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BIBLIOMETRIC ANALYSIS OF THE MATHEMATICS EDUCATION JOURNALS IN THE *SSCI*

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ABSTRACT

We present a study about the Mathematics Education production in the Social Sciences Citation Index (SSCI) accessing through the Web of Science (WoS) database. We analyse the four journals specifically focused on Mathematics Education and indexed in the SSCI. We identify co-authorship patterns, diachronic production, the publication's language and the universities' productivity. This study has the aim to identify the international production of each country and university, as well as, to know the most important institutional collaboration networks.

The study showed a 429,85% of production increment in 26 years, starting with 56 documents per year in the earlier stages up to 276 in the latter one. This increment rises up to 578,94% if we only take into account research articles. The overall Latin-American production is slightly higher than the European one, which regarding international research we found atypical.

KEYWORDS: Bibliometric, Co-authorship, Collaboration, Mathematics Education, Scientific Journals.

1. INTRODUCTION

Each scientific discipline generates its own specific knowledge-transfer means. It is a tradition that the disciplines examine these medias by analysing conference proceedings, scientific journals and articles. Through this analysis, it is possible to know the evolution of the discipline itself and the research and collaboration patterns at both global level and particularly for a country or region. As an example we have studies in Mathematics (Behrens & Luksc, 2010), Psychopharmacology (Portillo-Salido, 2010), Physics (Glänzel, Rinia, & Brocken, 1995), Chemistry (Schummer, 1997) and Social Sciences (Hua, Yuan, Yan, & Li, 2006; Nederhof, 2006), among others.

In the Social Sciences field, there are disciplines for which it is very difficult to determine which their specific research articles are. This is due to they are close linked to others disciplines and there is no clear frontier among them. This is just the case of the Mathematics Education. Mathematics Education is related to Mathematics, Psychology, Pedagogy, Sociology, Epistemology, Philosophy of the Mathematics, History of the Mathematics, and so on. Some bibliometric researches focused on Mathematics Education used data analysis techniques such as expert survey (Jiménez et al., 2011; Adamuz-Povedano, Jiménez-Fanjul y Maz-Machado, 2013), MathEdu thematic clasification (Bracho-López et al., 2012) or just analyse all the articles published in a specific Mathematics Education journal (Bracho-López et al., 2011; Maz, Torralbo, Vallejo, Fernandez-Cano, & Rico, 2009). However, these techniques result useless when the study is large and the recovery of the data are made through accessing a wide-scope database. In wide-scope databases, the aimed articles could be published in not only Mathematics Education journals but also General Education journals, or

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specific journals from others disciplines as mentioned before. That is the reason why the thematic classification is not a good indicator for this kind of studies.

There are international studies where the analysis is often centred only in specific journals of the field, assuring that way that all the articles covered are from the field under study (Herrero-Solana & Rios-Gómez, 2006; Mahoney, Buboltz, Calvert & Hoffman, 2010). In the field of Mathematics Education, we only found bibliometric studies of articles published in Spanish journals (Bracho-López, et al., 2012; Bracho-López, Maz-Machado, Torralbo-Rodríguez, Jiménez-Fanjul, & Adamuz-Povedano, 2010; Bracho-López, et al., 2011). We have no evidence of this type of studies for international journals.

Until 2008, the Thompson-Reuters databases indexed only one journal specific of Mathematics Education: the *Journal for Research in Mathematics Education*. Since 2008 three others specific Mathematics Education journals have been incorporated. Taking into account that Thompson-Reuters SSCI is an international prestigious database and indexes four journals specifically focused on Mathematics Education, we think it is mandatory to carry out a study of these international journals. The study shows us the international production rated per country and university, as well as, identifies the most important collaboration networks.

2. METHODOLOGY

We accessed the Social Sciences Citation Index through the Web of Science database at the end of February'12. We chose all the registers covered by the four Mathematics Education journals indexed. They are classified inside the Education & Educational research category in the SSCI. The journals are the following: *Journal for Research in Mathematics Education (JRME), Bolema-Mathematics Education Bulletin-Boletim de Educacao Matematica (BOLEMA), Educational Studies in Mathematics (ESM)* y *Revista Latinoamericana de Investigación en Matemática Educativa-Relime (RELIME).* Despite there being in the SSCI other journals which sometimes publish Mathematics Education articles we decided not to include them in our study because not all the articles published by these journals are related to Mathematics Education. 1356 registers were recovered in several plain files through the on-line SSCI. These files were exported to an *ad hoc* relational database for further treatment and analyses.

In order to be able to identify the collaboration networks, several filiation squared-matrixes were made. The value of each cell array X_{ij} in the matrix could only be set to 1 or 0, depending on whether the researcher has signed or not as a co-author, or depending on the institutional links, and so on. A filiation matrix shows the existing relationships by the number of co-authorships. Likewise, we defined the following indicators:

A) General Bibliometric Indicators:

A_1 Type of document.
A_2 Diachronic production.
A_3 Language.
A_4 Production per university.
A_5 Total amount of cites received.

B) Collaboration Indicators:

B_1 Number of authors per article.
B_2 Number of articles per country.

Indicators A_1 y A_2 consider all types of document published (Ndoc), whereas the rest of indicators only take into account citable documents widely known as primary production (Ndocc), i. e., articles (Moya-Anegón et al., 2007). In the same way, universities are the only institutions units considered in our study, not considering other institutions or research centres such as CINVESTAV. The main reason for that constraint is that these institutes usually are inside a university. For instance, the *Institut Freudenthal* of the University of Utrecht. Thus, the result of the frequency count made, differs from the one obtained by the on-line WoS tool analyse.

The collaborative index (CI) (Lawani, 1980) and the degree of collaboration (DC) (Subramanyam, 1983) show the scientific collaboration among researchers. So, for a set "K" of articles published in a journal, these indicators are defined as bellow:

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$$CI = \frac{\sum_{j=1}^{A} jf_j}{N} \quad \text{y} \quad DC = 1 - \frac{f_1}{N}$$

Where $0 \leq DC \leq 1$

f_1 = number of articles having *j* author in collection *K*.

N = total number of articles in *K*. $N = \sum_j f_j$.

A = total number of authors in collection K.

3. RESULTS AND DISCUSSION

A) General bibliometric indicators

A_1: Type of documents: It is found 13 types of different documents, being the articles the most published (63,42%) followed by the book reviews (19,54%) and editorial materials (8,78%). These three types of documents are the 91,74% of the total amount of documents (See table 1).

Table 1. Type of documents of Mathematics Education in SSCI

Type of Document	Nº Doc.	%
Article	860	63,42
Book Review	265	19,54
Editorial Material	119	8,78
Proceedings Paper	36	2,65
Note	24	1,77
Letter	19	1,40
Review	18	1,33
Correction	4	0,29
Bibliography	3	0,22
Correction, Addition	3	0,22
Item About an Individual	3	0,22
Biographical-Item	1	0,07
Reprint	1	0,07
Total	1356	

A_2: Diachronic production: The first document regarding Mathematics Education indexed in the SSCI was published in 1986. In Figure 1 a comparison between the diachronic production of the total production (Ndoc) and articles (Ndocc) is presented. It is shown an increment from 56 (Ndoc) documents up to 276 in 26 years, that is a 429,85% increment. Regarding scientific articles (Ndocc), the increment is even a 578,94%. It is necessary to point out that up to 2008 the only journal of Mathematics Education indexed in the SSCI was the JRME, since then the other journals BOLEMA y RELIME were indexed and in 2011 ESM was also incorporated. The high productivity of JRME (See Table 2) is explained due to both this fact and also that JRME publishes five issues per year whereas ESM publishes 9 and BOLEMA and RELIME publishes three each one.

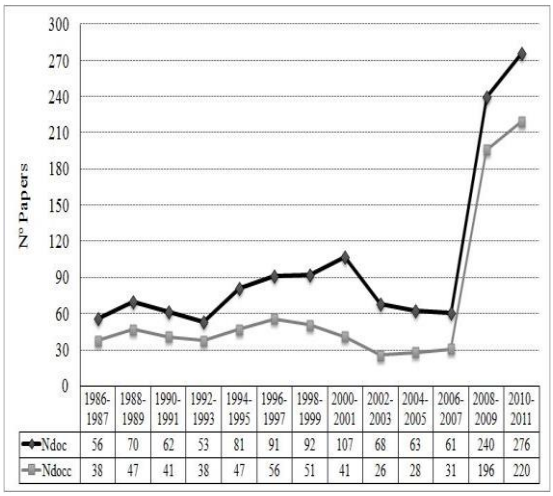

Figure 1. Diachronic production in Mathematics Education journals in SSCI

Table 2. Number of Mathematics Education articles published, per journal

Journals	Articles
JRME	496
BOLEMA	160
ESM	156
RELIME	48
Total	860

A_3: Language: English is the predominant language chosen for articles (76,4%), followed by Portuguese (18,6%) and Spanish (3,95%).

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Table 3. Publication language of the articles of the SSCI Mathematics Education journals

Language	Articles
English	657
Portuguese	160
Spanish	34
Unspecified	7
French	2

There are only two articles written in French, and there are 7 articles written in unspecified language. Both JRME and ESM publish in English that is why English has the higher percentage. An important aspect shown by the study is that despite being both BOLEMA (Portuguese) and RELIME (Spanish) indexed in the same year and publishing the same number of issues per years, there are a big difference between the total number of articles published in each one.

A_4: Production per university: The 1356 articles of our sample under study are signed by authors linked to some of the 392 universities found. The university with the highest productivity rate is the Michigan State University (Table 4). The first Latin-American University regarding scientific production is the *Universidad Estadual Campinas*, being also the first non-USA University in the ranking. The first European University is the University of London, which is in the 22th position of the ranking with 8 articles. The Tel-Aviv University is the first Asian University with 7 articles.

Table 4. Universities with 10 or more Mathematics Education articles in the *SSCI*

University	Articles
Michigan State Univ	21
Univ Georgia	18
Purdue Univ	18
Univ Wisconsin	17
Univ Illinois	15
Univ Michigan	14
Univ Pittsburgh	13
Univ Estadual Campinas	12
Rutgers State Univ	11
Univ Fed Minas Gerais	11
San Diego State Univ	11
Arizona State Univ	11
Indiana Univ	10

A_5: Total amount of cites received: The articles of these four journals were cited 7805 times, that is an average of 9,06 cites per article. However, the 97,7% of these are cites of articles published in the *JRME*. So that the number of cites received by articles from the other three journal is minimal. The 38,14% of the articles of the sample have never been cited, whereas 7 articles were cited more than 100 times (Table 5). The article signed by Yackel & Cobb published in the *JRME* in 1996 and titled "Sociomathematical norms, argumentation, and autonomy in mathematics" is the most cited one with an overall of 108 cites received.

Table 5. Mathematics Education articles citation

Nº cites	Articles	%	Nº cites	Articles	%
0	328	38,1	18	13	1,5
1	71	8,2	19	7	0,8
2	37	4,3	20	14	1,6
3	37	4,3	21	8	0,9
4	25	2,9	22	5	0,5
5	29	3,3	23	8	0,9
6	27	3,1	24	4	0,4
7	21	2,4	25	5	0,5
8	23	2,6	26	6	0,7
9	17	1,9	27	7	0,8
10	13	1,5	28	4	0,4
11	16	1,8	29	7	0,8
12	10	1,1	30	6	0,7
13	15	1,7	31-40	26	3,0
14	9	1,0	41-50	20	2,3
15	10	1,1	50-100	9	1,0
16	4	0,4	+100	7	0,8
17	12	1,4			

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B) Collaboration Indicators

B_1: Number of authors per article: The 860 articles (Ndocc) presented in the sample were signed by some of the 1347 authors who generate a total amount of 1838 signatures. The 38,62% of the articles are signed only by one author, being this type of authorship predominant and followed by the articles signed by two authors. These two types of authorship are the 74,56% of the total (Table 6). The collaborative index CI is 2,144 which is slightly higher than the CI shown by other studies focused on the Spanish journals *Enseñanza de las Ciencias* (1,84) and *Suma* (1,74) (Bracho-López et al., 2012; Maz et al, 2009). This CI is the same that the one calculated for other disciplines, such as Applied, physical & analytical chemistry (Stefaniak, 1982) and Chemical engineering (Subramanyam & Stephens, 1982). On the other hand, the CI yielded is very close to the CI (2,29) calculated for the Social Education (Valenciano, Devís-Devís, Villamón & Peiró-Velert, 2010). The degree of collaboration DC is 0,61 which indicates that almost the half of the articles are written in collaboration.

Table 6. Number of authors per Mathematics Education article

Nº Authors	Nº Articles	%
1	331	38,62
2	308	35,94
3	122	14,24
4	44	5,13
5	19	2,22
6	12	1,40
7	4	0,47
8	12	1,40
9	2	0,23
10	2	0,23
20	1	0,12
Total	**857**	**100**

An article signed by 20 authors was found in the sample. The most productive authors are Paul Cobb with an amount of 12 articles written and Karen C. Fuson with 11. They are the only two "big producers", in Lotka's words.

B_2: Number of articles per country: The articles were written by authors of 42 different countries.

Table 7. Mathematics Education Production per country (with 7 or more articles)

Country	Nº Articles
USA	426
Brazil	139
Canada	52
Israel	49
England	45
Australia	37
Spain	32
Mexico	16
Portugal	13
Germany	11
Italy	10
France	9
Belgium	8
Holland	8
South Africa	7

USA contributes with the 32,44% of the total amount of articles, followed by Brazil with the 15,81%. The rest of countries are far away from them. The production of Brazil is important and it is almost the third part of the USA production (Table 7).

Grouping the production per geographical regions result that USA-Canada are biggest producers with the 37,09% of the articles (See Table 8). An important issue is that the Latin-American production is slightly higher than the European one which is unusual regarding international research. It could be thought that this fact is because two of the four journals studied are from this region.

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Table 8. Mathematics Education per geographical regions

Region	Nº Art.	% of 860
USA-Canada	478	55,58
Latin-American	170	19,77
Europe	168	18,6
Asia	71	8,26
Oceania	43	0,81
Africa	10	0,58

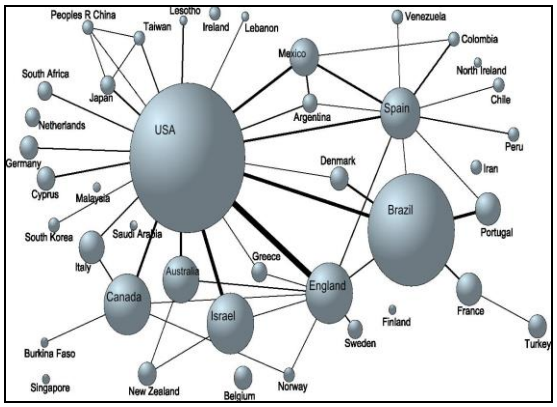

Figure 2. Country collaboration network

USA authors collaborate with others from 20 countries, being the collaboration between USA-English authors the biggest one with 13 articles. Spain, despite having less production than other countries, collaborates with 10 other countries. Therefore, Mexico is the most important collaborator of Spain. There are 9 countries that have no collaboration with other countries: Saudi Arabia, Belgium, Finland, Ireland, Iran, Singapore, Malaysia, North Ireland and Netherlands (Figure 2).

4. CONCLUSIONS

The incorporation of two Latin-American journals specific of Mathematics Education in the SSCI in 2008 has implied not only an exponential increment of the Mathematics Education production but also more visibility for Ibero-American authors.

The study shows that USA is the biggest producer of Mathematics Education research articles and also USA is the country with the higher international collaboration rate. Spain is the centre of the collaboration among Latin-American countries. These latter countries in overall overcome the European production.

North-American Universities are similar producers. Four Brazil Universities are among the 20 first positions in the ranking whereas the first European University is the University of London with only 8 articles. The co-authorship index is slightly under those calculated for Spanish Mathematics Education journals and very close to Social Sciences ones.

Brazil is second producer, positioning Latin-American region at the same level than Europe, regarding international visibility.

The results found point out the necessity of widening this study by including also those journals that despite not being specific for Mathematics Education, frequently publish articles of this field. That way, it could be proved whether the trends and patterns detected in this study can be extended to the overall Mathematics Education production.

5. REFERENCES

1. Adamuz-Povedano, N., Jiménez-Fanjul, N., & Maz-Machado, A. (2013**).** Búsqueda de descriptores que caractericen una disciplina emergente en WoS y SCOPUS: el caso de la Educación Matemática. *Biblios. Revista electrónica de bibliotecología, archivología y museología*, 50, 1-14.

2. Behrens, H., & P Luksc. (2010). Mathematics 1868–2008: a bibliometric analysis. *Sientometrics*, 86(1), 179-194.

3. Bracho-López, R, Maz-Machado, A., Gutiérrez-Arenas, M. P., Torralbo-Rodríguez, M., Jiménez-Fanjul, N., & Adamuz-Povedano, N. (2012). La investigación en Educación Matemática a través de las publicaciones científicas españolas. *Revista Española de Documentación Científica,* 35(2), 260-280.

4. Bracho-López, R., Maz-Machado, A., Torralbo-Rodríguez, M., Jiménez-Fanjul, N., & Adamuz-Povedano, N. (2010). La investigación en educación matemática en la revista Epsilon. Análisis cienciométrico y temático (2000-2009). *Epsilon. Revista de*

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Educación Matemática, 75, 9-25.

5. Bracho, R., Maz-Machado, A., Jiménez-Fanjul, N., Admuz-Povedano, N., Gutiérrez, M. P., & Torralbo, M. (2011). Análisis cienciométrico y temático de la revista SUMA (1999-2010). *Suma*, 68, 47-54.

6. Glänzel, W., Rinia, E. J., & Brocken, M. G. (1995). A bibliometric study of highly cited European physics papers in the 80s. *Research Evaluation*, 5(2),113-122.

7. Herrero-Solana, V., & Rios-Gómez, C. (2006). Producción latinoamericana en information and library science en el Social Science Citation Index (SSCI) 1966-2003. *Information Research*, 11(2), paper 247. Retrieved from http://InformationR.net/ir/11-2/paper247.html website.

8. Hua, W., Yuan, S., Yan, M., & Li, Y. (2012). A quantitative analysis of Arctic related articles in the humanities and social sciences appearing in the world core journals. *Scientometrics*, 91(3), 1-16.

9. Jiménez, N., Adamuz, N., Maz, A., Bracho, R., Lupiáñez, J. L., & Segovia, I. (2011). Producción científica internacional en educación matemática en SSCI y SCOPUS (1980-2009): construcción de descriptores. In J. L. Lupiáñez, M. C. Cañadas, M. Molina, M. Palarea & A. Maz (Eds.), *Investigaciones en Pensamiento Numérico y Algebraico e Historia de la Matemática y Educación Matemática – 2011*. Granada: Dpto. Didáctica de la Matemática, Universidad de Granada.

10. Lawani, S.M. (1980). *Quality, collaboration, and citations in cancer research: a bibliometric study (PhD thesis)*. Florida: Florida State University.

11. Mahoney, K. T., Buboltz, W. C., Calvert, B., & Hoffman, R. (2010). Research productivity in select psychology journals, 1986–2008. *The Journal of Psychology*, 144(4), 361-411.

12. Maz, A., Torralbo, M., Vallejo, M., Fernandez-Cano, A., & Rico, L. (2009). La Educación Matemática en la revista Enseñanza de las Ciencias: 1983-2006. *Ensenanza de las Ciencias*, 27(2), 185-193.

13. Moya-Anegón, F., Chinchilla-Rodríguez, Z., Corera-Álvarez, E., González-Molina, A., & Vargas-Quesada, B. (2007). *Galicia (ISI-WoS, 2004): Patrones de Colaboración Científica*. Santiago de Compostela: Xunta de Galicia.

14. Nederhof, A. J. (2006). Bibliometric monitoring of research performance in the Social Sciences and the Humanities: A Review. *Scientometrics*, 66(1), 81-100.

15. Portillo-Salido, E. (2010). A Bibliometric Analysis of Research in Psychopharmacology by Psychology Departments (1987-2007). *The Spanish Journal of Psychology*, 13(1), 503-515.

16. Schummer, J. (1997). Scientometric studies on chemistry I: The exponential growth of chemical substances, 1800–1995. *Scientometrics*, 39(1), 107-123.

17. Stefaniak, B. (1982). Individual and multiple authorship of papers in chemistry and physics, *Scientometrics*, 4(4), 331-337.

18. Subramanyam, K. (1983). Bibliometric studies of research collaboration: A review. *Journal of Information Science*, 6(1), 33-38.

19. Subramanyam, K., & Stephens, M. (1982). Research collaboration and funding in biochemistry and chemical engineering. *International Forum on Information and Documentation*, 7, 26-29

20. Valenciano, J., Devís-Devís, J., Villamón, M., & Peiró-Velert, C. (2010). La colaboración cientifica en el campo de las ciencias de la actividad física y el deporte en España. *Revista Española de Documentación Cientifica*, 33(1), 90-105.