

A Look at Doctoral Theses in Mathematics Education at Andalusian Universities (2010-2020) from a Gender Perspective

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Abstract – In recent years, bibliometric studies on mathematics education have allowed us to learn more about the scientific production in this field. To continue this line of study, in this research we have focused on the doctoral theses published on mathematics education and, in particular, on the role of women in the production, direction and evaluation of doctoral theses in this field, focusing on Andalusian universities. For this purpose, a bibliometric study has been carried out using the Teseo database. The results show a decrease in Andalusian doctoral production in this field in recent years and how, although the number of women who have completed doctoral theses in this field is greater than that of men, in the case of the direction of them, the number of male directors is greater than men directors.

Keywords – Doctoral theses, mathematics education, gender, Andalusia, bibliometrics.

1. Introduction

The completion of a doctoral thesis is a starting point in the stage of any researcher, while participation in the supervision or evaluation of

doctoral theses is the recognition of the training or research experience of those who participate in these processes.

In recent years, different studies have focused on the gender perspective in the university environment, for example Resa Ocio [1] analyzed gender equality training in Primary Education degrees at the Complutense University of Madrid or Bas-Peña et al. [2] studied the gender training of students in Social Education degrees at 36 Spanish universities.

The gender perspective in doctoral theses has also been a topic of interest among researchers. For example, Ortega et al. [3] highlighted that less than a third of the 333 doctoral theses on Physical Activity and Sport Sciences that they analyzed were written by women, with a greater number of male supervisors and also highlighting that women have the least presence in the figure of the president in the theses tribunals. This same aspect was highlighted by Rodríguez-Faneca et al. [4], regarding the presidency of the tribunals that evaluate Spanish doctoral theses in Translation and Interpreting.

Mathematics education (ME) is a discipline within the field of mathematics education that investigates the processes involved in the teaching and learning of mathematics from different focuses.

As Reys et al. [5] point out, doctoral programs in mathematics education have the responsibility to prepare students for a wide range of career options, which makes the design and implementation of a doctoral program in mathematics education a challenge, and therefore both the doctoral training programs and the results of the doctoral theses need to be analyzed.

Scientific production in ME is increasing every day and there are frequent studies that analyze this production from the point of view of bibliometrics. Bibliometrics allow, among many aspects, to identify trends, patterns or find indicators of scientific production in a given field [6].

Among the bibliometric studies on the production of scientific articles in ME, a study on ME has also

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been published in SCOPUS [7] which shows an exponential growth in production, and highlights the productivity of authors such as Verschaffel with 38 papers or Srimanan and Skovsmose with 22 papers each. Likewise, Muñoz-Nungo et al. [8] analyzed the scientific production on mathematics education in Colombia that is indexed in the Emerging Sources Citation Index database.

Production in ME has also been analyzed on specific themes, for example, narrative. The researchers did not find the presence of major producers in this area, while the thematic trend is oriented towards problem solving, teacher training and the history of mathematics and of the discipline itself. On the other hand, Planas [9] made a first bibliometric approach to the role of sociocultural theories in mathematics education.

On the other hand, some authors have focused on specific journals in the area such as Science Education [10], [11]. Doctoral theses in Mathematics Education offer an interesting option for finding out about the research trends on which new research is based. Adnan et al. [12] analyzed doctoral dissertations in ME in the online databases of the Higher Education Council of the Republic of Turkey (YÖK). They found that 24% were focused on primary (6-8) and secondary (9-12) students.

Li & Yu [13] conducted a review of 195 doctoral dissertations in EM conducted in China between the years 1993 to 2012. They determined that 51.8% used quantitative research methods and 23.6% mixed methods.

In this line of work, aspects related to the sociology of science that accompanies the preparation of a doctoral thesis have been studied in Spain. The academic networks generated in this process were analyzed between 1976 and 2009 [14]. The 328 theses studied revealed that there was a bias in the gender of supervisors in favor of men, but no such bias in authorship. They found that Dr. Luis Rico and Dr. Jose M^a Fortuny had the highest number of participations in theses supervised with 39 and 32 respectively. While Luis Rico and Carmen Batanero were the most prolific supervisors with 17 and 14 theses supervised each.

[15] Torralbo et al. (2003) carried out a documentary and longitudinal study of doctoral theses in ME in Spain between 1975 and 2002, and according to the subject and using the descriptors of the Zentralblatt fuer Didaktik der Mathematik (ZDM). They found that topics related to the psychology of mathematics education and mathematics education and instruction stood out.

In another study, Torralbo et al. [16], when analyzing doctoral theses on EM in Spain between 1976 and 1998, found that 38.5% used an interpretive paradigm, 31.1% a mixed paradigm and 18.5% a nomothetic paradigm.

Vallejo-Ruiz et al. [17] analyzed a sample of ME doctoral theses in Spain from a gender perspective. No significant differences in authorship were found: men 48.3% and women 50.7%. Thus, it was found that 70.05% of the theses were directed exclusively by men.

Considering a study on gender and doctoral theses in mathematics education, Vallejo et al. [17] found that women have achieved the same productivity as men, but the bias towards women still exists in management. These results should be taken with some caution as this study has certain limitations since the search criteria used in the TESEO database are not exclusive and exhaustive. Among other things, because TESEO uses UNESCO descriptors that do not consider specific didactics, so many of the descriptors used are somewhat artificial for mathematics education.

Considering previous research and the limitations pointed out in some of them, we wanted to analyze the production of doctoral theses in Mathematics Education from a gender perspective, in a recent period in the existing universities, in the Autonomous Community of Andalusia, in Spain.

The objective is to know and describe the production of doctoral theses in mathematics education in Andalusia from a bibliometric point of view, specifically analyzing the role of women in the production, direction, and evaluation of these doctoral theses.

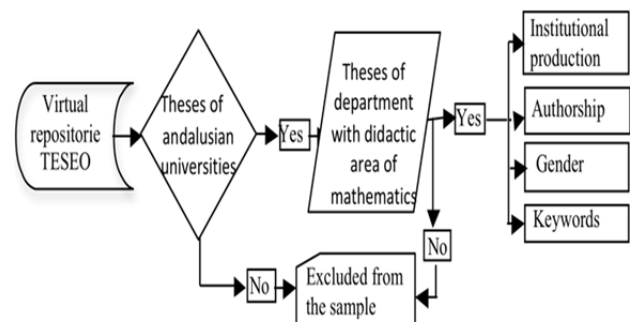


Figure 1. Process diagram
Source: Own elaboration

2. Methodology

All the websites of the Andalusian universities were consulted in order to identify the departments in which the area of didactics of mathematics is integrated. Then, the website of the TESEO database were visit, which is the institutional repository of the Spanish Ministry of Education, Culture and Sport where the file of each of the doctoral theses defended in Spain is stored since 1976.

(<https://www.educacion.gob.es/teseo/irGestionarConsulta.do>).

All the doctoral theses written in the departments that include the area of knowledge of Didactics of Mathematics were downloaded from TESEO to ensure that all the theses to be analyzed correspond to the field of study (Figure 1).

A total of 235 theses were obtained, this information was transferred into an ad hoc database and a triangulation analysis was carried out by experts in Mathematics Education from the universities of Cordoba and Pontificia of Salamanca to determine which theses were in Mathematics Education based on the title and abstract. Finally, it was found that only 90 theses corresponded specifically to Mathematics Education, and these were the ones that constituted the sample. It should be mentioned that ME theses may have been carried out in other departments such as History or Psychology. Be brief and state the most important conclusions from your paper. We recommend not using equations and figures here.

3. Results

In the period analyzed, 90 doctoral theses on ME were defended in Andalusian universities. The highest number of defenses took place in 2012, and as shown in the following table, there was a gradual decrease in production (Table 1).

Table 1. Diachronic production of doctoral theses in ME in Andalusia

Year	No. Theses	%
2010	2	2.22
2011	9	10.00
2012	15	16.67
2013	10	11.11
2014	10	11.11
2015	13	14.44
2016	9	10.00
2017	4	4.44
2018	7	7.78
2019	8	8.89
2020	3	3.33
Total	90	100.00

The University of Granada (UGR) is the leading Andalusian institution in terms of doctoral production in ME (Table 2). This university produces 65.6% of the total. This fact coincides with that shown by Maz-Machado et al. [14] for the period 1976-2009. Of the 11 universities in Andalusia, 8 of them (all of them public) have produced some thesis in the field, while none has been produced in the other three institutions.

Table 2. ME thesis production by university

University	No. Theses	%
University of Granada	59	65.6
University of Huelva	12	13.3
University of Malaga	8	8.9
University of Cordoba	6	6.7
University of Almeria	2	2.2
University of Cadiz	1	1.1
University of Jaen	1	1.1
University of Sevilla	1	1.1
Total	90	100.0

There are 54 different researchers from various universities in Spain. Portugal and Colombia have participated in the direction of these doctoral theses. In this period, Dr. José Carrillo from the University of Huelva is the most productive with 12 theses, of which he has supervised 8 individually and 4 in co-direction. All these theses were supervised at the University of Huelva. He is followed by Juan Díaz Godino from the University of Granada (UGR), with 10 directed, three of them in co-direction and all of them at the UGR (Table 3). This shows a change with respect to the 1976-2009 periods, in which Luis Rico (UGR) and Carmen Batanero (UGR) were the most productive directors in Andalusian universities [14].

In terms of the law of Bradford [18], we can state that there are two major producers in the task of supervising doctoral theses in ME in Andalusian universities ($\log n \geq 1$). There are 19 medium producers ($0 < \log n < 1$) and 33 transient producers ($\log n = 0$).

Table 3. ME thesis production by university

Director	N	%
Carrillo Yáñez, José	12	8.5
Diaz Godino, Juan	10	7.1
Batanero Bernabéu, Carmen	9	6.4
Castro Martínez, Encarnación	9	6.4
Castro Martínez, Enrique	8	5.7
Flores, Pablo	7	5.0
Cañadas Santiago, María Consuelo	6	4.3
Maz Machado, Alexander	6	4.3
Molina González, Marta	6	4.3
Rico Romero, Luis	6	4.3
Segovia Alex, Isidoro	5	3.5
González Marí, José Luis	4	2.8
Gómez Guzmán, Pedro	3	2.1
Lupiañez Gómez, José Luis	3	2.1
Contreras García, José Miguel	2	1.4
Fernández Escalona, Catalina	2	1.4
Gallardo Romero, Jesús	2	1.4
Moreno Verdejo, Antonio Javier	2	1.4
Muñoz Catalán, María de la Cinta	2	1.4
Oliveras Contreras, María Luisa	2	1.4
Rico Castro, Nuria	2	1.4

Considering the gender in the authorship of theses, women have written more theses than men (Figure 4). However, the situation is reversed when analyzing the gender of those who have supervised the theses. In this case, men are in the majority with a percentage of more than 60% (Figure 3).

Figure 2 shows the evolution of the production of theses in the period analyzed, according to the gender of the author. It is observed that, in 2010, no woman defended her doctoral thesis and in 2020, only women did so. However, in these two years the production was scarce, and this determines this particularity. The average number of theses defended by men was 4 per year while the average for women was 5 per year.

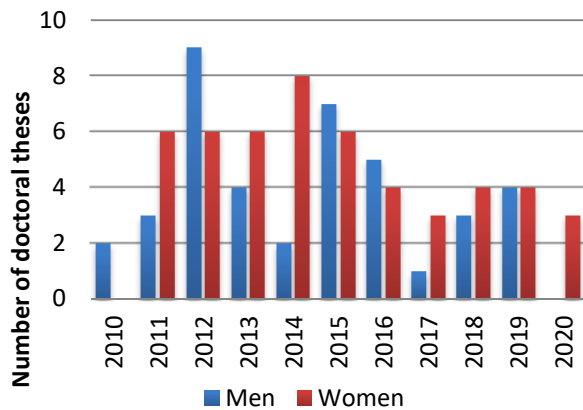


Figure 2. Diachronic production of doctoral theses according to the gender of the author

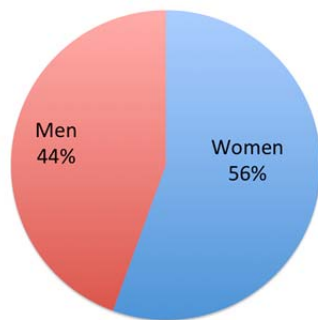


Figure 3. Gender of the directors

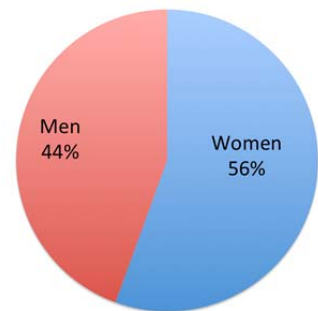


Figure 4. Gender of the authors of the directors

If we discriminate the composition of the direction of the theses according to whether they were only men, only women or mixed supervision, we observe that most of the theses were supervised only by men (55%), doubling the number of those directed only by women (26%), (Figure 5).

42 theses had a single director (27 male and 15 female supervisors), 55 theses had two directors, and 3 theses had three directors (one of these with only female supervisors and two with mixed supervisors).

In this sense, it is possible to see a change in trend with respect to Maz-Machado et al. [14], who indicated that less than 20% of the theses analyzed were co-directed.

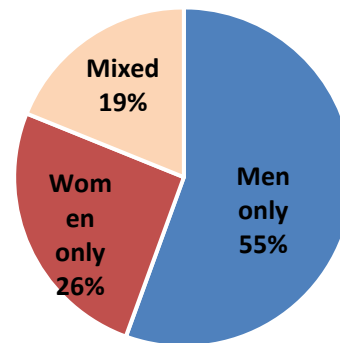


Figure 5. Percentage of theses in ME according to the gender of the directors

If we analyzed the gender in terms of both authors and directors, it is observed that both men and women, who carried out their theses in ME (Figure 6), in Andalusia, have been mostly supervised by individual men (Table 4). The chi-square test gives a p-value of 0.73, so there is no statistically significant difference between men and women.

Table 4. Gender of authors with respect to gender of directors

		Gender of director			Total
		Mixed	Only men	Only women	
Gender of authors	Man	9	21	10	40
	Woman	8	29	13	50
	Total	17	50	23	90

When we analyze the keywords of these theses, the most used keyword is Teacher training followed by Mathematics (Table 5). It is observed that keywords associated with general educational aspects prevail; this may be due to the fact that in TESEO only UNESCO descriptors can be chosen for the theses which some researchers have already pointed out as not suitable for specific didactics [19], [20].

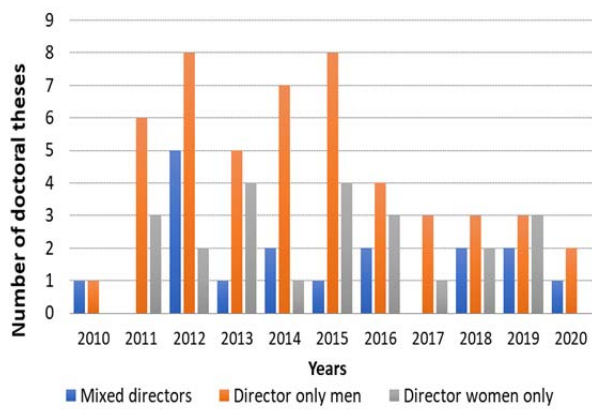


Figure 6. Diachronic production of doctoral theses according to the gender of directors

Table 5. Most frequently used descriptors

Keywords	Frequency
Teacher training	50
Mathematics	49
Higher education	19
Student assessment	17
Cognitive processes	15
Teacher training and employment	14
Educational methods	14
Basic education	13
Computer-assisted education	13
Algebra	11
Learning difficulties	11

Figure 7 allows us to identify how the keywords are related according to the co-appearances in the doctoral theses. Some keywords have no connection with mathematics descriptors, for example, "data analysis" or "computer-based teaching".

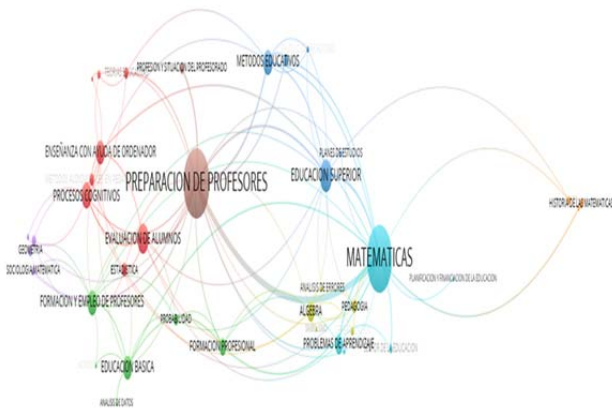


Figure 7. Keyword network

4. Conclusions

This study presents a comparative analysis of the production of doctoral theses in Mathematics Education between 2010 and 2020. Among the results highlighted, a decrease in the production of doctoral theses in ME in Andalusian universities is evident. This fact is worrying since theses make up an important part of the scientific production of

universities, as well as they determine the generation of new researchers.

The University of Granada is the largest producer of these theses in the period 2010-2020, similar to the findings of Vallejo et al. [17]. However, Dr. José Carrillo, from the University of Huelva, is the most productive with 12 theses. The study shows how some of the trends already present in mathematics education theses between 1976 and 2009 [14] have not changed. There is a bias in favour of men in the direction of doctoral theses, but not in authorship as more women have written theses in this field. However, both women and men choose more men to supervise, while there are an almost equal number of mixed supervisors for men and women.

Finally, it is necessary to highlight the change in the trend towards co-direction of theses, more common now than in the past, in this area of knowledge.

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