Some Current Research Questions in the Field of Knowledge Organization

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Abstract: The research dynamics of knowledge organization (KO) show a tendency towards the reformulation of previous questions in the new technology-driven and interdisciplinary context of KO. Current research questions in KO are dominated by a noteworthy interest in quality, related not only to the informational contents recorded in knowledge organization systems (KOS) but also to technical and technological considerations. The integration of knowledge would seem to constitute a quality indicator present in most proposals, and it also responds to the need for KOS with frameworks comprehensible for all user sectors, respecting the diversity of users. The flip side of knowledge integration entails the conjugation of technical, formal and technological aspects, well represented by the word *interoperability*, or the search for a way to simplify and harmonize the great variety of structures and formats that coexist in the Internet. This paper addresses the aforementioned major research concerns expressed in the last decade of KO literature. It is structured into two broad sections: 1) *A demand for quality*, touching on research questions related to multilingualism, cross-culturalism, social groups, minorities and ethics, as well as the integration of structures, forms and formats and the respective proposals by scholars; and 2) *A demand for managing emergent knowledge in KOS*, with a discussion of how to represent and organize work-oriented and organizational knowledge domains, where multidimensional knowledge (multi-, inter- and trans-disciplinarity) is addressed together with the responses put forth by various researchers.

1. Introduction

When facing the study of research interests in a particular field, especially one like knowledge organization (KO) that is quite new (McIlwaine & Williamson 1999) and interdisciplinary in nature, it is important first to call attention to some characteristics that might aid in understanding the domain's dynamics and behaviour, and that might facilitate a general understanding of research trends. This paper highlights some characteristics that seem most relevant for the topic and objective at hand.

1.1 LIS and KO fields: Some characteristics

The concept of KO itself is under revision nowadays. LIS scholars argue that the conceptual limits of what has been understood by KO do not correspond with how KO is viewed today. It calls for reconsideration. Information technology, new uses of KO and the development of other specialized areas nearby, such as Knowledge Management, make evident the need for an updated and more exact definition.

The editor of the journal *Knowledge Organization,* expressing a quite frequent opinion in the field, has underlined this matter in editorial notes. In one of them, he addresses the question of what precisely KO is, recognizing that there is no general consensus (Smiraglia 2005), although many have written about it. In a second editorial note he asks, "whither knowledge organization?" (Smiraglia 2006) and, in a search for answers, he goes back to the initial discourse of KO, when it was called classification, clearly functional in origin. He also suggests that

the analysis of research fronts in LIS could be another way of grasping the whole meaning of KO, with an example taken from the ISKO Vienna 2006 Conference. Special attention is drawn to Dahlberg´s article *KO: a new science* first published in 1994: indeed, a detailed account of the name and meaning of KO and of its fundamental features is reprinted, with only minor changes, in the same issue of the journal (Dahlberg 2006).

Discussion of the meaning and conceptual borders of KO today is alive in other spheres as well, such as the International Society for Knowledge Organization (ISKO): their Scientific Advisory Council is engaged in studying this and the relation/distinction between KO and Knowledge Management, as also indicated by Smiraglia (2005, 2006). This activity has motivated interesting e-mail communication between several members of the Scientific Advisory Council and some others on the ISKO Executive Board. The ISKO list (ISKO-l) and the last ISKO International Conferences have also provided a forum for occasional discussions and exchange of opinions.

This short description of what may be considered one of most pertinent current questions in the knowledge organization field opens this article because it highlights some characteristics of LIS and of KO. Bearing these peculiarities in mind will, I believe, enhance understanding of the field's own research activity, behaviour and achievements.

The fact that the concept and limits of KO demand renewed attention and study converges with another acknowledged feature of our field: there are few really "novel" research topics in KO. As McIlwaine puts it, "The search for a universal information language acceptable to all seems to be a thing of the past. Rather, nowadays there is interest in mapping one information language onto another" (McIlwaine 2003, 77). In a previous paper, McIlwaine and Williamson (1999, 25) called attention to the fact that "Some areas of investigation [in KO] are not as new as they may seem ... their prominence in discussions has increased with the growing sophistication of technology."

It is not uncommon to find familiar old questions that are reformulated because of changes produced by external circumstances, as McIlwaine suggests above. There are a number of underlying reasons for this:

1. The technology-driven foundation of KO, as pointed out by Hjørland (2003). The end effect is that of jumping from one platform to another without generating enough research to produce "new" basic knowledge. According to Hjørland, there are five technology-driven stages that constitute what KO means with LIS: manual indexing and classification in libraries and reference works, documentation and scientific communication, information storage and retrieval by computers, citation-based retrieval and Full text, Hypertext and Internet. He concludes (Hjørland 2003, 104):

   > It is important to realize that this development has been very much technology driven. This is not a satisfactory circumstance for a discipline with the ambition of being a science.... Although those [technology driven] five stages define a topic and a common goal, they do not define a cumulated fund of findings, theories or principles. On the contrary, they are often latent, conflicting view between those stages ... this is why overall concepts for thinking about KO have been missing or at least strongly underdeveloped.

2. The field lacks a consistent and coherent, well-articulated body of theories and methods. This gives rise to an overall conflicting panorama and an absence of communication among the different viewpoints. In other words, there are epistemological problems to deal with. Some scholars argue that there is a need for reflective studies in Information Science (IS), "the long-term endeavours of interpretivist researchers might need to continue because the paradigmatic progress appears somewhat inconsequential" (Cheng & Hirschheim 2004, 197). Others hold this situation to be a shortcoming for IS as a speciality (Hirschheim & Klein 2003). Recent attempts to fill this gap, with the intention of developing a unified research framework to synthesize similarities between cognitive science and information studies, particularly language, are one useful tool for future information study research (Holland 2006). Nevertheless, the overall panorama is not optimal for producing a solid corpus of theory that contributes to new basic research questions. Quite the contrary, it pushes one to revisit old or traditional research questions in order to respond to new situations and technological problems.

This state of things could be seen as a consequence of the aforementioned technology-driven stages, but we must not forget the perception of KO as a field

populated by theoretical models and methods without much inter-connection (Hjørland 2003; Gnoli 2006; McIlwaine 2003) and without much awareness of the exact dimensions of its conceptual limits — two notions that have much to do with KO´s interdisciplinary identity. Other authors point in a similar direction, adding that there is an increasing chaos in Information Science and Communication, where a plethora of theories, concepts, approaches, methods, and findings plague researchers in the field. The origins and symptoms of these disciplinary overloads are very much related to the field's interdisciplinary nature (Dervin 2003).

Characteristics of other interdisciplinary domains, as studied by Denda (2005), include an unstable, fast-evolving, scattered terminology, mainly because of the incorporation of new terms from outside disciplines. At the conceptual level, there may be an additional problem deriving from the migration of terms from other disciplines towards the interdisciplinary domain, together with difficulties in determining conceptual dynamics. Fuzzy epistemological borders are also a common pattern (López-Huertas & Barité 2002; López-Huertas, Barité & Torres 2004; López-Huertas 2006b). These problems worsen when the interdisciplinary domain is not consolidated (Caidi 2001). In fact, studies of the Information Science domain confirm its interdisciplinarity. Accordingly, LIS shows a need for the development of an individual terminology to overcome terminological and conceptual problems with terms coming from disciplines outside Library Science itself (something that happens in Gender Studies as well). "Confounded notions" in the peripheral terms are also reported (Kobashi, Smit, & Tálamo 2002). A contribution by Gatten in the early nineties emphasizes the paradigmatic problems in LIS because of its interdisciplinary nature. Gatten (1991) argues that scholars are becoming increasingly interdisciplinary in their approach to research, but traditional structures of knowledge within the social sciences may limit their ability to view a phenomenon in its entirety. His conclusion is that interdisciplinary research into the applied disciplines of Librarianship is inhibited by paradigms.

Considering that interdisciplinary domains are characterized, to some extent, by all the features mentioned above, LIS and KO are exhibiting behaviours that could be anticipated, being common to other interdisciplinary domains. They share a role in interdisciplinary epistemological dynamics. This is not the only key to the theoretical and methodological problems in KO; yet we cannot ignore the fact that an interdisciplinary domain has epistemological problems that affect its activities all around.

The very last characteristic of LIS and KO research that I would like to mention is the often slow reaction to original ideas and recommendations proposed in scholarly publications. It normally takes some time for scholars to react to original proposals, even when they stand as recent developments of previously accepted ideas. It would be interesting to study or follow-up the impact and obsolescence of research results, as another indicator of the research activity and behaviour within LIS and KO.

For example, Marcia Bates introduced the "user-thesaurus" concept in 1986, as opposed to the traditional indexer-thesaurus. One of the main features of the user-thesaurus was the need for including a vast entry vocabulary, geared to end-user requirements, and for introducing more numerous semantic relations than those included in the traditional thesaurus (Bates 1998). This called for thesaurus designers to include user terminology in the vocabulary entry of thesauri, and to offer more varied conceptual relations among terms. The presence of as many non-descriptors as possible was also called for. After nearly a decade, interest had eventually been stirred up and more research on these topics came to be published, among others, by Green (1995a, 1995b, 1996, 1997, 1998), Bean (1998a, 1998b) and López-Huertas (1997), who stressed the importance of identifying more numerous semantic relations and of enriching the conceptual structure of thesauri and indexing languages in general. The International Society for Knowledge Organization (ISKO) also echoes this renewed quest for relations and structures in KO in its fifth Conference (in Lille, France) under the theme "Structures and relations in Knowledge Organization" (Mustafa el Hadi, Maniez & Pollitt 1998). This trend has persisted until now.

Does this behaviour mean that LIS is moving slowly towards innovation? Could it be that the reformulation of older topics to respond to new external situations is the means that LIS has found to grow and consolidate until the field becomes an established domain? Further study is needed to focus on confirming (or not) these apparent reactions in research behaviour and in knowledge development in LIS and KO.

1.2 Some previous contributions in KO research trends

Some studies have aimed to identify the research interests of scholars in KO. In reviewing some of these

contributions, it is interesting to take note of the research fronts in our field and how they evolve over time. At the same time, we might have a chance to identify some of the research characteristics mentioned in the previous paragraphs.

The work by McIlwaine and Williamson (1999) on international trends in KO is a good point of departure, as it presents exhaustive coverage of the matter, having analyzed literature from 1988 to 1997; this gives background deep enough to let us trace what has been going on in KO and also to understand today's tendencies. It is often remarked that a repetition of research topics is seen in the examined period as compared with older times. To illustrate this assertion, the authors cite Vickery's claim at the Study Conference on Classification Research in 1997, that all the conference issues had already been raised at Dorking forty years before. This idea is expressed several times in the article and conclusions, and the text ends with the following sentence: "We should treat that as an object lesson, and try to ensure that the findings of the nineties do not once again flounder in the next millennium" (McIlwaine & Williamson 1999, 28).

The major research interests found were universal classification systems, thesauri, cognitive processes, structures and relationships, terminology and natural language processing. Less important issues were topics such as concepts and categories, semantics, semiotics, linguistics, classification of images, taxonomy and ontologies. No doubt, the stars of the research interests were universal classification systems and thesauri, but in both cases importance was given to the adaptation to new technologies. McIlwaine and Williamson stressed efforts in the adoption of universal classification systems to machine-readable forms, and the need for new kinds of thesauri for the online systems. Emerging and merging research on multilingual thesauri was also reported. Mapping one system to another, the organization of the Internet with a special focus in visual browsing, citation indexing, data mining technologies, hypertext thesauri and intelligent software agents were among the outstanding topics at the end of the 20th century.

A different approach to research in KO was that made by Hjørland and Albrechtsen (1999) when analyzing some trends in classification research. The paper refers to two structuring principles for KO: disciplines and fiction/non-fiction, in the wake of an article by Beghtol on the same topic. Hjørland and Albrechtsen explain the two principles adopting an epistemological perspective. Of special interest are their reflections on the principle of discipline. The authors identify rationalism beneath facet analysis, and state that systems such as *DDC* and the like are "expressions of a pragmatic, historicist and realistic philosophy of knowledge". Since the discipline principle is much criticized elsewhere, it is suggested that alternatives to disciplines as structuring principles should be based on real or critical organization of knowledge. Social organizations of knowledge are fundamental units for KO, so an important new trend in classification research would be the study of work-based classifications, or applied classification. They consider that tendencies toward more historical, cultural and social understandings of knowledge, its production, organization and use, are central issues for a vital shift in classification research (Hjørland & Albrechtsen 1999).

A recent survey on trends in KO research, to cap a previous study (McIlwaine & Williamson 1999), was written by McIlwaine in 2003. A trend emerging at the end of the last century took five years to be consolidated: interoperability, understood as the ability of systems to talk to one another, since then a frequent research topic. McIlwaine also emphasized the increasing interest in devising systems for automatic classification and the use of artificial intelligence for retrieval purposes, signaling expert systems and natural language processing as main areas of interest. Meanwhile, thesauri remain under the spotlight, attracting much attention and preferred over systematic classifications. Facilitating the retrieval of information in a Web-based environment is an overall concern. Moreover, work on classification schemes and subject headings is reported to continue, with a trend toward the revision of current applications and potential of traditional classification schemes for information retrieval from the Internet. The longstanding idea of searching for a universal information language has been reformulated through the interest in mapping one information language onto another. Some projects aim to find a general classification or to build a megathesaurus on which to map several different vocabularies. The visual presentation of information has likewise gained attention, and KO in the commercial environment is a recent trend to which much research is being dedicated (McIlwaine 2003).

Of special interest is the concern in solving the "bias" described by McIlwaine in KO and in Knowledge Organization Systems (KOS), involving the problems posed by words evoking different interpretations in different societies, or the problems of gen-

der in systems constructed in a male-dominated society. These contributions are important in that they constitute expressions of a more general problem dominating part of research activity today: a noteworthy trend in KO referred to as the integration of knowledge. It embraces a number of aspects: cultural diversity, cultural bias problems such as gender, multilingualism problems (which have attracted considerable research in Terminology), ethical issues, etc.

In view of the panorama described above, it can be said that the research interests in KO and in LIS from 1988 to 2003 are focused on longstanding research topics. The field is still wondering about classification principles such as disciplines, fiction and non fiction, etc., it is looking for a kind of switching language to connect different KOS, or an "umbrella" classification, and searching out a universal language. The development of the Internet is a change that again obliges researchers to rethink the big questions in order to respond to new needs proceeding from the Web.

Traditional KOS adapt themselves to electronic formats, and there are recommendations for designing thesauri to be used in electronic environment. KOS are adapted for information retrieval on the Internet, as well as for constructing ontologies for usage on the Web. Artificial intelligence methodology is present in LIS: automatic classification and information retrieval, expert systems and natural language processing, for example, are reportedly current trends in research. The Web also has stressed the importance of multilingualism and cultural differences, to be addressed in KO. It is argued that classification research needs a shift and that LIS and KO need more theoretical research to construct a solid and coherent platform of their own. These claims seem to be of great importance because this might be one of the causes for revisiting many research questions so often, as often as technology and new environments demand. It might be said that the research questions remain, but what changes are the responses to those questions; therefore, talking about current questions in research is tantamount to giving current responses to ever-open questions.

1.3 Objectives and structure of the paper

The following pages are dedicated to talk about some current research questions in the KO field. It is not an exhaustive list of all possible questions. On the contrary, it is a selection of some outstanding issues according to my point of view. It is divided into two main sections:

- A demand for quality, and
- A demand for managing emergent knowledge in KOS.

To collect data, the *Social Sciences Citation Index* was used, and the source for the journal titles was provided by the *Journal Citation Reports Social Sciences Edition* under the category Information Science and Library Science. The search was limited to the last ten years. Search terms and the search strategy were the following:

> *classicat* languag* or classificat* system* or descriptor languag* or document* classificat* or document* organizat* or document* languag* or index* languag* or knowledge organization or organization of knowledge or knowledge structur* or libr* classifcat* or subject head* thesau* or conceptual structur* or bibliograph* classificat* or classification or information structur**

This information was completed with a search in LISA with the same strategy plus the revision of the Proceedings of International ISKO Conferences from 1998 to 2006.

2. A demand for quality

From the literature analyzed, a deep, shared desire for quality in KO and its main areas of concern can be detected. Much of this concern is technology driven and, above all urged by the Internet, with its ensuing, continuous need for updating. This fact is not entirely new, but what is new is the actual environment that encourages new questions rooted in older topics. This behavioural pattern of lending so much relevance to external conditions in the development of the field seems to be characteristic of LIS and much of KO research, as mentioned in the Introduction. It is important, then to remember that discussing current issues is not the same as discussing new issues; rather, we should refer to current solutions or current questions stemming from more permanent research topics.

One of the biggest problems that the Internet has created is the need for dealing with a huge amount of heterogeneous information, an initial challenge that became an urgent problem to solve. As a result, quality was overlooked as a major problem at first. Nevertheless, the Internet has meant an increase of not only quantitative information but also a remarkable rise of qualitative information that has not been

properly attended to, although in recent years a trend in this direction has been detected. The novelty is that qualitative issues have recently become a priority target in KO research, and therefore more and more important in the Web, so we see an increase in quality together with the increasing quantity. The Semantic Web affords one good example of this, with its objective of providing "metadata not just concerning the syntax of a Web resource, but also its semantics, in order to replace a web of links with a web of meaning" (Legg 2007, 410). Nowadays, one lingering, important, research question is:

2.0.1 How to ensure quality in knowledge representation and organization and information retrieval in the Internet environment?

This is a very general question that has many layers of implication, and one that is generating much current research. Quality in this context is largely related to semantics, which is probably the biggest latent issue in KO (Hjørland 2007). Along this search for a quality umbrella, questions related to the integration of knowledge, as a quality indicator in a very broad sense, will be addressed. Here, the integration of knowledge is understood to mean two main things: 1) the capability of KOS to represent and organize knowledge while avoiding a global, standardized view. Contrariwise, it looks for diversity at different levels constructed in one harmonized reality as an expression of the complexity of knowledge and of media. 2) The other face of integration is dealing with the systems' capabilities to improve design, to develop structural devices that can represent and harmonize the heterogeneous information sources and different structures coexisting in the Internet. Interoperability and the mapping of systems onto one another to improve communication in online information systems is one of the possible responses to this quest for quality. Yet integration in the context of information systems can have additional meanings: in a broad sense, integration has become synonymous with a utilitarian goal of greater efficiency, effectiveness and competitiveness in organizations (Wainwright & Waring 2004). At any rate, integration in this context is considered as a quality indicator. A token of this relevance can be seen in the seventh International ISKO Conference in 2002, devoted to this topic (López-Huertas 2002).

Main features in the integration of knowledge approach will be: A) multilingual, cross-cultural social issues, and professional ethics; and B) KOS design demands for integrating knowledge.

2.0.1.1 A) Multilingual, cross-cultural and social issues in KO

These topics are a centre of attention because the existence of the Internet has heightened their significance and implications: the Web crosses or defies cultural and linguistic boundaries around the world.

2.0.1.2 How do we manage multilingual and socio-cultural diversity? How can we strive toward universality without sacrificing diversity?

These have become current research questions. Allowing for pluralistic representation and organization in knowledge structures is a way of improving quality in KOS and in the Web environment. It is a way of building more suitable tools for different uses and users.

2.1 The mutilingual issue in KO

The multilingual issue in KO needs to be addressed repeatedly because the Internet is plurilingual and use has greatly increased among non-English speakers—there is a 60% rise in use among English speakers versus 150% among non-English speakers (Yang & Luk 2003). To these authors, research in crossing language boundaries, especially in Europe and Asia is in the initial stages.

Much research is focused on multilingual thesaurus construction. Yang and Luk's proposal is centred on "cross-lingual semantic interoperability by developing automatic generation of a cross-lingual thesaurus based on English-Chinese parallel corpus" (Yang & Luk 2003). Some other studies focus on the design and construction of thesauri in order for them to respond to multilingualism and the integration of multilingual thesauri. Schmitz-Esser (1999) stresses the importance of types of relations among concepts, notions and universals among languages that are later studied beyond the approach in the origin thesauri. Hudon (1997, 1998) stresses the fact that dealing with the construction of multilingual thesauri goes beyond finding equivalences for concepts and terms. She underlines specific semantic problems in multilingual thesauri that are very much connected with problems of sociocultural and political nature. Other proposals for building multilingual thesauri can be

found in Frâncu (2002, 2004). Meanwhile, proposals for the automatic construction of multilingual thesauri are given by scholars such as Jorna and Davies (2001), who developed a pilot multilingual thesaurus —InfoDEFT— that also acts as a model for new online thesauri to be used for artificial learning programmes. Some other authors have contributed to multilingual thesaurus construction (Li & Wing 2005; Dejean et al., 2005; Retti & Stehno 2004).

Other approaches to multilingualism are represented by research findings in cross-language information retrieval. These involve the implementation of search capabilities in multilingual environments. Some authors focus on an appropriate metadata selection together with the user needs and behaviour (Menard 2006), whereas others study the introduction of cross-language techniques to overcome and enhance information searching problems in monolingual systems (Rosemblat, Tse & Gemoets 2004; Rosemblat & Graham 2006; Jin 2004; Oak, Devaraj & Venkatesh 2005; Levow et al., 2005). Research results from multilingual projects include MACS (Multilingual Access to Subjects), a Web-based interface through which equivalents among three Subject Headings (German, French and English) can be created for users to access information (Landry 2004; Clavel-Merrin 2004). Other multilingual systems are reported in Garcia, Díaz and Gervás (2002).

2.2 Cultural and social issues in KO

International networks, international cooperation, projects and learning, global information systems of any kind have evidenced a reality already known in KO but never perceived to be as demanding as it is nowadays: cultural warrant. This concept needs reformulation according to these new circumstances. There is a need for representing and organizing cultural differences in an integrated way not only in KOS, although it is a major concern here, but also in other settings as could be the case of systems for e-learning. This aspect is much related to that of multilingualism, as is recognized by some authors, where multiculturality goes hand in hand with multilingualism (Hudon 1997, 1998; Keränen 2006).

2.2.1 How to integrate socio-cultural differences in KO? How do we turn cross-cultural issues into a desired quality for KOS to have?

The need for cross-cultural research has been detected by many scholars, and the impact of these issues in information systems requires research in order to face the problems posed by new global information systems (Hunter & Beck 2000). An important contribution in this sense comes from Beghtol (2002a, 2002b), who widened the scope of cultural warrant. She argues that classification systems are based on assumptions of a certain culture, which means that the respective systems are useful for those belonging to the system but not to others. A knowledge organization system for global usage must integrate knowledge across cultural, geographic and linguistics boundaries in order to be of use. These global systems should introduce "the syntactic and semantic foundations of any and all of the world's cultures, and the creators of knowledge organization systems create techniques for polycultural information retrieval" (Beghtol 2002b, 45). Beghtol also formulates the concept of cultural hospitality as an extension of cultural warrant, which will help KOS to privilege "the needs of different cultures, whether they are national, ethnic, domain or disciplinary cultures."

Olson (2000) goes over essential principles for KO in the Western world—mutual exclusivity, teleology and hierarchy—and claims that organizing knowledge based on other different structural principles would favour cross-cultural understanding and enhance KO. Other studies urge reflection about the theoretical concept of multiculturalism as a "dangerous slogan and not sufficiently critical as to tackle the rights of diversity and singularity even within a given (but not real) monocultural society.... Research on KO must be open to a new paradigm in which Critical Theory and hermeneutics go together" (García Gutiérrez 2002, 516).

Some authors, while recognizing that cultural issues are often neglected in information systems, point out that "much research has focused on the effects these systems hold rather than viewing systems as tools to be designed given an understanding of sociocultural context. Emerging research in community information systems and archives has highlighted possible interactions between system design and ethnographic research" (Srinivasan 2007, 723). There is a call for developing systems based on ethnographic knowledge and for concrete proposals regarding the design of such systems.

In this context it is interesting to note that studies on indigenous knowledge at different levels and realms are emerging. Main research questions revolve around:

– *How to manage indigenous knowledge (written or oral)?*
– *How to organize it?* (Rao 2006; Kargbo 2005; Muswazi 2001; Espinhero de Oliveira 2002; Liew 2004 and Doyle 2006),
– *How to carry out indexing activities using controlled languages in indigenous cultures?* (Monajami 2003) and,
– *How to construct controlled vocabularies for indigenous knowledge?* (Amaeshi 2001).

From a more general standpoint, several studies address the question of how cultural differences are affecting information systems. Zeng, Kronenberg and Molholt (2001) address the design of a conceptual framework for Complementary and Alternative Medicine integrating different cultural environments. Special attention was paid to subject coverage, the representation of medical concepts in the conceptual framework, the incorporation of concept names existing in individual traditional systems, and the relationships among concepts. Other experiments entail determining to what extent cultural visions pose differences in the perceptions and conceptualizations of the same topics. Hassan (2003) found that different countries showed different patterns in the manner of organizing scientific and technological activities within the field of space communications. Liew argues that the Maori language can be reconciled with worldwide use in digital libraries (Liew 2004). Another attempt to have global systems accommodate the peculiarities of local environments is that described by Rolland and Monteiro (2002).

Universal access bears a great relation with the capacity of systems to integrate cultures in their structures. As Treitler (1996) argued, without the integration of cultural differences in information systems, universal access cannot be guaranteed.

It is also worth mentioning here that universal classification systems are doing as much as they can to focus on cultural issues. For instance, the *DDC* scheme is being revised to adapt it to multicultural usage (Dong-Geun & Ji-Suk 2001; Mitchell 2004, 2006) and make the system culturally hospitable (Kwasnik & Chun 2004). Furner and Dunbar (2004) have studied the difficulties of racial categorization due to the biases found in bibliographic classification schemes, and suggest critical race theory might be useful in determining how these systems should be structured.

2.2.2 Are minority and marginalized social sectors taken into account in general systems? Are they properly represented and integrated in general systems? How these cultures could be included and managed in KOS?

These are some emergent concerns that show once more the interest for researchers to have KOS representing different levels of reality even though these are not of general concern. Integration means not only handling cultures in a recognisable way for their own users and understandable in other cultural environments in universal KOS, but also to accommodate in a similar way small groups with special needs or social situations. These questions and the efforts of scholars to answer them are an expression of wanting a richer representation, closer to reality, in KOS, although it also means the use of alternative methods and theories of KO, some of which have been mentioned in the paragraph above. Harmonization of methods and theories is also a challenge dealing not only with marginalized sectors but also with specific cultural environments. The fact is that very little attention has been dedicated to consideration of these approaches until now. Nevertheless, it is a research concern for several scholars and a research question that needs to be answered. Reflections on these topics can also be found in Olson (1998a, 1998b).

The Gender perspective, a social minority, has lacked any consideration in KO until very recently, because it has been suffering from social marginalization. The androcentric western culture in which the main universal classifications have been created impeded such approach. It is well known that for many years women, feminism, etc., were located inappropriately under Ethnology in schemes such as *DDC* and *UDC*, but from the mid-20th century onwards both schemes introduced changes and selected a location at the head of class 300/3 Social science respectively to make more appropriate provision. The interest in Gender and Women Studies in relation to KO is being increased lately. One of the scholars to have dealt with this topic is Hope Olson. She has been studying the Gender perspective in KO from different points of view. In one of her approaches, structures for subject access, expressions of a patriarchal society, are studied using feminist deconstruction as analytical method. The results show the potential for less stable, but more adaptive systems (Olson 2001). The Gender issue has been also studied in relation to KOS, especially in DDC, and solutions have been suggested to integrate this marginalized topic in the

general schemes (Olson 1998b). The study of Gender and Women's Studies in relation to the terminological and conceptual problems faced by this speciality in the field of KO are addressed by López-Huertas, Barité and Torres (2004, 2005). An attempt to design a conceptual structure based on the analysis of the Gender Studies domain is developed by López-Huertas (2006b, 2006c). The representation of Gender in indexing systems, especially in thesauri and some identified problems related to literary warrant and terminology are addressed by López-Huertas and Torres (2007). Other studies show how to develop ontologies to manage information on Gender Studies (Denda 2005).

Some other studies related to minorities are focused on homosexuality social constructions and its echo in KO. It is not new to say, for example, that conceptual relationships between homosexuality and perversions could be found in subject headings. On the other hand lesbian and gay information resources on the Web are growing rapidly and need to be addressed and categorized according to their culture that goes far beyond "the predictable needs to support identity and find communities, to embrace such subject as history, entertainment, activism and human rights" (Campbell 2000, 2004). The resulting problem is similar to that mentioned earlier; that is, there is a need for integration of specific subcultures into a general system to be used worldwide. Campbell found that facet analysis is promising for improving information access to gay and lesbian information resources and gives suggestions for Web-based browsing designers.

Homosexual discourse reflected in medical information systems is analyzed by Huber and Gillaspy (2000). The authors study the emergent recognition of the health care needs of a marginalized population, especially AIDS patients. They focus on how this information is delivered in biomedical literature and the relationship between the delivery of the health care and organization of knowledge. After examining the Medline database, they found that cultural perceptions of this group are reflected in the indexing terms. They concluded that classificatory structures "have a political character that can be used to gauge societal thinking" (Huber & Gillaspy 2000, 222).

2.3 A question of professional ethics

Multilingualism and cultural and social differences are an important part of reality and they should occupy a prominent place in KO, especially when looking at global information systems, either specialized or universal. The importance of cultural and linguistic issues to KO goes even beyond its objective importance, it is also a question closely related to professional ethics. The relation between cultural warrant and ethics is widely developed by Beghtol (2002a, 2002b). It is also a question of being aware of what could be behind global systems in the sense that these systems might be using standardized views and KO models that are designed to fit certain visions of the world that reflect views and beliefs of dominant economies and cultures. There might be different excellent final reasons for addressing cultural topics in KO, but there is one that cannot be overlooked and this is the responsibility for us to watch over the information needs in non dominant cultural and economic regions or groups by representing them in global information systems. Users belonging to these areas have the right to access to information in an way understandable for them and to be aware of it and to respond by creating the media to allow such a communication is an ethical question for KO researchers and professionals. This is also the meaning of integration of knowledge in this paper.

2.3.1 Ethics in KO?

This is a current research question that is not often addressed by scholars but that it is of great importance. For instance, this topic rarely appeared openly in ISKO international or national conferences until the 2002 International Conference in Granada, Spain, during which there were dedicated sessions and round tables devoted to this matter. Since then, this issue has been present in ISKO conferences. Ethics was one of the main themes at the German 2006 ISKO Conference in Vienna. Ethics in KO could also be seen as part of what has been called the "Global Information Justice" described by Smith (2001).

Beghtol (2005) has called attention on the role of ethics in KO, stating that an ethical foundation for knowledge representation and organization systems is an issue that has not been fully addressed. She goes deep into the ethical concept in KO and into the levels in decision making under the ethical perspective.

Other approaches to the ethical issue are those devoted to analyzing the principal ethical values in the representation and organization of knowledge (Fernández Molina & Guimaraes 2002). The authors identified seven ethical values and researched to what degree these were included in the ethical codes of

professional associations. This line of research has been continued by Guimaraes et al., as can be seen in the following papers (Guimaraes et al., 2005a, 2005b; Guimaraes 2006; Guimaraes & Pihno 2006).

Ethics in KO is gaining much importance nowadays. This fact can be seen not only by the increased number of publications in the field but also by the existence of research lines on this topic conducted by some universities which means that there is a great potential for publications and dissertations on this matter to come (Gimaraes 2007).

2.3.2. *B) KOS design demands for integration of knowledge*

The Internet has become a platform where any kind of information, documents and resources are expected to be. The Web not only has broken cultural, social and linguistic boundaries, but also the design boundaries of what was understood by conceptual structures before it came. Now, there are many different structures of a very different nature coexisting in the Internet that acts as a unique system, there are new items on the Web potentially relevant for KO that did not exist before. More and more the richness, although not yet qualified, of this global system demands richness in the design and construction of semantic tools for information retrieval. This situation gives rise to several questions:

2.3.2.1 *How to integrate different structures on the Web?*

Much research is being done around this demand that is also an effort to improve communication on the Web. This activity has been identified by McIlwaine (2003) as interoperability, mentioned very often in publications, that she relates with the search for a universal formulation language. This has been a long-desired goal, described as "a paradise lost of information scientists" by Maniez (1997) when talking about the compatibility of indexing languages as an expression of a dream of universal communication between information languages. He comments that there were 500 documents published in the last forty years dealing with the compatibility and integration of order systems. He also expresses a need for a general study of the compatibility problem and points out that new factors such as natural language processing and online searching have modified this issue recently. Two solutions are suggested by Maniez: the harmonization of several information languages and the automatic harmonization of the indexing formulas through concordance tables constructed before hand (Maniez 1997).

Interoperability is a recurrent topic and a major concern in publications as was also acknowledged by McIlwaine (2003, 75): "Interoperability has become a favourite topic, interpreted in various ways ... to embrace the ability of systems to talk to one another, or to switch from one subject retrieval system to another."

As was said before, this is a long story that has evolved and that has changed scope with time. We are today in the third generation of interoperable systems that are focused on information and knowledge with special emphasis on semantic interoperability at a much higher level than before. Before the Internet expanded, interoperability was concerned with data syntax and structure for intersystem communications. The Internet brought new insights to fundamental concepts such as distribution and heterogeneity together with that of autonomy that have influenced the systems architecture and design in such a way that their components tend to be system independent, adaptable and reusable (Cordeiro & Slavic 2002). These authors suggest that this trend can be seen, for instance, in the Semantic Web movement and all developments around it.

The reality is that the Internet is housing different generations of interoperable systems, because interoperability among controlled vocabularies is also an important part of the Internet. "Traditional" and newer semantic tools need to understand each other and to share knowledge for integration in the Internet. This aim was the central topic of the 6th Networked Knowledge Organization Systems Workshop, reported by Mai (2003).

Chan and Zeng (2002) give an overview of projects that involve interoperability of any kind and of the methods used Mai (2004) examines several ways of addressing interoperability and also the potential of switching languages. He points out that mapping indexing languages is an approach to explore and argues for the use of a general classification to access local or international collections

Semantic integration is a special concern to many scholars, and there are many publications on this topic. Some representative articles are discussed below.

Several proposals integrate "traditional" and newer tools. There is an instance where the authors are looking to construct a semantic, strongly structured model for representation of knowledge, based on the

integration of different kinds of semantic tools (taxonomies, thesauri) together with metadata (or attribute-value pairs) and domain-specific markup languages, as well as specialized models for learning scientific concepts (Smith & Zeng 2003). In other cases, the focus is to organize knowledge coming from heterogeneous sources by integrating natural language and semantic mapping involving thesauri and metadata (Park 2002). Gazan (2003) addresses a similar problem suggesting the integration of several elements: the content of resources, different classification schemes and the election of metadata by experts. Lin and Chan (1999) combine retrieval methods used by professional librarians and advanced Web technology to construct a tool capable of organizing information and subject access. The usage of thesauri, classification systems, taxonomies and other types of controlled vocabularies to build SKOS (Simple Knowledge Organization System) has been recently reported. SKOS is an application of the Semantic Web that contributes by bridging the gap between traditional indexing and formal ontologies for the Semantic Web (Cantara 2006).

Studies dealing with indexing languages, ontologies and interoperability are another focus of attention. Nicholson et al. are working on the High Level Thesaurus (HILT), a project that focuses on subject interoperability to facilitate cross-searching information environments with multiple subject schemes. HILT is intended to be used by libraries, archives and museums in the UK (Nicholson, Dunsire & Neill 2002; Nicholson 2003; Will 2002). Kent (2004) is studying the integration of ontologies in the environment of the Information Flow Framework. This is a framework for organizing the information that appears in digital libraries, distributed databases and ontologies. He suggests the semantic integration of ontologies consists of two steps: 1) ontological alignment that facilitates sharing common terminology and semantics through a mediating ontology, and 2) ontological unification that consists of the fusion of the alignment diagram of participant community ontologies. Other methods for merging ontologies are those described by Silva and Rocha (2002).

In other papers, attention is paid to the integration of thesauri for building aids to indexing and searching. This is the case of proposals that suggest the use of thesauri integrated in information retrieval interfaces (Shiri, Revie & Chowdhury 2002).

Gateways to the Internet can be seen as efforts to integrate knowledge and interoperability in the Web. Franco (2003) distinguishes between Web sites or megasites that list major resources and are subject oriented and library portals that are dealing with information and resources grown from some of these Web sites. They have been developed into highly organized projects supported by government or other agencies, and often they are financed independently from a library. The main issues on gateways and portals ask for reflection on interconnectivity and standardization of their contents when there are multiple portals and on development of tools to describe the Web content and to guarantee bibliographic control within portals. An analysis of the organizational schemes used by academic libraries to arrange their electronic resources on their Web based information gateways can be found in Lee and Carlyle (2002).

The broad front of research that interoperability and integration of knowledge occupy focus attention on the lack of the Web systems design and construction. There is a need for cross domain, multisystem usability of KO data and for improvement of modeling data structures (Cordeiro & Slavic 2002). Other suggestions stress the need for transdisciplinarity research in the Internet (Hunsinger 2005) and for interdisciplinary research to address the problems pose by the integration of knowledge in the Web environment, because it is the best way to get to desired results (Herring 1999; Cordeiro & Slavic 2002).

3. A demand for managing emergent knowledge in KOS

The Web environment has made more obvious, among many other things, the existence of nontraditional knowledge domains, as for instance, the need to address interdisciplinary environments. It also has brought to the front line of KO concerns topics that also ask for alternative approaches. In both cases, there is a demand for designing and constructing conceptual structures that fit this new situation. As an example, work- oriented organizational and interdisciplinary domains shall be addressed.

3.1 How to represent work-oriented and organizational environments in KOS?

Emergent knowledge areas favoured by the Internet development have been detected lately. Organizations of different kinds have flourished in the Web, and the question of how to represent them in information systems has arisen. Addressing this question requires alternative design principles, because representing organizational structure is conditioned by

capturing the organization's knowledge and learning the organization's capability to create knowledge. Learning about the organization at very different levels in order to identify the elements that have to be taken into account to construct the structure is a main concern. The process of capturing the organization's knowledge and the organization's creation of knowledge can be helped by the research results found in papers dealing with organizational knowledge creation as in the case of Heinrichs and. They investigate "the potential combined impact of the use of organizational decision models and competitive intelligence tool proficiency on knowledge creation and strategic use of information competence" (Heinrichs & Lim 2005, 621). This is an interesting conceptual connection between Knowledge Management (KM) and KO in the sense that KO might use research findings of KM in the aforementioned topic, because many relevant elements for work based and organizational classification structures can be found in research of the kind mentioned in Heinrichs and Lim.

Work-centred and organizational environments can be considered as domain oriented approaches that are related to a contextual classification research framework. This latter orientation is viewed as a postmodern response that considers that classifications are intended to provide a "pragmatic tool for specific domains, while modern classifications aim at representing the universe of knowledge" (Mai 2004). Classification is conceived as dependent on particular contexts, that is, dependent on how people act in particular contexts and circumstances (Mai 2002). This is considered a current shift in classification research that is oriented to contextual information as the reference basis for classification design. The aims of such classification research are to create classification systems to support activities of a given domain and to increase communication between the elements involved in that system. Work-oriented and organizational environments design for classification structures is in relation to activity theory. This approach has theoretical, methodological and analytical possibilities, because it favours developing (Solomon 2000, 256): "a unified account of knowing and doing for some situation, ... it provides a methodological framework for studying the situation and ... it points attention to elements: agent, object and community, and their interactions: instruments, rules and roles and division of labor."

Jacob (2001) contributes to this perspective with proposals that are in favour of studying the evolution and application of classification systems in practice, and she argues that it is imperative to investigate situated classification by studying its impact within the settings of everyday activity. She suggests two approaches: classification-as-scaffolding, as knowledge storage devices, and classification as infrastructure that views classification systems as social conventions integrated with technological structures and organizational practices.

Ecological work based classification is another response to managing contextual knowledge for work and organizational settings. It is an approach to design classification structures for complex work domains on the basis of "the invariant structures of the work domain and of the information needs of its actors" (Pejtersen & Albretchsen 2000). Work- centred design is interested in domain analysis and scheme construction, based on the framework of cognitive work analysis. Collaborative task situations are introduced as new units of analysis to capture evolving semantic structures in work environment. This proposal is developed in the framework of a collaborative project involving three film archives (Albrechtsen & Pejtersen 2003). A design for a work domain oriented thesaurus is that reported by Marianne Lykke Nielsen (2001, 2002). She used a varied set of methods together to capture knowledge in the work domain, and found that study methods made it possible to build a thesaurus according to the work domain dynamic and characteristics.

The introduction of an organization's knowledge context in the design of domain- oriented knowledge structures has been evaluated as a success. This is the case reported for the *International Classification of Diseases* that keeps administrative and organizational past in current form. It is argued that the system works with efficiency because of the union of these two factors: Classification scheme and organizational form (Bowker 1998).

The need for developing the domain of organizational analysis in information systems is stressed by Wainwright and Waring (2004). They think that is the way to understand issues concerned with structure, social and historical context, power, politics and culture of the systems. The authors suggest a model for integrated information systems design that incorporates three analytical domains: technology, strategy and organization.

Other responses to organizational design of information systems are based on the usage of a metadata system that covers different formats of documents. Yu, Lu and Chen (2003) use a multi-XML

schema to construct an XML system framework that can address the weaknesses of traditional object-oriented languages in information sharing.

Another basis for studying organizational communications is by using genres, defined as "typified communicative actions characterized by similar substance and form and taken in response to recurrent situations" (Crowston & Williams 2000). Communication on the Web should reproduce and adapt existing genres and look for the emergence of new ones. On other occasions, genres are understood as another view of a document different from a subject or a topic, and use genre as a criterion to classify documents. A classification of Web documents based on multiple sets of features to classify genres is described in Lim, Lee and Kim (2005). A faceted taxonomy of genres of digital documents has been attempted by Kwasnik, Chung and Crowston (2006) that recognizes attributes and functions for them. They argue that it is an effort to build a multidimensional representation of complex phenomena in organizational communication.

3.1.1 How to represent and organize multidimensional knowledge in KOS?

The arrival of new means of knowledge and knowing is one consequence of postmodern times, inspired by complex thinking (Morin 1995) and giving rise to a type of new knowledge that we can refer to as multidimensional knowledge, with variants such as multidisciplinarity, interdisciplinarity and transdisciplinarity. (It could also be called complex knowledge, but there is an agreement about the fact that complex thinking aspires to multidimensional knowledge. It is known that complex thinking is impossible because one of the complexity axioms is the impossibility to reach omniscience. This type of knowledge stands as a reaction against modernist reductionism and aspires to modify the way we become familiar with our environment, favouring its compatibility with the human being, who cannot be reduced to one single level of reality. This emergent knowledge can hardly be understood, represented or organized within the traditional systems of indexing and information retrieval with disciplinary foundations.

It is easy to see that for a specialized field elaborated largely on public awareness and socialized knowledge, and expected to construct parallel systems of representation, such a change in perspective is bound to affect some of the established or traditional models, assertions and methodologies of KO and KOS deeply (McIlwaine 2000). Therefore, we need to take a new look at matters related to terminological and conceptual structures and dynamics and the conceptual derivations that may take place.

Up to now, no satisfactory response could be found, and no effective model has been accepted overall, to manage the information of the inter- and transdisciplinary domains in order to retrieve information. This is evident when we take a close look at the indexing and retrieval tools generally used, and note their inadequacies when dealing with interdisciplinary domains (Denda 2005), despite the early references by Brown regarding the importance of complex interrelations among subject areas and the need for interdisciplinary thematic access (Beghtol 2004). Inadequacies in representing and organizing interdisciplinary knowledge can be seen in a wide array of systems: bibliographic classifications, subject headings, thesauri and the Internet (López-Huertas & Barité 2002; López-Huertas, Barité & Torres 2004; López-Huertas & Torres 2007).

After the lack of coordination between new knowledge forms and the tools available for their processing had been detected, a string of proposed solutions came along. Some have been adopted here and there: 1) Adaptation of classification systems in use (Williamson 1998, 2002; Beghtol 1998a, 1998b; Satija 1979), 2) the creation of alternative hybrid systems (Jacob 1994; Albrechtsen & Jacob 1998; Olson 1998a, 1998b; Kublik et al., 2004), and 3) the creation of new systems as suggested by Beghtol (1998b).

3.1.2 How to organize multidimensional knowledge?

Some current proposals are addressed below.

3.1.2.1 The concepts of Facet and Phenomenon in dealing with interdisciplinarity

While this is not a novel proposal, it can be seen as a reinterpretation and new application of an older concept to a current situation. The capacity of the facet to describe reality, departing from linearity and therefore adapting better to complex realities, makes it a good candidate for providing responses to the matter in hand. The components of the Classification Research Group have partly adopted the faceted classification of Ranganathan because the facet concept allows for the expression of interdisciplinary themes (Beghtol 1998a).

In this area lies the idea put forth by Gnoli (2006) and Gnoli and Poli (2004), with the objective of establishing the basis for creating a faceted and non-disciplinary universal classification. For this purpose, they reinstate concepts such as phenomenon, facet, and integrative levels, used in classification research and in predicative logic. The classification proposed is based "on phenomena of the real world instead of on disciplines: phenomena can be arranged in a sound order by the integrative level to which they belong, and class marks can be obtained by combining the constant notations of each compounding phenomenon" (Gnoli 2006, 11). The facets would refer to classes of phenomena rather than classes of disciplines, which in turn would be considered as special classes of phenomena. In a faceted classification, each class could represent a predicate with a series of potential arguments. The function of the argument markers can be carried out through facet indicators. Gnoli holds that the expression of phenomena can include both substantial and relational aspects, and can be defined by a set of internal relations as well as relations with other phenomena expressed by the facets. Any phenomenon, then, can generate facets. A classification constructed along these lines would make it possible to elaborate a non-disciplinary system that makes full use of facet analysis while bypassing the limitations that a disciplinary view entails for classifiers and users (Gnoli 2006). This pattern has been used to develop a classification scheme now in the experimental stage.

3.1.2.2 Domain analysis as an approach for the knowledge and management of inter- and transdisciplinary spaces

In the wake of the traditional debate about the advantages of creating universal systems, it is argued that we need to account for the dynamics and circumstances of concrete domains and their contextuality to make proposals that adjust to the reality and identity of each. Here we will look at proposals rooted in the latter standpoint. If we accept the domain analysis model (Hjorland & Albrechtsen 1995; Hjorland 2002) as the basic point of reference for the construction of indexing and information retrieval systems, and further accept that the knowledge articulated in domains (disciplines, specialized areas, subject fields) is the objective of such systems, and that these domains must be represented therein terminologically, conceptually and structurally, it is necessary first to identify the dynamics of a given domain. Only then can the organization of knowledge for the construction of the systems be undertaken properly. Hence, delving into a deeper study of the dynamics of these domains would be a prerequisite for the representation and organization of the knowledge of interdisciplinary domains in a way that is user-friendly and ultimately effective. This stands as a macro-inductive approach that concedes indisputable levels of quality to the resulting structures. Of the different methods for accessing domain knowledge pointed out by Hjørland (2002), we shall look at: a) the bibliometric approach, b) the terminological approach, and c) the joint application of different methods, including terminology, the analysis of thesauri and the indexing of specialized documents.

3.1.2.2.1 The bibliometric approach

Some types of domain analysis have a finality other than that of retrieving information. Nonetheless, they may provide valuable information regarding the composition of the subject map that forms the domain, information that proves highly useful when dealing with inter- and transdisciplinary themes. The lack of knowledge about matters related to the representation of the terms and the ways in which the themes interact, or their representativity within the interdisciplinary domain, all call for some sort of theoretical approach prior to any attempt to structure these domains.

Within this group we should underline the importance of studies deriving from Bibliometrics in general, citation analysis, multivariate analysis, or neuronal networks. The final objectives are diverse, yet they leave behind an uncovered structure and view of dynamics that hold great interest for researchers of KO and KOS. Another noteworthy contribution of such approaches is that they make manifest conceptually relevant relationships that are not based on document content; this means a broader perspective, clearly necessary in a heterogeneous setting such as the Internet.

Some studies carried out under the bibliometric scope and focusing on the structure of a specialized area are those in Biotechnology, affording a view of its structure obtained through multidimensional scaling or MDS (Hinze 1996). Biotechnology is the subject of choice for another study of the structure and relevance of constituent subject areas, in order to observe its evolution in practically real time, and thus constituted an automatic model for updating

other classifications (Moya & López-Huertas 2000). Publications related to the structural discovery of various interdisciplinary fields can be seen Schwechheimer and Winterhager (2001), López-Huertas and Jiménez (2004) and Glenisson, Glänzel and Persson (2005). Another approach departs from the identification and study of interdisciplinary relationships, an alternative form of analysis used to arrive at the structure of a given interdisciplinary domain of study (Tomov 1996).

3.1.2.2.2 The terminological approach

It is difficult to identify the terminology that is truly representative of an interdisciplinary domain, above all when the domain under study is an emergent one. Yet this knowledge is vital for analysis of the domain. This is the notion behind the proposal of Kobashi, Smit and Tálamo (2002), who approach the Information Sciences from the focal point of the terminology used, attempting not only to reveal possible terminological problems in the domain and its conceptual structure, but also its epistemological status. This is an interesting means of studying a domain because it describes new knowledge that otherwise would have been difficult to detect; and it offers well-founded explanations for the apparent chaos which would seem to characterize interdisciplinary domains to some degree. Hopefully, future ventures in this direction will provide numerical results, as quantification would enhance the clarity and visualization of such an approach.

3.1.2.2.3 The joint use of different methods for interdisciplinary domain analysis

This combined approach for the analysis of interdisciplinary domains is based on the study of thesauri in use, and on the indexing of specialized documents. The interdisciplinary domain chosen for this particular research is Gender Studies (López-Huertas 2006a).

– *Analysis of thesauri in use with reference to Gender Studies and Women*. The results of this analysis show an excessively diverse terminology, or dispersal, which leads one to imagine that some terms might not be meaningful for the domain; along with a lack of standardization of terms in the area. A great many terms proceed from other disciplines, which may outnumber those generated from within the interdisciplinary nucleus of activity. These are incorporated into thesauri, then, without apparent reformulation. The conceptual structure proposed by the thesauri is likewise dispersed and not very expressive of the meaning of the interdisciplinary domain (López-Huertas, Barité & Torres 2004, 2005).
– *Indexing of specialized publications.* Through the indexing of 600 primary documents, the following observations were made: the terminological set analyzed shows the existence of two dynamic principles that are closely related to the disciplinary origin of the source terms. A first group represents the terms created from the interdisciplinary domain itself, constituting its nucleus; these represent 32% of the total terms. A second group is made up of the terminology incorporated by the interaction of the different disciplines and subject areas that integrate the interdisciplinary domain; these represent the other 68% and show dynamics different from the other group. The terminology of the second group is more numerous, and the terms represent new concepts in the discipline (glass ceiling, household salary, vertical discrimination, etc.) or refer to already existing concepts whose significance is underscored by the gender perspective (domestic violence, sexual harassment, etc.).

From the terminology studied, one may arrive at a weighted thematic set that is representative of the interdisciplinary domain of study. The importance of the themes in the set is determined by the number of terms corresponding to each subject. The thematic areas that constitute Gender Studies are, in order of importance: Laws/Law, Politics, Customs, Family/Society and Health, clearly significant for the formation of the interdisciplinary map; and Psychology, Culture, Administration, Body/Image, and Others (Demographics, Religion and Groups) that are less important for the thematic configuration of Gender Studies (López-Huertas 2006b, 2006c).

3.1.2.2.4 The creation of interdisciplinary ontologies

Another step in the presentation of specific proposals for the management of interdisciplinary spaces can be seen in the work by Denda (2005), who explains the design and construction of an ontology for the specialized area of Gender Studies. Most interesting is the methodology developed, as it combines several methods for domain representation, in particular for the identification of useful ontological

terms and their relationships: indexing, terminological study and discourse analysis, from a perspective that can be framed within the cognitive model. The ontology created is capable of communication with the subject headings of conference material in the Web environment. The author shows how the Internet again reveals the inefficiency of traditional search tools, and that an ontology can be more flexible and expressive of a domain than the proposed specialized thesauri.

3.1.2.2.5 The creation of heterogeneous interdisciplinary systems

A further alternative responds to the problem of interdisciplinarity through the creation of heterogeneous interdisciplinary databases (Bartolo 1998, 2000). These act as an online system, and have the added benefit of incorporating a variety of users from different sources, while integrating resources of a very diverse nature, including multimedia. The database described is created with the end intention of building a system able to interconnect five research projects.

We have seen, then, some concrete proposals that attempt solutions for the problems residing in multidimensional knowledge, from an array of theoretical and methodological positions that represent current research trends. All of them are signs of progress, yet more research is needed to arrive at a model responding to the real dynamics of interdisciplinary domains as a whole, rather than the sum total of parts. This understanding should underlie any specific method of representation and organization.

4 Conclusions

KO and LIS domains have some characteristics that are affecting research behaviour and epistemological development in a particular way. It has been noted that reformulation of older research questions is an evident trend, so many "new" research questions in KO are not really expected but new or modified responses to previous questions caused by external circumstances. Another perception is that there are epistemological problems in the field, and the field lacks a consistent and coherent, well articulated body of theories and methods. Although empirical studies are needed, it seems that two possible factors, among others, may be causing these dynamics: 1) technology driven that is claimed as a fundamental of KO and 2) KO and LIS are interdisciplinary domains that, as most interdisciplinary domains, have problems with terminology, conceptual borders and epistemological development.

Two broad research challenges have been identified: the concern for quality in KO and KOS and the need for managing emergent knowledge in KOS. Quality is a really major concern that affects to diverse aspects of KO, and the main question is how to ensure quality in knowledge representation and organization and information retrieval in the Internet environment. Efforts in finding an answer are directed towards integration of knowledge as a quality indicator. Two main meanings for integration of knowledge have been found: 1) the capability for KOS to represent and organize knowledge avoiding a global, standardized view. That is, integration of cultures, languages, social minorities and the role of professional ethics in doing so, and 2) the systems' capabilities to improve design, to develop structural devices to represent and harmonize in classificatory structures heterogeneous information sources and different structures coexisting in the Internet.

To specific questions such as: how to manage multilingual and socio-cultural diversity; how to be universal without leaving behind diversity; are minority and marginalized social sectors taken into account into general systems; are they properly represented and integrated in general systems; and, how could these cultures be included and managed in KOS, the researchers respond unanimously saying that it is a must to handle these issues when designing and constructing KOS, and that the Internet must also follow this trend. Much information about concrete proposals is given in the paper. The other side of integration is dealing with the technical part of it for allowing integration of knowledge to be. Questions such as: how to integrate different structures on the Web; how to integrate the Internet heterogeneous information and resources; and, how to avoid non-communication by integrating structural and formal barriers, have been answered in a very different ways but under the term interoperability most of the time. General concerns in the proposals for designing and constructing integrated systems or structures include improving semantics and enhancing meanings.

Managing emergent knowledge in KOS is another challenge that is stressed in the Internet environment. Work-oriented and organization domains are examples of new spaces that need special design. The question of how to represent work-oriented and organizational environments in KOS has attracted much research attention and it can also be said that

many alternatives to handle the problem have been given. These go from the theoretical research done that gives foundation for further research to specific proposals to represent and organize this domain.

4.1 How to represent and to organize interdisciplinary and transdisciplinary domains?

This is a question that has not been fully answered in the past and that the Web environment has brought to the front line now. Much current research on this topic is being done both from universal and domain-oriented perspectives that are giving alternative ways of dealing with multidimensional knowledge. There are differences between interdisciplinarity and transdisciplinarity and within each group, even though they share some characteristics. To study each domain beforehand is a recommended method when constructing KOS.

Even though not all goals have been reached and although some questions remain unanswered, the overall demand for quality and integration is a healthy sign that also indicates some degree of maturity in KO research.

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