A case study of knowledge organization patterns within Curricular Information Systems

Soleidy Rivero Amador *
Maidelyn Díaz Pérez **
María José López Huertas Pérez ***
Dayron Armas Peñas ****

Article received on:
November 6, 2013.
Accepted on:
March 9, 2015.

Abstract

History teaches us that need to systematize knowledge of the outside world is the main driver in the creation of classification systems of scientific knowledge. The development and evolution of the prevailing systems of information and knowledge management have achieved a respectable representation of the complexity of the organization of knowledge, even in the face of the unfolding nature of the knowledge classified, its systemic features and interdisciplinary essence. This research aims principally to provide an analysis of the classification of knowledge of scientific research results and identify compositional patterns that may serve to

* Universidad de Pinar del Río. Pinar del Río, Cuba. soly@upr.edu.cu
** Grupo de Gestión de Información y Conocimiento (PROGINTEC). Universidad de Pinar del Río "Hermanos Saíz Montes de Oca", Cuba. maidelyn@upr.edu.cu
*** Universidad de Granada, España. mjlopez@ugr.es
**** Grupo de Gestión de Información y Conocimiento (PROGINTEC). Universidad de Pinar del Río "Hermanos Saíz Montes de Oca", Cuba. dayron@upr.edu.cu

enhance its management. The paper consists of a case study of scientific researchers of the University of Pinar del Río, and employs the curricular approach entailed in the Institutional Information and Knowledge Management System of the University of Pinar del Rio, as well as other diagnostic techniques to identify patterns in the structuring of the institution's knowledge.

Keywords: Knowledge Organization; Information Systems Curriculum; Taxonomies of Scientific Knowledge.

Resumen

Patrones para la organización del conocimiento en los Sistemas de Información Curricular. Un caso de estudio
Soleidy Rivero-Amador, Maidelyn Díaz-Pérez, María José López-Huertas Pérez y Dayron Armas-Peñas

La historia de la humanidad delata que la imperiosa necesidad de sistematizar todos los conocimientos sobre el mundo exterior ha sido una de las causas fundamentales de la aparición de las clasificaciones del conocimiento científico. En la actualidad, el desarrollo y evolución de los sistemas de gestión de información y conocimiento han logrado representar bastante bien la complejidad de la organización del conocimiento, a pesar de la naturaleza desarrolladora del propio conocimiento que se clasifica, y sus características sistémicas y esencia interdisciplinar. El objetivo principal de esta investigación es el análisis de la clasificación del conocimiento procedente de los resultados científicos de los proyectos de investigación para identificar patrones en su composición que permitan su gestión. Se toman como caso de estudio los profesores investigadores que desarrollan proyectos científicos en la Universidad de Pinar del Río y se propone como instrumentos el Sistema de Gestión de Información y Conocimiento Institucional de la Universidad de Pinar del Río con enfoque curricular, así como otras técnicas de diagnóstico para la identificación de patrones en la estructuración del conocimiento de la institución.

Palabras clave: Organización del conocimiento; Sistemas de información curricular; Taxonomías del conocimiento científico.

Introduction

The organization of knowledge is the science of systematically structuring groups of knowledge units (concepts) in accord with inherent features (Dahlberg, 2006). Postulates from decade of the 1990s hold that the organization of knowledge is inclined toward social and interpretive points of view. Such is the case of analysis of discourse, gender studies and domain analysis. Since then, several semiotic and critical-hermeneutic approaches have been developed (Hjørland, 2005). The main objective of this science is to apply operations such as classification and ordination to create systems of physical and intellectual distribution that respect sequence, hierarchy, association and other key features in order to guarantee the retrieval of information and knowledge at the institutional level.

The development of the process of scientific research itself is a consequent outgrowth of the complexity of knowledge organization. It is evident that new scientific problems and phenomena cannot be reduced to any single disciplinary vision. At the same time, we must face current reality from a new scientific-methodological standpoint or vision. Greater openness is needed and the interaction can provide greater enrichment of the scientific perception of reality (Morin, 1995). Whenever knowledge is classified and organized, its dynamic essence must be taken into account, especially in the development and application of information systems in the organizational environment.

Despite considerable efforts made by science and technology organisms, problems persist in many institutions (Navarrete and Banqueri, 2008), including:

- Coexistent instruments for capturing data that do not provide standardized systems of storage and retrieval.
- Inefficient integration of interoperability and communication capacities among data bases and insufficient homogenization of formats of researchers' curricula.
- Under exploitation of the information that is systematized by science and technology information management organizations, with regard to both strategic management and policy making and for the purpose of promoting and increasing the visibility of results. This creates a bottleneck on exchanges, collaboration and communication among scientists and researchers at the regional, national and international levels.

Many of these problems have been solved through implementation of Scientific Information Systems (SIS) calibrated to the characteristics of each organization or region, even though certain problems with the focus and scope of such systems persist. This problem is reflected in shortcomings in the management of science and technology activities and their results, the impossibility of structuring the scientific knowledge held by and institution and efficiently measuring scientific impact as a social process (Armas, Díaz and Giraldes, 2008; Báez et al., 2008).

While this paper approaches some of these issues, it is specifically focused on an analysis of the structuring of knowledge held by an organization and its representation using diverse tools for structuring what the organization has come to know through research in the areas of knowledge it studies. The main objective is to analyze the classification of knowledge proceeding from the results of scientific research projects in order to identify compositional patterns that serve the purposes of management. This paper consists of a case study of researchers at the Universidad de Pinar del Río and proposes an Institutional Information and Knowledge Management System of the Universidad de Pinar del Río (CV-UPR) with a curricular focus, as well as other diagnostic techniques for identifying patterns in the structure of knowledge in said institution.

Materials and methods

The Universidad de Pinar del Río designed and implemented the CV-UPR several years. It is registered and certified and has been validated in other studies. In this system, the Curriculum Vitae (CV) of the researcher constitutes the sole and main source of data entry and update. One of its main features is that it was developed for research activity, since a hierarchal structure was designed that includes all of the activity and its composition, including diverse taxonomies for classifying scientific results (Armas, Díaz and Giraldes, 2008). For documental analysis, the reports and methodological documents issued by the Vice-Rector's Office of Research, Information Systems and Postgraduate Studies (VRIIP) were examined, as were the Science and Technology Balances for the period under study.

To complement this study, empirical techniques were used that allow quantitative information to be secured from non-documental sources. A diagno-

sis of the population under study was performed. This population consists of UPR researchers responsible for coordinating research projects. Research projects in course in the period from 2001 to 2013 were examined. The diagnostic was applied to 33 researchers who coordinate projects in the period under study. Sampling of this population was discarded in favor of applying the survey questionnaire to every subject researcher. For the purpose of better interpretation and association of results, data analysis was performed using the Statistical Package for Social Science (SPSS, version 11.5, 2004) and Microsoft Excel (2010).

Results

In general terms, science is viewed as a knowledge production system, existing largely in the form of publications. Publication is understood as any "information recorded in permanent supports and available for common use" (Spinak, 1998:142). This recorded information may be published in numbered, high impact journals, though it also exists in the daily processes of science at the institutional levels and in everything the researcher does as the driver of this process. The process of management of science and technology entails definition and assessment of policies needed to promote science at the national or regional level. To fulfill this purpose, the parties responsible for these activities need to design methodologies that guide both the gathering of information and the use of information systems that facilitate analysis and provide approximations of scientific capacities and dynamics.

The design of these systems seeks to respond to the concrete operational management needs at micro, meso and macro levels of the organizations or institutions that promote research and technological development. In the institutional field, SIS aspire to the following objectives (Armas, Díaz and Giraldes, 2008):

- To structure operative and functional information needed by organizations to operate efficiently and achieve results.
- To respond to the concrete needs of organizations that promote science and technology research in sustainable development of innovation and technological change.
- To develop and support science and technology macro policies needed by organizations and their processes.

- To define and evaluate strategies followed in research, development and innovation activities (R+D+I).
- To evaluate the scientific and technological production and activities of researchers and institutions.
- To provide proper management of the distribution of material and human resources devoted to R+D+I.
- To promote national and international collaboration, exchange and transfer of innovations in science and technology.

These purposes clearly reflect the internal and external interactions of the SIS. The activities of the researcher and their interactions with other actors in the field of science occur in an institutional setting. As such, the institutional standpoint offers greater regional results in terms of implementation of indicators for managing science and technology. The CVs of researchers provide valuable information that make up part of the results of research. The observation of the activity surrounding any given researcher allows:

> evaluation of the CVs of scientists and surveys as a source of information. The first as a subset of data for obtaining indicators of scientific activity and the second as a source of information to establish […] the social (organizational structure of the environment, available human capital, etc.) and economic (research funding) framework in which scientists habitually work (Martín-Sempere and Rey-Rocha, 2009: 2)

The empirical literature examines works that use the CV as a source of information for studying the behavior of science at its diverse levels where it is practiced. These studies are performed in order to assess the impact of researchers' affiliation to research centers on their productivity, collaboration and funding (Gaughan, Branco and Bozeman, 2007). For the researcher, the CV is a representation of their "knowledge value" (Jaramillo, Lopera and Albán, 2008).

UPR recognizes the importance of each research professor's CV and the power of curricular information systems in the management of science and technology activities at the institutional level. This is why the Institutional Information and Knowledge Management System of the Universidad de Pinar del Río (CV-UPR) was developed. Among its main management, evaluation and projection objectives is to account for the behavior of scientific activity in all areas, including identification of research patterns and the structuring of all the knowledge held by the university in accord with existing national and international taxonomies.

As the researcher publishes work, secures degrees and generally undergoes professional development, the data and fields of knowledge reflected in the CV are updated. The following is a list of occasions that researcher will often update in the associated CV field:

- Securing postgraduate degrees: results associated with research performed to obtain the postgraduate degree.
- Work as thesis advisor: results associated with serving as thesis advisor in both undergraduate and postgraduate programs.
- Results of research associated with projects, or associated with research work in the research project to which he or she is tied.
- Results of research not associated with projects that are relevant to the researcher and the institution.

Through this structure, the results of the research process are deepened for each researcher and the institution, whether generated or not within a research project. At the same time, the diverse results (methodology, product, etc.) generate a broad subset of output typologies, including articles, patents, books, monographs, informatics and non-informatics product registries, brands, standards, etc.

In the structure of the CV-UPR, each result output includes different areas of knowledge. In this case, the research professor classifies each one of their results in accord with three taxonomies: The Taxonomy of the United Nations Organization for Education, Science and Culture (UNESCO), the Taxonomy of the Organization for Cooperation and Economic Development (OCED), and classification taxonomy currently in use in Cuban. The UNESCO taxonomy is international in nature and the OCED taxonomy is widely used in Spanish speaking countries of the greater Americas.

Figure 1 shows the structure of the fields used by CV-UPR for collecting data derived from research: types of results, fields of knowledge and result outputs. This distribution allows for the measurement of knowledge generated by each type of research activity and structuring research results as a function of the activity that produced them in accord with the nature of the knowledge itself.

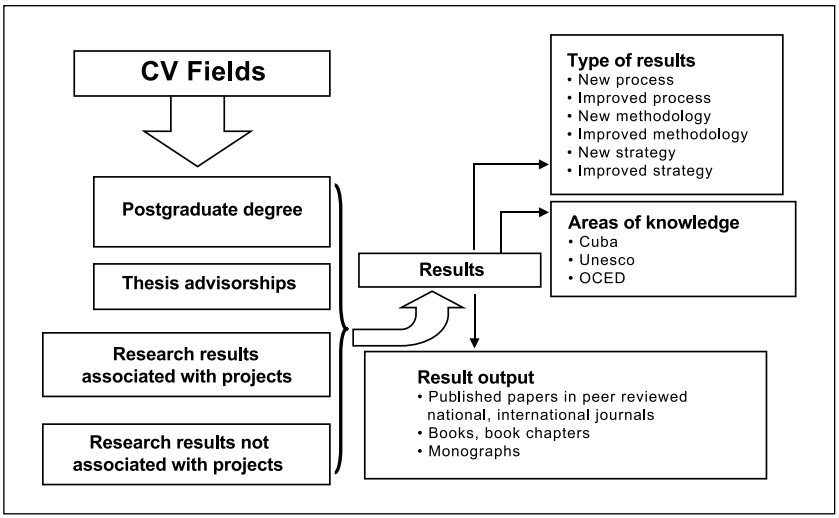


Figure 1. CV fields that are updated with research results.
Source: Armas, Diaz and Giraldes, 2008

This distribution within the CV-UPR system has allowed one to know about the disciplinary composition of research in the university. One can infer the existence of a propensity to establish interdisciplinary relationships in diverse areas of UPR. To corroborate this, we propose performing a diagnosis of the results arising from research project.

The results of the techniques employed exhibited a broad group of interdisciplinary research whose results issue from distinct areas and disciplines of knowledge. As such, in several instances they are difficult to classify using these taxonomies. Interdisciplinary approaches also prevail in doctoral dissertations. This behavior merits further study in order to discern the characteristics of the research projects of the institutions and the lines of research and researchers involved.

Eighty percent of the coordinators assert that the results of the projects they coordinate are associated with more than one scientific discipline (Figure 2).

By crossing two of the variables under study, 37% of those surveyed assert that their project has at least 5 or 10 members and it is associated with more than one scientific discipline (Figure 3).

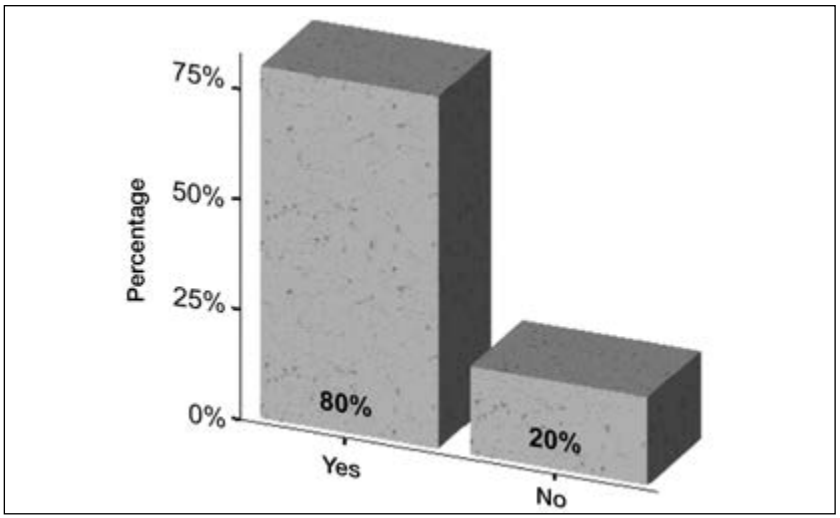


Figure 2. Response to question 5 in the survey
Source: By author on the basis of SPSS

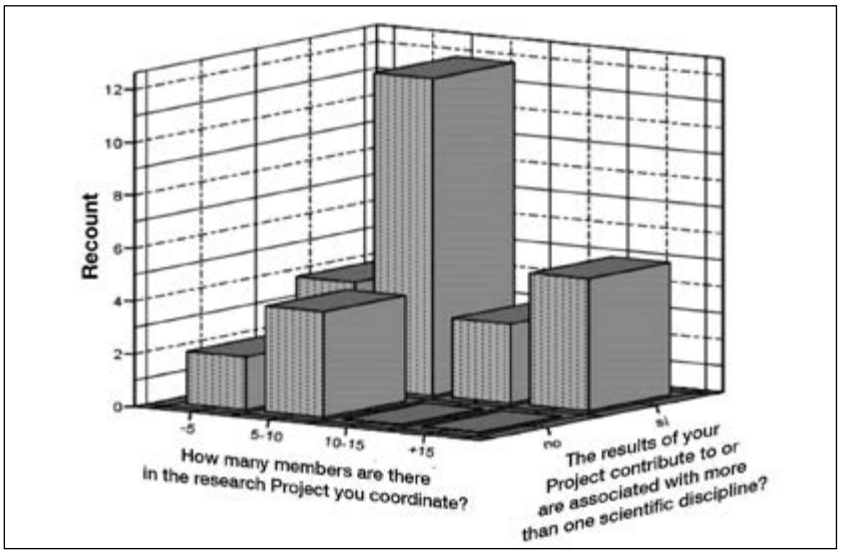


Figure 3. Cross comparison of responses to two questions
Source: By author on the basis of SPSS

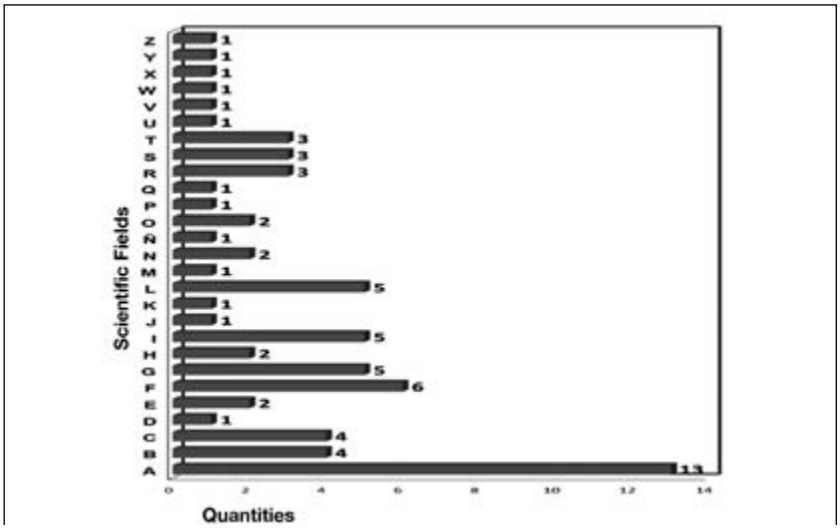
Similarly, those who coordinate projects with more than 15 members report having results associated with several scientific disciplines. This analysis evidences that there are certain features of the projects analyzed that can influ-

ence the determination of interdisciplinary relationships. This is one of the factors that makes of results resistant to being pigeonholed under a given classification approach.

The number of members working in a project, the objective sought, the scope and level of interaction with other disciplines for solving a given problem constitute factors that influence the degree of interdisciplinary cooperation. The areas associated with social sciences, in general, exhibit a distinctive pattern of comportment with regard to interdisciplinary cooperation.

The study showed that of the 61 lines of research of the UPR in the period under analysis, thirty work in conjunction or require contributions from other fields of science. Salient among these are Pedagogical Science, Forestry Science, Economic Science and Technical Science (Figure 4). The most frequent combinations are as follows:

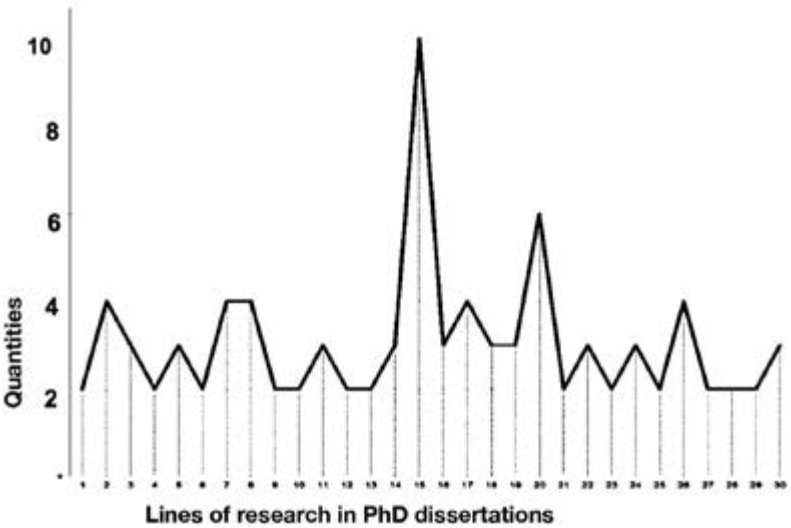
- Mathematics
- Applied Social Sciences, Mathematics, Economic Sciences, Agrarian Sciences
- Applied Social Sciences, Mathematics, Economic Sciences
- Mathematics, Economic Sciences, Agrarian Sciences
- Biological Sciences
- Economic Sciences, Mathematics
- Chemistry



Legend	
A	Mathematics
B	AppliedSocialSciences,Mathematics,EconomicSciences,AgrarianSciences
C	Applied Social Sciences, Mathematics, Economic Sciences
D	Technical Sciences
E	Mathematics and Chemistry
F	Mathematics, Economic Sciences , Agrarian Sciences
G	Biological Sciences
H	Mathematics, Economic Sciences, Chemistry and Informatics
I	Economic Sciences, Mathematics
J	Sociology
K	Mathematics,Sociology,AgrarianSciencesChemistry,Biology,Psychology
L	Química
M	Economic Sciences, Political Sciences and Mathematics
N	Mathematics, Agrarian Sciences and Informatics
Ñ	Applied Social Sciences, Mathematics, Geology, Biology
O	Agronomy and Biology
P	Sociology, Psychology, Economic Sciences
Q	Philosophy and Applied Social Sciences
R	Applied Social Sciences
S	Agrarian Sciences
T	Sciences of Education
U	Mathematics and Technical Sciences
V	Regional Geology and Mineral Deposits
W	Economic Sciences
X	Psychology and Theory of Communication
Y	Mathematics and Geochemistry
Z	Physics

Figure 4. Areas of science that contribute results to doctoral dissertations
Source: By author based on SPSS

Mathematics is a representative example in Figure 5, because it contributes the methodologies needed in other research. The same holds true for Statistics. We can conclude that interdisciplinary research projects are those that exhibit the greatest number of combinations of areas with their results. Each doctoral dissertation, in turn, matches a given line of research, which manifests the existence of several lines of research in the institutions that are nourished by diverse fields of science.



Legend	
1	Patentometrics
2	Cooperation
3	Rural tourism management
4	Hydrogeology
5	Construction of forestry roads
6	Integrated pest management
7	Wood technology
8	University-business cooperation
9	Accounting processes informatics
10	Financialeconomicmanagementoftechnologicalinnovationprojects
11	Thermochemical processes
12	Commercialization system for higher education
13	Administration and management of companies
14	International Economy
15	Pedagogy and didactics in higher education
16	Payment for environmental services
17	Human resources management
18	Economic theory of the transition to socialism
19	Forestry
20	Coastal ecosystems and environmental education
21	Agro-ecology of the forestry system
22	Communitarian social development and popular education
23	Pyrolysis and gasification in fluidized solid waste bed
24	PsychopedagogicalorientationofstudentsintheNewCubanUniversity
25	Geochemical of rocks and mines
26	Linguistics
27	Linguodidactics
28	Pre-lexicographical and pre-terminographical studies

29	Marine intrusion, water quality and environmental geology
30	Forestry inventory

Figure 5. Number of areas of knowledge that contribute results to research
Source: By author based on SPSS

The lines associated with the greatest number of science fields are Pedagogy and Didactics in Higher Education, Coastal Ecosystems and Environmental Education (Figure 5). These lines are respectively associated with 10 and 6 areas of science. There are five lines of research that are associated with four following sciences: Cooperativisim, Technology of Wood, University-Business cooperation, Human Resources Management and Linguistics.

Discussion of the results

As Hjørland and Albrechtsen (1995) have stated, in the complex scenario of the organization of knowledge the best way to focus its application to the reality of Information Systems is to study how people think and imitate these regularities of thought. In the case study under analysis, this assertion is fulfilled by contrasting the results of research in research projects and the classifications in the taxonomies used in the CV-CPR system.

It has been shown that there is no single way to organize the knowledge derived from institutional research projects, and that existing taxonomies are not absolute. With regard to information from research projects, it is important to design representations that facilitate the organization of knowledge in accord with its particularities, and on basis of diverse criteria or positions, such as relevance of the topic or line of research, connections existing between diverse disciplines (of the same area or of distinct areas), the demands exerted by results of research on other areas of science, and the number and diversity of members of the projects.

It is clear that the social aspect exerts a considerable influence on the process of organization of knowledge through ideologies, traditions and paradigms which combine with intellectual aspects. Fundamentally, one must make the use of knowledge viable for real or potential users (Hjørland, 2003; Peña, 2010).

On the basis of these ideas, this study proposes performing the classification of research results on the basis of the lines of research to which each work

belongs, since the research project leaders, department heads and heads of research centers and research groups have the greatest capacity for classifying these lines into the distinct fields and disciplines of the taxonomies used to organize scientific knowledge.

This proposal directly associates the lines of research with tributary research. The lines would appear classified in the taxonomies used by the CV-UPR system, and researchers must classify themselves in the line to which they belong. This is a simple task for the researcher, because it is part of their everyday work. Those responsible for classifying the lines of research are the project leaders, department heads, heads of research centers and research groups and other authorities within the research realm of the institution. All of these persons must be trained in this regard. In this way, classification and organization of knowledge for structuring in the CV-UPR system is facilitated.

The analysis offers both advantages and disadvantages as listed below:

Advantages:

- There is integration in the development of research project among specialists belonging to the distinct areas of the institution and outside of it.
- The clients of the projects work lines of research associated with research activities of the university.
- The coordinators of the projects know about the phenomenon of interdisciplinary approaches and they associate it with profiles and lines of research that work in the diverse projects they direct.

Disadvantages:

- The researchers confuse the field with the scientific discipline when classifying their results.
- The information on science and technology in the UPR is very disperse in the distinct areas of the institution. The main source is the researchers themselves. As such, ongoing consultation must be possible.
- Processing and analysis of results and performance of the research project become onerous processes for the persons in charge of coordinate the projects and for institutional authorities.

Finally, it is worth highlighting that most of the results derived from the research projects are associated with the area of Science of Education. In the classification of researchers in accord with the three taxonomies, the highest percentages are found in fields associated with this activity used. The study

shows that there is complete harmony between the criteria of the researchers analyzed and the information from the research balance reports of URP over the same period of time.

Under this proposal, organization of knowledge is performed with a plural conception that pools cognitive, social and technological features, allowing one a view of the entire length of the participative process. In this case, the logical-semantic and discursive organization, which the researchers themselves have used to construct and organize their knowledge, is respected (García, 2001), and the organization of knowledge is performed more harmoniously within the information system, one of the main paradigms within the process of scientific research (Smiraglia, 2012).

Conclusions

The study of scientific bibliography, in conjunction with the empirical techniques used, showed the validity of including the organization of knowledge resulting from the research in the scientific information system of the institution.

The classification of the results of research must be structured in taxonomies of scientific knowledge that exist nationally and internationally.

At the international level, the categories of knowledge or scientific areas establish a classification of knowledge in terms of discipline. On occasions, this behavior encumbers the process of categorization of the results of a given science, since they are increasingly influenced by the combination of disciplines and the emergence of new interrelated sub-disciplines.

The diagnosis performed of researchers who head up projects shows that the practice of classifying results by areas of knowledge is not habitual nor is it required by authorities. We recommend incorporating this procedure at the outset of research projects that articulate diverse areas of knowledge while obtaining varied interdisciplinary results.

We propose the institutional management systems of curricular information as the best tool for managing the scientific knowledge of an institution, as well as for the identification and interpretation of patterns for structuring institutional knowledge. In this case study, we have validated the Information and Institutional Knowledge Management System (CV-UPR) as a platform for ob-

taining and contrasting relevant information on the structuring of knowledge derived from the results of research in accord with established taxonomies and the analysis of patterns as per lines of research and research projects.

Works cited

Armas, D., M. Díaz, and R. Giraldes. 2008. "Sistema Institucional para la Gestión de la Ciencia y la Técnica en Universidades: una perspectiva cienciométrica para su análisis y evaluación." Paper presented at Memorias Información, La Habana, Cuba.

Báez, J. M., F. Peset, F. Núñez, and A. Ferrer. 2008. "CVN: normalización de los currículos científicos." El profesional de la información, 17 (2) (March-April): 213-220.

Dahlberg, I. 2006. Knowledge Organization. Accessed February 6, 2010. http://www.iva.dk/bh/lifeboat_ko/concepts/Knowledge_organization_Dahlberg.htm

García, A. 2001. "Redes digitales y exomemoria." Binaria: revista de comunicación, cultura y tecnología, 1. Accessed February 22, 2009. http://www.ic-journal.org/data/downloads/1265039267-2garcia-gutierrez.pdf

Gaughan, M., P. Branco, and B. Bozeman. 2007. "Using quasi-experimental design and the curriculum vitae to evaluate impacts of earmarked center funding on faculty productivity, collaboration, and grant activity." Proceedings of ISSI 2007: 11th International Conference of the International Society for Scientometrics and Informetrics, I-II, 305-313.

Hjørland, B. 2003. "Fundamentals of knowledge organization." Knowledge Organization 30 (2): 87-111.

Hjørland, B., ed. 2005. Lifeboat for knowledge organization. Accessed May 31, 2009. http://www.db.dk/bh/lifeboat_ko/home.htm

Hjørland, B., and H. Albrechtsen. 1995. "Toward a new horizon in information science: domain analysis." Journal of the American Society for Information Science 6 (6): 400-425.

Jaramillo, H., C. Lopera, and M. C. Albán. 2008. Carreras Académicas. Utilización del CV para la modelación de carreras académicas y científicas. Bogotá: Facultad de Economía, Universidad del Rosario. Accessed May 16, 2012. http://www.urosario.edu.co/FASE1/economia/documentos/pdf/bi96.pdf

Martín-Sempere, M. J., and J. Rey-Rocha. 2009. El currículum vitae y la encuestacomofuentesdedatosparalaobtencióndeindicadoresdelaactividad científica de los investigadores. Accessed April 16, 2008. http://www.ricyt.edu.ar/interior/normalizacion/III_bib/Sempere_Rey.pdf

Morin, E. 1995. "Sobre la interdisciplinariedad." Revista Complejidad 1 (0): 4-8. Accessed February 28, 2010. http://www.pensamientocomplejo. com.ar/docs/files/morinsobreinterdisciplinaridad.pdf

Navarrete, J., and J. Banqueri. 2008. "Los sistemas de información científica: herramientas para medir el impacto de la investigación biomédica." Revista Medicina Clínica 131, 71-80. (Supl. 5.)

Peña, T. 2010. "El acceso al saber requiere aplicar organización y representación del conocimiento." Revista Interamericana de Bibliotecología 33 (1) (January-June): 13-29. Universidad de Antioquia. Medellín, Colombia. Accessed January 12, 2011. http://redalyc.uaemex.mx/src/inicio/ArtPdfRed.jsp?iCve=179015628001

Smiraglia, P. 2012. "Knowledge organization: some trends in an emergent domain." El profesional de la información 21 (3) (May-June): 225-227. Accessed September 22, 2012. http://dx.doi.org/10.3145/epi.2012.may.01

Spinak, E. 1998. "Indicadores cienciométricos." Ciência da Informação 27 (2): 141-148.

Universidad de Salamanca. 2005. Manual de Usuario Portal del Investigador. Accessed May 25, 2009. http://campus.usal.es/~infouxxi-inv/archivos/manualuxxi.doc

To cite this article as an online journal:
Rivero Amador, Soleidy et al. 2016. "Patrones para la organización del conocimiento en los Sistemas de Información Curricular. Un caso deestudio".InvestigaciónBibliotecológica:Archivonomía,Bibliotecología e Información. 68: 91-107. [Include URL here] Consulted on: [Include date here]

To cite this article from an information service:
Rivero Amador, Soleidy et al. 2016. "Patrones para la organización del conocimiento en los Sistemas de Información Curricular. Un caso deestudio".InvestigaciónBibliotecológica:Archivonomía,BibliotecologíaeInformación.68:91-107.[Includenameofinformationservice and URL] Consulted on: [Include date here]