Bibliometric Study of Educational Production in Iberoamerica

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Abstract – The bibliometric study of scientific production in the field of education that has been carried out in Ibero-American countries between 2000 and 2020 and indexed in the Social Sciences Citation Index (SSCI) database of the Web of Science (WoS) is presented. 4786 documents have been analyzed using bibliometric techniques, finding a considerable increase in scientific production, with Brazil being the country with the highest production. Likewise, the distribution of the magazines in Bradford zones was determined, noting that the core is made up of two journals, the first published in Latin America and the second in Spain. There was evidence of a decline in single authorship in documents and an increase in international collaboration, reaching in 2000 percentages like those of national collaboration. Through this study, production patterns and trends have been identified, as well as the main channels for disseminating research in the field of education in Ibero-America.

Keywords – Bradford zones, bibliometrics, collaboration type, education, Ibero-America.

1. Introduction

The study of the ways of disseminating the results of scientific research in the different fields of knowledge is not new. In recent years, systematic research and analysis have been carried out on both means of dissemination (written or virtual) and the patterns, trends and sociological relations that derive from the processes of collaboration at different levels. Examples of this can be found in the Scientific Literature on Sciences [1], [2], Social Sciences [3], Humanities [4], [5] or Engineering [6].

Bibliometric studies are tools that allow to know specific aspects about scientific production in different fields of knowledge or regions, countries, institutions, researchers, etc. [7]. Specifically, the scientific production in education has been the subject of several analyses from different perspectives. There are studies carried out on sets of educational journals [8] or a single journal [9]. Analyses have also been made by thematic fields of education [10] or relating to the educational output of a given country [11], [12].

If we focus on Ibero-American countries, some researchers have argued that it is not convenient to measure the production and impact of educational research in the region using the standard methodology based on data recorded in the WoS and the SCOPUS [13], [14]. However, other fields have not agreed on this and have conducted several studies both by country and by region. Thus, Jacinto [15] analyzed Brazil's production in higher education indexed in the WoS between the years 2001 to 2018, comparing it with other MERCOSUR countries. He found that Brazilian production occupies the seventh position in the world, but 24th place with respect to citations, and that 60.9% of this production was published in Portuguese. This study did not discriminate by type of document so it considered the entire WoS main collection. Do Prado et al. [16] conducted a review of the educational production related to nursing in Brazil and Spain between years 2000 and 2005. They found that Brazil was

responsible for 76% of the publications. The priority of the study was to analyze the thematic focuses, highlighting those that dealt with teaching and learning processes in nursing.

Educational production in Spain, as the following examples, has been reviewed: Moreno [17] focused its attention on the production in educational inspection, searching on Google Scholar. He detected little production, most of it indexed in Latindex (70.7%). Morales et al. [11] analyzed the production in music education that appeared in the WOS between 2000 and 2015. They found low production, that had little impact (56.64% had never been cited) and 76.06% had been published without any type of collaboration. Globally, Fernández-Cano [18] analyzed Spanish educational production in the SSCI between years 1998 and 2009. The results indicate that 50.6% of the articles had no citations and that there were only two major producers (n≥10). They also showed that 45.44% of the production is published in Spanish journals.

Production in nursing education, in Brazil and Spain, published in the CUIDEN database has also been studied. This study reveals that 45.6% was published in Brazil and 33.7% in Spain (Prado et al., 2011). Macías-Chapula [19] analyzed the Latin American production in medical education, and they found that Brazil, Mexico, and Colombia produce 50% of the region.

The production in mathematics education in Latin America has been analyzed in the ESCI [20] and in the ALME journal [21]. The ESCI shows 0.9 degrees of collaboration and ALME reveals a good collaboration between countries such as Argentina, Cuba, Mexico and Chile.

Table 1. Some previous biometric studies in education in Ibero-American countries

Author	Year	Country or region studied	Field	Database or Journal	Number of data	Time period
Macias-Machupla	1992	Latin America	Medical education	MEDLINE	1745	1979-1988
do Prado et al.	2011	Brazil-Spain	Nursing	CUIDEN-LILACS	313	2000-2005
Fernández-Cano	2011	Spain	Education	SSCI	1067	1998-2009
Torres-Alfonso et al.	2014	Latin America	Mathematics education	ALME	1357	2005-2009
Morales et al.	2017	Spain	Musical education	WoS	143	2000-2015
Moreno	2019	Spain	Educational inspection	Google Scholar	92	2009-2019
Jacinto	2021	Brazil	All fields	WoS	36033	1995-2020
Rodríguez-Faneca et al.	2021	Latin America	Mathematics education	ESCI	939	2005-2020

2. Objectives

The aims of this study are as follows:

- To discover the Ibero-American diachronic production in education indexed in the SSCI
- To identify the most productive countries
- To know the scientific productivity of the authors who sign the analyzed documents
- To identify the journals indexed in the SSCI in which Ibero-American researchers publish on education
- To determinate the kind of collaboration by countries

3. Materials and Methods

The present study uses an exploratory and descriptive design focused on a bibliometric analysis of documents. These documents were selected in February 2020 from the WoS website. Specifically, all articles published from 2000 to 2020, in the main collection of the Social Sciences Citation Index database, were selected. For that purpose, the following keywords were entered in the TOPIC section to make the selection: (Educat*) OR (teach*) OR (instruc*) OR (learn) OR (didactics) OR (textbook) OR (school) OR (curricul*) OR (assessment) OR (student) OR (pedagogy) OR (history) OR (knowledge) OR (achievement) OR (competences). A total of 464814 documents were accessed. Afterwards, the search was refined by filtering out the type of document (article and review were selected), obtaining 427576 contributions.

In the next step, categories Education & Educational Research, Education Scientific Disciplines, Education Special and Psychology educational were chosen to ensure that we only obtain education-related articles and reviews, reducing the study sample to 216028 contributions. Finally, only the Ibero-American documents were selected. The completion of these phases gave rise to a total of 4786 publications; 4644 of them were articles and the other 142 were reviews. They all form the final sample of the study, which we will call documents for the rest of the document, without discriminating the type.

All these information was downloaded and dumped into an ad hoc database using Microsoft Office 2019 software (Access and Excel). In addition, the 1.6.15 version of the VOSviewer software [22] was used to create the cross-country collaboration graph.

The year of publication of the document, the name of each author, the name of the journal, the home country of each author, the number of documents per year and the language of publication were all taken as study variables.

Most of the authors' names appeared only with the initial of their first name, so it was necessary to search the full name of the authors in order to identify them. To this end, we reviewed the webpages of the institutions where they were affiliated. In some cases, it was necessary to check the full names with Ibero-American colleagues. Finally, a process of standardization of the names was carried out since some researchers varied their signatures over the years. In other cases, the transcription of the names differs from those offered by the WoS, as the examples below: Abrantes Farias, Mayrhon José and Abrantes Ferias, Mayrhon José; Andrade Nascimento Junior, José Roberto and Andrade Do Nascimento Junior, José Roberto; Quintanilla Gatica, Mario y Quintanilla Gatica, Mario Roberto.

When the same author had published with several institutional affiliations in a paper, only one of them has been taken in account, prioritizing Ibero-American affiliations to determinate the type of collaboration.

4. Results and Discussions

Diachronic Production

In the period studied for the analysis of scientific production on education in Ibero-America and published in journals indexed in the WoS, from 2000 to 2020, 4786 documents were obtained. The general production pattern denotes that the best fit for a deterministic model is a positive exponential growth (R^2 = 0.929). The highest rate of year-on-year variation (TVI in Spanish) is 160.9% in 2008, while the lowest occurred in 2003 with a value of -22.8% (Figure 1.).
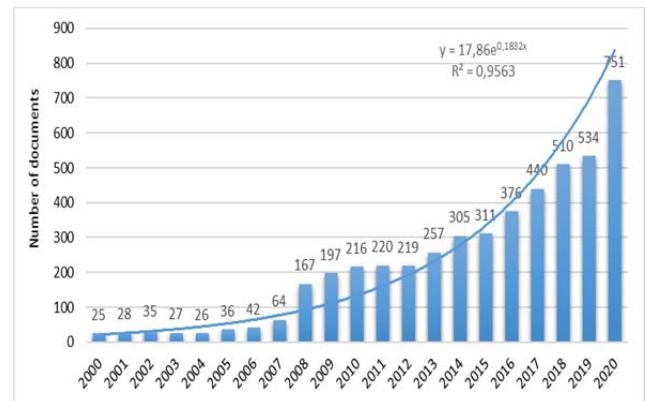

Figure 1. Evolution of the number of documents per year

It was found that the production in Ibero-America were written mostly in English (72.6%), followed remotely by Portuguese 17.3% (Table 1.) and Spanish (9.8%). There were documents published in other languages, but they all together are a rarity because they only represent 0.2% (Table 2.).

Table 2. Publication language

Language	Document No.	%
English	3476	72.6
Portuguese	830	17.3
Spanish	470	9.8
Others	10	0.2
Total	**4786**	**100.0**

Scientific Production by Country

The production of education studied is located in 18 of the 22 countries of the region. Only Andorra, Nicaragua, Paraguay, and Dominican Republic do not have any production of this field of knowledge. The country with the highest production is Brazil (42.56%), followed by Chile (21.17%) and Mexico 13.21% (Figure 2.), although Brazil doubles the production of Chile, and Chile doubles the production of Mexico, Spain, and Colombia.
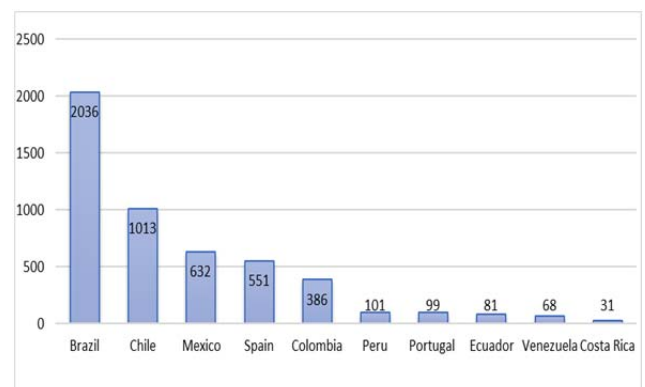

Figure 2. Number of documents by country (n>10)

There has been a great collaboration between authors from the different Ibero-American countries in the documents analyzed. Chile participates in articles signed by authors from 57 countries, being the most collaborative country of those studies. It is followed by Brazil that collaborate with 50 (Figure 3.). The USA is the main partner of the countries, and England is the European country with the greatest collaboration with these countries.
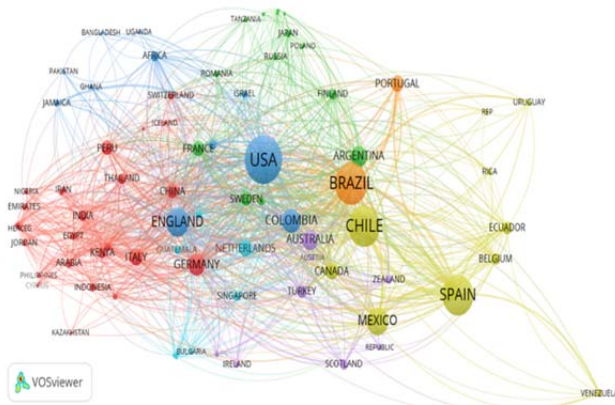

Figure 3. Cross-country collaborative network (n>10)

Productivity of the Authors on Education

A total of 11037 different authors were identified, which gave rise to 15408 signatures, revealing an average of 3.21 authors per document. Figure 4. shows the distribution of authors grouped into three levels of productivity: LP=0 (log 1), authors who publish only one document; $0 < LP < 1$ (log1 + to log 9), authors with 2 to 9 published papers; and $LP \geq 1$ (log 10+), authors with 10 or more published documents. There are 9240 authors with only one published paper, 1742 authors with 2 to 9 published papers, and only 26 authors who have published 10 or more documents.
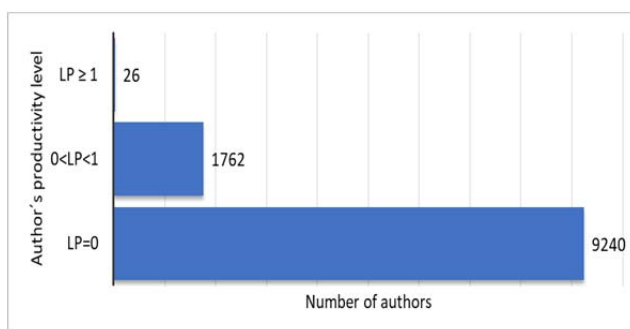

Figure 4. Productivity levels of authors in education)

Table 3. shows the authors with the highest production ($LP \geq 1$). The most productive author is Wanderley Marchi Junior from the Federal University of Paraná, Brazil, with 52 published papers. Nelci Adriana Cicuto from the Federal University Sao Carlos, Brazil, follows him with 19 papers. The total production of these 26 authors represents 7.48% of the total of documents analyzed.

Table 3. Distribution of authors with productivity ≥ 10

Authors	No. of documents published
Marchi Junior, Wanderley	52
Cicuto Ferreira Roch, Nelci A	19
Nussbaum, Miguel	17
Guzman Valenzuela, Carolina	16
Perez Sanagustin, Mar	16
Sato, Masatoshi	15
Trevino, Ernesto	14
Capraro, Andre Mendes	14
Mazo, Janice Zarpellon	13
Espinoza, Oscar	13
Strasser, Katherine	12
Zavala, Genaro	12
Claro, Magdalena	11
Montecinos, Carmen	11
Hilliger, Isabel	11
Lucchetti, Giancarlo	11
De Souza, Juliano	11
Vaz, Alexandre Fernández	10
Alario Hoyos, Carlos	10
Delgado Kloos, Carlos	10
Scheuer, Nora	10
Bracht, Valter	10
Dos Santos, Wagner	10
Justi, Rosaria	10
Do Nascimento, Juárez Vieira	10
Font, Vicenc	10

International collaboration was around 40% at the beginning of the period analyzed. It reached the lowest percentage (0%) in the year 2003. From that year onwards, it increased until reaching its maximum value in the year 2006. Then it decreased and gradually increased again until reaching percentages similar to the initial ones, in recent years. In terms of national collaboration (collaboration between authors from the same country), it has increased to slightly surpass international collaboration and reach similar percentages at the end of the period 2000-2020. Individual authorship of papers (without collaboration) has been decreasing in recent years (Figure 5.).
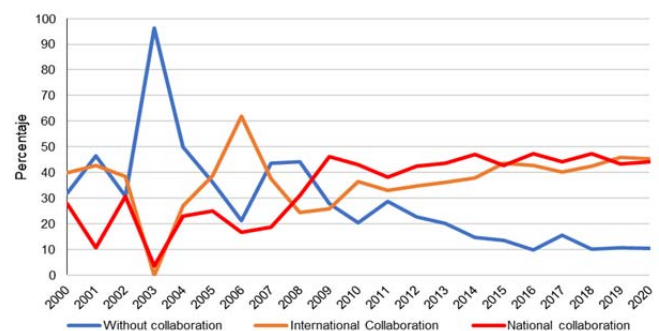

Figure 5. Type of collaboration

When the number of authors is analyzed in detail, it appears that 16.78% of the documents have been single-authored, and those signed by two or three

authors represent 49.42% of the total. The number of documents with four or more authors were almost anecdotal until 2008. From 2009, co-authorship with four or more authors began to increase, up to represent 27.82% of the documents published in 2020 (Table 4.).

Table 4. Patterns of authorship[1]

Year	Single author	Two authors	Three authors	Four authors	Five authors	6 or more authors
2000	8	13	3	1	0	0
2001	13	8	5	2	0	0
2002	14	15	4	2	0	0
2003	26	0	0	0	0	0
2004	13	7	4	0	0	1
2005	10	11	6	7	1	1
2006	8	5	13	10	2	4
2007	22	16	12	5	2	7
2008	62	43	33	8	10	11
2009	44	87	26	20	8	12
2010	48	77	41	19	14	17
2011	49	63	51	25	11	21
2012	46	75	53	21	9	15
2013	60	72	56	22	21	26
2014	40	103	61	39	24	38
2015	43	78	87	41	25	37
2016	42	103	87	52	37	55
2017	66	107	108	69	39	51
2018	53	122	118	90	54	73
2019	56	106	143	90	57	84
2020	80	181	162	119	68	141
Total	**803**	**1292**	**1073**	**642**	**382**	**594**

[1]*Distribution of Ibero-American production in Education according to Bradford's law.*

An important aspect in the analysis of the journals that make up the main channel of dissemination of Ibero-American research is to study how the dispersion of publications on education in the WoS is made by Ibero-American authors. To this end, we proceeded to apply the law of dispersion of scientific literature or Bradford's law [23], so we determine the different zones. Three documents were not included in this part of the study due to the fact they did not indicate the name of the journal. Productivity data of documents and journals were analyzed, and that distribution of journals according to document production is shown in Appendix 1.

Figure 6. allows us to graphically illustrate Bradford's law. The horizontal axis represents the log-scale number of cumulative journals in descending order of productivity, while the vertical axis represents the cumulative number of articles. The resulting curve R(r) is monotonous and increasing.
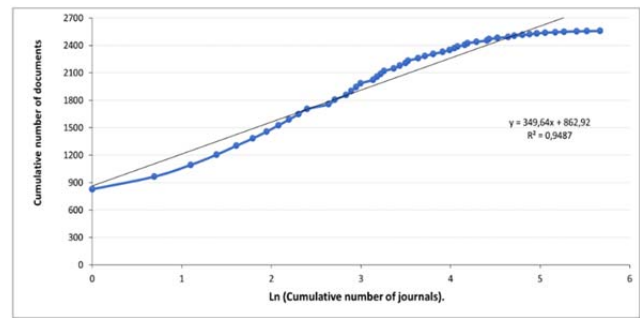

Figure 6. Dispersion of the scientific literature according to the Bradford model

We searched the Bradford zones using Leimkuhler's law [24] which is expressed in mathematical terms as follows: $R(r) = a \cdot ln(1 + br)$. For such purpose, we have followed the procedure proposed by Egghe [25] that has been tested in other recent studies [20], [26], [27].

If we consider that:

r_0 is the number of journals in the first Bradford zone.

y_0 is the number of items in each Bradford zone (each zone must be of equal size).

K is the Bradford multiplier.

$R(r)$ is the cumulative number of articles published by the journals.

a and b are the constants of the Leimkuhler formula:

$$R(r) = a \cdot ln(1 + b \cdot r).$$

Egghe (1986) indicates that the following formulas are used to find the values of the constants a and b: $a = \frac{y_0}{Lnk}$ and $b = \frac{k-1}{r_0}$. First, we need to determine the number of Bradford zones that we want to find, so $p = 3$. Now, we can find the value of k, following Egghe (1986):

$k = (e^\gamma \times y_m)^{\frac{1}{p}}$; as γ = Euler's Constant = 0,5772, then $e^\gamma = 1,781$.

$$k = (1,781 \times y_m)^{\frac{1}{p}} = (1,781 \times 828)^{\frac{1}{3}} = (1474,668)^{\frac{1}{3}} = 11,3823$$

$r_0 = \frac{T}{1+k+k^2+\cdots+k^{p-1}} = \frac{T(k-1)}{k^p-1}$ T is the total number of journals.

$$r_0 = \frac{T(k-1)}{k^p-1} = \frac{340(11,3823-1)}{11,3823^3-1} = \frac{3529,982}{1473,65383} = 2,3954$$

Once we obtain the values of k and r_0, we proceed to find a and b.

$a = \frac{(4786/3)}{ln(11,3823)} = 655,9598$ and $b = \frac{11,3823-1}{2,3954} = 4,3342$

To calculate the number of journals in each of the Bradford zones $(r_0 + k \times r_0, k^2 \times r_0, \dots)$, Egghe [28] recommends using the exact values of r_0 and k and therefore, the exact values of a and b in the Leimkuhler's law formula.

$$R(r) = a \cdot ln(1 + br) = 655{,}9598 \times ln(1 + 4{,}3342 \times 340)$$
$$= 655{,}959 \times 7{,}296 = 4785{,}99$$

Table 5. Distribution of all journals in three Bradford zones

Zones	Journals	Papers	k
Core	2	966	--
Zone 1	22	1091	11
Zone 2	316	2729	14,36
Total	**340**	**4786**	

Table 5. presents the distribution of all the journals in the three Bradford zones, in which we can see that the core is formed by 2 journals that accumulate 966 documents. This core is made up of a journal published in Brazil (Movimento) and another published in Spain (Enseñanza de las Ciencias) (Table 6.).

Table 6. Core of journals that publish educational Ibero-American research in the WoS

Country	Journal	Frequency
Brazil	Movimento	828
Spain	Enseñanza de las Ciencias	138

5. Conclusions

The scientific production produced in Ibero-America concerning education experiences an exponential growth in the analyzed period, increasing from 25 documents published in 2000 to 751 published in 2020. In the last five years there have been published more documents than in the previous 15 years, which means that 54.55% of all production in the region has been published in the period 2016 to 2020.

This increase is due to the incorporation of the *Emerging Sources Citation Index databases* and *SciELO* in the WoS, among other reasons. *Emerging Sources Citation Index databases* includes a good number of journals from the region, and the *SciELO* is a specific database of Ibero-American journals.

The analysis about the language of publication shows that 72.6% of the documents were published in English, which agrees with the fact that English has been considered as the principal language for the international dissemination of scientific knowledge for decades [29]. It is therefore clear that most Ibero-American countries carry out educational research which is presented to the international scientific community. Furthermore, all countries, with a few exceptions, carry out educational research that is also presented to the international scientific community.

Movimento journal is the main channel for the dissemination of educational publications in Ibero-America, publishing 17.3% of all papers. *Enseñanza de las Ciencias* journal, published in Spain, is the second preferred dissemination channel, publishing 2.88% of the total production analyzed.

This research also reveals that the increase in collaboration between authors, as indicated by the increase in the number of signatures per article in recent years, is a normal consequence of the advances in the means of communication, as well as the academic exchanges and doctoral training abroad that the different countries have been promoting in recent years in the region.

This study offers useful information that has made it possible to identify different patterns and trends in production, as well as in the channels of dissemination of educational research in Ibero-America.

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Appendix 1

Supplementary data

Table 7. Distribution of journals according to the publication of documents

Journals=a	Docs=b	a x b	Cum. journals = c	Ln c	Cum. docs.
º1	828	828	1	0,0000	828
1	138	138	2	0,6931	966
1	128	128	3	1,0986	1094
1	111	111	4	1,3863	1205
1	99	99	5	1,6094	1304
1	79	79	6	1,7918	1383
1	75	75	7	1,9459	1458
1	69	69	8	2,0794	1527
1	63	63	9	2,1972	1590
1	59	59	10	2,3026	1649
1	55	55	11	2,3979	1704
3	54	162	14	2,6391	1758
1	50	50	15	2,7081	1808
2	49	98	17	2,8332	1857
1	45	45	18	2,8904	1902
1	42	42	19	2,9444	1944
1	41	41	20	2,9957	1985
3	39	117	23	3,1355	2024
1	33	33	24	3,1781	2057
1	32	32	25	3,2189	2089
1	31	31	26	3,2581	2120
3	30	90	29	3,3673	2150
2	29	58	31	3,4340	2179
2	28	56	33	3,4965	2207
1	27	27	34	3,5264	2234
4	26	104	38	3,6376	2260
3	24	72	41	3,7136	2284
4	23	92	45	3,8067	2307
5	22	110	50	3,9120	2329
4	21	84	54	3,9890	2350
3	20	60	57	4,0431	2370
2	19	38	59	4,0775	2389
5	18	90	64	4,1589	2407
2	17	34	66	4,1897	2424
7	16	112	73	4,2905	2440
9	15	135	82	4,4067	2455
2	14	28	84	4,4308	2469
8	13	104	92	4,5218	2482
12	12	144	104	4,6444	2494
7	11	77	111	4,7095	2505
11	10	110	122	4,8040	2515
10	9	90	132	4,8828	2524
11	8	88	143	4,9628	2532
14	7	98	157	5,0562	2539
19	6	114	176	5,1705	2545
18	5	90	194	5,2679	2550
29	4	116	223	5,4072	2554
27	3	81	250	5,5215	2557
40	2	80	290	5,6699	2559
50	1	50	340	5,8289	2560