Impact of Open Educational Resources in Higher Education Institutions in Spain and Latin Americas through Social Network Analysis

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Abstract

The modernization of the European education system is allowing undertake new missions such as university responsibility. Higher education institutions have felt the need to open and provide educational resources. OpenCourseWare (OCW) and Open Educational Resources (OER) in general contribute to the dissemination of knowledge and public construction, providing a social good. Openness also means sharing, reuse information and create content in an open environment to improve and maintain the quality of education, at the same time provide an advertising medium for higher education institutions.
OpenCourseWare Consortium himself and other educational organizations stress the importance of taking measurement and evaluation programs for an institution OCW. Two main reasons are argued:

- Allow monitoring the usefulness and usability of Open Educational Resources (OER) and the efficiency of the publishing process, helping to identify and implement improvements that may be relevant over time.
- Measure the use and impact of the parties involved in the OCW site helps ensure their commitment.

This paper the authors evaluate social network analysis like a technique to measure the impact of open educational resources, and shows the results of applied this kind analysis in OpenCourseWare Spanish and Latin American, trying to tackle the above problems by extending the impact of resource materials in the new innovative teaching strategies and mission of university social responsibility providing updated information on the impact of OCW materials, and showing the true potential inherent in the current OCW repositories in Latin American universities.

To evaluate the utility of Social Network Analysis in open educational resources, different social networks were built, using the explicit relationships between different participants of OCW initiatives, e.g. co-authorship, to show the current state of OCW resources. And through the implicit relationships, e.g. tagging, to assess the potential of OCW. To measure the impact of OCW, the social relationships, drawing from the information published by universities of Spain and Latin American, between OCW actors are described and assessed using social networks analysis techniques and metrics, the results obtained let to: present a current state of OCW in Latin America, know the informal organization behind the OCW initiatives, the folksonomies arise from using tags to describe courses, and potential collaborative networks between: universities, professors linked to production of OCW.

I Introduction.

The OpenCourseWare Consortium (ocwconsortium.org) has highlighted the importance of measurement and evaluation programs for an institution's OCW. Among the aspects that are recommended to measure are the accesses, use, and impact, as well as user satisfaction. However, these studies have limitations because it is difficult to establish relationships,

contacts, participate in creating and re-use of content, repurpose existing content to other contexts and different purposes, expand research, etc.

The analysis of social networks (Social Network Analysis, SNA) is a tool for measuring and analyzing emerging social structures of relations between different social actors (individuals, organizations, nations, etc.). Also known as structural analysis, and is often cited for its acronym, SNA. "Social network analysis is a set of analysis techniques for the formal study of relations between actors and to analyze social structures that emerge from the recurrence of these relationships or occurrence of certain events". [1]

The SNA is an approach used to find information not evident within the structures formed by the interaction between user groups or entities. As you can read in [2] the objective is to detect and interpret patterns in the social ties between actors that provide additional relevant information about the operation and characteristics of a network of some kind. Because of its inherent power to reduce a system to its individual components and their relationships (network characterization), moreover the existence of several metrics (sociometric) and indicators that characterize these structures, is an approach that has gained popularity in recent years, successfully applied in scientific and technological disciplines as diverse, mentioned in [3], some examples of projects: conflicts of interest [1], criminal networks [4], search of influential individuals [5], study of co-authors networks [6], among others.

In education, the SNA is a promising and unexplored research area [7] that has been used in projects that try to investigate how social network positions of K-12 students correlate with their behavior and academic achievements concluding that exists a social contagion of academic success taking place in their social network [7]. Similarly in [8] used SNA to show how the students create social networks of friends according to his academic performance, the social network of high performing students is created during the first weeks of the course and tend to excluded to the low performing students. And in [9] the SNA and its metrics were used on the information generated in an Educational Congress to answer a set of questions about the formation of ontological families, through social relationships.

For a few years ago the social network analysis has been used in several initiatives, such as shown in [10], which have selected as a data source the content generated via social web tools and have developed networks in order to apply concepts of social network analysis and find a starting point on the road to the Semantic Web, showing that the semantics can emerge from users communities and through simple actions such as tagging. For the creation of ontologies, the SNA has been used on data repositories created by user's communities to find light ontologies, lacking some formalities such as restrictions, but they cover a large number of entities that have been created to through simple actions, but extremely participative.

The focus of this work is the analysis of relationships among Spanish and Latin American OCW stakeholders. The social network analysis is based on individuals or groups of individuals with patterns of relationships or interactions between them. Examples of such networks are the relationships of teachers belonging to universities, departments, areas of knowledge, among authors of OCW resources, relationships between teachers from their areas of expertise and tags associated with materials and courses taught by them.

Through the analysis of social networks, relationships are transformed into maps showing how the informal organization does its work. The types of social networks that we build is the network of creators, and other personnel associated with OCW offices of institutions of

higher education, or a trusted network, which show the relationship between those who share information by areas of knowledge.

This paper presents a research about whose main objective is an assessment of SNA as a tool to measure the impact of OCW initiatives. Firstly the methodology is explained (section II). Later the results of the different analysis done (section III). And finally the conclusions and future work.

II Methodology

The objective of this research is to evaluate social network analysis like a technique to measure the impact of open educational resources measured as the potential of collaborative networks between universities and professors linked to production of OCW. We aim to show the results of the application of this kind of analysis in OpenCourseWare Spanish and Latin American.

The science of SNA uses the relationships as principal concept, because it leaves indelible marks. Thus, observing and studying these patterns we can answer many questions about any community [13], this feature is the most important difference of other kinds of analysis like statistic. The SNA metrics allows perform calculations based on relationships between nodes and the position of nodes within a network; allowing find another type of features that would be difficult to obtain using metrics based only on numeric properties.

For the above, the authors analyzed only the information of OCW resources and initiatives published in the Web, and found that exists explicit and implicit relationships. In the first case, the relationships emerge from direct and intentional interaction between participants, and the following networks were found: co-authorship and folksonomies. And in the second scenario, the implicit relationships arise due to shared interests, and collaborative networks are purposed via common tags.

Social networks have to be analyzed to understand your structure, consequences and draw conclusions [14]. To do this some SNA metrics were studied trying to find which characterized each network. In this case two metrics were selected: centrality-betweenness to get powerful nodes and k-core to analysis communities. In the SNA metrics, centrality is commonly used to show the power that a node has, power to access to information, to connect others nodes and influence. The metric of centrality used was Betweenness, because it help to found relevant nodes when these nodes are maximally utilized by nodes to connecting other nodes. While to study communities, k-core was selected because is a metric that show structures though these are not necessarily cohesive subsets and is used to identify the strong ties in a network o community [15].

II.a Application context

This work is based on data extracted from OCW resources published by Latin America universities, distributed among four geographic areas: Central America, North America, South America and Europe. Data are covering 9 countries, Costa Rica, Mexico, Argentina, Brazil, Chile, Colombia, Ecuador, Peru, Venezuela and Spain. Data set is made up of 2511 courses in Spanish language. The courses belong to universities who may be members of OCW UNIVERSIA Consortium or to the OpenCourseWare Consortium (OCWC) or both. There are 3147 unique OCW authors and 7024 unique keywords or tags.

The following table summarizes the OCW datasources on which the SNA is applied.

TABLE I. OCW Data used in this study

Consortium	Continent	Country	City	University	Number OCW
OCWC	Central America	Costa Rica	San José	U. Estatal a Distancia	12
OCW UNIVERSIA	North America	Mexico	Ciudad de México	U. Anáhuac	32
			Monterrey	U. de Monterrey	32
				Tecnológico de Monterrey	11
	South America	Chile	Santiago de Chile	U. de Chile	40
				Pontificia U. Católica de Chile	10
			Valparaíso	Pontificia U. Católica de Valparaíso	21
		Venezuela	Caracas	U. Central de Venezuela	15
		Ecuador	Loja	U. Técnica Particular de Loja	12
		Peru	Lima	U. Nacional de Ingeniería	26
			Arequipa	U. Nacional San Agustín	11
		Colombia	Cali	U. Icesi	9
				U. del Valle	12
			Bucaramanga	U. Nacional de Santander	10
		Argentina	Córdoba	U. Nacional de Córdova	40
	Europe	Spain	San Vicente del Raspeig	U. de Alicante	162
			Salamanca	U. de Salamanca	94
			Zaragoza	U. de Zaragosa	31
			Vitoria Gasteiz	U. del País Vasco	72
			Huelva	U. de Huelva	30
			Cadiz	U. de Cadiz	67
			Barcelona	U. Politécnica de Cataluña	305
				UOC	111
			Sevilla	U. de Sevilla	243
				U. Internacional de Andalucía	31
			Lleida	U. de Lleida	26
			Cartagena	U. Politécnica de Cartagena	47
			Madrid	UPM	133
				International Excellence	10
				Fundación Universitaria San Pablo CEU	4
				UNED	44
				UC3M	197
			Valencia	U. de Valencia	64
				UPV	118
			Palma	U. de Illes Balears	13
			Oviedo	U. de Oviedo	77
			Granada	U. de Granada	22
			Castelló de la Plana	U. Jaume I	23
			Murcia	U. de Murcia	138

Consortium	Continent	Country	City	University	Number OCW
			Pamplona	U. de Navarra	22
			Santander	U. de Cantabria	134

II.b Preparing data for SNA

The data used in the meta-analysis were collected from each of the Web sites of the OCW initiatives, being these ones an unstructured data source. The extracted data presented some problems related to the identity of the authors and ambiguity in both author names and tags used to describe the courses.

With the first problem, the identity of the authors, it was found that some courses have as names of authors, names like "root" (8 courses) or "admin" (4 courses) or the name of the institution that publishes them (12 courses) and not the names of the people involved in building of the course. Considering the limited information available to identify the author of the courses that are in this situation we do not take any action.

Within the same context, another problem with the names of the authors is the ambiguity due to variations in writing the names, for example the use of abbreviations, initials, the order of first name and last name, misspellings, etc. To address the problem, we used text-clustering techniques through PPM algorithm [11] that allowed that similar names are grouped and then is replaced by a single name. The results were the reduction of the list of authors from 3836 to 3147 and it was determined that if several authors that have similar names, use at least one common tag and have at least one co-author, almost certainly this is the same person.

With tags, as with the authors, the main problem is the ambiguity and as in the previous case, text clustering was used through Fingerprint algorithm [12]. This algorithm was used due to the small number of characters that have the tags (compared to the number of characters in the names of the authors) and by the use of tags in English (example: "politics" and "político" should not be replaced). It was found that when the number of characters in a tag is less than or equal to 3 should be a human being who determine whether they should be replaced. For example the tags: c++ and c# cannot be replaced because they represent different programming languages. The result was a consolidation of the 45% of the number of tags.

III Analysis of relationship

The analysis done try to describe the actual situation of the OCW and characterize the collaboration between entities (Institutions and authors of OCW) present in OCW initiatives. The analysis focused in the actual and future collaboration, for this were analyzed two aspects: a) the key words that are used to describe the courses and b) the co-authorship of courses.

The first aspect, tags, intended to study the folksonomies that are formed with the use the keywords as OCW's descriptors. A folksonomy is a social index, a collaborative classification using simple tags in a flat namespace without hierarchies or default kinships. This is a practice that occurs in social software environments whose best examples are shared sites like delicious.com (bookmarks), Flickr (photos), Tagzania (places), Flof (places) o 43 Things (desires). A folksonomy, which arises as a result of social interactions and collective

intelligence, can be used to develop automatic or semi-automatic classification tools to courses, which is a pending work within the world of OCW.

The co-authorship, intended to show the real collaboration in OCW initiatives, not only internally in educational institutions, but also with the outside (cities, countries, continents), further, show the potential of future collaboration, through the use of keywords, which surely enrich the world of OCW.

And, finally, after an analysis of the collaboration of institutions, we show a network analysis by tags and authors.

The SNA, as it will be discussed in the conclusions section, goes beyond statistical analysis because it is based mainly on the relationships between the network's members, such that their metrics, in addition to the quantitative properties, take in account different aspects, such the links between nodes to calculate its metrics.

III.a Network collaborative by tags of courses

To characterize the networks of tags, the authors have built folksonomies through the co-occurrence of tags on the OCW resources (when several authors use the same tags as descriptors of their courses). These folksonomies trying to find the most important tags, not only by the number of courses that use them, but mainly by the relationship between the tags that describe the same courses (co-occurrence).

The networks are formed by nodes that are tags and a link is established when two tags are used to describe the same course. The enrichment of this type of network, arise when a tag is used to describe more than one course, allowing increase relations between tags, creating folksonomies. In addition, the folksonomies allow a general idea of the issues addressed, as they are generally used as classification systems.

For SNA 6512 tags and 56195 co-occurrences haven been used. The available data allow building a network rather large, in size, although of all possible edges exist only the 0.3%. Nonetheless each tag is associated with an average of 17 tags; the tags farthest are separated by 9 links and the shortest path between tags is 3.5 on average (see table II). For example, if we mark a node as the source and another as target, on average, the size of the shortest path between source and target, is formed by 3.5 links, this causes a network of tags of neighbors close.

Table II: Network Information

Metric	**Value**
Nodes	6512
Links	56195
Average degree	17.2
Network density	0.003
Network diameter	9
Average path length	3.5

The authors applied two centrality metrics, specifically, node degree and betweenness (see Table III). The first measure, node degree, indicates the number of edges or links that a node has, allowing highlight those tags that are commonly referenced by others. The second measure, betweenness, not only highlights those nodes that are important for the number of links, also shows the tags that are bridge or link between several groups of tags.

The result of the analysis shows a huge amount of knowledge areas. For the Spanish universities, the most common OCW topics are social and legal sciences, technical education and health sciences. Figure 1 shows a partial image from the analysis done.

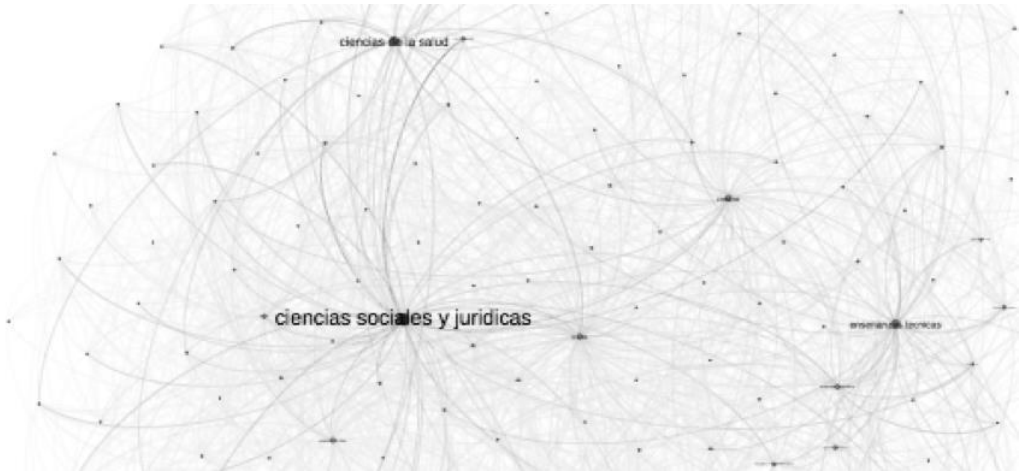

Figure 1. Extract of the tag cloud generated by Spanish universities

Through a complete image can be observed other network characteristics. For example there is some isolated regions, which indicate that there are OCW resources that use specific tags that are not related to any other OCW, even when they share the same knowledge domain, e.g.: “dolor”, “implantoprotesis”, “orofacial”, “patología de la oclusión”, “prótesis dental”, “prótesis maxilofacial”, “prótesis mixta” y “sobredentaduras”; terms that are used in dentistry and belong to the course: “16597 – Curso de prótesis Dental y Maxilofacial II, 2010-11”

The table III shows the 10 most important tags used on OCW from Spanish universities sorted by betweenness. The betweenness is the best way to calculate the level of influence of a tag compared with the order that it occupy if the influence is calculated by the number of times used to describe an OCW resource.

Table III: Most influential labels in Spain

Tag – knowledge areas	**Nodal Degree**	**Betweenness**	**Order of tag based on Betweeness**	**Order of tag based on times used**	**Three first Universities with major number of courses**
Ciencias sociales y jurídicas – Social and Legal Sciences Number of OCW: 107 Number of universities: 7	494	2707533.06	1	3	U. Alicante (30 OCW) U. Cantabria (30) U. Valencia (28)
Ciencias de la salud – Health Sciences Number of OCW: 65 Number of universities: 7	409	1938641.56	2	7	U. Cantabria (26 OCW) U. Murcia (22 OCW) U. Valencia (7)
Enseñanzas técnicas – Technical	449	1645292.01	3	8	U. Cantabria (49 OCW)

education Number of OCW: 62 Number of universities: 3					U. País Vasco (9) U. Salamanca (4)
Ciencias - Sciences Number of OCW: 136 Number of universities: 13	210	1183433.49	4	1	U. Murcia (40 OCW) U. Alicante (33) U. País Vasco (14)
Análisis - Analysis Number of OCW: 27 Number of universities: 9	261	986119.17	5	36	U. Sevilla (17 OCW) U. Pol. Valencia (3) U. Pol. Madrid (1)
Matemática aplicada – Applied Mathematics Number of OCW: 66 Number of universities: 14	293	778618.05	6	5	U. Carlos III (11 OCW) U. Valencia (10) U. Sevilla (8)
Ciencias sociales – Social sciences Number of OCW: 55 Number of universities: 7	255	757680.71	7	12	U. Murcia (41 OCW) U. Salamanca (7) U. Carlos III (1)
Arquitectura y tecnología de computadores – Architecture and computer technology Number of OCW: 52 Number of universities: 5	220	658649.79	8	15	U. Pol. Valencia (32 OCW) U. Carlos III (14) U. Pol. Madrid (4)
Derecho – Law Number of OCW: 59 Number of universities: 14	274	576101.65	9	10	U. Sevilla (20 OCW) U. Oviedo (14) U. Jaume I (4)

To a teacher, student or a self-learner, a higher value of betweenness reflects high availability of OCW resources in those areas of knowledge. It is also possible to detect groups of authors who are providing open educational resources in that domain of knowledge. From the perspective of the universities and academic policy makers, a low betweenness value reflects an opportunity to publish OCW resources in this area of knowledge.

To the rest of continents o geographical areas, the authors did the same kind analysis. By reasons of space we summarize briefly the results obtained:

South America

Table IV. Metrics of South America

Metric	Value
Nodes	627
Links	2313
Average degree	15
Network density	0.012
Network diameter	15
Average path length	5.55

The selected metrics show the characteristics of the network, here there is a decrease in the number of nodes and edges 627 and 2313 respectively, due to decreased courses belonging to this continent. The tags, on average, are linked to 15 tags, and network density indicates that only, there is the 1.2% of all possible edges, the distance of the farthest nodes is 15 and the average distance is 5.5.

Like the above analysis there are isolated groups of nodes that are too specific tags and abbreviated tags in different ways. In the first case, specific courses have tags as “paso de mensajes”, “compilador”, “interpretador” that are specific to programming. In the second case, abbreviations, we find “kdd”, “tda(h)”, “add”, “ipc” that are uncommon.

There are also nodes disconnected, because there are courses described by a single label. The featured nodes, by their level of betweenness can be seen in Table V.

Table V: Featured tags

Tag – knowledge areas	Degree	Betweenness	Order of tag based on Betweeness	Order of tag based on times used	Three first Universities with major number of courses
Educación - Education (6) Number of OCW: 9 Number of universities: 3	38	20068.93	1	6	U. Nac. De Córdoba (4 OCW) PUC Valparaíso (3) U. Téc. Particular de Loja (2)
Aprendizaje - Learning (30) Number of OCW: 4 Number of universities: 3	32	10719.48	2	30	U. Nac. de Córdoba (2 OCW) U. de Chile (1) U. del Valle (1)
Computación – Computing (11) Number of OCW: 5 Number of universities: 11	10	10322.71	3	11	U. Téc. Particular de Loja (5 OCW)
Estadística – Statistics (10) Number of OCW: 6 Number of universities: 3	11	10256.96	4	10	U. Icesi (4 OCW) U. Téc. Particular de Loja (1) U. Nac. De Córdoba (1)
Chile (17) Number of OCW: 4 Number of universities: 2	17	10240.80	5	17	U. de Chile (3 OCW) PUC Valparaíso (1)
Matemáticas – Mathematics (33) Number of OCW: 4 Number of universities: 3	10	9728.46	6	33	U. Téc. Particular de Loja (2 OCW) PUC Valparaíso (1) U. de Chile (1)
Calidad – Quality (62) Number of OCW: 2 Number of universities: 2	13	9344.28	7	62	U. Nac. De Córdoba (1 OCW) U. de Chile (1)
Comunicación audiovisual y publicidad - Audiovisual Communication and Advertising (95) Number of OCW: 2 Number of universities: 1	9	9219.04	8	95	U. Nac. De Córdoba (1 OCW)
TIC (13) Number of OCW: 5 Number of universities: 3	27	8862.61	9	13	U. de Icesi (3 OCW) U. Nac. De Córdoba (1) U. del Valle (1)

North America

Table VI: North America metrics

Metrics	Value
Nodes	185
Links	643
Average degree	6.9
Network density	0.038
Network diameter	6
Average path length	2.615

In this case the number of courses causes the decrease in the number of nodes and links, but being a small network, the density increases and the diameter of the network and the average distance between nodes also decreases.

As in the previous case, there are unconnected tags, i.e. have been used only once and the groups of isolated tags, as discussed above, is due to the use of specific labels and abbreviations.

Here stand out for their level of betweenness, the following labels: “cursos de profesional” - professional courses, “economía” - economics, “desarrollo y estrategias” - development and strategies. The Table VII shows the labels that have emerged in the relationship between tags.

Table VII: Featured tags for North America

Tag – knowledge areas	**Degree**	**Betweenness**	**Order of tag based on Betweeness**	**Order of tag based on times used**	**Three first Universities with major number of courses**
Cursos de profesional - Professional courses (2) Number of OCW: 15 Number of universities: 1	54	2882.50	1	2	U. de Monterrey (15 OCW)
Economía – Economics (10) Number of OCW: 4 Number of universities: 2	6	966.00	2	10	U. de Anáhuac (3 OCW) U. de Monterrey (1)
Desarrollo – Development(9) Number of OCW: 4 Number of universities: 2	14	910.00	3	2	U. de Anáhuac (3 OCW) Tec. De Monterrey (1)
Estrategias – Strategies (22) Number of OCW: 2 Number of universities: 2	14	666.00	4	2	U. de Monterrey (1 OCW) Tec. De Monterrey (1)
Sistemas – Systems (11) Number of OCW: 3 Number of universities: 2	9	462.00	5	2	U. de Anáhuac (2 OCW) U. de Monterrey (1)
Ingeniería – Engineering (4) Number of OCW: 7 Number of universities: 1	6	321.00	6	1	U. de Anáhuac (7 OCW)
Cursos de posgrado – Postgraduate courses (20) Number of OCW: 2 Number of universities: 1	7	12.00	7	1	U. de Monterrey (2 OCW)
Sociedad – Society (14) Number of OCW: 2 Number of universities: 1	7	4.50	8	1	U. de Monterrey (2 OCW)

Central America

Table VIII: Metrics to Central America

Métric	**Value**
Nodes	16.00
Links	20.00
Average degree	2.50
Network density	16.70
Network diameter	2.00
Average path length	1.48

Being a small network, attempt to characterize it is complicated, so it only describes it. Here there are no of isolated groups of tags.

In summary, the analysis allows us to say that the differences between folksonomies studied are related to the number of courses that exist on each continent. Although it is possible to see how, on every continent, there are tags or knowledge areas predominate and that could mean the orientation of the majority of OCW courses.

To a teacher, student or a self-learner, a higher value of betweenness reflects high availability of OCW resources in those areas of knowledge. It is also possible to detect groups of authors who are providing open educational resources in that knowledge domain. From the perspective of the universities and academic policy makers, a low betweenness value reflects an opportunity to publish OCW resources in this knowledge area.

III.b Course authors Networks

The collaboration between course authors was measure by the analysis of the co-authorship of courses i.e. when two or more authors appear in the list of authors of a course. The networks that have been studied have nodes that represent to authors of the OCW and a link between two nodes shows that they are co-authors of an OCW resource. This analysis has been done to determinate internal collaboration within universities.

The main metric that is used to analyze these networks was the betweenness. This metric allowed us to determine those nodes that are bridge or link to several groups of authors, thus showing the collaboration between groups of authors. To display groups of authors we used k-core, which displays groups of nodes with at least k number of links. For this analysis, k was 2.

Co-Authorship – Spain

For this analysis we used 2883 authors, some facts: only three authors have produced OCW resources belonging to different institutions; there are authors who have written 772 courses without the cooperation of others and 431share the authorship with someone else

In Spanish universities there is little collaboration between groups of authors, as shown by the following data: only 6.4% (183 authors) liaise between groups of authors, distributed as: 33 U. Carlos III de Madrid, 29 U. Politécnica de Valencia, 24 U. De Murcia, 18 U. De Alicante, 14 U. De Cantabria, 14 U. Nacional de Educación a Distancia, 12 U. Politécnica de Madrid, 12 U. De Sevilla, 8 U. Jaume I, 8 U. Oberta de Catalunya, 7 U. De Valencia, 2 de U. De Oviedo, 1 U. Del País Vasco y 1 U. De Salamanca.

Co-Authorship South America

Within this context, the network of authors have the following data: 217 authors, only one of them has created courses in two different institutions, 156 authors no share co-authorship for the courses, while 36 authors have as co-author to another. This is an only author is a bridge.

Co-Authorship of North America

50 nodes with only three links form the network; more than one person has developed only three courses. No authors are bridge between groups of authors.

Co-Authorship Central America

In this case there is only one university that is part of this analysis as only the State University of Costa Rica is a member of OCWC. But in its 12 courses has a single name of author, the same institution, so it is not possible to perform any analysis in this regard.

III.c Networking by tags and authors

Given the lack of collaboration between groups of co-authors, we sought a form of collaboration, for the future. We propose collaborative networks among authors whose OCW resources are described with the same keywords.

With this objective we constructed several networks whose nodes were names of authors and the links between nodes indicate that two authors have used the same label to describe their courses. Other networks built, had by nodes to tags and authors, and the links indicates that an author used a label. These kinds of collaborations allow authors to search and find other authors, not only within the same institution, even outside their continent.

The metric that was used in the analysis of these networks was the nodal indegree, which allow finding the most used tags without geographic limit.

Figure 2 shows the potential collaboration between South America and Spain authors in the field of mathematics through the courses that have been described with the keyword "math".

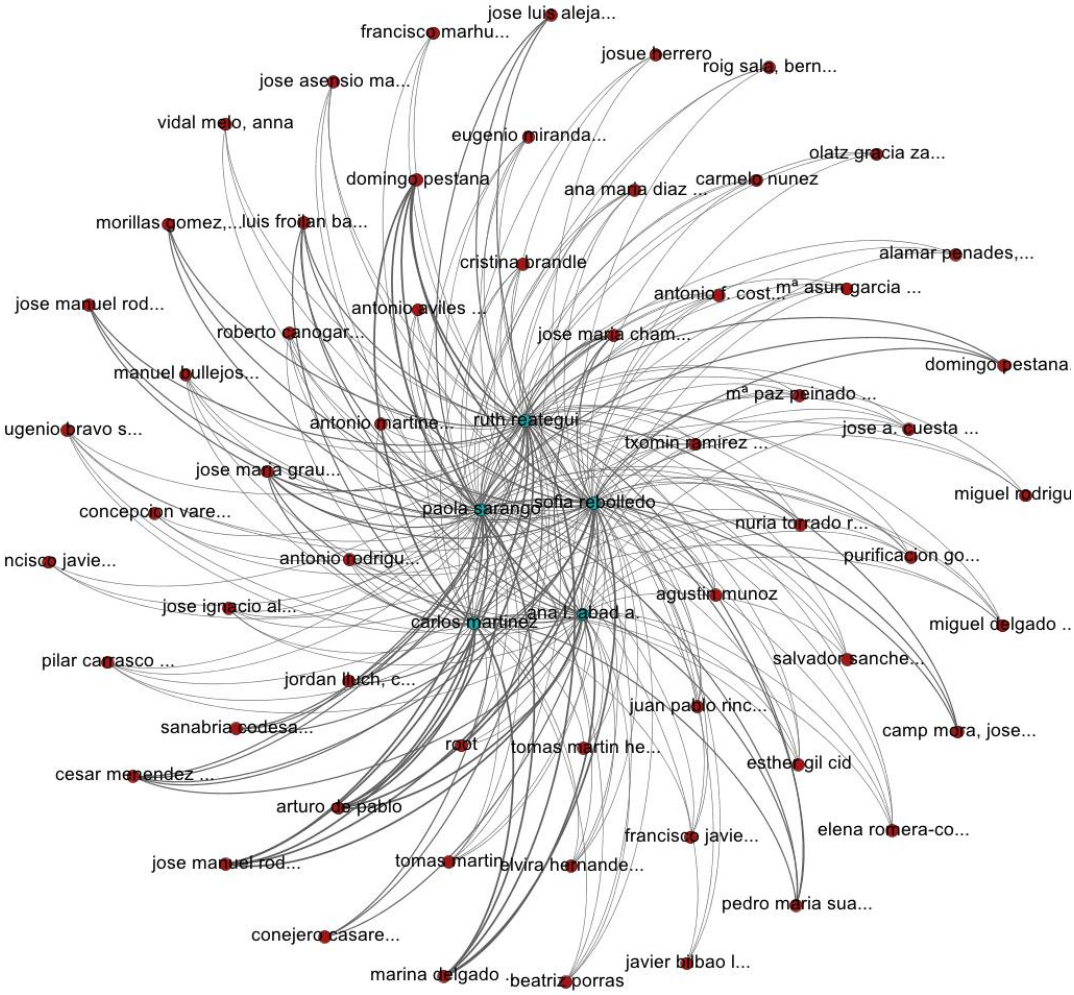

Figure 2: Potential collaborative network in math (South America and Spain)

The red nodes belong to Spain, while the light blue corresponds to authors of the South American. This way you could generate several networks of collaboration between authors within the same university, city, country and continent. Tags with a greater potential for collaboration between authors are shown in the table IX.

Table IX: Example of potential collaboration of tags

Tag	Total	Europe	Norh America	Central America	South America
Ciencias – Sciences	205	191 – Spain	2 – Mexico	1 – Costa Rica	12 – Peru (7), Argentina (4) y Chile (1)
Ciencias sociales y jurídicas - Social and Legal Sciences	172	172 – Spain	0	0	0
Ciencias de la salud - Life Sciences	139	139 – Spain	0	0	0
Matemática aplicada - Applied Mathematics	138	136 – Spain	0	0	2 – Argentina (1) y Colombia (1)
Lenguajes y sistemas informáticos - Languages and Systems	115	106 – Spain	0	0	9 – Colombia (8) y Argentina (1)
Enseñanzas técnicas - Technical Education	109	109 – Spain	0	0	0
Ciencias sociales – Social Sciences	106	105 – Spain	1 – Mexico	0	0
Arquitectura y tecnología de computadores - Architecture and Computer Technology	101	100 – Spain	0	0	1 – Argentina

Caminos - Roads	87	87 – Spain	0	0	0
Ingeniería informática - Computer Engineering	80	80 – Spain	0	0	0

Some examples of collaboration between three continents:

- Between Spain, North and South America are: accounting, economics, finance, information systems, technology, research, philosophy, development, surgery, marketing, chile, psychology and engineering.
- Between Spain, Central and South America are: social and material.

In addition there are 269 labels that show indegree equal to two, which shows the ability of collaboration between two continents.

IV. Conclusions and Future work

The results obtained by analyzing OCW initiatives in Latin America prove that SNA is a data analysis technique that can be used to study the impact of OCW in universities because it analyzed both, the current state and allow analyze the potential that OCW have, through explicit and implicit relationships respectively and it can will be use in other OER initiatives.

The value of betweenness applied a knowledge areas help to teachers, students or a self-learner, to found high availability of OCW resources and to detect groups of authors who are providing open educational resources in a specific knowledge domain. From the perspective of the universities and academic policy makers, a low betweenness value reflects an opportunity to strengthen the publishing of open educational materials in this knowledge area.

Within providers of spanish OCW resources, the continents can be classified through folksonomies, by thematic:

- In Spain there are a variety of topics (tags with high betweenness) and relatively small differences between them, probably due to the large number of universities and the diversity of their courses. Although one could say that a trend in Spain is the Law and Social Sciences.
- In South America, the difference between tags with higher betweenness is nearly double, and the first two tags are closely related (education and learning) so that it can be said that the main theme is Education.
- In North America we can summarize his interest in economics.
- The exception is Central America; the classification is risky because of the limited data available.

One way to validate the above was the creation of a classification system of courses using the folksonomies of each continent using the tags with higher betweenness. The preliminary results are: in Spain, 8% of the courses are under the folksonomy of Social Sciences and Law. In South America, 60% of the courses are in the folksonomy of Education and in North America and 20% belongs to the economy. This classification method is still experimental and subject to improvements, but can help set certain trends.

The tags have been classified into generals and specifics (which includes abbreviations). The specifics tags, form small and isolated groups (unconnected islands), showing those tags that

are so specific that only can be used in a small number of courses, or even in a single course. This isolation prevents the formation of folksonomies.

If we consider the folksonomy as a non-formal classification system, where general and specific terms are organized hierarchically, is possible to say that, as the average distance of the path, the folksonomy that forms in Spain has an average of 4 levels of hierarchy, while for South America the average is 6 levels. This could indicate a higher level of expertise in the classification of OCW in South America.

With the theme of collaboration has been determined that there are small groups of teachers (on average 3 teachers) who are the authors of OCW courses and collaboration between groups (within the same institution, between institutions, cities, countries and continents), is low, tapering to disappear in proportion to geographical distance. To more geographical distance then less collaboration. The pertinence of this behavior is beyond the scope of this analysis, thus we inviting educational institutions to seek answers to these questions.

But there is a potential energy of collaboration that is not yet being exploited and that will help enhance these initiatives. It is possible to exploit the use of tags and folksonomies through tools to find potential partners according to the topic of interest.

In these moments, and as continuation of the work here presented, we are developing systems that permit validate the models that we propose here. On the one hand we are development a classification system based on folksonomies and SNA metrics to classified semi-automatically OCW resources. And on the other hand we are developing a recommender system using social relationships and SNA, to improve the finding and reuse the OCW. A preview with limited features (only allows: search courses, see universities and his relationships, and recommend tags based on SNA metrics) can view in http://j4loxa.com/snaocwservices/

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