

The Mathematical Education of Primary Teachers in Spain

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Summary

Recent years have seen major changes in Spain's educational system, accompanied by modifications in initial teacher education. Some of the traditional dilemmas in teacher education are analysed, together with the influence that the successive Study Plans have had on subjects related to mathematics education, where there is found to have been a continual erosion of class hours.

In the light of this analysis, some suggestions are put forward that may aid in improving the mathematics education of our future primary teachers in Spain.

The Mathematical Education of Primary Teachers

1 Introduction

One benefit of the social and political upheavals that took place in the last decades of the twentieth century has been the series of major changes in Spain's educational system. There remain, however, some problems in initial teacher education, such as the unresolved tension between theory and practice, the ever-present gulf between professional and culturally oriented plans, and the academic and social status of Initial Education Centres and their students (Sierra & Rico, 1996). One would have to add the growing distance, both administratively and academically, between initial teacher education and actual practice in infant and primary schools. This is the situation that the present work will analyse from the perspective of mathematics education.

2 Historical references

2.1 Initial teacher education in the Spain of the 1970's and 1980's

Various authors, such as Balbuena (1991), Armendariz, Azcárate & Delofeu (1993), Rico (1994), Rico & Sierra (1994), have pointed to the 1970's as being the decade which saw the beginnings of major changes in mathematics education in general, and in mathematics teacher education in particular. In that decade, with the passage of the General Law of Education, the setting up of a new educational system with innovative curricular proposals, approval was given to the formal incorporation of the initial General Basic Education teacher training into the university system. The previous 'Escuelas Normales' were integrated into the University as 'Escuelas Universitarias' (University Schools). At the same time, there were new study plans and programs that reflected a greater interest in the problems of the teaching/learning of school-level content.

The 1971 plan elevated the category of the primary teaching certificate to that of a university diploma, at the same time as raising the academic level required for entrance into the centres. Despite the call from many in the educational and social sectors of society for a full university degree to be granted, this concession was blocked for economic reasons (Rico 1996).

The institutional recognition in 1984 of the Didactics of Mathematics as an 'area of knowledge', as a result of the passage of the University Reform Law, was a qualitatively important step in teaching and research related to the initial mathematics education of primary teachers. Notwithstanding the great diversity of administrative solutions that were applied (Rico 1994), many of us opted for this 'area of knowledge' (the administrative term in Spain's university system), with

the consequent real incorporation into university departments, in some of which the area plays a predominant role. This was not just a quantitatively important step for mathematics education. It also represented a great qualitative leap forward for initial teacher education in Spain in general, since many of us instructors turned our teaching activities towards the problems of the teaching/learning of school-level mathematics. We began to set up research teams within the University, and intensified our search for channels for doctoral theses and research projects on problems in the fields of teaching and mathematics teacher education.

The study plans of the 1970's offered specialist qualifications for primary teachers in Humanities, Sciences, Pre-school, and Spanish and Foreign Languages. They reflected the predominance of scientific training over specific didactics. Indeed, the didactics not only occupied just a small part of some subjects, but even then it depended on the willingness of the instructors to include it.

Sierra (1987) made an interesting analysis of the 1971 Study Plans of the EGB Teacher Education Schools (which remained in effect until the early 1990's), describing the scientific and didactic content with respect to mathematics. These plans distinguished between the (various) subjects with scientific content and the (single) subject of the Didactics of Mathematics for students specialising in Sciences. Sierra notes that

'the Didactics of Mathematics occupies approximately 25% of the curriculum of the Schools [of teacher education] relative to their overall mathematics education' (p. 105).

For the other specialisations, there appears only a single subject called 'Mathematics and its Didactics' in which the syllabus content again reflects the sparse or null reference to the Didactics of Mathematics.

We ourselves remember that the programs of the lecture courses showed the predominance of content over didactic aspects (E.U.F.P., 1982, 1984), and that the bibliography for the courses was of a general nature and theoretical in content. The infinitesimal calculus and algebraic structures formed part of the future primary teacher's curriculum. Sections devoted to the Didactics of Mathematics only appeared at the end of a chapter or at the end of the book, but even then always as an Appendix to the content, and basically dealing with resources and materials, but hardly ever with even the most simplified theories of the teaching/learning of mathematics. Even the expression 'Mathematics and its Didactics', which is an eloquent reflection of a certain way of thinking about the content of the subjects in these Centres, was not yet in frequent use, although now it is the most often used course description (Abraira et al., 1997). The latent idea was that you just had to 'give them' mathematics, and that was practically sufficient. Culture-based teacher education was stifling the professional character that is essential to such education.

This situation was common to other countries too, as Cooney (1994) reminds us. 'Indeed, in the 1960's and 1970's the modus operandi of most teacher education programs was to train the teacher to be a reasonably competent mathematician and introduce a little pedagogy on the side' (p. 225). One has to agree with Llinares's (1998) observation, however, that that was the time when there started to become patent the preoccupation about what content of the Didactics of Mathematics should be included in the lecture courses, about the relationship between mathematical content and mathematics teaching, and about the nature of the mathematical content that is best suited to primary teacher education. 'The Didactics of Mathematics began to enlarge its 'theoretical knowledge' on the basis of cognitive research, theoretical reflections, etc., at an ever-increasing rate, and this posed questions relative to how to incorporate the said theoretical knowledge into the lecture courses for teacher education' (Llinares, 1998, 26).

At that time too, all of us who were participating in teacher education (teacher educators, in-service teachers, students and administration) declared our concern that the education the

prospective teachers were receiving was poorly suited to the requirements of the profession and that there was a (teaching and administrative) gulf forming between the initial teacher education centres and schools of the obligatory levels of education.

2.2 Initial teacher education in Spain in the 1990's

At the beginning of the 1990's a Royal Decree was published setting out the general directives of the Primary Teacher Certificate, specifying seven specialities in this certification:

- Infant Education,
- Primary Education,
- Physical Education,
- Foreign Language,
- Music Education,
- Special Education and
- Audition and Language,

in consonance with the educational system depicted in the LOGSE (the General Education System Planning Law) passed in 1990.

Later in that same decade some University Schools were transformed into Faculties of Education, integrating with such affine courses as Psychopedagogy or Pedagogy. This all led to the elaboration of new Study Plans in teacher education, in which some of us teacher educators, without too much success, continued to insist on the professional nature of teacher education and on the importance of giving an essential role to the didactics of specific areas.

Neither on this occasion were the future primary teachers granted the level of a full university degree, and there was avoidance of any analysis of the social and academic level of the students gaining access to these centres, and of any evaluation of the development of primary teacher qualifications to determine whether our work as teacher educators was fulfilling the set objectives.

Notwithstanding the advance in the consideration given to the Didactics of Mathematics in the programs of the different subjects and in the Study Plans since the 1970's, there are still a number of aspects that need correction. One must be somewhat preoccupied by the continuing lack of importance given to mathematics education in initial primary teacher education as is reflected in the new Study Plans that were approved at the end of the 1990's.

Despite 'the difficulty involved in carrying out a comparative study of the homogeneity or heterogeneity of the content in the different universities' proposed programs' (Ruiz 1998a, 49), an analysis of current Study Plans for primary teacher education and of the programs of the lecture courses clearly indicates that there is a great diversity in denomination, number of credits, and content of the courses. In some cases, the orientation is exclusively towards the domain of mathematical content, and in others the orientation is didactic and professional (Abraira et al., 1997; Ruiz 1998a). Fortunately, although the process is even slower, there are ever more Plans which take this latter perspective in an attempt to adapt the programs to the vision of mathematics and its teaching/learning which underlies the current Primary education curriculum, while taking account of the ever faster growing number of publications on primary mathematics teacher education (Giménez, Llinares & Sanchez, 1996; Blanco & Cruz, 1997; Abraiara, C & de Francisco, A, 1998; Murillo, Escolano & Gairín, 1998; Carrillo, J & Climent, 1999; Contreras, L.C. & Climent, (eds.), 1999; Corral & Zurbano, 2000; etc.).

Abraira et al. (1997) analyse the Study Plans of 60 initial teacher education centres. In the Plans for the speciality of Primary Education, they calculate a mean of 13.5 core or obligatory credit hours in mathematics-related subjects, corresponding to 6.4% of the total of credit hours. But for the other specialities, one finds this percentage reduced to 3% of the credit hours devoted to the Didactics of Mathematics. In some Study Plans of the speciality of Special Education, one finds the extraordinary situation of there being no course at all on the Didactics of Mathematics, i.e., the number of credit hours on the Didactics of Mathematics as a core or obligatory subject that the future Special Education teachers must take is zero in some Centres. Amongst other issues, this points to a certain discrimination against pupils with special educational needs (hearing, sight, or intellectually impaired, ...) and a mentality which does not consider that they should have any mathematical preparation with respect to the arithmetic operations, and spatial or geometrical orientation which is the core of mathematical content at the primary level. This goes entirely against the guidelines on school integration set out in the LOGSE.

In a later review article, Rico & Carrillo (1999) note that

'in the Primary Teacher speciality, education in mathematics and its didactics attains hardly 8% of the total credit hours; in the other specialities the figure is only 2%' (Rico, 2000, 50).

This shows the progressive disappearance of mathematics education from the Plans of initial teacher education at the primary level.

The present situation of the Study Plans in the Education Faculty in Badajoz, while above the average, is quite explicit as an example of the foregoing statements (Figure 1). It clearly illustrates the lack of importance that specific education in the Didactics of Mathematics has in the initial education of our prospective teachers.

Speciality	Total of core and obligatory credit hours	Credit hours mathematics education	% of credit hours
Primary	163.5	15	9.1%
Infant	162	7.5	4.6%
Foreign Language	166	4.5	2.7%
Physical Education	166.5	4.5	2.7%
Special education	166.5	4.5	2.7%
Audition and Language	166.5	3.5	2.1%

Figure 1 Credit hours of the subjects of mathematics education in the Study Plans of teacher education in the Education Faculty of the University of Extremadura

1 Credit = 10 hours

In 1997, the participants at the II Simposio sobre el currículum en la formación inicial de los profesores de Primaria y Secundaria en al área de Didáctica de las Matemáticas (II Symposium on the Curriculum in the Initial Education of Primary and Secondary Teachers in the Area of the Didactics of Mathematics) (Abraira, C & de Francisco, A., 1998)

'manifested their dissatisfaction with the number of credit hours assigned to the Area of the Didactics of Mathematics in the new Study Plans, since in at least one case the lecture load has been reduced by more than 50% with respect to the 1971 Plans' (Ruiz, 1998b).

The little importance given to mathematics education in the various specialities is in evident contradiction with what the educational system sets out for the different subjects in infant and primary education. Thus, in the three cycles of primary education, 16% of the hours are allocated to mathematics, with a consideration that is far greater than what is programmed during the process of initial teacher education. This datum alone should lead one to think of the possible need for a greater weight given to the subjects of the Didactics of Mathematics in the Study Plans. But the situation is yet more alarming when one looks at the dynamics of how the LOGSE is being put into effect. The present system of 'oposiciones' (competitive examinations to enter teaching as a tenured state functionary) does not include the offer of any positions for teachers with the speciality of Primary Education. Those teachers therefore who have least studied the Didactics of Mathematics are being converted into generalists and thus responsible for mathematics education in primary schools. This situation was denounced in the aforementioned symposium by the teachers of this area, but nothing has been done in this regard (Ruiz, 1998b, 166). The Study Plans and the system of access to the profession once again reflect the growing distance between initial teacher education and the educational reality in infant and primary schools.

Furthermore, at that time, all the sectors who share in teacher education (teacher educators, in-service teachers, prospective teachers, administration) manifested our preoccupation that the initial education that teachers were receiving was poorly suited to the requirements of the profession. We are still seeing ever greater distance (both in teaching and in administration) between initial teacher education centres and schools at the obligatory education levels.

This situation leads one to agree that

'teacher training for an education of quality with new problems has not been given serious consideration' (Camps, 2000, 83),

as is indicated in the document drawn up by the Fundación Alternativas on the problems of today's education. Rico (2000) goes further in considering

'critically the present situation and denounces the desolate panorama that is looming, which makes it understandable that there is the social preoccupation being expressed about the degradation in primary mathematics teaching, one of the major causes being the sparse and deficient preparation of the teachers.' (p. 50).

3 Tension between theory and practice. New referents

One of the problems mentioned in the Introduction referred to the tension between theory and practice. Recent years have seen contributions to the literature on mathematics education which have set up new referents for the reconsideration of the subject. There have been analyses connecting the knowledge of mathematics, the knowledge of the didactics of mathematics, and pedagogical knowledge; others with interesting conclusions drawn from mathematics education research, especially studies analysing the knowledge of prospective, novice and expert primary teachers; and there has been an intensification of the search for nexus between initial and ongoing teacher education (Rico & Carrillo, 1999).

There have also been numerous important Spanish contributions on mathematics education dealing with the characterisation of the basic theoretical and practical knowledge to be considered in the mathematics education of teachers (Llinares, 1994; Blanci, Mellado & Ruiz, 1995; Carrillo, J. & Climent, 1999; Contreras, L.C. & Climent, (eds.), 1999; Corral & Zurbano, 2000), allowing new teaching projects to be designed in this field. The starting point for all of them is to consider the process of learning to teach as taking place on the basis of active processes that are developed in a

specific context characterised by the time, the place and the actors.

These contributions assume that, in teacher education, the teachers endow their actions as a whole with meaning with reference to their own previous school-level experiences. The result is that they have a firmly fixed body of knowledge and conceptions about mathematics and the teaching/learning of mathematics, as well as about the exercise of the profession of mathematics teacher.

Also, one's own teaching experience together with the results of numerous investigations show the prospective teachers to have a deficient level of knowledge of basic mathematical content. The studies show that the mastery of the content is directly proportional to the capacity to manage the class and to the skill in creating and sustaining a productive discourse in the classroom (Mellado, Ruiz & Blanco, 1997).

These results lend urgency to the continuing debate on the relationship between mathematical content and the Didactics of Mathematics in teacher education. They are used to justify the maintenance of mathematical content subjects in initial teacher education Study Plans. In my opinion, the prospective teachers' low level of mathematical knowledge concerning specific topics does not mean that we have to return to giving them that same content normally following transmissive procedures.

The repetition of content studied in primary, secondary and pre-university education, on most occasions following similar models, contributes to reinforcing and consolidating the students' conceptions on mathematics and its teaching/learning which, more often than not, represent significant contradictions and misfits with the current curriculum proposals. Neither is such reiteration of content and methods any guarantee that the students will attain a higher level of mathematical knowledge. Rather it serves to reinforce their ideas about the difficulties of mathematics and their general aversion to the subject. All of this obviously has a highly negative impact on their education and future activity as mathematics teachers.

As Fortuny (1995) notes:

'We must always keep in mind that the choice of way of working influences, if you wish, indirectly the formation of conceptions and habits of prospective teachers. These hidden habits strongly condition the conceptions and teaching performance of our students. They have become integrated into schemes of teaching action by way of a 'hidden curriculum' which is learnt, without any of its intentions being made explicit, by way of the (often unconscious) life experiences of the teacher educators. At times, this process of cultural adaptation transmits tactics which are undesired or in contradiction with the explicit curriculum of the subject.' (p. 45).

The problem is not that our prospective teachers have to study more mathematics, but that attention has to be shifted to other variables. The reason is that a teacher's knowledge is different from that of a specialist since it is related to the school-level context and to the teaching/learning process itself. Consequently, one will have to take into account simultaneously and coherently school-level mathematics and the problems of its teaching and learning, the knowledge and conceptions that students have about the topic, and contributions to the literature on the teaching/learning of mathematics. All of this will have to be considered in the light of specific teaching practice.

Finally, one notes that the tension between theory and practice reaches a new dimension when one considers the results concerning the characterisation of prospective teachers' practical knowledge. These results indicate that the teachers' teaching strategies differ according to the material that they are teaching, and that their activities and teaching practices depend on the subject (Mellado, Ruiz & Blanco, 1997). As a consequence, we believe that, in addition to an overall

analysis of the practical knowledge appropriate to psychopedagogical topics, there is a need for the differentiated intervention of the Didactics of Mathematics during practice teaching as part of the process of learning to teach. The reason is that the prospective teachers do not possess sufficient cognitive schemes to learn effectively from their classroom observations and experiences. This therefore requires the introduction into initial teacher education programs of activities to aid our prospective teachers to learn to teach mathematics through observation and practice, by means of processes of reflection on their actions. These activities would have to be structured and sequenced according to the prospective teachers' level of preparation and to whether the period concerned is before, during or after their practice teaching.

All of the above should lead to the establishment of a new curricular framework for the mathematics education of primary teachers in which account is taken of the recommendation of Ruiz (1988a) that

'the subjects ascribed to our area of knowledge must offer prospective teachers the knowledge of the Didactics of Mathematics that they will find useful for understanding, designing, managing and evaluating the processes of the teaching/learning of mathematics. Nonetheless, a subject's content must be chosen taking into account its instrumenatality for the exercise of the teaching profession, and not be limited to a series of theoretical notions whose interest corresponds essentially to the work of a researcher.' (Ruiz, 1998a, 5).

The constant perspective has to be one of educating reflexive and self-reliant professionals capable of taking on the singular, ambiguous and uncertain situations involved in life in the classroom, and of designing and constructing at all times suitable teaching strategies, and with the capacity to experiment and evaluate (Blázquez, 1995).

4 Conclusions

In the light of the foregoing reflections on different issues relating to initial primary teacher education in the area of mathematics, I would like to point to, by way of revindication, a number of questions that we must face in the immediate future. It is only fair to recall that many of these questions were set out as conclusions to the various symposia that have been held on the subject (Blanco & Cruz, 1997; Abraira & de Francisco, 1998; Murill, Escolano & Gairín, 1998; Corral & Zurbano, 2000), as well as in Rico (2000).

- The university level for initial primary education must be a full degree, This will permit homologation with other European countries, where the normal duration of the courses is four or five years.
- This enlargement would involve the design of more professional Study Plans, with a common core syllabus, allowing the education firstly of primary teachers, and then of specialists in the different specialities of the LOGSE.

'The passage to the full degree level would allow a solid common education for all primary teachers to be conjugated with an initiation into specialisation, which would involve in a differentiated manner all the areas of the curriculum.' (Rico, 2000, 51).

- There must underlie all the future curricular modifications the perspective of regarding the teacher as a reflective and self-reliant professional who must know how to take decisions and design and construct teaching strategies which are suited to school-level mathematics content and to the specific contexts in which the call for such strategies might arise.

- This implies continuing to encourage research into teacher education in the area of mathematics, so as to more deeply analyse teaching/learning problems on specific topics of school-level mathematics, based on classroom situations and promoting the construction and development of the mathematical Pedagogical Content Knowledge of the prospective teachers.
- It also implies considering, from the above perspective, the curricular renovation of initial teacher education, setting out goals, content, methods, and evaluation criteria according to the knowledge that the primary teachers will need in their career. But to put these intentions into practice would require, as Llinares notes (1998), a coherent and collective response to attain common referents for subjects with the same title and in the same university degree course but in different universities. 'The search for common ground within which to form a response to the challenges posed by the new changes in the study plans is a complicated task.'
(Llinares, 1998, 27)
- We must procure the greater involvement of the Didactics of Mathematics in practice teaching as the necessary context for learning to teach mathematics. Reflection during and on teaching action in mathematics must be under the direction of a specialist in the area.
- There must be set up a stable, rigorous and coherent institutional framework between the university and non-university institutions involved in initial and ongoing teacher education which will allow the issues that we have been reflecting on to be approached with seriousness and seriousness and rigour. Finally, by way of a summary, let me repeat one of the conclusions of the 'Jornadas Matemáticas' (sessions devoted to Mathematics) in the Spanish parliament's Congreso de Diputados in January 2000 as part of the celebration of the year 2000 as the Year of Mathematics, which noted
'the need to carry out major transformations in the preparation of primary teachers with respect to their education relating to mathematics and its didactics in order that our educational system will be able to completely face the required changes'. (Díaz, Fernández, Martín & Riera, 2000, 127).

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