

Analysing Practice in Preservice Mathematics Teacher Education¹

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This paper presents the case of a yearlong course based on fieldwork activities provided to secondary school mathematics preservice teachers, just before their student teaching practicum. The activities are a first experience in investigating professional practice—some concern the school as a whole, while others focus on the mathematics class. Using a qualitative and collaborative methodology, we discuss the implications of this work for preservice teachers' education. We argue that such fieldwork activities may help prospective teachers in developing a professional discourse and in assuming a professional identity, acquiring new ways of expressing new educational ideas and assuming a new point of view about educational phenomena.

Student teaching is a very important part of most mathematics teacher education programs. However, before student teaching, other field experiences may help the young teacher candidate in developing a professional perspective. This paper concerns the case of one course (Pedagogical Activities of Observation and Analysis [APOA]), based on fieldwork provided to preservice teachers, alongside several other educational courses. We present some of the activities carried out and discuss what teacher candidates may take from them. Our aim is to contribute to the discussion about the role of such field experiences in mathematics teacher education.

Professional Discourse and Identity in Preservice Teacher Education

Preservice teacher education must provide student teachers with the basic knowledge they need to begin their professional activity. Teacher education institutions need to make sure that student teachers acquire an adequate preparation both in the subject they will teach and in its teaching methods. New teachers need to know about pupils' learning processes, recognise the influences of sociocultural backgrounds, be aware of key educational issues such as exclusion, know the critical features of the mathematics curriculum, and know how to go about preparing and conducting a lesson and evaluating pupils. Also, an important dimension of their future professional activity is their insertion in the school, participating in its projects, working alongside other teachers in all kinds of activities, including activities related to the community. Young teachers must start their professional life knowing that they will still have much to learn during their

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careers and that they will have to search for opportunities of professional development according to their needs and objectives.

A preservice teacher education program needs to take into account all these dimensions of professional knowledge and has to consider the way student teachers may develop them. The strong criticism suggesting the inefficacy of preservice teacher education programs shows that this is not an easy task. These programs are criticised, for example, for not taking into account student teachers' previous knowledge and beliefs, for not paying attention to schools' realities, for being too "theoretical", for predominantly providing "academic" learning experiences, and for preparing teachers to fit in the existing schools and not act as agents of change (see Lampert & Ball, 1998 for a thorough discussion).

In mathematics education, there is a wide consensus that it is necessary to take into consideration pupils' learning processes. In preservice teacher education it is also necessary to have in mind student teachers' learning processes. This includes, for example, considering their previous knowledge, beliefs, and conceptions, and valuing the role of their activity and reflection on the activity (Korthagen & Kessels, 1999); promoting the construction of meaning through classroom interactions, between instructor and student teachers and among student teachers (Llinares, 1999); and appreciating the heuristic value of an investigative dimension in learning as well in the teachers' work (Ponte, 2001).

To be a teacher it is not enough to know how to carry out professional activities. It is necessary to assume a teacher's point of view, to internalise the teacher's role. It is necessary to regard oneself as a member of the teaching community and to be able to use the specific resources of the profession. In short, it is necessary to assume a teacher's professional identity (Putnan & Borko, 2000), that is, to identify with the teacher's professional group. A professional identity requires, of course, the mastery of knowledge and abilities essential to professional performances, but it also involves assuming essential norms and values of the profession and an attitude of commitment to improving education. Its construction poses complex problems to teacher education programs (Munby, Lock, & Smith, 1999).

As Lampert (1999) refers, an important element in the construction of a professional knowledge and professional identity is the insertion into a discourse community. In such communities, members tell each other about new practical ideas and concerns as they do what they do. For that to happen, it is necessary that they (a) share common meanings for the terms that they use to talk about their experiences, and (b) share norms on what may be accepted as evidence for their assertions. Preservice teacher education must induct young teacher candidates in the ways of talking and thinking necessary to the teacher who wants to reflect upon and investigate practice. The role of the instructor, then, is to establish with student teachers a suitable environment where they can start having access, in a natural way, to this discourse and making it gradually their own.

A Fieldwork Course

This section presents the course and its institutional and social context. It describes the activities carried out, detailing the rationale for the pedagogical approach and teaching methods. It also presents the issues that surround the course, indicating those that are the focus of this paper and the methodology used to study them.

The course and its context

The educational system in Portugal includes basic education (compulsory, grades 1-9) and secondary education (non-compulsory, grades 10-12). Secondary education is attended by about 80% of the student population. Mathematics is a separate discipline that all pupils take from grade 5 up to grade 9 and most pupils (but not all) take from grade 10 to 12. Mathematics teachers are single subject teachers, except in grades 5 and 6, where some of them also teach science.

This article describes the case of APOA, a course offered at the University of Lisbon in the penultimate year of a preservice mathematics teacher education program for the upper section of basic education and for secondary education in Portugal (i.e., for grades 7-12 corresponding to pupils in the age range 12-18 years old). This is a five-year program. The first three years concern mathematics studies (identical to those provided to mathematics majors), the fourth year involves education courses, and the fifth year is a year long *practicum*, during which student teachers are responsible for teaching two classes. Similar programs exist in many other Portuguese universities to prepare secondary school mathematics teachers. Our program is unique in the emphasis provided to practical experiences in the fourth year of the course.

The APOA course has three weekly hours throughout the whole school year. It has existed for about 15 years in the program and its main objective is to provide student teachers with an opportunity to reflect on educational phenomena, to start regarding them from a teachers' point of view, and to develop their capacity of analysing and reflecting upon educational situations. It is a course mostly based on experiences such as observations and reflection on observations jointly done by student teachers and instructors. In contrast to the other courses of the program, this course does not have a curriculum consisting of topics.

The first semester focuses on the school as a whole, its operation, government bodies, structures, and services, paying attention to the different roles of the teacher as a member of the school organisation. The second semester focuses on mathematics teaching and learning, observing and discussing classes. The main activity involves planning a set of lessons with a cooperating teacher and observing how it unfolds in practice. Student teachers identify a topic of interest, related to the educational objectives of those lessons, and collect data to evaluate how it was reached.

Given the nature of the work to be carried out in this course, classes have at most 12 to 15 student teachers. The visits to schools are prepared with the cooperating teachers in their schools and with student teachers in sessions at the

university. In these sessions, there are also discussions about observing, collecting, analysing, and presenting data concerning educational issues, as well as discussions about the school system, school administration, and mathematics education. Following the first visits to schools, student teachers choose a topic that attracted their attention for developing a further inquiry. Group work—usually involving three or four student teachers—is used throughout the year. They present a report in class involving the data they collected. These activities constitute an initiation into the practice of inquiry into professional issues. In the current school year, the course is run by a university faculty member (the second author) and five experienced secondary school mathematics teachers, who undertook this activity in addition to their regular school load.

Rationale and teaching methods

Several assumptions about preservice teacher education underlie the work carried out in this course. A first assumption is that the observation of practical situations is important to provide student teachers with the opportunity to reflect, question, and theorise about the school and mathematics teaching and learning based on concrete, rich, and shared material. Without such personal experiences, lived in schools, it is very difficult to analyse educational phenomena related to teachers' professional activity.

A second assumption is that observation only produces a formative effect if it is subject to a constant inquiry by student teachers, reflecting, questioning, identifying problems, and searching for solutions. To observe without questioning has no educational value. Moreover, questioning without a constructive intention, such as looking for solutions, may be all right for the sociologist or the philosopher but does not fit in with the teacher's way of being. Reflection and questioning begin informally in oral discussions in classes carried out at the university and continue in the preparation of oral presentations in class and written presentations. This reflection, carried out in an environment that encourages the free expression of opinions and the arguing of different points of view, constitutes an important step in the student teachers' process of construction of a critical and analytical discourse on professional practice.

A third important idea is that the identification of specific aspects to observe and to question, the collection of data regarding these questions, and the presentation of conjectures and conclusions, constitute an investigative activity for student teachers. Such activity provides an initiation into the practice of inquiry into practice. The work done throughout this course does not aim directly at the construction of knowledge about topics such as mathematics, curriculum, instruction, or pupils' learning. Rather, it aims at developing abilities of observing and identifying problems, and designing solutions, that is, abilities necessary to investigate practice.

Moreover, this course aims at developing in student teachers a way of relating to problems and educational realities that is important for their future professional identity: developing a critical stance, a desire to perceive the reasons, a taste for perfection, and personal commitment. It strives to help student teachers begin

constructing a teacher's perspective about the objects and situations that they are used to seeing as pupils.

The small class size allows a close instructor-student teacher relationship. The instructor has an opportunity to interact individually and to know each student teacher much better than in any other moment of the program. Group work constitutes a general working strategy in the course: student teachers are organised in sub-groups, which assume their own projects and which often do their observations in different schools. The importance given to group work is meant to provide a setting for interactions among student teachers, fostering the development of common meanings about the course objectives and methods. It also aims at familiarising them with the processes of cooperative work, that demands sharing meanings, common planning, adequate division of labour, and joining different contributions from members.

Informal discussions and the participation of student teachers are key features of classes held at the university. The main role of the instructor is to propose tasks and to lead discussions. However, formal situations (such as verbal presentations in the classroom and discussion of written projects) are also valued, requiring a strong sense of responsibility and engagement from student teachers.

This course aims at achieving the double goal of (a) helping student teachers fit in the existing schools and (b) promoting their role as change agents. They come to know the "inner side" of the school activity and develop confidence in their relationships with different educational actors. The analysis of the problematic aspects of the school activity is also a recurrent concern, aiming to stimulate student teachers' engagement in transforming them.

Research about the course and study methodology

The activity of this course raises many problems. Things may go wrong in a number of ways, such as (a) students reverting to conventional forms of work, or (b) not taking reflection and analysis as far as they should go. Among the issues that we have given special attention to in our reflection, are, for example:

- functioning and work organisation – that is, issues related to the formative device, the opportunities for activity provided to student teachers.
- planning and carrying out observations – for example, what preparation is necessary before doing an observation?
- reflecting on the observations – what conditions foster good discussions in the university classes?
- planning intervention activities to carry out in schools and their observation – what must be the teacher's intervention?
- the expected performance of student teachers – what type of product should they be asked for? How must projects be oriented and evaluated?

This paper pays special attention to two aspects: (a) planning and doing observations, and (b) discussions carried out in university classes. We are especially concerned with how much the course promotes student teachers'

integration into a discourse community of practice and the formation of a professional identity.

The investigation is an outcome of collaboration between the two authors. The second author is a teacher of the course and the first author the current department head. Data were collected through several instruments: (a) joint oral reflections by the two authors on classes, originating joint written reflection notes; (a) a diary, written by the second author, including lesson objectives, a short description of what happened, the story of some incidents, and a reflection on the extent to which the class objective was reached; (c) reflection notes by the first author on staff meetings involving all the teachers of this course; and (d) written reflections of student instructors about their experiences in this course.

Analysis and Discussion

This section addresses planning and doing observations by student teachers and discussions carried out at the university about the observations performed in schools. The data is drawn from student teachers' reflections and the diary of one of the instructors. The analysis focuses on preservice teachers' development of professional discourse and professional identity.

Observing educational activity

Fieldwork is highly regarded by student teachers as a most valuable activity. However, to be fruitful, it must be carefully planned. How can visits to schools be prepared? What type of observations should student teachers be expected to do and with what instruments? What point of view must be adopted in the observations? When one does not have a good idea of what to observe, attention is spread out towards many objects. It becomes difficult to systematise what is observed and it leaves off the picture many aspects that one could otherwise consider significant. As a consequence, observations need to be guided—that is, they must be led by a problem and be carried out with some instruments.

Student teachers invariably focus on the instrument to use, for example, defining a set of items to observe or constructing a grid. However, any instrument always presupposes a problem, even if only implicit. It is the problem that gives sense to the instrument and, therefore, it must be carefully considered. The danger of giving little importance to the problem and centring all the attention on the instruments is a key issue in this phase of the work.

Instead of starting to construct grids right away, in class we discuss other ways to organize the observations. A strategy that often provides good results is to divide the focus of observations among the several members of a group of student teachers. This allows them to collect much more data and to compare different perspectives. This is illustrated in the following narrative concerning contrasting viewpoints:

Sónia, Catarina, Rita and Francisco observed a seventh grade lesson the previous week. Now, they are reporting to the class what happened. Within the group, they decided to separate the focus of the observations. Francisco focused on the general

environment, Catarina on the physical space, Rita on the teacher, and Sónia on some pupils. Thus, each one talked about the lesson, placing special emphasis on the observed objects but, naturally, also referring to aspects observed by the others. One point that they all commented on was the class environment and, particularly, pupils' behaviour. This strong attention to pupils' behaviour is to be expected, given that it is something that causes anxiety in student teachers and that many frequently report as their strongest fear ...

Sónia started by saying that the pupils were quite agitated and noisy and found the environment too disturbed. Francisco described the pupils as being interested and fond of participating and following the rules—for example, raising their arm when wishing to speak. Everybody noticed the difference between the two observations and I tried to explore the reason why that happened. A few student teachers suggested the idea that such descriptions were associated with their different experiences, particularly with the fact that Sónia and Catarina had not yet observed really problematic classes. Someone pointed out that the pupils had a study visit that afternoon and the mathematics teacher was organizing it, which explained why they were asking so many questions on that subject at the beginning of the lesson. This was regarded by Francisco as natural, particularly taking into account pupils' ages, whereas Sónia and Catarina focused on that initial moment of the lesson and its agitation. When I asked them about the content of the pupils' interventions later on, after the talk about the study visit had finished, the group was unanimous in saying that they tried to answer the questions, comment and correct answers of their colleagues, only doing so with a certain lack of discipline. (*Lina's journal*, 23-03-00)

The different readings of the lesson are associated with different points of view. Francisco analyses the situation through what the pupils do in the context of the work in progress and characterises the environment of the lesson based on that. His comments take into account the age of the pupils and their maturity. Sónia and Catarina carry out their observation led by their fears as future teachers. They centre their report on small elements of the lesson that shape their vision of the events. Moreover, they seem to subscribe to a perspective of the mathematics class as one in which the pupils are listeners rather than active participants.

Student teachers observed the "same" events and interpreted them in opposite ways. The attention paid to different objects contributed towards this, but the most important factor is the point of view of each observer. A mathematics lesson in which pupils are encouraged to argue among themselves will always have a certain level of noise—which is regarded as a nice working environment for those who value pupils' active role in learning and as an undesirable feature for those who consider that the teacher cannot teach without controlling everything that is going on in class.

The diversification of objects of observation in the classroom allows student teachers to begin perceiving the complexity of the factors that influence teaching and learning, which for them is a new perspective. As one of them wrote:

The observation allowed us to look at the classroom in a completely different way, a "teacher's" look. It was there that we began paying more attention to the type of class, to the physical conditions, to the teacher's methodology, to the pupils' reactions. (Eduardo)

Learning how to observe educational activities constitutes an important goal of the course. Another goal is the development of the capacity to analyse and to argue about what was observed. To foster that, student teachers' reports also later assume the form of verbal or written presentations in which they present their observations in a systematic way, with a critical analysis, and, sometimes, with proposals of further activities that could be carried out in schools.

Discussing educational activity

The field visits, either to observe or to intervene, need to be well prepared, and the best way of doing so is through widely participated discussions by student teachers. The results of the visits to schools also need to be subject to discussion. Discussions are thus a particularly important form of work in this course, contributing to constructing a discourse about professional practice. Discussions are good opportunities to contribute to the development of student teachers' critical ability. The problem is how to promote good discussions.

The following episode illustrates a discussion in a lesson in which student teachers prepared materials to use in an eleventh grade class. It concerns what it means to arrive at a definition.

In the very beginning, when I came to the group, the student teachers told me that they wanted to make a worksheet so that from it the pupils could arrive at the definition of sequence. I asked them if they already had concrete ideas on how to go about that and they had said, 'No' and were finding it a difficult task. I decided to explore the situation better. As they had met with the cooperating teacher and had discussed what they would prepare, I tried to understand to what extent this idea had been suggested to them, or whether it was their own. I asked them what they had settled with the teacher.

Rosa answered for the group: 'We need to choose a set of problems or an investigation involving sequences for pupils to begin working so that later they arrive at the definition of sequence.'

I insisted: 'But your idea is that the pupils will arrive at the definition just by themselves?'

They replied with some embarrassment: 'The teacher insisted that it would be necessary to proceed with the formalisation of the concept later on...'

I then called their attention to the fact that we may have rather different things. Pupils can work on many problems with the knowledge that they have... That does not mean that all the work has to be done by the pupils. In creating a lesson plan we must have a clear view about the type of lesson we want to do.

Student teachers seemed satisfied with this perspective that they did not think of before and went on with their work... As the class they are working with is in a business strand, the group looked for problems related with trading and savings. They found a nice situation (because the results are unexpected) that concerns interest. They decided to use it as well as another simpler one so that they could compare the two. (*Lina's journal, 13-04-00*)

“To arrive at the definition” may mean quite different things depending on what one has in sight and on the role of teacher and pupils. Without a clearly established common referent (Lampert & Ball, 1998), what may happen is an apparent agreement but not a real agreement. Reflection on this small episode shows the need to pay attention to the fact that the use of certain key expressions – in education as in other fields – does not necessarily mean that the interlocutors are thinking about the same thing. This episode shows how important it is to give voice to student teachers in a way that the instructor can understand their thought. It also shows that through communication we can support them to construct an appropriate discourse to describe the activity of pupils and teachers.

Developing professional discourse and identity

The observations, the oral and written reflections, and the subsequent discussions led student teachers to begin developing a discourse about educational situations, characterising the educational objectives aimed in different activities, the pupils’ processes of reasoning, their ways of working in the classroom:

The lesson that we attended consisted of the presentation of a project done in a group ... It is curious, that from the observation we could perceive the way the pupils did the work. (Fernando)

Informal oral reporting and writing field notes help student teachers to speak about their experiences in a spontaneous way. They start using terms like “task”, “project”, “discussion”, “activity”... The different ways of reflecting upon the observations undertaken support the appropriation of new terms to describe ideas and feelings, sharing common meanings, and this is a first step into the process of entering a discourse community.

By visiting schools and discussing observations, student teachers experience a change of point of view, one of the elements that characterise the formation of a new professional identity. A new perspective – now that of a teacher – is gradually developed, supported by the teachers with whom they come into contact (from the university and from the visited schools) and by the new ways they interact with pupils:

While I circulated in the corridors, among pupils, teachers, and staff, I had the opportunity to look at things differently and see things that I had never noticed before. (Beatriz)

This visit [to the school] ... now made me enter a world that I already knew, but with other eyes, in another role, a little [as I will do] in the future as a teacher. I no longer felt like a pupil although I [still] do not feel like a teacher. (Ana)

This process is just at the beginning. The way of participation in the school life that student teachers now experience is different from that which they had before. They are no longer pupils, even though they are still not qualified teachers. The uncertainty regarding how they will be accepted and adjust to their future professional roles is one of the problems that student teachers face at this point.

This uncertainty is well captured by the thoughts that Glória experienced in her first school visit:

In the trip [to the school], I think, all of us were thinking how it would be there: will they regard us as pupils? Will we go unnoticed? (Glória)

The development of a professional identity also involves assuming new roles. The support provided by the discussions carried out in classes—especially at the university—is essential for the development of a perception of the multitude of changes that are occurring in the work of mathematics teachers. We can trace this in the following student teachers' written reflections:

It is clear that I also liked it because it was a different lesson, I had never seen pupils presenting group projects in a mathematics lesson. (Dora)

I could see that the methodologies used in the mathematics lesson have changed a lot in the last 5 years. (Fernando)

But besides mathematics teachers, student teachers will be teachers and, hopefully, active members of the school institution. To understand what is happening in schools and the changes that are occurring there is part of the development of their professional identity:

Although I left secondary school 5 years ago I can already see that it went through great changes ... (Dora)

I feel it was important that our attention was brought to the reforms and all administrative rules involved in the process, otherwise we would not have access to them... It was good to see that the environment is different from when we were there ... (Cândida)

The first visit allowed me to discover a well organized school, which gave me some ideas to apply later, when I begin to be an active part of the school institution. Moreover, I got to know some of the projects that it is possible to carry out in a school, even without the support of the Ministry and with a lot of effort from teachers ... Through contact with the teachers I was more aware of the difficulties that teachers go through and that enriched my learning and my experience as a future teacher. (Carolina)

The notion of change, in mathematics education and in the school institution, has a very different meaning when it appears in a university class as opposed to when it appears as the result of observations and discussions on visits to schools. The same happens with the idea of educational reform, the new regulations and curricula, and changes in pupils' ways of work, especially group work. All these are elements that enter naturally into the student teachers' discourse through discussions and reflections on observations. Student teachers understand that they are not dealing with "theoretical" constructions apart from "reality", but with processes that are lived—often in contradictory ways—by teachers who work in the field.

Carolina shows she perceives the school as an institution whose projects require a strong commitment on behalf of their protagonists, who must count on themselves. This is an important aspect of the construction of a professional

identity associated with a strong and permanent intervention as member of the school. It is, once again, an idea that needs the mastery of a discourse in which it can be stated. The support of rich and adequate fieldwork experiences is crucial for that to happen.

Summary of Findings and Conclusion

APOA plays an important role for student teachers, allowing them to become part of a discourse community concerned with professional practice and to develop identity elements that can be framed within a critical and intervening perspective. This results essentially from the discussions carried out in classes—especially those taking place at the university—but these would be impossible without the fieldwork activities. By assuming a voice, student teachers integrate into their discourse new elements concerning innovative classroom methodologies, the dynamics of the school institution, and the educational system. In these discussions, they become aware that it is not simply the use of certain words that provides understanding of meaning, an important idea that they must always keep in mind in their future professional practice. This course helps them to understand the importance of observing practice in a critical and disciplined way. It is necessary to question what one observes, but that must be done within certain rules, taking into account the existence of a variety of points of view. The observation does not end upon realising the problems and the reasons for their existence but must go further to question the way of dealing with them.

Student teachers in APOA are approaching a critical period, in which they will be responsible for teaching two classes (in next year's *practicum*). They are unsure about what will happen and their personal adequacy for those functions. This course provides them with an important experience regarding the teacher's activity. In a natural way they start using terms that are essential to describe and analyse educational activity. They become aware that important changes are occurring in the practice of mathematics education and in the activity of schools. They understand that teachers in general and mathematics teachers in particular have new roles to fulfil and must be protagonists in their areas of intervention. Reflection and networking, fundamental building stones of professional development (Krainer, 1999), are also experienced throughout this course.

From an institutional point of view, student teachers are still students and not yet teachers (Munby, Lock, & Smith, 1999). We cannot expect them to develop, at this point, a full professional identity. It is not possible to achieve now what must be done in the following phases of professional activity (i.e., student teaching and first years of practice). However, an important step may be provided. The recognition, by student teachers, of the value of joint analysis of educational situations with other professionals and the notion that they can have an active participation in identifying educational problems and in proposing activities to deal with them constitute important elements for their future evolution as mathematics teachers.

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