This paper focuses on the production of a portfolio in the subject of Mathematics Didactics, a component of the study plan of Mathematics preservice teacher education. We present some evaluation results, showing how the students view their experiences, which kind of learning they developed and the main role of the reflections. Finally, we conclude with a discussion about the potential of the portfolio in preservice teacher education, some of the difficulties students encounter and the required conditions to throughout the process.

Introduction

In Portugal, initial teacher education follows several models, depending on the teaching level and the educational institution. The School of Sciences of the Lisbon University trains Mathematics teachers for the 3rd cycle of basic education (students for 12 to 14 years old) and for secondary education (students from 15 to 17 years old). During the first three years, the students only have Mathematics, under the responsibility of the Mathematics Department; in the fourth year they have Educational subjects and Didactics of Mathematics, taught by the Department of Education; and in the fifth year they teach Mathematics at a school, with the supervision of a teacher from the school and two from the university, one of mathematics and one of didactics.

The subject Didactics of Mathematics is annual, with 5h of class per week. General themes of Mathematics teaching and learning are discussed, such as the Mathematics curriculum, the Mathematics class, current problems in education and the Mathematics teacher, and specific aspects of Mathematics teaching themes are worked on, such as Geometry, Algebra and Functions, Numbers and Statistics and Probabilities.

In 2003-04 school year, for the first time the elaboration of a portfolio was introduced as one of the assessment tools. We intended to create opportunities for preservice teachers to reflect about the work they were developing and to provide them with the experience of working on with this tool.

The portfolio as an assessment tool

Over the last decade the portfolio has been used as an alternative assessment tool of students at different levels of schooling and especially in initial and in-service teacher education (Porter et al., 2001; Wade & Yarbrough, 1996). But resorting to the portfolio means more than using a new assessment tool. Above all, it is a theoretical action (Shulman, 1999), for it implies a set of presuppositions regarding learning and evaluation. Learning is seen as an action developed by the subject through meaningful, relevant experiences, whose interaction with others constitutes a favourable context. Assessment, as a monitoring process of learning, should contribute to pertinent, contextualised work, that calls for reflexive thinking, that
allows and facilitates meta-cognition (Hadgi, 1997), teamwork and engagement, responsibility and affectivity (Forgette-Giroux & Simon, 1997).

The portfolio can have two different purposes. During its construction process it may contribute importantly to learning, through self-evaluation, external feedback and reflection about what was learnt and how and the identification of strengths and weaknesses (Tillema, 1998). When it is finished, it permits to access the student’s evolution over a vast period of time, such as a school year (Clarke, 1996).

By portfolio we mean a diversified and representative sample of work produced by the student over a vast period of time. It is up to the student to choose each work that is to be included in his portfolio. Each one must be accompanied by a personal reflection that explains the meaning that the work had for the student. A final reflection must also be included at the end, about the work carried out and its contribution to the student’s learning. Therefore, the portfolio is characterised by the set, selection and organisation carried out by the student and shows his reflections and learning (Wade & Yarbrough, 1996).

So the portfolio is a means to develop the student’s ability to reflect about what he did and how he did it and to give him more autonomy for making decisions, both in choosing the materials that constitute the portfolio and in organising it, thus allowing the student a more active role in his own assessment (Clarke, 1996). But the portfolio also brings advantages to the teacher. The accompanied construction process of this tool narrows student-teacher communication, allowing the teacher to get to know the student in greater depth.

However, certain conditions are essential and some risks are to be avoided. Both teacher and students have to assume that the serious construction of a portfolio takes a long time (Shulman, 1999) and goes on for a vast period. A portfolio cannot be produced in one afternoon, neither can include just one or two items (Wade & Yarbrough, 1996). They must also be aware of the risk of (i) trivialising it, by including items that are not worth reflecting about; (ii) turning it into a simple exhibition of the best we can do, while devaluing a context that is favourable for reflection; and (iii) twisting its nature, establishing very objective criteria in order to establish comparisons among students (Shulman, 1999).

Methods

Context for the study. My Didactics of Mathematics class in the 2003-04 school year had 9 boys and 19 girls. On the first day of school, when the subject’s program was presented, the students were informed that they would have to elaborate a portfolio. As this was for all of them a first experience, I was aware of the difficulty in fully understanding immediately what I was asking them to do (Wade & Yarbrough, 1996). Therefore, a small document was distributed, explaining what was intended. It stated what the portfolio should include (index, introduction, 6 to 8 tasks, each accompanied by a reflection and a final reflection), the criteria for choosing the tasks to be included in the portfolio (being representative of the diversity of the nature of the work developed and of the themes handled in this subject) and the
evaluation criteria (content 80%; presentation and organisation 20%). Each task had to indicate the date it was included in the portfolio. A task included in the portfolio could later be replaced by another, and this replacement had to be adequately justified.

On that same day, we negotiated which was to be the first class devoted to supporting the students in elaborating their portfolios. Actually, instead of one class two were taken up and this task was completed with other moments of support outside classes. As the reflection was what students found most difficult to do, each one read a reflection that was already written and the other elements of the groups made comment on it, after which I concluded with my comments, many times in the form of a question. While I supported one group, the remaining students, also in groups, shared their difficulties. A co-evaluation began to develop. At the end of the first semester, I took all the portfolios home and commented them one by one, highlighting what they had already achieved and what still needed to be improved. During the second semester there were no classes dedicated to the portfolios, but once in a while the students bring their questions to me.

**Procedures.** The study used three data collection methods: the sessions of monitoring the process that was audio-taped; document analyses (the portfolios) and a final questionnaire applied to all the students. This questionnaire has only open-end questions. Applied once the school year had ended, this questionnaire was anonymous so as to give the students the chance to express their opinions without feeling any sort of constraint. 23 (82%) students answered the questionnaire.

The data were submitted to content analysis concerning three fields: the perspectives that the student teachers had faced, the kind of learning they got through the construction of this tool and its contributions for the development of their abilities to reflect. Trough document analysis, in particular, the portfolio of each student teacher and their answers got by the questionnaire, the different contents have been coded and grouped by their meanings. In this way, the categories of the analysis were constructed as the data analysis was developed.

**Results**

**The portfolio.** As expected, the students had never come into contact with this tool, so at the beginning they did not know its meaning and even wondered why it emerged in this subject: “I couldn’t understand why a future Mathematics teacher had to do something like that now” (T). Some of them decided to find out more about the portfolio, by reading or on the Internet: “I immediately went to look it up, I consulted books and did research on the Internet” (L).

One year later, the students stress the main differences they identify in the portfolio when compared to other assessment tools they know, particularly written tests or exams, the most frequently used forms throughout their students’ experiences.

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1 The questionnaire had 7 questions, but in this text only two questions will be used.
Question2: What kind of learning do you think you achieved with the elaboration of the portfolio?
Question6: What are the main differences you identify between this assessment process and others that you knew?

2 When a letter is used, we are referring to a portfolio, a number refers to an answer in the questionnaire.
One of the differences they point out concerns the object of assessment that, in their opinion, did not fall upon specific knowledge, but instead had a wider scope, emphasising different types of higher-level capacities, namely meta-cognition:

The other assessment processes assess the specific knowledge we acquire directly. But the portfolio seems to assess our thinking about acquired knowledge. (4)

The fact that it is a construction process that develops over time, “without stress”, favours the monitoring character of assessment, especially self-evaluation:

It’s a work that’s never finished and that can always be improved. (14) The fact that halfway through the portfolio elaboration we were given an opinion about our work up until then guided our work performance in a positive way. (17) Each improved task made me go over the same content, self-evaluate the work that was being done. (F)

The moments of interaction that occur between teacher and students as well as the fact that the students had the opportunity to write what they think about several issues, that are particularly important to them, seem to contribute to “a greater student/teacher proximity, giving the latter a better chance to identify difficulties and help the students” (16). Particularly for the shyer students, the portfolio may be an opportunity to show who they really are:

The portfolio has a crucial utility for students like me. I’m one of those who easily go unobserved in classes. I don’t like to participate, I probably even show discouragement, but I simply prefer to hear the explanations and reflect about them internally. This way, this work shows the teacher the attention, interest and dedication that I had. (F)

But the biggest difference students found is related to the high level of autonomy they are given in the process, associated with a greater accountability that is required: “The portfolio ends up being a big responsibility for me. With it I truly have the notion of being in the centre of the teaching-learning process” (E).

The students’ active role in the assessment process is heavily related to the personal character the portfolio assumes to them. As one student explains, “this document isn’t just an assessment work, it’s also the representation of my thoughts, my ideas” (F). So, being a document in which students reveal a lot of themselves, much of what is often in their intimacy, it is understandable that they grow attached to the portfolio that they see as an extension of themselves:

I have never had a diary but I think this experience was quite similar, although I don’t describe my days here I describe my thoughts, and so it becomes much more intimate and personal. The separation’s going to be hard and I really think I’m going to miss it. (E)

**The learning process.** The students feel that they have learned a lot while they developed the portfolio. More specifically, the need to be organised was one of the
aspects that emerge: “Choosing the tasks for the portfolio allowed me to develop my organisational capacity” (8). Actually, from my observations of the classes and compared to previous years, I noticed that these students showed more concern in recording the discussions that took place in class and in keeping all the documents they did as they knew they might need them in the future, for their portfolio.

Considering that in previous years they had little or no work in terms of written documents, developing arguments through writing was another thing the students refer they learned: “I’ve always found it very hard to express myself in writing. With this work, I think I developed this competency quite a lot and I actually improved quite a lot” (AF). In fact, on the last day of school, when we were making a balance about the portfolios, the majority of the students said they had turned to other people’s help to improve their writing in the documents they elaborated. This attitude shows, on the one hand, that they were set on doing good quality work and, on the other, that they acknowledged their difficulties in this dimension.

Naturally themes related to the teacher’s practice were referred to, as well as bibliographical research, but I think this kind of learning has not exclusively to do with the portfolio. However, knowledge of an alternative assessment tool is another thing they learned that is clearly related to this specific work: “I got to know a new assessment method and the difficulties students may have carrying it out” (14). According to the procedures that were developed, the fundamental role the teacher gave the students was highlighted: “I learned that the comments a teacher makes on a student’s work have a lot to be said, you can’t say too much, but you can’t say too little” (A), as well as the importance of co-evaluation: “once more I can follow the teacher’s example and ask my students to read their group colleagues’ portfolios and comment on them. That would be a great way to value discussion and a critical spirit” (E).

The fact that they had to choose tasks led many students to improve their first problem solution, carried out individually or in group. So, “thinking more before doing anything, and acknowledging mistakes” (16) contributed to learning in a more meaningful and permanent manner over time: “the activities I chose became more important and what I learned with them became really solid and expressive” (T).

But undoubtedly the fact that they had to reflect about what they did, how they did it and the issues that emerged from these experiences seems to have marked the students the most in the whole experience. Above all, it allowed them to get to know themselves better: “I think the most important thing I learned was getting to know myself better, not just as a future teacher, but also as a person” (4).

**Reflection.** The greatest difficulty the students faced when they did their portfolio was to have to develop a reflection to accompany each task they chose. Below is a good example of this difficulty, reported by a student:

[when I was told I had to do a portfolio] First I was scared, then curious, and then scared again (…) I avoided writing the first reflection for weeks, although after each class, on the bus on the way home, I imagined what I would write about what I’d just
seen, but I never put it on paper. Until we got to the last day (...) it was very hard to write the first sentence. I had lots of ideas, but I didn’t know where to start. (…) When I finished and reread what I had written I couldn’t help smiling. At that moment I realised what the teacher meant when she talked to us about the importance of elaborating a portfolio. (T)

In the first meetings of joint work, most of the students presented rather impersonal reflections, mostly descriptive, with a low level of inquire. Most students’ evolution in this respect was not immediate, that is, it did not happen between the first moment of work and the end of the first semester. It was only after a second feedback, already in the second semester, that more generalised improvement was visible.

The open nature of the reflections may explain why some students referred that this task is always open to improvement: “the truth is this work is eternally imperfect” (E). As if this weren’t enough per se to make this work demanding, the possibility of replacing one task with another was grabbed by several students, not because they considered that what they had done was poor, but because something else had arisen that was more important to their learning:

When I decided to replace a reflection it wasn’t because I felt that the one I’d done was not worth anything, or that it was bad, but because related to that theme I’d reflected about, I found another one that seemed much more important to me and whose reflection could teach me more. (E)

While the reflections were a great challenge for the students, it is also true that having to reflect led them to develop this capacity and create a new stance, “I learned to create a habit of reflecting about situations I consider to be important” (11); “nowadays I am used to reflecting about the work I do and self-evaluating myself” (AF). Is was also thanks to reflecting that some students questioned their concepts of teaching and learning Mathematics, heavily marked by their personal experience as students:

The reflections and even the analysis itself of the chosen situations were what made me change certain ideas I’d already formed about teaching Maths (A)
This is going to be my greatest difficulty because only throughout this year I had the opportunity to become aware of these changes and I know I’m going to have to fight hard not to yield to the temptation of going back to lessons of oral exposition/problem solving. (AF)

**Conclusion**

We may say that the production of a portfolio in the subject Didactics of Mathematics was a successful experience, if we take into account what students say, and document in the portfolio, that they learned. More specifically, they developed their argumentation, writing ability, organisation, research, autonomy and responsibility in the learning process.
The monitoring role of this tool is probably its largest potentiality. The fact that the products of the chosen tasks and the first versions of reflections can be improved, based on the teacher’s comments, creates most certainly new moments of learning (Tillema, 1998). The strong reflective component that was present throughout the whole process and moments of teacher/student interaction are the preferential means that allow students to develop their self-evaluative capacity (Hadgi, 1997; Jorro, 2000).

The development of an ongoing reflection based on specific tasks (Schön, 1983) allowed students to get to know themselves better as persons; to become aware of their one believes regarding teaching and learning and to question them in face of important issues of the teaching practice (Christiansen & Walter, 1986). Therefore, the portfolio constituted a favourable means for developing a reflective stance, a requirement currently considered to be essential to teachers (Mezirow, 1991).

What concerns Mathematics education, the student’s teacher contacted and developed an alternative assessment instruments that focus in high level capacities instead on specific knowledge, valorising one of the trends of what is consider, in our days, knowing mathematics (NCTM, 2000).

But certain difficulties arise in developing a portfolio. The students need to engage in it seriously. It is a demanding task where they have to expose themselves. In order to do so, they must acknowledge its importance and the teacher/student relationship has to be one of trust. The increase in work for the student and for the teacher is enormous – many hours, days, weeks! Studying the day before an assessment moment is not enough. It is ongoing work. Teachers must devote classes to this work, create different moments in teacher/student interaction, accompany and support their students. In short, it requires a new culture of evaluation, in which learning is the intended objective. How is it possible to prepare students and teachers for this culture of evaluation? How can they accept to spend so much time on this? How can we break away from such a strong-rooted, albeit currently questioned concept of assessment? These are questions that must be addressed in the future, so that the portfolio may become not the exception, but a more generalised practice, justified by its potentialities. These potentialities also included an important and even indispensable data for the teacher to get a deep understanding of the students’ point of view of his or her one role. This dimension will be discussed in another paper.

References


