Mexican collaboration networks in the international and regional arenas

Jane M. Russell [1] Maria J. Madera-Jaramillo[1] Yoscelina Hernández-García [2] Shirley Ainsworth [3]

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Abstract

A comparison was made of the international collaboration networks of Mexican scientists through coauthorship analysis in the period 2000-2005, both publishing in the mainstream literature as evidenced by the Web of Science, and for the first time from regional journals through the CLAPER database, containing records from some 3,000 Latin American journals from the Clase and Periódica databases. Mexican production in the social sciences, arts and humanities is particularly well represented in the Clase database. Collaboration between countries was visualized using Pajek social network analysis software. 44% of the WoS documents were written with institutions outside the country, whereas the corresponding percentage for the CLAPER database was only 5%. The dominant subjects in CLAPER were Applied Biology, Earth Sciences and Multidisciplinary Sciences, and in the mainstream journals the spread of subjects was more evenly distributed, apart from Engineering, Mathematics and Multidisciplinary Sciences which were less present. Three levels of international collaboration were analysed, Level 1: intra regional, Level 2: extra regional, Level 3: both intra and extra regional. CLAPER documents show higher percentages of intra-regional collaboration than the mainstream journals. However, in both databases extra-regional collaboration is dominant with notable differences in subject areas. In both databases Cuba is the most frequent partner in intra-regional collaboration, followed by Brazil. The US is the dominant international partner both without or with the presence of other LA countries (levels 2 and 3) with Spain showing the greatest presence of the European countries at both levels. Brazil leads the LA countries in level 3 collaborations.

1 Introduction

Scientific research is increasingly becoming a more global, more collaborative human activity, motivated not only by material objectives (access to funding, state of the art equipment, for instance) but also by social and intellectual factors associated with sharing and pooling non-material resources to achieve results unattainable by individual effort. Collaboration is particularly crucial to researchers working in developing countries where inadequate facilities and resources both human and material, encourage them to look outside their own environment for collaborators able to compensate for less than ideal conditions at home. On the other hand, scientists from the industrialized world are

[1]Centro Universitario de Investigaciones Bibliotecológicas, Universidad Nacional Autónoma de México (UNAM) Ciudad Universitaria, 04510 México DF, Mexico. jrussell@servidor.unam.mx majj@servidor.unam.mx
[2]Programa de Posgrado en Bibliotecología y Estudios de la Información, UNAM. yosce23@aim.com
[3]Instituto de Biotecnología, UNAM. shirley@ibt.unam.mx

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constantly on the lookout for new problems to study, new approaches to explore and new sources of intellectual stimulation which they in turn often find by reaching out beyond their local surroundings and their particular cultural and social confines.

It comes as no surprise then that for a number of years now, Latin American (LA) collaboration has been of interest to scientometricians and science policy analysts from different countries, such as the UK (Lewison et al., 1993), France (Narváez-Berthelemot et al, 1992), Spain (Fernández et al., 1998; De Moya-Angón and Herrera-Solana, 1999; Sancho et al., 2006; De Filippo et al., 2008), as well as those from LA countries themselves (Krauskopf et al., 1995; Dagnino and Thomas, 1998; Vehlo, 2005; Russell et al., 2007). The LA region represents a group of countries bound by a dominant language and by a common colonial history making it an interesting scenario in which to study collaborative activities, not only with countries from outside the region but also between countries within the region. LA is said to have a significant number of regional treaties suggesting a considerable level of local cooperation and cohesion.

From the perspective of the communication of science, questions relating to why developing country scientists choose to publish in mainstream journals and what work they decide to send to national journals, are of considerable interest as much to editors as to evaluators and policy makers. It has been suggested that two groups of scientists coexist in developing countries; the elite publishing in international journals on topics of a basic nature or of applied nature of universal interest and the non elite publishing mainly in Spanish in Latin American journals on topics of local interest or of limited significance to a wider audience (Russell and Galina, 1998). This may be a simplification as many researchers combine mainstream and national publications strategies (Russell, 1998), nonetheless it can be argued that the majority of authors from developing countries fall predominantly into one or other of the two groups.

Publishing their best work and that of interest to an international audience in mainstream journals and leaving publication of research of lesser worth or of a more applied nature to the local and regional journals, is often put forward as a general strategy employed by many developing country scientists. In the case of Indian journals it has been alleged (Raval, 2007) that there may be a 'dismal lack of originality' in national publications, suggesting that papers published locally are more likely to be of poor quality. Mainstream publication is probably out of reach for a substantial sector of developing country scientists, regardless of the nature and quality of their research, in many cases due to a poor grasp of the English language. International coauthorship is one of the ways developing country scientists are able to achieve publication in international journals.

Regional journals are predominantly general journals (Del Río, 1982) reflecting the absence of established specialist groups in many areas of scientific research resulting in few of these publications being able to compete in the international scientific arena. In 1995, only 35 Latin American journals were indexed by the Science, and Social Sciences Citation Indexes, by 2003 this figure had increased to 55 (Collazo-Reyes et al., 2008). In all 121 Latin American journals were included in these two databases plus the Arts and Humanities Citation Index, at some point from 1961 to 2005 but few enjoyed continuous coverage (Luna-Morales y Collazo-Reyes, 2007).

The objective of the present study is to visualize the international collaboration networks of Mexican scientists when publishing in the mainstream literature from 2000 to 2005 and to compare these with those found through a coauthorship analysis of papers published in regional journals during the same period.

2 Method

Two databases with distinctive characteristics were used in the study, both of which include institutional affiliations and addresses for all authors for the period covered by our study, essential for carrying out coauthorship analysis.

CLAPER, a relational database in PostgreSQL containing records from the Periódica and Clase Open Access Bibliographic databases edited by the UNAM which cover a group of some 3,000 Latin American journals in all knowledge fields from the late 1970s to date,

Periódica in the sciences and Clase in the social sciences, humanities and the arts.[4] The main limitation of this source for bibliometric studies is associated with certain characteristics typical of many Latin American journals, such as delayed publication, lack of quality peer review and variety of content. In relation to these last two characteristics, the declared editorial policy of Periódica and Clase is to include academic, technical, and professional journals related to science, technology and cultural issues when these comply with established standards of editorial quality.

In their publicly accessible form, these databases can be consulted via the Aleph system, a commercial integrated library system from *Ex-libris,* which somewhat limits their ability to be exploited for bibliometric studies. Thus the data have been extracted from here and integrated into the CLAPER database, developed as part of a project to construct a web interface for the bibliometric analysis of records from these two databases. The bibliometric indicators offered by the Web of Science databases were used as a blueprint for the indicators required for CLAPER which also allows searching on all available fields. CLAPER offers a distinct advantage for collaboration studies in that author affiliations have been normalized and at article level each record is catalogued with subject headings and keywords in both English and Spanish, an important feature taking into account the general nature of many of the LA journals.

Web of Science (Science Citation Index Expanded, Social Science Citation Index, Arts and Humanities Citation Index), a multidisciplinary database covering approximately 8,700 of the most highly cited journals published worldwide.[5] These databases, unlike CLAPER, include abstracts within the records, references to citing and cited articles, and classify the journals within subject categories, as well as providing author keywords and KeyWords Plus at article level. The Web of Science includes English translations of original Spanish and Portuguese article titles, whereas CLAPER retains the originals. Although these databases have been criticised for their lack of coverage of Latin American journals, their strength lies in the ability to track published research in mainstream journals by authors with a Latin American institutional affiliation. In the case of WoS these affiliations are not usually normalized.

The following procedure was carried out to ensure correct representation of the national and international environments.

CLAPER: Records from journals not appearing in the 3,058 titles comprising the catalogue section of the Latin American periodical directory Latindex were excluded to ensure a "quality" journal set in the final analysis.[6] The catalogue comprises only those Latin American journals with proven editorial quality complying to a set of evaluation criteria based on international standards, more rigorous than those used for inclusion in Periódica and Clase. While the CLAPER database assigns several subject categories to each paper, we took into account only the first which is considered the most important.

WoS: Latin American journals were eliminated to avoid duplication of records with CLAPER.

Both CLAPER subjects at article level and ISI subject categories at journal level were aggregated into larger scientific disciplines utilizing OST Indicateurs de Sciences et de Technologies 2006 [7] for sciences and the new classification suggested by Glanzel for social sciences and humanities (Glanzel and Schubert, 2003). The newer ISI subject category Nanoscience and Nanotechnology was grouped with Multidisciplinary Sciences for the purpose of this study.

Variables considered for both databases were: collaboration level (Level 1: solely intra regional, Level 2: solely extra regional, Level 3: both intra and extra regional); collaborating countries; subject areas; publication year. The country names were normalized across databases and each counted just once in each document.

Where appropriate, these were visualized using social network analysis (Jamali and Abolhassani, 2006; Nooy et al., 2005), an approach widely used in collaboration studies and previ-

[4] http://www.dgbiblio.unam.mx
[5] http://scientific.thomson.com/products/wos
[6] http://www.latindex.org
[7] http://www.obs-ost.fr/

ously used to analyse the publication and web structure of the COLLNET network (Kretschmer and Aguillo, 2004).

3 Data

All records for Mexico in the address field with publication dates 2000-2005 in each of the three ISI Web of Science databases and from CLAPER (Clase and Periódica) were downloaded, and divided into those with any kind of external collaboration and those with either no collaboration or purely national collaboration.

The *Web of Science* records were included in databases in Reference Manager 11. The 4,113 records from journals published in Latin America were removed from our set (both with and without collaboration), which represent 11% of the total. 620 duplicate records between the three WoS databases were detected and only one ocurrence was retained, using the first subject category as the filter. 37 records representing false drops, were also removed.

A total of 38,104 records were downloaded from the CLAPER database, 9,150 of which were deleted after the application of the first filter; ie those titles not included in the Latindex catalogue, leaving a total of 28,954 for our analysis.

4 Results

Table 1 shows that the total number of documents where Mexican institutions figure as authors is greater in general in WoS than in the regional databases, 37,526 and 28,954, respectively. However, documents in the social sciences, arts and humanities are much better represented in the Clase database than in the corresponding citation indexes, 9,971 compared to 1,781. It is also interesting to note that the percentage of Mexican documents in international collaboration is significantly higher in the mainstream non-Latin American journals than in the group of regional journals even in the social and humanities areas. While 43.8% of all WoS documents in our sample were written with institutions outside the country, the corresponding percentage for the CLAPER database was only 5.1%.

Table 1: International collaboration (IC)

Database	Without IC	With IC	Total records	% IC
SCI*	19,733	16,012	35,745	**44.8**
SSCI*	985	372	1,357	**27.4**
AHCI*	375	49**	424	**11.6**
Total WoS*	*21,093*	*16,433*	*37,526*	***43.8***
Periódica	17,634	1,349	18,983	**7.1**
Clase	9,839	132	9,971	**1.32**
Total CLAPER	*27,473*	*1,481*	*28,954*	***5.1***

* Non-LA journals only
** 19 have only one author but with institutional affiliations in Mexico and another country

Only a small percentage (0.47%) of the Mexican documents in international collaboration and published in WoS non-Latin American journals were only in Spanish, in contrast to the CLAPER documents with 53.7% of the total written in the local language (Table 2). The presence of languages other than Spanish and English was scarce with only a few papers appearing in Portuguese. The most prevalent document type was the journal article: 89.5% in WoS and 90.1% in the quality regional journals covered by CLAPER (Table 3).

Table 2: Main language in international collaboration

Database	Language		
	English	*Spanish*	*Other or more than one*
SCI*	15,902	60	50
SSCI*	363	7	2
AHCI*	39	10	0
Total WoS*	*16,304*	*77*	*52*
Periódica	571	677	101**
Clase	7	119	6
Total CLAPER	*578*	*796*	*107*

* Non-LA journals only
** 87 published simultaneously in English and Spanish

Table 3: Document type in international collaboration

Database	Document type		
	Article	*Mtg Abst**	*Other*
SCI	14,365	886	761
SSCI	313	26	33
AHCI	30	0	19**
Total WoS	*14,708*	*912*	*813*
Periódica	1,221	*	128
Clase	114	*	19
Total CLAPER	*1,335*	*	*146*

* Periódica and Clase do not have this category
** 6 reviews

The majority of documents in international collaboration corresponded to level 2 (with countries outside the region) both in general (84.6%) and with respect to WoS and CLAPER, 86.1% and 68.3% (Table 4). In the case of purely intra-regional collaboration (level 1), a higher percentage was found with respect to the regional journals than the international non-LA journals, 28.7% and 7.2%, respectively. The journal article was the most common document type, accounting for between 86% and 92% in all instances.

Table 4: International collaboration by levels and percentage of articles

Database	Level 1		Level 2		Level 3	
	total	*% arts*	total	*% arts*	total	*% arts*
WoS	1,191	*92.5*	14,146	*89.5*	1,096	*86.7*
CLAPER	425	*89.2*	1,011	*90.5*	45	*91.1*
Total Mexico	***1,616***	***91.6***	***15,157***	***89.5***	***1,141***	***86.9***

Language differences are reflected in the distribution of documents written in English and Spanish in the three levels (Table 5). While 796 of the 1,481 total documents (53.7%) in international collaboration in CLAPER were published in Spanish, the corresponding percentage for WoS is 0.47% (77 out of 16,433). At level 1, the corresponding percentages for Spanish were 68.9% for CLAPER and 1.0% for WoS.

Table 5: International collaboration by levels and language

Database	Level 1		Level 2		Level 3	
	Eng	*Spa*	*Eng*	*Spa*	*Eng*	*Spa*
WoS	1,177	13	14,044	53	1,083	11
CLAPER	95	293	458	483	25	20
Total Mexico	***1,272***	***306***	***14,502***	***536***	***1,108***	***31***

Half the documents in intra-regional collaboration (level 1) in CLAPER were published in Mexican journals, rising to 95% in the case of purely extra-regional collaboration (level 2) and 69% for both intra y extra-regional collaboration (level 3).

Whilst in WoS subjects of the documents in IC are evenly distributed accounting for between 14% and 15% in all cases, with the notable exception of Engineering 9%, Mathematics 4% and Multidisciplinary Sciences 1%, CLAPER has a more uneven distribution. Applied Biology with 28%, Earth Sciences 19% and Multidisciplinary Sciences with 14% of documents, together account for more than half of the documents. The social sciences and humanities occupy 8% of publications in the regional database, as opposed to 2% in the mainstream journals.

At level 1 the dominant subject in CLAPER was Applied Biology (41.9%), at level 2 Earth Sciences (23.9%) closely followed by Applied Biology (22.8%), and at level 3 Earth Sciences represented 31.1% of documents. In the case of WoS Chemistry (24.3%) was the dominant subject at level 1, at level 3 Medical Research

(22.7%), while at level 2, the subjects were more evenly distributed within the sciences.

In all subject areas it is readily apparent that the majority of the documents correspond to purely extra-regional collaboration; in the case of WoS, ranging from 80.3% in Physics to 95.7% in the Social Sciences 2 (Figure 1). The areas of Chemistry and Physics, with 12.9% and 9.7% respectively are the most prolific at the intra-regional level, while in level 3 these correspond to Medical Research with 10.7% and Physics with 10%.

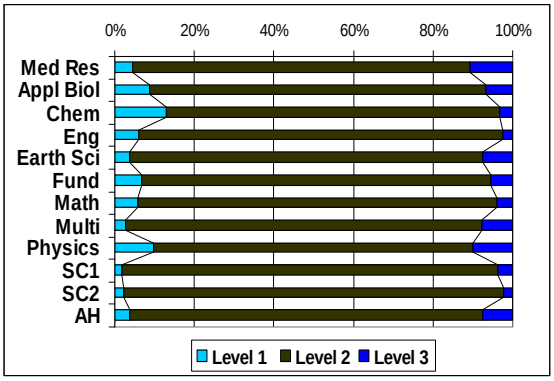

Figure 1: **WoS** IC in Mexican research at the three levels by subject area.

The picture is rather different in the case of CLAPER (Figure 2), with collaborations at the first level (regional) assuming a greater importance, as might be expected. All subjects, apart from Earth Sciences and Multidisciplinary subjects correspond to more than 10% of intra-regional collaborations, which in Medical Research reaches 91%, although this figure corresponds to just 61 documents. Purely extra-regional collaboration as represented in CLAPER demonstrates a broader range than WoS, from 4.5% of Medical Research in this category to 98.1% of Multidisciplinary subjects. In several areas CLAPER shows no level 3 collaboration whatsoever, although Mathematics appears to be the exception in that it represents 32.3% of intra and extra-regional collaboration, in marked contrast to 4% in WoS.

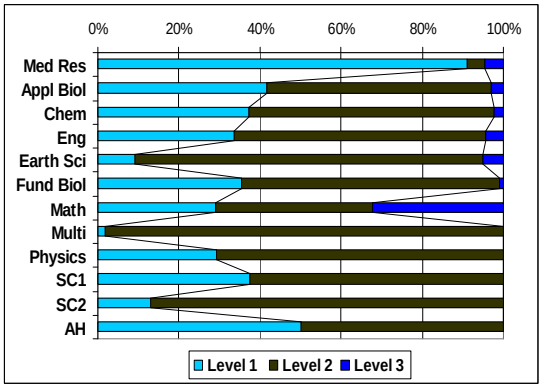

Figure 2: **CLAPER** IC in Mexican research at the three levels by subject area.

Figures 3-5 represent Mexican collaboration with other countries at the three levels in CLAPER, utilizing a method to model centrality within social network analysis. Countries with more collaboration are located nearer to the centre while those with less are on the periphery. Thicker connecting lines (or *edges* in Pajek parlance) indicate more collaboration.[8] Certain countries such as Bulgaria at level 2 do not have a high level of collaboration with Mexico (Figure 4). The fact that their production however small, is with high producing countries with many connections explains their central position. Figures 6-8 correspond to WoS. These graphs can be consulted on our server[9] in both svg and jpg formats, as their visualization requires rather greater space than permitted here.

[8] http://vlado.fmf.uni-lj.si/pub/networks/pajek/
[9] http://biblioteca.ibt.unam.mx/CollnetBerlin

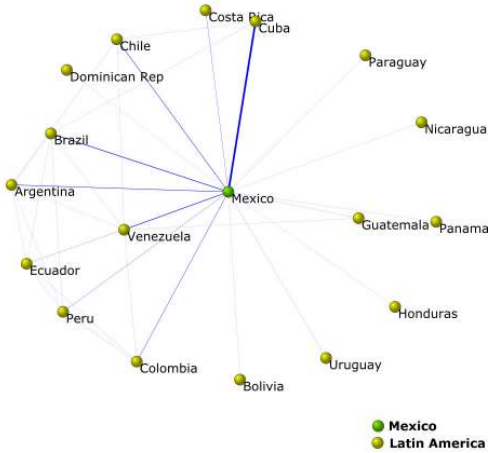

Figure 3: CLAPER Leve1 l Intra-Regional

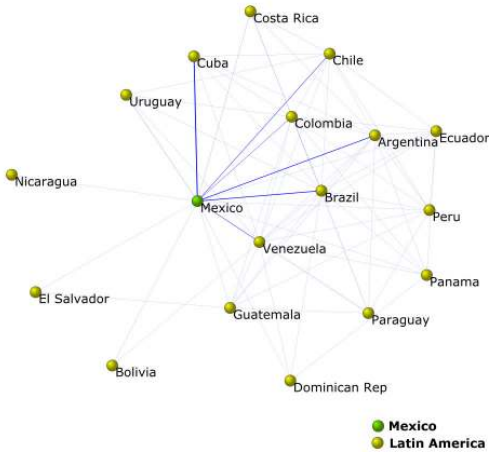

Figure 6: WoS Leve1 l Intra-Regional[10]

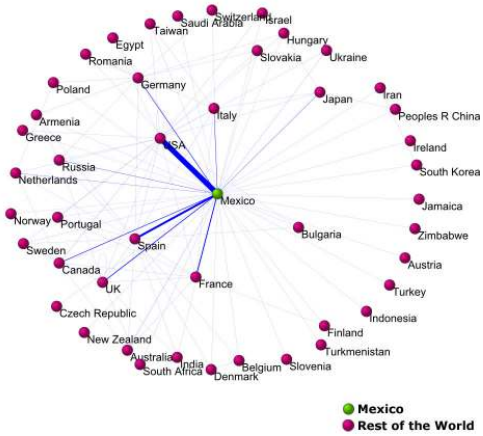

Figure 4: CLAPER Leve1 2 Extra-Regional

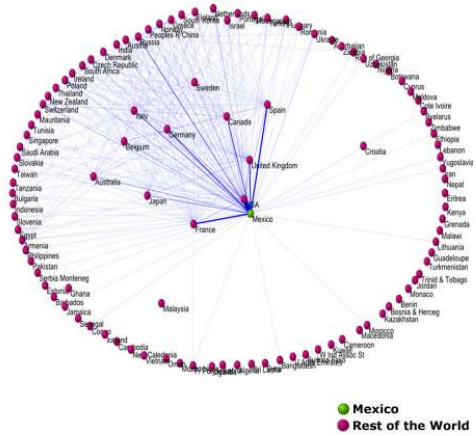

Figure 7: WoS Leve1 2 Extra-Regional[10]

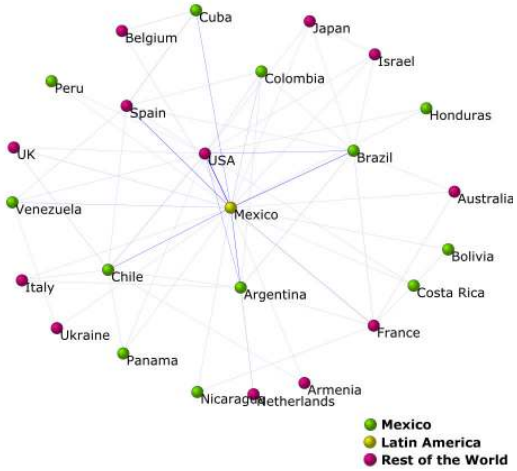

Figure 5: CLAPER Leve1 3 Intra-Extra Regional

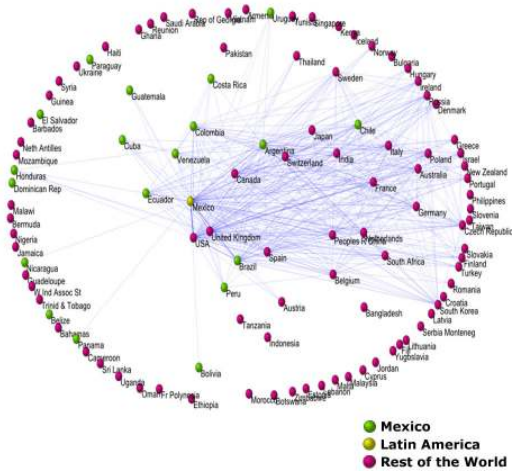

Figure 8: WoS Leve1 3 Intra-Extra Regional[10]

[10] Numbers of collaborations were represented on a scale 1:10.

The number of countries participating in a document as well as the number of collaborations can be observed at the three levels, which increase considerably in mainstream journals. Tables 6-8, apart from indicating the countries with most collaboration with Mexican institutions, show the total countries involved in each level as well as the number with only one collaboration and those with more than one collaboration in this period.

It is apparent that documents at all levels included in the international journals represent a richer and more consistent collaboration between countries, 1% overall showing a single collaboration as opposed to 57% in the regional journals.

Table 6: International collaboration level 1

Country	CLAPER	WoS
Cuba	163	331
Brazil	54	244
Venezuela	51	129
Argentina	41	222
Chile	38	140
Colombia	28	94
Total countries	18	18
Number of lines with value = 1	13	1
Number of lines with value ≠ 1	21	71
Edges	34	72

Table 7: International collaboration level 2

Country	CLAPER	WoS
USA	482	6,728
Spain	187	1,879
France	83	1,497
UK	64	1,350
Canada	51	945
Germany	45	1,062
Total countries	46	108
Number of lines with value = 1	64	16
Number of lines with value ≠ 1	45	1,104
Edges	109	1,120

Table 8: International collaboration level 3

Country	CLAPER	WoS
USA	20	659
Brazil	12	416
Spain	11	197
Chile/UK	9	250
Argentina	9	287
Cuba/France	7	204
Total countries	25	108
Number of lines with value = 1	40	31
Number of lines with value ≠ 1	23	2,302
Edges	63	2,333

Given the special status that Cuba occupies within Latin American socio-politics, it is interesting to note that at level 1 in both regional and international journals Cuba is the most frequent partner, followed by Brazil. Cuba also has the greatest relative participation in CLAPER while Brazil and Argentina have the least. The US is the dominant international partner both without or with the presence of other LA countries (levels 2 and 3), with Spain showing the greatest presence of the European countries at both levels. We should bear in mind that collaborations at the third level are also LA collaborations, but only those including at least one other country from outside the region. Brazil leads the LA countries in level 3 collaborations, while the Cuban position is almost reversed in the case of WoS, occupying eleventh out of the top twelve positions, almost on a par with Canada.

The majority of Mexican collaborations in mainstream journals involve just one other country, 92% and 78% within the first two levels, and those with two or more countries, 8% and 22% respectively. For the third level 50% of the documents represent two countries, 31% between 3 and 5, while the remaining 19% include more than 5 countries, the maximum being 50 different countries involved in one article. The regional journals show a similar pattern, 96% and 91% with just one other country in the first two levels, but 80% with 2 others in level 3 and 20% with 3-4 countries.

5 Discussion

Our novel bibliometric work with CLAPER has enabled us to contrast and compare Mexican international collaboration patterns in regional and international journals, complementing what has been observed in previous studies on mainstream publication. The possibility of using the Clase and Periódica databases for bibliometric analysis of regional production has been previously suggested (Alonso Gamboa and Reyna Espinosa, 2005) nonetheless, technical difficulties in the main, have delayed this application. Also in our study, by excluding Latin American journals from the WoS data, we get a clearer picture of Mexican collaboration present in mainstream international journals. Of particular note in our results is the low percentage of documents with international collaboration represented in CLAPER, the dominance of Spanish and the fact that most of these documents in collaboration with foreign partners, were published in Mexican journals. Mexican journals represent 10% of the titles within the catalogue section of Latindex, while Brazil is present with 17%. Although Clase includes many more documents in the social sciences and humanities than the citation indexes, the percentage involving some kind of international collaboration was lower than that in WoS.

The dominant mode of international collaboration in both databases was found to be exclusively extra-regional collaboration. CLAPER showed a higher percentage of purely intra-regional collaboration, though less in terms of the numbers of documents, and confirmed the regional character of many of the documents with Mexican authorship published in LA journals.

The dominant subjects of IC in CLAPER were Applied Biology, Earth Sciences and Multidisciplinary Sciences. Intra-regional collaboration in Applied Biology was the most important, though nearly all Medical Research was at this level. In extra-regional collaboration Earth Sciences closely followed by Applied Biology were the most important subjects, with 98% of the Multidisciplinary Sciences documents situated at this level. At level 3 Earth Sciences was the most important subject but Mathematics intra- and extra-regional collaborations represented the most collaboration at this level.

In WoS the subject distribution within the sciences was more even overall, with no notable differences between subject distribution and its importance within the levels of collaboration, suggesting an established Mexican international research profile independent of what countries are the international research partners. The dominant presence of Cuban collaboration in both regional and international journals at level 1 confirms the tendency noted in Russell et al., (2007) of Cuba-Mexico bilateral collaboration being the second most prolific at regional level during the period 1995-2004, after Brazil-Argentina, as well as the changing pattern at level 3 when countries outside the region are involved.

In a previous study on the international collaboration of Mexico from 1980 to 1990 in the mainstream literature, Clinical Medicine, Physics and Biology were all represented with between 15-20% of the total, with other major areas such as Chemistry, Biomedical Research, and Earth and Space Sciences not far behind (Russell, 1995). The major partner was the US but with a rising European presence and little coauthorship with other LA countries.

We intend to continue analyzing the data, in the hope of answering questions such as the role of a scientifically advanced countries in cementing collaboration between LA countries. Of particular interest is to test what specialists have previously stated, that articles published in international collaboration tend to attract more citations than those published by a single country. The internal geographical distribution of Mexican collaboration is another aspect we intend to explore.

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