

Mathematics education in the curricula of the preservice teacher in early childhood education in Spain

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ABSTRACT

The objective of this research is to describe the situation of mathematical training in the early childhood education degree curricula in Spain through the analysis of the teaching guides of the subjects with mathematical content offered in the different Spanish universities. The aim is to identify the typology of subjects, the number of subjects offered, and the recommended bibliography. The methodology used is descriptive, exploratory, ex post facto, and census. For this purpose, the registry of universities, centers, and degrees was first consulted during the 2019-2020 academic year to obtain a list of all the Spanish universities that offer degrees in early childhood education and, therefore, to be able to download the corresponding teaching guides. Of the 91 universities in Spain, the early childhood education degree is taught in 66. Likewise, 101 subjects with mathematical content have been identified, although only 99 are available for analysis. Most are compulsory, have a study load of six European credit transfer system (ECTS) credits, and are taught in the third year of the degree. The recommended bibliography mainly concentrates on publications from 2001-2010 and mostly on book references.

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1. INTRODUCTION

Early childhood education is an educational stage that is fundamental in the development of human beings since it is during this period of their formation that the foundations for learning basic skills are laid in young children. In this sense, the age at which they are found is crucial for social and emotional development [1], [2]. From an early age, social skills are acquired for effective action, adjustment, education, and quality of life. In addition, they develop personal skills, acquire problem-solving abilities, learn to express their wishes and feelings and develop academically [3], [4]. For this reason, the educational activities carried out at this stage include art, theater, music, games, movement, science, mathematics, literacy approximation, and trips outside the classroom [5]. These aspects analyze the characteristics of the initial training of future teachers of early childhood education interesting and relevant, as they will be the ones who will lead the students of this age in the processes.

Training future teachers does not belong to a clearly defined discipline since it integrates knowledge from other disciplines such as psychology, sociology, and pedagogy, as well as didactics in specific areas such as language, mathematics, social and experimental sciences, among others [6]. In this way, early childhood education teachers acquire complete competence to be tutors and be responsible for the learning of

students from 0 to 6 years of age [7]. For this reason, this training must be aimed at promoting meaningful learning for students, as well as training them to become researchers of the processes that occur in their classrooms, generating didactic knowledge about curriculum development, and at the same time training them to be able to design their educational intervention processes [8].

However, initial teacher education was not viewed this way until relatively recently, as it has changed throughout history to become the formal education we know today. For a long time, it was thought that caring for young children was a task that required much patience but little professionalism. It did not require knowledge of specific subjects since only the care function was practiced, where all that was necessary was to entertain and supervise the infants [9].

In the 18th and early 19th centuries, various non-university institutions for teacher training were created in Spain, such as the Cátedra de Educación, the Junta de Exámenes, the Real Instituto Militar Pestalozziano and the Escuela Mutua de Madrid, which were the precursors of the central school of teachers, that is, the first normal school for men in Spain. Some years later, the central schools of teachers were created as normal schools, located on inadequate premises, with poorly paid staff, and under the influence of the catholic church. In these schools, future teachers received little pedagogical training, which was very practical. It was exacerbated by female teachers, who had to devote part of their time to domestic work [10].

The law “Ley de Instrucción Pública de 9 de septiembre” [11], known as the Moyano Law, included for the first-time primary school teachers in its Chapter III, referring to professional education. However, it was not until the law “Ley 14/1970, de 4 de Agosto, General de Educación y Financiamiento de la Reforma Educativa” [12] that teacher training was included as a university education, referring specifically to preschool teachers. Since then, the training of future teachers has evolved from professional training with a low degree of specialization to a degree integrated with the current university structure [7].

When focusing on the mathematical training of the early childhood education teacher, it must be considered that he is not, nor should he be a mathematics specialist, but must know and master, in addition to mathematics as a discipline, the teaching of mathematics. Mathematics; is called “Pedagogical Mathematics” [13]. In Spain, the profession of early childhood education teacher is regulated by the law “Resolución de 17 de diciembre de 2007, de la Secretaría de Estado de Universidades e Investigación, por la que se publica el Acuerdo de Consejo de Ministros de 14 de diciembre de 2007, por el que se establecen las condiciones a las que deberán adecuarse los planes de estudios conducentes a la obtención de títulos que habiliten para el ejercicio de la profesión regulada de Maestro en Educación Infantil” [14]. These teachers are trained in the Faculties of Education and receive general didactic and pedagogical training. At the same time, they acquire specific skills related to the knowledge that they will work with their students in the early childhood education stage. Consequently, future teachers must be trained to design, develop, and build appropriate teaching strategies for different school contexts. They must also acquire the necessary skills to develop specific mathematical competencies in their students.

In terms of mathematical competence, this means knowing and managing essential mathematical elements (different types of numbers, measurements, symbols, geometric elements, and others) in real or simulated daily life situations and carrying out reasoning processes that lead to solving problems or obtaining the necessary information. These processes make it possible to apply this information to a greater variety of situations and contexts, follow storylines, identify the underlying ideas, and evaluate and question the logic and validity of some arguments and information. In a study conducted by Kesicioglu [5], it is stated that future teachers have the necessary mathematical training to teach their students mathematical concepts. However, they need to learn how to transfer this knowledge. On the other hand, future teachers’ years of experience, their learning about mathematics, and their practical observation of how mathematics is taught in the classroom strongly influence their attitudes, emotions, and beliefs [15]. For this reason, the mathematical training that future teachers receive is essential to guide students’ cognitive and socio-affective development related to this science.

Until the implementation of the European higher education area (EHEA), the Spanish study model had teacher qualifications organized in pre-degrees (bachelor’s degrees of three years) [7]. This joint European framework for higher education has made it possible to organize a comparable system of degrees organized in two cycles (bachelor’s and master’s degrees), has facilitated the mobility of students between different European universities, and has introduced an European credit transfer and accumulation (ECTS) credit system that focuses on student effort and has established teaching methods based on competency-based learning and continuous teacher training [16]. After the creation, its establishment, of the seven teaching specialties offered in the old curricula, namely early childhood, primary, physical education, music education, special education, foreign language, and hearing and speech, only the first two teaching diplomas were transformed into degrees with a duration of 240 ECTS credits [17]. In the current Spanish university model, within the framework of the EEES, each university adapts the curriculum of the degrees in early childhood and primary education to its specificities. Therefore, there is no uniformity in the curricula of future teachers. In other words, this model has led to the absence of common knowledge or skills in the initial

training of early childhood and primary teachers in Spain [18], [19], which can lead to a problem of inequality.

One way to find out, to some extent, what content or competencies are taught and promote the learning of teachers in training is through a detailed analysis of the teaching guides for the subjects taught in this degree at each university since they are public and officially provide all the information on each subject [20], [21]. The teaching guides have been and continue to be a fundamental tool, both for the student and the teacher, that establishes in an orderly way the academic content of each subject and allows planning its teaching in detail, describing learning objectives, skills, methodology, bibliography, activities, and evaluation [22]. Various studies are beginning to use university teaching guides as tools that allow identifying the treatment of equality and equity in the training of university students [23] or the training of different areas of knowledge through the different elements and curricular aspects of grade subjects [24]–[26]. In general, we can find research focused on the analysis of teaching guides, such as Rodríguez-Faneca *et al.* [27], in which the situation of the Italian language as a working language within the Translation and Interpreting Degree in Spanish universities is analyzed. The results show the imbalance of this language concerning others, such as English or French, in terms of its offer and accessibility to study it.

Another similar study is the one carried out by Olmo-Soto *et al.* [21], in which when analyzing the competencies and learning objectives related to plastic and visual education in the subjects of the education degrees of the University of Córdoba, little presence of these were found in the subjects of the Primary Education degree. The Early Childhood Education Degree's inclusion was only identified in some elective subjects. Also noteworthy are the studies carried out by several researchers [28], [29] in which the evaluation systems established in the teaching guides of Spanish universities are analyzed. The analysis of the teaching guides of the visual arts subjects of early childhood and primary education degrees in terms of learning outcomes, content, resources, activities, learning modality, and evaluation addressed by Andrieu *et al.* [30].

On the other hand, the gender perspective in the teaching guides of the degree in primary education subjects in the field of didactics of social sciences of the autonomous community of Castilla y León has been analyzed. The results show the tendency to make education invisible toward gender equality [31]. In a similar study by Madrid *et al.* [32], the bibliographic references of the subjects with mathematical content in the Degree in Early Childhood Education of the Universities of Castilla y León were identified from a gender perspective. These authors found many references written by one or more men than by women or in collaboration.

In this sense, the analysis of the bibliography recommended in the teaching guides of the subjects with mathematical content within the curricula of the degrees of early childhood and primary education shows that these are outdated documents in which the information of the bibliography is incomplete or incorrect. Likewise, the most referenced author in Primary Education is Enrique Castro and in Early Childhood Education is María del Carmen Chamorro [20], [33]. Focusing on the training of future early childhood teachers, Alsina [18] conducted a partial analysis of the degree and found that mathematics didactics subjects represent only 2.5% of the total ECTS credits in Spain. However, this study only analyzed one university from each autonomous community in Spain. Hence, it is necessary to extend this objective to analyze all the teaching guides for the degree in early childhood education from all the universities in Spain. Thanks to this, it will be possible to know in greater depth and certainty the mathematical training from future teachers of the degree in early childhood education in Spain.

The main objective of this study is to describe the situation of mathematics training within the Early Childhood Education degree curriculum in Spain. To this end, the following specific objectives have also been established: i) To analyze the offer of early childhood education degrees in Spain, both in public and private universities, and to inquire about the offer of subjects with mathematical content in these degrees; ii) Identify the type and number of subjects offered by each university; and iii) Analyze the bibliography collected on subjects with mathematical content in the training plans of future early childhood education teachers.

2. RESEARCH METHOD

This research is descriptive, exploratory, and ex post facto to describe some characteristics present in the mathematical training plans of future teachers of early childhood education. It is a census study since the curricula of all Spanish universities that meet the defined criteria have been analyzed. For this purpose, the web pages of the Spanish universities listed in the register of universities, centers, and degrees (RUCT) were consulted during the 2019-2020 academic year. All universities have a web page where all the data related to the degree in question are collected, so the information analyzed is public and accessible through the internet.

2.1. Population and sample

The population under study comprises teaching guides for subjects in the degree of early childhood education with mathematical content. In order to access this information, the first step was to collect information from all the Spanish universities that teach degrees in early childhood education. For this purpose, the RUCT registry was accessed, where all the universities teaching the early childhood education degree were identified, excluding those with a double degree. The early childhood education degree is taught in 66 of 91 Spanish universities. The distribution of early childhood education degrees in each autonomous community and the ownership of the university can be seen in Figure 1.

Subsequently, they then agreed to consult the websites of all these universities. Specifically, the information related to the degree in early childhood education. However, at the time of this request, the degree in early childhood education was not listed at the University of Deusto. Likewise, the European University of Madrid reported on its website that this degree would begin to be studied in distance modality as of October 4th, 2021, and the European University of Valencia specified that this degree would be extinguished to present a new one online. It should also be noted that the faculties of the autonomous cities of Ceuta and Melilla belong to the University of Granada, so their information is integrated into it.

One hundred-one subjects with mathematical content were found in the early childhood education degree. From all of them, it was impossible to analyze the information of the two subjects of the European University because the web does not give access to any information. Likewise, for the other four subjects, it was only possible to obtain information about their nature, the number of credits, and the course and period in which they are taught. These subjects correspond to the International University of Villanueva (2), the Catholic University of Santa Teresa de Jesús de Ávila (1), and the University of Girona. Therefore, to realize this work, 95 guides of subjects with mathematical content have been studied in their entirety. Four of them were partially analyzed.

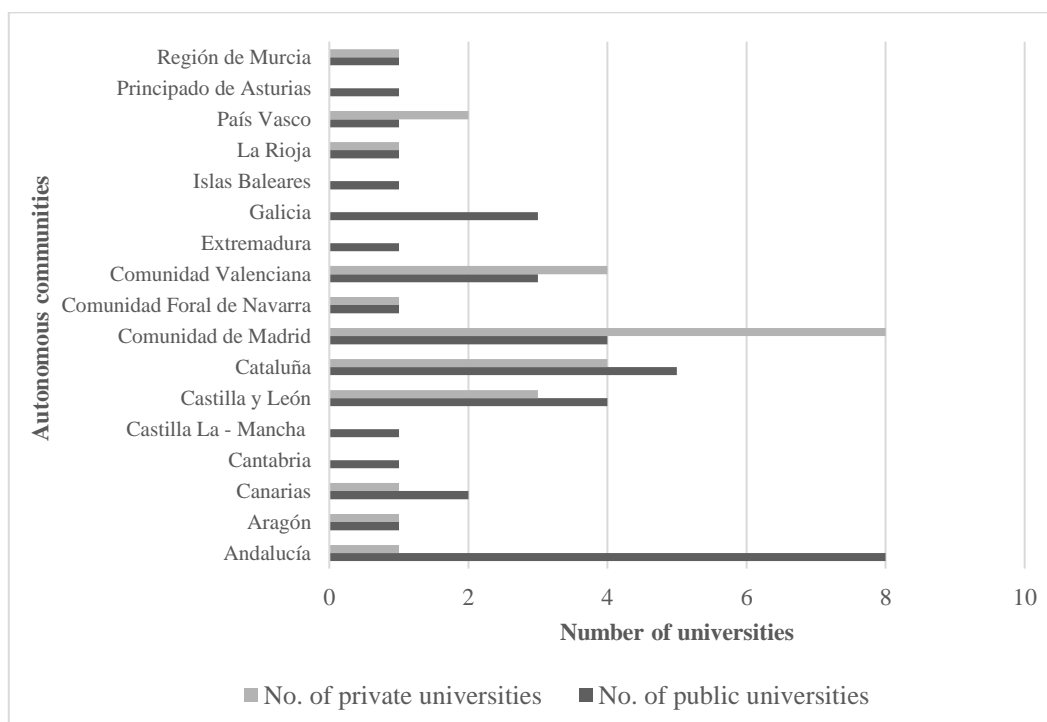


Figure 1. Distribution of early childhood education degrees by autonomous community

2.2. Information processing

Once the training plans and the teaching guides of all the subjects were located, a triangulation process was carried out among experts in the field of mathematics didactics from the Universities of Córdoba, Salamanca, and the Pontificia de Salamanca in order to identify the subjects with mathematical content. Next, all the teaching guides were downloaded and entered into an ad hoc database. Since they were in different formats (pdf, word, or HTML), format unification and inscription identification were carried out systematically and homogeneously.

The variables selected for the study were:

- TIP : about the type of university, whether public or private.
- NOM : in which the name of the subject is collected.
- UNI : records the university's name where the subject is taught.
- CAR : indicates the type of subject, i.e., whether it is basic, compulsory, or optional.
- CUR : indicates the academic year in which the subject is taught.
- CRE : collects the number of credits assigned to the subject.
- TEMP : refers to the timing of the subject, i.e., if it is a four-month subject (first or second semester) or a yearly subject.
- AÑO : indicates the year of publication of the reference.
- REF : type of the referenced document, i.e., if it is an article, a book, a chapter, a legislative document
- AUT : collects the first and last name of the author(s) of the recommended resource.
- TIT : returns the full title of the document.
- BIB : collects all the bibliographic recommendations of each teaching guide.

These variables have been standardized to avoid duplication in the authors' names or titles of recommended documents due to misspellings, the exclusive use of capital letters, or other languages. An example of this is that the name María del Carmen Chamorro appears in 13 different ways: Chamorro Carmen; Chamorro Mari Carmen; Chamorro M^a Carmen; Chamorro M.C.; Chamorro MC; CHAMORRO PLAZA María del Carmen; Chamorro; Chamorro C; Chamorro C.; CHAMORRO C.; CHAMORRO M.C.; Chamorro M^a del C.; and CHAMORRO M^a del C.

3. RESULTS AND DISCUSSION

The results obtained in this work are presented in two sections, one presenting the main results of the analysis of the subjects with mathematical content and the other analyzing the bibliography recommended in these guides. There are 91 universities in Spain, 66 of which offer a degree in early childhood education, 39 of which are public. Figure 1 shows that the community that offers the degree in early childhood education in more universities is the Community of Madrid, with a total of 12. It is followed by Catalonia and Andalusia communities, each with nine universities offering this degree.

On the other hand, it is observed that the community where more public universities offer this degree is Andalusia, with eight university centers, followed by the Community of Madrid, which has five centers. On the contrary, in terms of private universities, Madrid is the community with the most centers, with a total of 8, followed by Catalonia and the Valencian community, with four private centers each. It should be noted that there are six autonomous communities, namely Cantabria, Castilla La-Mancha, Extremadura, Galicia, the Balearic Islands, and the Principality of Asturias, where you can only study for a degree in early childhood education in a public university.

3.1. Subjects with mathematical content

Next, the subjects that have some mathematical content in the curriculum of early childhood education and that are offered in each of the Spanish universities are analyzed. A total of 101 subjects were found, of which it was only possible to fully analyze 95 because it was not possible to access the complete information of four of them since the teaching guides were not available on the web when downloading the data. In the analysis of these 99 subjects with mathematical content, the name of each of the subjects (NOM), the credits of each one (CRE), the course in which it is taught (CUR), and the timing of these (TEMP).

In Table 1, it is included information about the number of subjects with mathematical content offered by each university. It can be observed that more than 50% of the degrees include a single subject with mathematical content in the early childhood education curriculum; 19 offer two subjects, and only 9 degrees offer three subjects. Therefore, the average number of subjects with mathematical content in early childhood education is 1.54 per university, see Table 2. Regarding the nature of the subjects, it can be observed that most of them are compulsory, a total of 78; only two are basic, and 15 are optional. The nature of the four subjects, which could only be partially analyzed, is unknown, as the degree website does not provide this information, as shown in Figure 2.

Of the 15 optional subjects counted in Spanish universities, 10 constitute the second subject with mathematical content offered in the degree. The remaining five electives constitute the third subject of the degree. The information collected in Table 2 on the number of credits corresponding to subjects with mathematical content shows that most of them are assigned six ECTS credits. There is significant variability among the other subjects since they can be assigned from 3 to 9 ECTS credits. Specifically, Figure 2 shows that 76% of the total number of subjects are assigned 6 ECTS credits, followed by 8%, a significantly lower

number of subjects assigned nine ECTS credits. It should be noted that one of the subjects analyzed does not present this information.

Table 1. Number of subjects with mathematical content per university

Autonomous community	University	Type	No. subject	
Andalucía	Universidad de Almería	Public	2	
	Universidad de Cádiz	Public	2	
	Universidad de Córdoba	Public	1	
	Universidad de Granada	Public	3	
	Universidad de Huelva	Public	1	
	Universidad de Jaén	Public	1	
	Universidad de Málaga	Public	2	
	Universidad de Sevilla	Public	1	
	Universidad Loyola Andalucía	Private	2	
Aragón	Universidad de Zaragoza	Public	1	
	Universidad San Jorge	Private	1	
Canarias	Universidad de La Laguna	Public	1	
	Universidad de Las Palmas de Gran Canaria	Private	2	
	Universidad del Atlántico Medio	Private	1	
Cantabria	Universidad de Cantabria	Public	3	
Castilla La-Mancha	Universidad de Castilla-La Mancha	Public	1	
Cataluña	Universidad Autónoma de Barcelona	Public	2	
	Universidad de Barcelona	Public	1	
	Universidad de Girona	Public	2	
	Universidad de Lleida	Public	1	
	Universidad Rovira i Virgili	Public	3	
	Universidad de Vic-Universidad Central de Catalunya	Private	3	
	Universidad Ramón Llull	Private	1	
	Universitat AbatOliba CEU	Private	1	
	Universitat Internacional de Catalunya	Private	3	
	Universidad de Extremadura	Public	1	
Galicia	Universidad de A Coruña	Public	3	
	Universidad de Santiago de Compostela	Public	1	
	Universidad de Vigo	Public	2	
La Rioja	Universidad de La Rioja	Public	1	
	Universidad Internacional de La Rioja	Private	1	
Islas Baleares	Universitat de les Illes Balears	Public	1	
País Vasco	Universidad del País Vasco/Euskal Herriko Unibertsitatea	Public	1	
	Mondragón Unibertsitatea	Private	2	
Castilla y León	Universidad de Burgos	Public	2	
	Universidad de León	Public	1	
	Universidad de Salamanca	Public	2	
	Universidad de Valladolid	Public	2	
	Universidad Católica Santa Teresa de Jesús de Ávila	Private	2	
	Universidad Internacional Isabel I de Castilla	Private	1	
	Universidad Pontificia de Salamanca	Private	1	
	Universidad Autónoma de Madrid	Public	3	
Comunidad de Madrid	Universidad Complutense de Madrid	Public	3	
	Universidad de Alcalá	Public	1	
	Universidad Rey Juan Carlos	Public	3	
	Universidad a Distancia de Madrid	Private	1	
	Universidad Alfonso X El Sabio	Private	1	
	Universidad Antonio de Nebrija	Private	1	
	Universidad Internacional Villanueva	Private	2	
	Universidad Camilo José Cela	Private	1	
	Universidad Francisco de Vitoria	Private	1	
	Universidad Pontificia Comillas	Private	1	
	Comunidad Foral de Navarra	Universidad Pública de Navarra	Public	2
		Universidad de Navarra	Private	1
Comunidad Valenciana	Universidad de Alicante	Public	2	
	Universidad Jaume I de Castellón	Public	1	
	Universitat de València (Estudi General)	Public	1	
	Universidad Cardenal Herrera-CEU	Private	1	
	Universidad Católica de Valencia San Vicente Mártir	Private	1	
	Universitat Internacional Valenciana	Private	1	
Principado de Asturias	Universidad de Oviedo	Public	2	
Región de Murcia	Universidad de Murcia	Public	2	
	Universidad Católica San Antonio	Private	1	

Table 2. Character and number of ECTS credits of the subjects of mathematical content

Type	Number of signatures	Number of credits	Total subjects by type
Basic	2	6	2
Compulsory	2	3	78
	2	4	
	4	4.5	
	58	6	
	1	7	
	1	7.5	
	3	8	
	6	9	
	1		
	1		
Optional	1	3	15
	2	4.5	
	12	6	

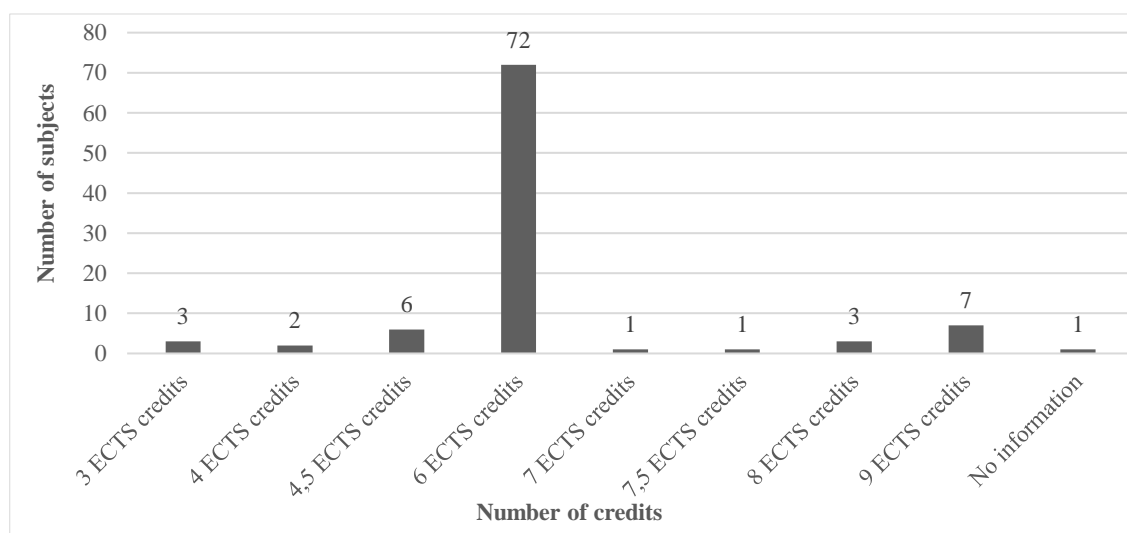


Figure 2. Distribution of subjects according to ECTS credits

The distribution of subjects by course is also varied, concentrated in the third academic year of the degree, where there are 47 subjects, followed by the 28 subjects taken in the second year. Most of them are compulsory. On the other hand, we can see that more than half of those optional are taught in the fourth year, as shown in Table 3. The analysis of the presence of the early childhood education degree in Spanish universities shows that this degree is offered in most Spanish universities, both public and private, and is present in 66 of the 91 Spanish universities registered in the RUCT. In all universities, this degree includes various subjects with mathematical content. This data aligns with similar studies' results [18]–[20].

Finally, it is striking that only 8 of the total subjects are taken annually; 81 are taken quarterly, and we do not know the timing of 7 of them. The analysis of the characteristics of these subjects has shown that in half of the universities, only one subject with mathematical content is offered. Two or three subjects are offered in the other half, averaging 1.54 mathematical subjects per university. This result shows the scarce presence of mathematical subjects in the training of future early childhood educators. Similarly, it shows the shortcomings of teacher training at the university level to guarantee the provision of effective mathematics programs in infant classrooms [15].

Table 3. Distribution of subjects per year

Nature of subjects	First	Second	Third	Fourth
Basic	1	1	0	0
Compulsory	4	27	39	6
Optional	0	0	6	8
Information not available	0	0	2	2
Total	5	28	47	16

3.2. Bibliographic recommendations

In the specific analysis of the variable BIB (recommended bibliography), which includes all the bibliographic recommendations that the teachers propose in the guides to complement the contents of the different subjects with mathematical content in this degree, the typology of the resources (REF) is analyzed, the year of publication (AÑO), the most recommended authors (AUT), and the titles of the most critical resources (TIT). A first analysis of the type of resources recommended by the textbooks for studying the subject is included in Figure 3, where a great diversity is noted. However, most correspond to books and journal articles (719 resources).

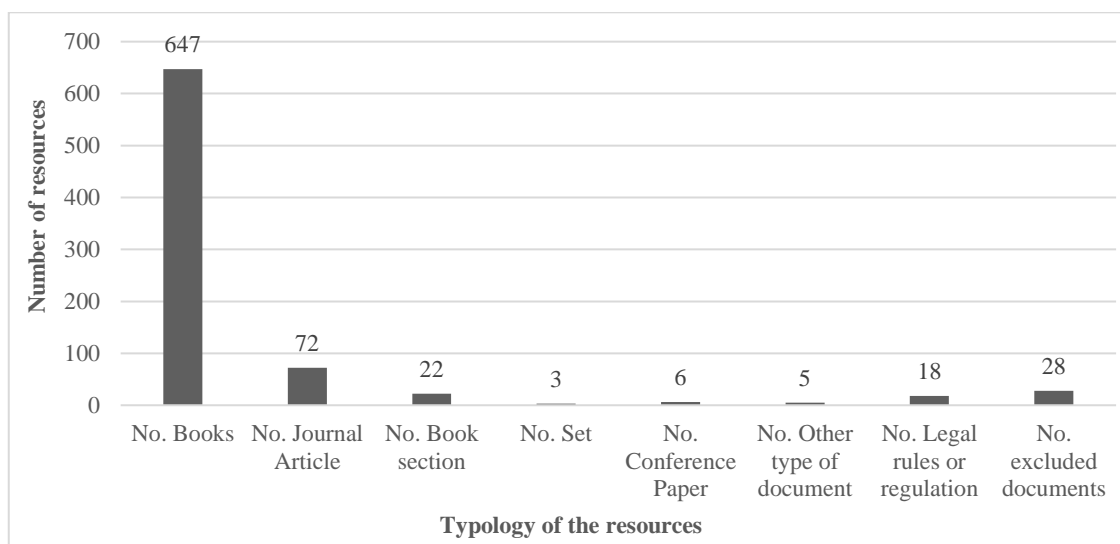


Figure 3. Bibliographic references typology

Also included are references to websites, which are usually listed at the end of the guide and usually without any explanation of their content. As shown in Figure 4, the bibliographic references included in the guides cannot be considered current, as most of them were published between 2001 and 2010. It is also worth noting that the most recommended bibliographic references were published in 1988, with 30 different bibliographic references. For being the most recommended in the different guides, the most influential authors are Ángel Alsina, María del Carmen Chamorro, Constance Kamii, and María Antonia Canals. Similarly, Table 4 shows that the works most used as support material are the book entitled *Didactics of Mathematics for Early Childhood Education*, published by Pearson, whose author and coordinator is María del Carmen Chamorro, and the book entitled 'How to Develop the Mathematical Thought from 0 to 6 years' by Ángel Alsina, published by Eumo.

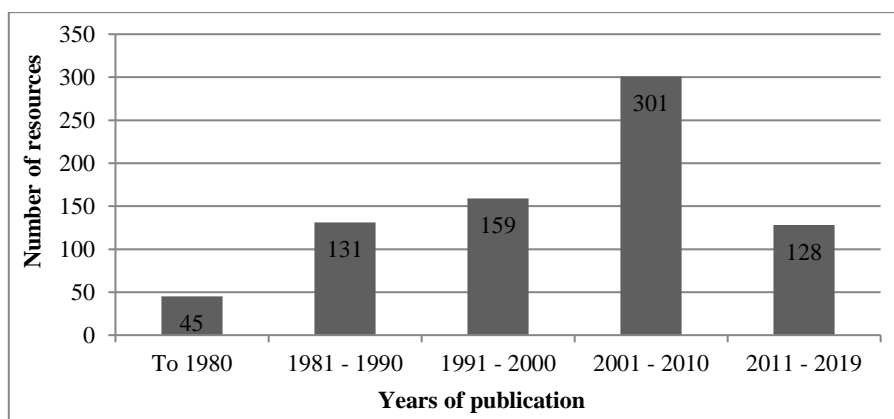


Figure 4. Distribution of the recommended bibliography by periods

Table 4. Most recommended references in the teaching guides

Bibliographic references (translation)	Number
Chamorro, <i>Didáctica de la matemática para la educación infantil</i> (Didactics of mathematics for early childhood education) [34]	46
Alsina, <i>Cómo desarrollar el pensamiento matemático de 0 a 6 años</i> (How to develop mathematical thinking from 0 to 6 years) [35]	17
Kamii, <i>El número en la educación preescolar</i> (The number in preschool education) [36]	12
Alsina, <i>Educación matemática en contexto: de 3 a 6 años</i> (Mathematics education in context: from 3 to 6 years) [37]	7
Canals, <i>Lógica a todas las edades</i> (Logic at all ages) [38]	5
Fernández, <i>Didáctica de la matemática en la educación infantil</i> (Didactics of mathematics in early childhood education) [39]	5
Alsina, <i>Cómo desarrollar el pensamiento matemático de los 0 a los 6 años: propuestas didácticas</i> (How to develop mathematical thinking from 0 to 6 years: teaching proposals) [40]	4
Canals, <i>La geometría en las primeras edades escolares</i> (Geometry in the early school ages) [41]	4
Canals, <i>Vivir las matemáticas de 3 a 6 años</i> (Live mathematics from 3 to 6 years) [42]	4
Chamorro, <i>El problema de la medida</i> (The measurement problem) [43]	4

4. CONCLUSION

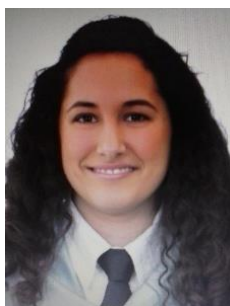
The results section shows that future early childhood education teachers have not received the same initial training in mathematics, as this depends on the university where they have been trained. The nature and importance of these subjects in the curricula vary from one university to another. Considering the importance of a subject such as mathematics in the development of young children at this stage of their education, it seems that the number of subjects and their extent are not sufficient to provide future teachers with the skills they need for their students to develop comprehensively. On the other hand, the recommended bibliographies included in the guides for these subjects are old, for example, you can find classic works such as Jean Piaget's published in 1992. In the recommended bibliography, there is a lack of research articles, books, or more recent handbooks, as well as the presence of innovations in the field of education. Studies such as this are of great interest because they describe the panorama of mathematical training of future early childhood teachers in Spanish universities. It is clear that, in the future, it will be necessary to continue analyzing other pedagogical aspects in order to find out what the trends and patterns of training are in order to identify both the outstanding aspects and the weaker ones that can be improved in order to offer these students an optimal university education and, above all, valid for their future professional development.




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