<sup>1</sup>.

Pre-service teacher education is taught in public and private higher education institutions. Universities are in charge of teacher preparation for junior high and secondary schools. Higher schools of education, within the polytechnic system, are responsible for the preparation of teachers for elementary and middle schools. For professional progression, public teachers need “credits” from in-service activities. These activities may have several formats (course, module, project, seminar, *practicum*, extended workshop, and study group) and may be carried out by universities and schools of education, school associations, and teachers’ associations such as the Association of Teachers of Mathematics (APM). Courses have been the most popular format but in the last few years extended workshops and study groups have increasingly been offered as in-service activities. However, few activities specifically targeted to mathematics teachers occur outside the main cities.

Until the early 1990s, the Portuguese curriculum was inspired by the new mathematics movement, emphasizing abstract mathematics but also complying with the requirements of computational mathematics. In 1991, a new curriculum was established, with a rather eclectic perspective. It comprised problem solving, mathematics applications, pupils’ understanding, mathematical reasoning and computation. The secondary school level curriculum was radically revised in 1997, resulting in a stronger emphasis on using technology (especially graphic calculators)

and suggesting that pupils carry out mathematical investigations, such as in the study of functions.

Mathematical investigations are tasks closely related to problem solving, modelling and projects. They bring the student to an activity similar to that of the research mathematician. Therefore, investigations provide a stimulating context for students, requiring them to justify their reasoning before the teacher and colleagues (Mason, 1991). As they confront their different conjectures and justifications, pupils constitute a small mathematical community and mathematical knowledge may develop as a common undertaking. Investigations are good starting points for an inquiry-based mathematical class (Wood, 1994). However, they pose new demands on the teacher's competencies and that is why teacher education is necessary on this topic.

### **Distance teacher education**

For mathematics teachers, especially those living in remote areas, distance education is a useful framework to provide in-service opportunities. However, distance education can represent a large variety of pedagogical perspectives. The most common approach is to follow a highly structured format, specifying objectives and sub-objectives in detail; tasks are then designed to fit these objectives, assessing each one in turn and moving forward only when a subset of objectives is met. Another possible approach is to design distance education as a framework for flexible learning (Collis & Moonen, 2001), regarding teachers as the main agents of their professional development, supported by an environment rich in challenges and interactions.

We adopted this second perspective, viewing professional knowledge as including knowledge of mathematical content, curriculum, pupil learning and instruction. Professional knowledge may be regarded as integrated, oriented towards action (Elbaz, 1983), and constructed by reflection on and about practice (Ackerman, 1993; Shulman, 1987). Professional development may draw on professional collaborations (projects, explorations, reflections...) and participation in the professional culture (meetings, conversations, readings...) as well as on formal and informal teacher education opportunities. It is most effective when deeply contextualized in the teacher's professional activity (Hargreaves, 1994; Smylie, 1995).

The distance education initiative this paper presents involves three major ideas: (i) the relevance of interaction among several partners such as teachers, teacher educators, and machines; (ii) the importance of collaboration and reflection in professional development; and (iii) the potential of inquiry and exploration – working on projects, exploring links, bibliographic resources, software, and online documents – as a process of knowledge construction (Ponte, 2001).

### A distance teacher education course

*Objectives, format, and participants.* This experiment in in-service distance teacher education is carried out at the University of Lisbon under the name of “Learning mathematics by investigating” (See <http://ia.fc.ul.pt/ce>). We aim to offer teachers some theoretical ideas and practical experience from a perspective supported by the current curriculum – mathematical investigations – and to contribute towards professional development, providing opportunities for reflecting on their own practice, using ICT, and developing a culture of collaboration. This in-service activity lasts for six months and has the format of a study group – each group has twelve teachers and one or two teacher educators. It is divided in three segments: (i) Dynamics of the mathematics classroom; (ii) Investigations in mathematics and in professional practice; (iii) One experiment with investigations in the classroom.

The participants are middle, junior high and secondary school teachers. Registration was not individual, but in pairs. That is, teachers had to register with a partner of their own choice. These pairs were the basic working unit throughout the program<sup>2</sup>. The participants come from different regions in Portugal (2 from the rural North, 8 from Oporto; 6 from the Centre; 13 from the Lisbon area, 4 from the city of Lisbon; 1 from Alentejo) and 2 are from Brazil. Of the 36 that began, 2 dropped out and 34 completed the program with success.

The setting designed for this course includes a Web environment, through which various materials are provided. For each segment, there is a study guide and several papers, some of which are required, others optional. These papers were to be read and discussed by each teacher with their partner and possibly with the teacher educator, and also with other participants in a mailing list. Some papers were written for this course and others were drawn from the professional and academic literature; all of them were in Portuguese (original versions or translations). Examples of required papers are Fonseca et al. (1999), Poincaré (1996), Ponte et al. (1997) and Skovsmose (2000).

There were also five tasks and a final questionnaire that the pairs of teachers had to undertake and send to the teacher educator, who provided feedback. The tasks were quite open and diversified. In particular, in task 1, the teachers had to comment on one of the required papers; in task 2, they had to describe and analyse a classroom situation that they had experienced; in task 3, they had to select and analyse a Web site relevant to mathematics investigations; in task 4, they had to study a problem from the history of mathematics, and, in task 5, they had to design a mathematical investigation, use it in their classroom, and to reflect on this experience.

*Dynamics and roles.* This in-service course has three sections (two on Numbers/Functions and one on Geometry), organized according to the teachers’ preferences. There are many different kinds of interactions among the participants:

- Teacher educators and teachers interact face to face (first and last session);
- Teachers interact with their partner teacher, as they work collaboratively;

- Teachers interact with the system, downloading materials and looking for information on the Web site and elsewhere;
- Teachers interact with teacher educators, via email and the Web site, sending tasks, answering questions, and reporting their progress;
- Teachers and teacher educators interact in a discussion list.

Besides the participating teachers and teacher educators, the course involves a coordinating team that oversees the whole system, a technician who takes care of the Web environment, and a team of external evaluators.

*Evaluation.* For each teacher, evaluation involves three main aspects: carrying out the tasks, participating in the discussion list, and self and group evaluations. The program also has internal ongoing evaluation and external evaluation. One focus of interest is the setting and the materials used; another is its effects on the participants. The data collection methods were observation, questionnaire, interviews and document analysis. All the teachers and the teacher educators for the course and their interactions were considered. The questionnaire given to the teachers has two parts: (i) an evaluation of the course and (ii) a self assessment; all the questions were open-ended<sup>3</sup>. In this paper, we draw on the responses to the questionnaire that focus particularly on the main features of the model and the key elements of the course – papers and tasks. 33 participants out of 34 answered it at the end of the course, representing a 97% response rate. Some of the questionnaires were filled in individually, others jointly by both teachers of the same pair.

### Some evaluation results

*Teacher education model.* For all the teachers in the study group, this was their first experience of distance education. We sought to identify the key aspects they note in this approach. The feature they point out most often is that distance education allows for ample flexibility in working schedules (48%)<sup>4</sup>, which they like because it gives them the possibility of managing their time – this suits them better and they can adapt the course to their personal lifestyles: “the fact that it does not require a rigid schedule, makes this kind of teacher education more attractive to people like me who have a ‘bat rib’. Nights are always a great working period” (T24).

This setting also enabled teachers to reconcile their work at the school with their participation in an in-service course: “we can do a distance course without being away from our professional activity” (T25). It also allowed them to adjust their working periods throughout the course, according to their needs:

We said that we would meet on Thursday afternoon. But it just so happened several times that it wasn't possible and we found another day. Other times we needed to meet more than once a week. So there's not that rigid schedule that we have to follow. (T20)

Distance teacher education requires teachers to manage their time and work in an autonomous way. The teacher educator's control in face-to-face settings is clearly reduced here. Some teachers (27%) refer to the autonomy that they felt, classifying it as a positive feature: "I think it's a good approach for it provides a lot of autonomy for participants" (T22/23).

Some participants point out that distance teacher education may include teachers working far away from the big cities (27%), or even "from all over the world" (T7/8), thus contributing towards reducing their isolation, promoting interaction among teachers from several contexts, bridging the gap between teachers of different school levels, and allowing them "to work with people that interest us, without having to be face to face with them, bypassing limitations of time, sharing concerns, undertakings, and reflections" (T3). Some teachers also point out the lack of travel, associated with the economy of time. For example, one states that:

It saves time on not having to travel (...) to someplace that is sometimes not nearby. After a school day, it's not very appealing to face the traffic to attend teacher education. (T9)

The interaction between participants and teacher educators and different groups of participants took place through writing, and was therefore not synchronic. This was a new experience for them. The need to write, which is not often required in the professional practice of the mathematics teacher, is highly regarded by one participant: "we feel 'compelled' to write about professional matters, communicating quickly and efficiently, contributing to promote a professional culture of the Portuguese teacher" (T3). Others point out the contribution of this type of interaction in the reflection process: "the importance of writing reports, the self-reflection they promote" (T1). However, this process raises its problems:

This kind of communication is very different from face to face. Some things are impossible to transmit (such as irony), except when people know each other very well (...). Misunderstandings are easy. We feel it's necessary and urgent to create a culture of communication (...) among teachers, so that people feel free to participate, within rules of politeness, and without fear of hurting others. (T2)

However, as regards the setting, most participants stress the fact that they worked in pairs (not individually) more than the fact that this was a distance course. 58% of the teachers view working in pairs as one of the most positive aspects of this study group. One reason offered is that it yields a richer and deeper activity, "sharing and undertaking the proposed tasks with a colleague, exchanging ideas about readings, and clarifying doubts that arise" (T9). Another is that it reverses the individualist culture prevailing in schools: "team work is very important because teachers work in great isolation at the school" (T27). They feel that working in pairs reduces the difficulties due to the fact that this is a distance course. Two teachers actually stated: "Distance education, yes! But with a team mate" (T7/8).

Using ICT, another feature of this teacher education setting, is referred to by some teachers (15%), mostly in a positive manner, stressing the “possibility of working by email” (T1); “even indirectly, that’s ICT, which is becoming increasingly important in society and in education” (T32). However, two teachers point to the additional expense that this kind of course implies: “in the study group, besides the expenses with the Internet, all the printing of papers and other documents carries significant expenses that most professionals we know are not willing to support” (T5/6).

Despite such costs, most teachers involved in this study group recognize positive features in this new setting, especially the flexibility in managing their own time. They also feel encouraged to develop their autonomy and writing ability and appreciated working in pairs as a key feature of this course.

*Papers.* Participants’ general feelings about the papers that were used are positive, underlining their quality – “very good” (T29); “very interesting” (T9) – and their adequacy and pertinence – “adequate to the tasks proposed” (T7/8); “the papers were good, related to the tasks” (T31); “always adequate for the topics studied” (T22/23).

Some teachers remark how useful the papers were for doing the tasks: “important materials to carry out the tasks” (T10); “we used the papers whenever we needed support and always found what we needed there” (T2). Others stress their contribution to dig deeper into a topic: “they were quite useful as they supported a deeper reflection upon topics about which we have already produced some work” (T19); “I learned a lot” (T25), or for developing reflection: “I like the papers and consider that they contribute strongly for the reflection that we have developed” (T1); “in the papers we find clues for reflection” (T7/8).

Two teachers point out that coming into contact with these papers gave them a sense of how many publications on the topic of investigations already exist in Portugal. They were surprised and pleased: “it was gratifying to know that there are already so many publications in Portuguese” (T26). Two others indicate that they had some trouble in reading and interpreting some of the papers, requiring the support of the teacher educators: “some of them were difficult, justifying a direct discussion with the teacher educators” (T15/16).

Some teachers consider there were too many papers (42%). One comments on the weekly meeting time suggested to discuss papers and carry out the tasks: “The number of hours for reading papers, discussing/reflecting about them and carrying out the tasks was less than we needed” (T10). Two teachers talk about possible dangers related to the number of papers:

The volume of papers in each period was somewhat scary and having to read them made me lose my motivation. Sometimes I’d sit down with them in front of me and my mind flew elsewhere. (T24)

At times, I must admit, I felt scared at seeing so much paper to read. (T25)

The teachers welcome the division of the papers into two categories – required/optional –, as this allowed them to decide what to explore more deeply: “(...) it enabled those who wanted to go further” (T19); “each person can make their own choices, according to their interests and priorities” (T26).

Some teachers say that they had read the required papers but only “taken a look at the optional ones” (T20). Some intend to return to them in the future:

I just managed the required readings, sorry... because time didn't allow otherwise! I won't forget to continue to read, as soon as I can.  
(T2)

Teachers in Portugal are not very used to reading papers that deal with professional issues. The participants in this study group felt a bit overwhelmed by being asked to read so many papers, but appreciated their quality and reacted positively, making an effort to understand them and make use of them in their practice.

*Tasks.* Different aspects arise concerning the tasks teachers were asked to carry out. Some of them (24%) say that the tasks suited the proposed objectives: “adequate to completely fulfil the objectives” (T5/6); “relevant” (T15/16). But others question the emphasis on a theoretical approach (15%), contrary to their initial expectations:

This is the strongest criticism I have regarding the study group. It's true we're in a study group, which implies a certain theoretical component. But I think the study group could have had a more practical component. (T17)

I must admit I was a little disappointed with the tasks. To be honest, I expected more practical and less theoretical tasks. (T32)

This issue, in some cases, concerns the mismatch they felt between the tasks and the mathematical topic that they had chosen to focus on in their registration: “hardly related to the topic” (T21); “I expected a little more connection to the topic” (T28). However, one teacher refers to this but without making an issue of it in the light of other benefits drawn from working on the tasks:

At the beginning, we asked what was the point of belonging to a group on functions... But that wasn't important. Regardless of the topic, the issue was to investigate, to reflect about our practices and conceptions.  
(T1)

Other teachers also remark on the effects of the tasks (30%). All but one found them fruitful, as they let them “internalise things they learned” (T26) or stimulated discussion and reflection among teacher pairs: “they required reflection and discussion about practice that we all too often postpone or forget because of pressuring personal matters” (T24). The one exception states that “I do not consider that [the tasks] contributed much to what I expected to learn in this study group” (T32).

Teachers found that the level of difficulty of the tasks was appropriate (24%). Three teachers refer to the tasks' level of openness. For them, this is a positive characteristic as it allows "each person to search the path that best suits his/her own development in the topic, gradually leading towards the final objective" (T19).

Besides these general issues, some teachers made distinctions between tasks. The tasks most frequently referred to were 4 (27%) and 5 (33%). Doing task 4 provided satisfaction and task 5 promoted substantial learning. Seven of nine teachers who chose task 4 said it was the one that gave them most pleasure: "the most satisfying task was 4 (T7/8); "the task I worked hardest on was 4, which required a long, careful inquiry (...) but it was also the one I enjoyed most" (T22/23). Task 5, according to many teachers, was "very enriching" (T2); the "richest and most significant" (T10), emphasising the strong link that it had with teaching practice and classroom investigations.

In short, teachers did not find the proposed tasks difficult to carry out but question the adequacy of some of them, given their expectations and the sequence of issues in the study group. It is interesting to note that the tasks they valued most have a stronger flavour in terms of exploration and inquiry.

### **Conclusion**

The teachers participating in this virtual study group adapted positively to the distance education format. They appreciated the possibility of managing their time flexibly and not needing to travel to an institution. It also pleased them that this opportunity was provided for all teachers in the country and that there were favourable conditions for ongoing sharing of ideas and experiences among teachers of different schools and regions. The interactions stimulated by this framework constituted a favourable setting for teachers to work together in a flexible way for six months, think about many issues, learn useful concepts for their practices, and finish with a sense of achievement.

The study group developed a strong synergy due to having teachers collaboratively working in pairs. Teachers frequently reported intense discussion among themselves, and the tone of messages sent to the teacher educators was often enthusiastic. The fact that such a small number of teachers dropped out also indicates their level of satisfaction. The teacher pairs had to work for at least two hours a week but these were exceeded by far. Collaborating in pairs was very effective in helping them meet the course objectives, learning about the proposed topics, about how to work in a distance education format, dealing with email and the Internet. Collaboration with a partner was also very important in affective terms, providing the stimulus to overcome difficulties found in interpreting papers, dealing with tasks, and managing technology. This experiment shows that collaboration between teachers is possible and highly profitable provided the appropriate conditions are created to promote it (Hargreaves, 1994).



Reflection was also a prominent feature of the study group. Teachers had to read and make sense of papers dealing with professional issues related to their practice and to mathematics, which is a rather rare activity in most cases. They also had to write comments on their readings, expressing their understandings and difficulties, and report and comment on their practices. The writing mode, largely dominant in this virtual study group, certainly encourages reflection, since sentences may be written, read, changed, and re-written before they are sent to the teacher educator or a mailing list. Teachers' comments regarding their troubles with writing and how they developed this ability can be viewed as evidence of the progress they were making in using this medium to express ideas and to think about professional issues and problems.

The teachers report that the tasks they most appreciated were precisely those with a stronger investigative flavour, making sense of classical problems in mathematics and conducting and reporting a classroom experience dealing with pupils' mathematical investigations. This shows that this kind of task, strongly characterized by inquiry and investigation activities, is considered important for professional development (Ponte, 2001) and may be used in in-service teacher education.

The evaluation also suggests some points that need further attention. Many aspects could be improved with regard to the sequence of issues to consider, the content of some of the tasks, the collection of papers offered, and ways of fostering stronger communication between teachers and teacher educators. However, these evaluation results show that it is possible to carry out in-service teacher education based on the principles of collaboration, reflection and exploration and inquiry in a distance education format.

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<sup>1</sup> *Elementary school* (grades 1-4) is attended by pupils aged 6-9, *Middle school* (grades 5-6) by pupils 10-11, *Junior high school* (grades 7-9) by pupils 12-14, and *Secondary school* (grades 10-12) by pupils 15-17.

<sup>2</sup> Since the pairs of teachers had a large autonomy, working on their own and interacting mostly with the teacher educator, cross-phases was not an issue in this course.

<sup>3</sup> The questions that have been selected for this paper are:

- What do you think about this model of in-service teacher education?
- How do you regard the quality of the texts offered?
- How do you regard the tasks proposed?

<sup>4</sup> Since the questionnaire was open-ended, this percentage means that 48% of the teachers choose to mention this aspect in their responses. That does not mean that the remaining 52% had an opposite opinion but that only 48% decided to address that topic. A similar consideration applies to all responses analysed in this paper.