

THEMATIC SECTION:
MATHEMATICS EDUCATION



Models of Teacher Education and Professional Knowledge

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ABSTRACT – Models of Teacher Education and Professional Knowledge¹. In order to find relationships between the professional knowledge of teachers and the structure of training institutions, a comparative study is carried out between the pre-service training models that occurred in Portugal between the second half of the 19th century and the second half of the 20th century. Institutionalization forms, hierarchies and institutional relations with other educational organizations are discussed. Focusing essentially on the professional knowledge of teachers who teach mathematics, we study how it occurs within each of the models.

Keywords: Teacher Training. Knowledge of Teachers. Models of Teacher Education. History of Mathematics Education.

RESUMO – Modelos de Formação de Professores e Conhecimento Profissional. Com o objetivo de encontrar relações entre o conhecimento profissional dos professores e a estrutura das instituições de formação, faz-se um estudo comparativo entre os modelos de formação inicial que ocorreram em Portugal entre a segunda metade do século XIX e a segunda metade do século XX. Discutem-se as formas de institucionalização, as hierarquias e as relações institucionais com outras organizações educativas. Focando essencialmente no conhecimento profissional dos professores que ensinam matemática, estuda-se como ele ocorre no seio de cada um dos modelos.

Palavras-chave: Formação de Professores. Conhecimento dos Professores. Modelos de Formação de Professores. História da Educação Matemática.

Introduction

With the aim of finding relationships between the professional knowledge of teachers and the structure of training institutions, this text makes a comparative study among the training models used in Portugal between the second half of the 19th century and the second half of the 20th century. Focusing essentially on the professional knowledge of teachers who teach mathematics, we study how it occurred within each of the initial training models. Before entering the study of each model properly, we discuss the institutionalization of teacher education as well as professional teaching knowledge, concepts that are necessary for this text.

Institutionalization Models for Teacher Education

During the 19th century, especially in its second half, when professional training for teachers became urgently needed, the ways in which this training could be carried out were debated in several countries. The institutionalization of this training was accompanied by the creation of disciplines, some involving general knowledge needed by all teachers (psychology, general didactics, etc.), others built on methods for teaching specific subjects.

Analyzing teacher training institutions for primary education in some Swiss cantons, Borer (2009) characterizes two models. The first, the normal one, is made up of secondary-level training institutions to which future teachers access after primary schooling. In the second, the superior, institutions of general and professional formation are constituted. General training takes place first in secondary schools, complemented by professional teacher training in higher education institutions. In both cases, it is possible to establish a relationship between these models and the professional knowledge they generate.

In the Portuguese case, we find three models of teacher education: the first, which we will call the normal model, functioned through normal schools for the training of primary school teachers that, at the beginning, took on characteristics of secondary schools, and that, gradually, took the form of intermediate vocational training institutions; the second, which we will call the higher education model, centers professional training on higher education institutions and will occur in two moments, in the beginning of the 20th century, interrupted in 1930 and then in the last quarter of the century; the third, the pedagogical internship model, was in force for most of the 20th century for the training of secondary school² teachers and focused the main part of training on specific secondary schools, complemented by the attendance of broad educational disciplines at the university.

Some studies have contrasted these models. An overview can be found in Pintassilgo, Mogarro and Henriques (2010). The training of teachers for primary education was extensively analyzed in the project coordinated by Joaquim Pintassilgo (2012). As for secondary education,

the topic was initially studied by Joaquim Ferreira Gomes (2005)³ and, more recently, by António Gomes Ferreira and Luís Mota (2013), who articulated three components: scientific training in the domain of the specialty that the teacher will teach, the scientific preparation of the psychopedagogical scope and the teaching practice. As for the teaching of mathematics, a global study can be found in Matos (2018).

Teachers' professional knowledge

This work seeks to study professional teaching knowledge, and its purpose is, using the Portuguese case, to cover three models of teacher education, contrasting their relations with the production of specific teaching knowledge.

The studies initiated by Shulman (1986) provided a new perspective on teacher knowledge. In his first works on the subject, this author suggested some components for teacher knowledge, including content knowledge and pedagogical content knowledge. The emphasis given to the latter, highlighting its originality and its inseparability from teaching practice, in addition to giving an innovative view of the teacher's knowledge, making it indispensable in an appreciation of the quality of teaching, brought it to the center of educational policies, showing how essential it is for the understanding of the school and for the design of curricular and training changes.

The works of Hofstetter and Schneuwly have also been concerned with knowledge related to teaching and training (see, for example, 2009). Focusing, in particular, on formalized knowledge (p. 17), and moving away, therefore, from approaches that incorporate the practical dimension of this knowledge, they distinguish between knowledge to teach (*savoirs à enseigner*), that is, those that are the object of teaching and which constitute the center of the teacher's activity, and the knowledge to teach (*savoirs pour enseigner*), constituted by knowledge about what will be the object of training and which are like tools that teachers use to teach the first.

Other researchers, including Shulman himself, have developed models that allow for greater detail in the characterization of professional teaching knowledge, linking them to the specificities of each school subject. Among these authors, the work of Ball, Thames and Phelps (2008) deserves to be highlighted. Based on the observation of mathematics class activities and the analysis of teacher tasks, they distinguish different types of knowledge (which they call *domains*), allowing for a clearer disentanglement of the concepts of content knowledge and pedagogical knowledge, making them more adapted to the study of school mathematics knowledge. We highlight, in particular, common content knowledge, which refers to mathematical knowledge and skills that are also used in contexts other than school, and specialized content knowledge, composed of tasks mathematics that are normally performed by teachers to present mathematical ideas, answer students'

why questions, find examples for a specific mathematical aspect, recognize what involves using a specific representation, relate representations to the underlying ideas and to other types of representations, relate a topic that will be taught with other topics that have already been worked on or that will still be worked on, explain the objectives of the course to parents, evaluate and adapt the mathematical contents of the manuals, change the tasks to be proposed, making them easier or more difficult, assess the plausibility of what is asked by students, give and evaluating mathematical explanations, choosing and developing definitions, using mathematical language and notation and critiquing their use, asking mathematically productive questions, choosing representations with a specific purpose, and ascertaining equivalences.

In this text, we address the three models of teacher education used in Portugal, and, following the typology proposed by Ferreira and Mota (2013), we characterize their objectives, training components, duration, and functioning. To discuss the specific teaching knowledge involved in each model, we turn to the case of school mathematics.

The Normal Model

The institutional training of teachers for the first years of schooling in Portugal, primary education, began to take shape in the mid-nineteenth century. There are previous examples, such as the training of teachers associated with religious orders, namely the Jesuits; training experiences based on mutual teaching or in the military context, already at the beginning of the 19th century; or those of the liberal reforms, namely that of 1844, which regulates normal schools (Candeias 2021). However, it was not until 1862 that this training was institutionalized, with the inauguration of the Escola Normal Primária de Marvila, in Lisbon. At the end of the 19th century, the network of normal schools expanded throughout the country until, with the 1901 reform, a diploma from a training school became mandatory to practice the profession. The Normal Primary Schools will be the training place for primary school teachers until 1930. After this date, the Escolas do Magistério Primário will succeed them, which will operate until the second half of the 1980s.

It is the variations of these institutions and the way in which the professional knowledge of the teacher for the teaching of mathematics was modeled in them that we will analyze in this section of the text.

The Normal Primary Schools

Normal primary schools are regulated for the first time in Portugal in 1844, in the Costa Cabral Reform, but this regulation did not have practical effects. It was only in 1862 that these schools came into existence, with the inauguration of the Escola Normal Primária de Lisboa, for males, in Marvila, which operated until 1881. To broaden the scope of the normal schools, in the beginning of 1869, there was an attempt

to associate normal education with some liceus (secondary schools), where subjects of pedagogy would be taught. However, as early as 1870, a different path was chosen, creating reference normal schools in Lisbon, Porto, Coimbra, Évora and Viseu (Gomes, 1996). Already under the framework of the reform of 1878-1881, in the final decades of the 19th century, there was an expansion of normal education when qualification schools for primary teaching were established in the country's district capitals, with a simplified training in relation to the five reference normal schools.

In 1910, at the end of the Monarchy, there were six normal schools in Lisbon, Porto, and Coimbra, one for each sex, and 17 qualification schools for primary teaching. This number of schools was seen at the time as an oversizing of the system, because more teachers were being trained than was considered necessary. After the establishment of the Republic in Portugal, in 1910, a period of some instability followed, which was also reflected in education. Some enacted reforms had slow implementation and others were not even regulated. Only the 1919 reform, that brought a republican transformation to normal education, centered on the values of co-education and of a laic school, was effectively implemented. This reform will mark the beginning of the transformation of the qualification schools for primary teaching into higher primary schools, at the same time as the new republican normal schools begin their activity, first in Lisbon and then in Porto, Coimbra, Braga, and Ponta Delgada. This reduction in the number of normal schools represented an attempt to guarantee quality in the initial training of teachers at this level of education (Pintassilgo, 2012).

After the Military Dictatorship implanted in 1926, the normal primary schools operated until 1930. In that year the *Escolas do Magistério Primário* were created, which involved a change in the school organization, in the curriculum and the programs. This change was not easy because there were many supporters of the republican model in the educational field (Baptista, 2004). In 1936, enrollment in primary teaching schools was suspended, alleging that there was an excessive number of teachers at this level of education. In 1942, these schools reopened, reconfigured, and placed under the control of the central government, while the values of the *Estado Novo* began to be integrated into the curricular organization, a situation that continued until 1974 (Pintassilgo, 2012).

Primary school teacher training schools, whether normal schools or *Escolas do Magistério Primário*, were generally regulated by legislation for primary education, and were therefore under the supervision of the ministry that oversees public instruction. However, there were changes in their autonomy on the way they selected candidates, or how end-of-course exams or access to the profession were organized.

The Revolution of April 25, 1974, brought about significant changes in these schools, and two phases can be distinguished, that of the revolution (1974-1976) and that of normalization (1976-1978). Teacher training schools experienced moments of turmoil, however, the legisla-

tion was maintained with only occasional changes, in the next phase (Mogarro, 2014). Despite this, there was a demand for these schools much higher than in years prior to 1974, doubling the number of applicants.

Admission to Teacher Education Schools

The conditions of admission to primary school teacher training schools and the presence of mathematics in the entrance exams underwent some changes in the period from 1844 to 1930. Initially, the required qualifications were not mentioned, but after the reform of 1878-1881, preference was given to those who took the exam in the complementary course of primary education. During Monarchy, these qualifications were maintained, and, in general, an exam equivalent to the primary grades was required. However, the 1901 reform also required a special entrance exam. At this stage, the contents of mathematics were always present in the entrance exams, essentially focusing on arithmetic and the practice of the four fundamental operations with whole numbers (how natural numbers with zero were called then), decimals and “quebrados” (their name for fractions). It should be noted that, from 1869 onwards, the decimal metric system was included in the entrance exams, after this system was adopted in Portugal in 1852. The 1902 regulation, associated with the 1901 reform, also introduced practical exercises of geometry in the contents of these exams.

During the beginning period of the Republic, qualifications for access to normal schools gradually expanded, no longer requiring only the primary education exam. Now, the course of upper primary schools or even the final exam of the course of liceus, as happened in 1919, was required. This greater demand on qualifications was also reflected in the contents of the entrance exams, which, in addition to arithmetic and geometry, now include elementary algebra. These exams also comprised a linear drawing and ornamentation test, which included some geometry content. These schools are thus beginning to differentiate themselves from other secondary schools.

In the last phase of normal schools, after the establishment of the Military Dictatorship in 1926, the qualifications established for access to schools are maintained, requiring the 2nd cycle of the secondary school (5 years of schooling after primary), which reinforced the differentiation of their status in relation to secondary schools. The contents of the entrance exams continued to be centered on arithmetic, geometry, and elementary algebra, with written and oral tests.

After 1930, and when Escolas do Magistério Primário were instituted, the conditions of access were changed. We witness a reduction in the required qualifications, which are now only elementary primary education. The regime weakens the status of these schools, bringing them back to the level of secondary schools. However, candidates with the general course in secondary schools were exempt from the exam. Only after the reopening of schools, in 1942, were the access qualifications

increased again, with the 2nd cycle of secondary school being required, which remained until 1974. After this reopening, and for 40 years, the Escolas do Magistério consolidated themselves as professional training institutions distinct from liceus.

Mathematics contents remained in the exams for admission to training schools, both in written and oral tests. Despite the reduction in access qualifications after 1930, the contents of the entrance examinations were not revised and apparently remained over an extended period.

In 1977, after the 1974 revolution, new conditions for admission to schools were defined, requiring the complete course of secondary schools, which corresponded to 11 years of schooling. This new definition of minimum qualifications raised the level of demand for access to courses, namely in the subjects of Portuguese, History and Mathematics, with the completion of written and oral tests. This situation caused a high failure rate in the written admission tests. This increase in the minimum qualifications also demanded greater maturity from the candidates, who could thus only start their professional life after the age of 18.

Mathematics in the Courses of Teacher Education Schools

Mathematics content has always been present in the courses of normal primary schools, asserting itself in the syllabus as a central subject, with an identical weight to the disciplines of Portuguese. Adopting the nomenclature used by Baptista (2004), which divides the course plans into the component of specialty sciences and general education, pedagogical component, and practical component, we observe that the contents of mathematics are present in the different components of the course. In the component of specialty sciences and general education, they are, initially, disciplines that address contents of arithmetic and geometry, where, from 1860 on, the legal system of weights and measures was integrated. Algebra is also present in the disciplines of this component, namely from the 1878 reform, regulated in 1881. From 1870, the contents of these disciplines will also encompass applications of mathematics, namely the notions of commercial and agricultural book-keeping, giving the course a facet of professional training (Matos, Rodrigues e Candeias, 2019). After 1910, in the period of the Republic, other applications of mathematics are included, such as, cosmography and notions of rural economy.

In the final period of operation of primary normal schools, the disciplines of the specialty sciences component also start to incorporate contents related to the teaching methodology of arithmetic or geometry, in a curricular integration of contents from the different components of the course.

After 1930, disciplines with mathematical content moved to the pedagogical component of the course. In the 1943 syllabuses, the math-

ematical contents were approached in Didactics or Special Didactics disciplines, essentially developing the teaching methodologies of numbers and respective operations, the teaching methodology of fractions and decimals, the teaching methodology measures and problem writing rules. Despite changes in the global program made in 1960, those discipline syllabuses remained unchanged.

In the two phases described above, related to the moment after the 25th of April 1974, there were four changes in the study plan of primary teaching schools, also reflecting the political and social turmoil experienced at the time. A first change came in October 1974, with the elimination of some disciplines connoted with the ideology of the previous regime, such as the Political and Administrative Organization of the Nation or Women's Education and the modification of disciplines such as the Special Didactics of Group A and B, which were now called General and Specific Didactics, although their program was omitted in the decree that created this study plan. Regarding the component of specialty sciences and general education, only the discipline of Portuguese is introduced in the course curriculum, considered essential in teacher education.

In the following academic year, 1975/76, a new curriculum was approved, structuring the course in three years and the curricular structure distributed around three areas, psycho-pedagogical, scientific and expression. The scientific area was reinforced and, for the first time since 1930, there was a discipline of Mathematics in the first two years of the course, with two hours a week in each of these years.

The syllabus of the teaching schools changed again in 1977 and 1978. The discipline of Mathematics, which in the previous reformulation constituted its own scientific area, was now integrated into a set of subjects designated as the Area of Experience, that also included the disciplines of Natural Sciences, Modern and Contemporary History of the Portuguese Society and Cultural Anthropology. In the Mathematics program of this study plan, themes such as 1. Mathematical Logic and Set Theory, 2. Binary Relations, 3. Number, 4. Operations, 5. Rational Numbers, 6. Quantities and Measurement of Quantities, and 7. Introduction to Geometry.

The Area of Pedagogy, Methodology, and Didactics

As mentioned above, until 1930, mathematical contents were present in the different components of the courses in normal primary schools. Although the first regulation of 1844 did not indicate disciplines of pedagogy or methodology, as of 1860 these disciplines were included in the course's study plan (Candeias, 2021). Initially, the approach to methodology was generalist and focused on school organization and general teaching methods. The development of the special methodology, integrated in the disciplines of Pedagogy and Methodology, where the teaching methods of the different subjects that make up the primary education curriculum were developed, led to the produc-

tion of a specific knowledge for teaching, which ended up being materialized in the textbooks produced for these disciplines.

After 1930, the contents of mathematics were present exclusively in the disciplines of the pedagogical component. It is in the disciplines of Didactics, and later Special Didactics, that specific knowledge to teach will be developed. The reformulation of the course carried out in 1960 reinforced the component of teaching methodologies, either by increasing the workload of these subjects or by separating the subject into Special Didactics of Group A and B, in which group B included the didactics of subjects such as math or natural science.

The changes that emerged in the syllabus after April 25, 1974, ended the Special Didactics discipline for Group A and B. These disciplines were initially replaced by the disciplines General and Specific Didactics, although a program was not specified for this subject. In the syllabus approved in 1978, it is in the discipline of Methodology and Pedagogical Techniques, integrated in Educational Sciences, that this gap created in the training of primary school teachers is filled.

Objectified knowledge in textbooks for preservice teachers' primary education

The institutionalization of the training of primary school teachers in schools suitable for this purpose, normal primary schools or Escolas do Magistério Primário, led to the development of specific knowledge for teaching, objectified knowledge (Barbier, 1996), present in textbooks for both the disciplines of the specialty sciences component, as for the pedagogical component. Thus, from an early age, manuals that discipline professional knowledge, both those that describe the mathematics to be taught, and those that address the methods, sequences, and materials for teaching mathematics, emerge. Although the selection and approval of textbooks was centralized in the Government for a short period in the beginning of the 20th century, other local or national publications can also be observed throughout the different phases that these training schools go through.

Although an ascendancy of study plans and programs can be identified in the way manuals are prepared and organized, it is also possible to detect a certain autonomy of their authors (Candeias, 2021). While the authors of manuals in the specialty sciences and general education component, which publish manuals in the late 19th and early 20th centuries, are more focused on common knowledge of the content, this knowledge allowed the proposals presented in them to also promote a specialized knowledge of the content and the development of pedagogical knowledge of the content, namely of the content and its teaching.

The Higher Education Model

If, for the training of primary school teachers, a vision of the importance of dedicated training institutions has been consolidated in public authorities since the first half of the 19th century, this has not happened for secondary school teachers. This only occurred at the end of the 19th century, when the Portuguese secondary education system underwent a major change by the hand of minister Jaime Moniz (Proença, 1997). For the scope of this article, its Regulation, presented in 1895, promised to create specific courses for teaching qualification and established that, after 5 years, no candidate for teaching in secondary schools would be admitted to without having attended those courses. Although these courses were only created later, it was the first time that legislation was introduced to institutionalize teacher training for secondary education.

The Qualification Course for Secondary School

As a result of these intentions, in 1901 the Qualification Course for Secondary School (Curso de Habilitação para o Magistério Secundário) was created to operate in Lisbon, as part of the Superior Course of Letters (Pintassilgo; Mogarro; Henriques, 2010). The course lasted four years, the first three being dedicated to scientific training, given at one of the higher institutions in Coimbra, Lisbon, or Porto, and the fourth year, aimed at pedagogical training, was held in Lisbon, at the Superior Course of Letters. The curriculum for this fourth year consisted of three subjects: Psychology and Logic; Secondary Education Pedagogy; History of Pedagogy and of Secondary Education Methodology from the 16th century onwards. In the beginning, it only provided for the training of teachers in the humanities (*sciences of the spirit*, as they were then called), which was expanded the following year to the area of sciences, which included mathematics, physics and chemistry, the natural-historical sciences, and drawing.

The Normal High Schools

In 1911, after the establishment of the Republic in 1910, the Normal High Schools (Escolas Normais Superiores) (ENS) were created, attached to the Universities of Coimbra and Lisbon. These schools, in addition to training secondary school teachers, also aimed at training teachers for the Normal Primary Schools and Superior Primary Schools and the preparation of staff for admission to the competition for the posts of teaching inspectors. Born from the republican will to value education, the ENS intended to give the dignity of a higher course to professional teacher training and played a central role in the training of professionals for the teaching of mathematics for secondary schools (Santiago and Matos, 2019). They began operating regularly in 1915 and ended in 1930. Despite a precarious life, in these 15 years these institu-

tions played a central role in the training of professionals for the teaching of mathematics for secondary schools.

Candidates for ENS were required to have a bachelor's degree (three years) in a specialty area (for example in mathematics), obtained at the University of Coimbra or at the polytechnics of Lisbon or Porto. The ENS course lasted two years, the first of which was for pedagogical preparation and the second for initiation into pedagogical practice. The disciplines in the first year were⁴: Pedagogy, History of Pedagogy, Child Psychology, Theory of Science, General Methodology of Mathematical Sciences and Natural Sciences, and disciplines of legislation, hygiene, and morals.

This curricular plan valued general and specific pedagogical training in a context of affirmation of education and psychology as experimental sciences. Themes dear to the republican spirit of the time are also included: hygiene and moral education, the latter being educating for a republican and secular citizenship (Pintassilgo, Mogarro and Henriques, 2010). Most of these subjects are like those already existing in normal schools for teacher training for primary education (Candeias and Matos, 2016), but the General Methodologies are new as they focus on the specific professional knowledge of each school subject.

In the second year, the pedagogical practice took place in high schools. In addition to the master classes, once a week, conferences were proposed, followed by discussions, either on the work of great educators, from the 16th century onwards, on books or pedagogical articles recently published in Portugal or abroad, or on questions of method, hygiene, and school discipline.

The course of teacher training culminated in the State Exam whose jury was appointed by the government and made up of three secondary school teachers and four university professors. The Exam consisted of a class observation test taught by the candidate and a presentation on a theme of the program and the debate of a dissertation.

Teaching knowledge and the Normal High Schools

The ENS represent an outstanding point in the development of school knowledge in Portuguese secondary education. For the first time at this level, the Schools will provide a space for reflections and practices, focusing on both school mathematics and methods for teaching the subject. We will focus on the discipline of General Methodology of Mathematical Sciences, and on the dissertations presented by the candidates that have been studied (Matos, 2017; Santiago and Matos, 2019).

When we look at the everyday documents of the discipline, we find the appreciation of the laboratory approach, the predominance of concrete over abstract, intuition over logic, applications of mathematics over the abstract, perspectives that go back to the enthusiasm that Perry's ideas received elsewhere (Santiago and Matos, 2019).

Furthermore, the proposals of the Escola Nova movement are at the base of many documents studied in the discipline. In Portugal, this perspective was widespread from the end of the 19th century, as Education (or Pedagogy) and Psychology began to seek acceptance as scientific areas. The republican movement used the Escola Nova banner (intuitive teaching) as a perspective for improving schools (Mogarro, 2012). In the documents studied, the ideas of this movement are essentially associated with the laboratory method and its emphasis on student motivation and concrete approaches to teaching mathematics, although in dissertations these arguments are presented in greater depth, usually based on psychology or in thinkers of education.

The option for these themes should be attributed to the professor of General Methodologies, Luciano Pereira da Silva (Matos, 2020). A navigation historian and a mathematician by profession with many published works, he brought with him an appreciation of the heuristic dimension of mathematical thinking that he translated into the laboratory method and which he will teach intensively in the 14 years he oversaw the discipline. João Pereira Dias, his successor, followed in the footsteps of his mentor.

Studying the dissertations presented for the State Examination also helps us to characterize the professional knowledge of secondary school mathematics teachers taught in ENS (Matos, 2017). On the one hand, a good portion of the studied dissertations recompose the mathematical knowledge usually found at the university level, either in terms of content (definitions, properties, theorems, algorithms, etc.) or in terms of methods (sequence, resources, representations, metaphors, etc.), adapting it to secondary education. On the other hand, an important number of texts reflects on mathematics and its working methods, and almost all of them reject the primacy of deduction, whether in the construction or presentation of mathematical knowledge, emphasizing intuition and induction. The ideology of Escola Nova permeates many dissertations, many of them seeking to make it happen in secondary education (the lessons of things, focusing teaching on the sensitive, the laboratory method, the graphic method, etc.).

During the 15 years of operation, the ENS were never integrated into the university structure, always operating in temporary facilities. Not having its own faculty, the teaching of subjects was provided by professors from other faculties. These circumstances did not allow for the consolidation of objectified knowledge in the form of textbooks on the teaching of mathematics for secondary education.

Teaching Licenciates

From 1930 onwards, the model for training secondary school teachers changed, as we will see in the next section, and only in 1971 did it return to the university (Pintassilgo; Mogarro; Henriques, 2010). In that year, the Faculties of Science began to offer professional training as part of a undergraduate degree (Licenciatura). After three years

of scientific training leading to a bachelor's degree, future teachers entered the Educational Training Branch, consisting of two years, the first, pedagogical culture, that included disciplines as psychology, general didactics and methodology of Mathematics and the elaboration of a monograph. The second year consisted of an internship at a secondary school. The Faculties of Arts only adopted this model in 1988.

The Pedagogical Internships Model

In 1930, the ENS were extinct, and the professional training of secondary school teachers began to be carried out in two-year pedagogical internships carried out in Liceus Normais. The responsibility for training was, therefore, removed from universities and transferred to these liceus, under the direct coordination of the Ministry of Education. This change, which will be in force until 1971, reflects a desire for greater political control over teacher education as well as a perspective that teaching knowledge must be formed essentially in practical contexts (Almeida, 2018; Pintassilgo; Mogarro; Henriques, 2010). As for the ENS, these internships were accessed after a degree obtained at the Universities, which, for future Mathematics teachers, was the degree in Mathematics of the Faculties of Science. Training was provided in two separate parts: the pedagogical culture, given in universities, and the pedagogical practice in secondary education establishments (Liceus Normais).

In this model, the knowledge of the pedagogical culture was taught by the then created Section of Pedagogical Sciences of the Faculties of Arts and its study plan consisted of five subjects: Pedagogy and Didactics; History of Education; School Organization and Administration; General Psychology; School Psychology and Mental Measures; School Hygiene (single semester subject). The pedagogical culture component will provide future teachers with an identical theoretical professional preparation for all candidates. Enrollment in these disciplines was open to individuals with the secondary school course. Candidates could access these courses at any time during the licenciatura (usually they attended them in the 4th or 5th year) and they should have been approved in them before the second year of the internship. The diversity of students enrolled in these courses would certainly make it difficult for university professors to link this theoretical stage with practical training.

The pedagogical practice of future secondary school teachers was carried out only at the Liceu de Pedro Nunes, in Lisbon, and at Dr. Júlio Henriques, in Coimbra (later Liceu de D. João III). In this professional experience, a supervisor teacher (*metodólogo*) accompanied the future secondary school teacher and was responsible for guiding him or her during the internship. Supervisors were appointed by the Minister, at the proposal of the dean, from among the tenured professors of liceus.

During the two years of the internship, the trainees prepared and discussed lesson plans, attended classes as well as being assisted during

their own classes, held regular seminars with the supervisor, attended and presented conferences, among other works (class direction, teachers' meetings, rectory, vice-rectory, exams, etc.). In the end, trainees had to pass the State Examination. This exam consisted of three pedagogical tests – a written test, a critical essay and a lesson to students – and was intended to assess the candidates' knowledge of pedagogical issues in their applications to secondary education and teaching. The jury for the State Examination was appointed by the Minister of Education and consisted of a higher education teacher, the President, and four regular teachers of liceus, one of whom was the candidate's supervisor.

In 1947, teacher training was centralized in Liceu D. João III, in Coimbra. This concentration reveals the intention to standardize and, in this way, control even more teacher education. The dictatorial regime tried to control the desire for change in the post-war period, and the decision is accompanied by a set of repressive measures on the scientific community, when almost the entire group of mathematicians is expelled from teaching, and many emigrate. In 1957, in a context in which the regime, while maintaining its dictatorial character, sought to encourage economic development, internships were now carried out in three regular liceus, which now include the Liceu D. Manuel II in Porto.

The professional situation of secondary school teachers in the mid-1960s was very problematic. Grácio reveals that

[...]the condition of teachers has been progressively deteriorating at all levels of education; the shortage of teachers in the full range of academic and pedagogical qualifications, career desertion, recruitment difficulties, even to make up for the normal wear and tear resulting from the aging of staff, are symptomatic of a crisis (Grácio, 1968, p. 47, authors' translation).

Due to the lack of professionally qualified teachers, the training of teachers in secondary education will change considerably in 1969: the internship will last only one year, the intern will have their own classes, the remuneration of the internship is improved, and the internships may now occur in other liceus besides the three Liceus Normais (Almeida, 2018). All the supervisors were coordinated at national level by another, appointed for each subject by the Inspectorate. This coordinator-supervisor went to all schools where there were internships, attended classes and evaluated previously defined work, to standardize training. However, the model became untenable not only because of the number of meetings and displacements, but also because of the university's inability to respond, which should evaluate the latest scientific and pedagogical works (Henriques, 2017).

Professional Knowledge Developed During the Internships

Contrary to what happens in the normal model for primary school teachers, in which books for teacher education have been published since the end of the 19th century, there are no textbooks by Portuguese

authors explicitly aimed at the pedagogical training of secondary school teachers and this must be related to the fact that there were practically no schools dedicated to training for this level of education. There are, however, elements (Almeida, 2013) that allow us to state that it is very likely that trainees resorted to foreign authors. We will present two examples, the first of an intern in the early 1940s in Coimbra, António Augusto Lopes, who reveals, in interviews, that he relied on the books *The teaching of mathematics in secondary schools*, by Arthur Shultze, published since the 1910s and *The teaching of secondary mathematics*, by Jasper Ole Hassler and Rolland Ryther Smith, published since the 1930s, to reflect on the teaching of mathematics (Almeida, 2013). As for Liceu Pedro Nunes, trainees from the 1960s refer to works by the CIEAEM group and by Puig Adam, among others (Monteiro, 2018).

The written productions of the trainees in Liceus Normais reflect the elaboration of their professional knowledge. Teresa Monteiro's work (2018), analysing trainees' monographs from the 1960s when the reform of Modern Mathematics was beginning, allowed us to understand how the pedagogical knowledge of the content was slowly being built, not at the individual level, but at the within a professional community. It was possible to distinguish three periods: the first starting in 1957 and extending until around 1962, in which themes related to Modern Mathematics in general are proposed, and in which the monographs focus on conceptual explorations of new ideas. In this first period, the trainees and the supervisor recomposed their knowledge of the content: modern mathematics introduced new mathematical themes that are recomposed in a way relevant to secondary education. In a second period, until 1965, although the proposed themes continue to be of a general scope, the first concrete curricular proposals begin to appear, but without making practical applications. During this period, it proved necessary to invent and conceptually test language, sequences, new representations, etc., before applying them in class. In a last period, with effects from 1965, trainees reflect on the pedagogical experience of introducing Modern Mathematics in the last years of secondary education. The practical component of using mathematics in class is now very strong. This work suggests that, in a context of great curricular change (the reform of modern mathematics), it was not possible to immediately start the pedagogical recomposition without teachers first appropriating the new scientific contents. However, for this to happen, it was necessary to rewrite scientific knowledge itself in a way adapted to the purposes of secondary education. Thus, and still without including studies on use in the classroom, the first works focused on recomposing scientific knowledge, choosing the relevant themes, selecting appropriate sequences, developing appropriate terms, definitions, and symbols, etc. In fact, trainees, and, to a certain extent, their supervisors, only reliably refer to didactic applications once they have passed the test of practice. Unlike content knowledge and pedagogical knowledge, pedagogical content knowledge is essentially applied.

The generation of teaching knowledge can also be analyzed through the monographs of trainees drawn up in the years between 1937 and 1947, at Liceu de D. João III, in Coimbra (Santiago, 2020). In the texts studied, the trainees began by explaining the choice of the topic, which involved their interest in the topic: suggestion of the supervisor, its relevance, the fact that it was little explored from a didactic point of view, the difficulties that the students expressed the theme, its importance in university education, among others. Next came the first part, where the intern presented the description and critique of the topic in question, expressing his or her point of view and explanations of what could change, articulating knowledge of the content and pedagogical knowledge of the content.

We can see an example of how these articulations occurred. The monograph by António Augusto Lopes (AAL) is entitled *Proporções e Aplicações* (1941), a topic of the 2nd year of liceus. AAL reveals acquaintance with the content and the curriculum by declaring that it agrees with the general lines that the teaching of arithmetic proposed by the program should meet. However, he criticizes the remarks, as, in his opinion, they allow an abuse of numerical calculus. He also states that, given the age and mental level of the students, it is not practicable to give the teaching of proportions the importance that is intended in the instructions for the programs. AAL also reveals familiarity with students' learning problems. For AAL, the importance of reflections on this subject derives from the fact that such problems are never dealt with throughout the entire course of the Liceu. On the other hand, he considers that students reveal difficulties in applying proportions in mathematical and physics subjects. There is a perception of the relationship that the contents dealt with have with mathematical ideas that will only be worked on in the long term, that is, there is an acquaintance with the mathematical horizon. Further on, AAL extensively debates the teaching of ratios and proportions, evidencing specialist knowledge of content and knowledge of content and its teaching.

Professionalization in Practice

In the 1970s, the number of professionally qualified teachers remained too low for the needs of secondary schools. In fact, the number of students continuing their studies in secondary education had been growing since the previous decade. At the end of 1979, the plan of Professionalization in Practice (*Profissionalização em Exercício*) came to replace the previous internships. In 1985 it was entrusted to Polytechnic Schools and Universities (Monteiro, 2018). Teachers with at least a bachelor's degree in the scientific area of teaching had access to in-service professionalization, whether they were already teaching or were candidates for the first time to exercise teaching functions. The internship teacher carried out his or her professionalization during two school years at the school where he or she was teaching following an Individual Work Plan (PIT) for these two years he or she prepared. Co-

ordination was carried out, at national level by the steering council; at regional level, by the pedagogical support teams; and at local level, by the school's pedagogical council. One of the functions of the mathematics pedagogical advisors was the elaboration of the *Specific Mathematics Project*, featuring guidelines for the mathematical and didactic aspects of the PIT of each trainee.

The PIT would be the reference during the entire training period and covered three areas: education system, school, and class, aiming at improvement both in the scientific areas and in the sciences of education and considering observation and guided pedagogical practice.

The implementation of the PIT also implied that the professional trainee proposed activities at the school, promoting debates in the scope of the educational sciences; detected educational problems resulting, either from their pedagogical practice, or of a local nature; and define strategies for the respective solutions. Within the discipline, the teacher should carry out an analysis of the program, plan and execute the didactic units and evaluate the teaching-learning process. The preparation and implementation of this individual plan would be monitored by the pedagogical council through the delegate, with the collaboration of the respective pedagogical advisor.

Concluding

We tried to characterize how professional teaching knowledge occurred in each of the three models of initial teacher training implemented in Portugal. We noted how in the normal model, implemented since the end of the 19th century, textbooks were soon produced containing either a deepening of mathematical knowledge or proposals for didactic intervention for the teaching of mathematics. Although this model has undergone variations over the period studied, we believe that its early institutionalization in Normal Schools with some stability in terms of objectives, curriculum, teaching staff, and facilities, contributed to this objectification of school knowledge in Barbier's sense (1996).

This did not happen on the other two models. In the case of the higher education model, although its institutionalization began in 1911 with *Escolas Normais Superiores*, the lack of its own teaching staff, the absence of autonomy, namely financial, and the short time in which they functioned did not allow to produce manuals. The model of pedagogical internships provided for a disciplining of very general knowledge (Pedagogy, etc.) in the Faculties of Arts, but were formally disconnected from the practical training of future teachers that took place in secondary schools. In these there were no *disciplines* of education and there was, therefore, no space for the production of objectified knowledge, even in the form of articles in education journals.

We were able, however, to analyze how teacher training was processed in these two models through the written productions of the trainees, and we found how, even in the absence of this disciplinary ap-

proach, the different types of pedagogical knowledge proposed by Ball and colleagues (2008) took place.

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Notes

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- 2 We will use the terms liceus and secondary schools interchangeably.
- 3 Originally published in Gomes (1991).
- 4 The curricular plan undergoes minor changes three years after the schools came into operation, with the Theory of Science disappearing, dividing the discipline of Legislation into two semesters and contemplating a third discipline of General Methodology of the Sciences of the Spirit (Santiago; Matos, 2019).

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