Mapping recent information behavior research: an analysis of co-authorship and co-citation networks

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Abstract

There has been an increase in research published on information behavior in recent years, and this has been accompanied by an increase in its diversity and interaction with other fields, particularly information retrieval (IR). The aims of this study are to determine which researchers have contributed to producing the current body of knowledge on this subject, and to describe its intellectual basis. A bibliometric and network analysis was applied to authorship and co-authorship as well as citation and co-citation. According to these analyses, there is a small number of authors who can be considered to be the most productive and who publish regularly, and a large number of transient ones. Other findings reveal a marked predominance of theoretical works, some examples of qualitative methodology that originate in other areas of social science, and a high incidence of research focused on the user interaction with information retrieval systems and the information behavior of doctors.

Key Words

Information behavior; Research fields; Co-authorships; Co-citation analysis

Introduction

Following Wilson (1999), information behavior (IB) research may be considered the general term for a series of nested fields, including the sub-field of information seeking behavior, which is particularly concerned with the variety of methods people employ to discover and gain access to information resources. In turn, information *searching* behavior is defined as a branch of information seeking that studies the interaction between the information user and computer-based information systems, including information retrieval systems for textual data (Wilson, 1999).

The need for a theoretical and methodological basis to orient research into IB has been one of the recurrent subjects in the specialized literature since the second half of the 20th century. Indeed, there has been an almost exponential increase in publications on this subject since the 1990s (Wilson, 2008). Currently, the field of IB has achieved its own identity within the ambit of research into Library and Information Science (LIS) (Milojević, Sugimoto, Yan, & Ding, 2011). It is characterized, among other things, by being permeable to the focus of other disciplines, so it is common to find research published with several theoretical contributions and methodologies deriving from disciplines such as psychology, sociology, anthropology and education, among others.

In the 1990s, McKechnie, Pettigrew and Joyce (2001) demonstrated the importance of the use of theory in user research. More recently, however, this emphasis on theory has resulted in the publication of well-known references presenting numerous metatheories, theories and models that largely derive from other social sciences (Fisher, Erdelez, & McKechnie, 2005; Talja, Tuominen & Savolainen, 2005; Wilson, 2013). These contributions may assist in user research, but as with dynamism and diversity, can also be an obstacle to consolidating the research results achieved in the last few decades. Thus Vakkari (2008) stated that the continuous appearance of new theories did not allow for previously developed theoretical models to be properly tested and validated. Although the publication of such models is frequent, it does not follow that there is in-depth analyses of these models, of the relationship between them, or of the consequences and implications they may have for research or professional practice. There are, however, exceptions to this lack of in-depth review, including critical research that questions the value of widely accepted theoretical models (most of which are rooted in a constructivist or cognitive tradition) when applied to the study of the production and exchange of knowledge in the context of the social media or online communities (Olsson, 2012). This line of research even questions whether user-centered studies are in fact intended to serve user needs at all, or just those of the system itself (Tuominen, 1997).

This recent emphasis on theory would not have been possible without an orientation towards the social sciences and a novel qualitative focus on user research (Ellis, 2011), which replaced the hegemony of quantitative research by means of a variety of methodologies for the study of IB (McKechnie, Baker, Greenwood, & Julien, 2002). Although these new methodological approaches have introduced greater rigor in research design, they are not immune to criticism either. Davenport (2010), when analyzing some of the methods used to carry out user research in the context of everyday life, labels these methods as confessional, as they are designed to shed light on hidden facts and meanings, allowing the researcher to obtain information on activities and mental attitudes that are not directly observable. Olsson (2006) claims that these results produce a representation of the social interaction between the researcher and the researched, not the cognitive structures of the user. For this reason, Julien, Given, and Opryshko (2013) advocate the adoption of an emic focus that truly represents the user's point of view.

Given this situation, it becomes clear that the study of IB, far from displaying uniform theoretical and methodological assumptions, includes many researchers with greatly differing approaches. Although this could be considered to be a positive characteristic for the added value it brings to empirical research, it also makes it difficult to obtain an overview of the variety of different perspectives that are being developed internationally. There is, therefore, a danger of designing research with a limited perspective that lacks in-depth knowledge of the work of others in the field. Similarly, it increases the difficulty of taking previous findings into account when proposing novel approaches that produce new knowledge. Most importantly, the lack of a complete overall map of IB research hinders its critical analysis, impeding the objective evaluation of research value beyond questions of the status of a particular investigator or current academic trends.

During the last century, the various chapters dedicated to user research in the *Annual Review of Information Science and Technology* (e.g. Fisher and Julien, 2009) fulfilled an important role in updating and revising the progress of knowledge in this field. Similarly, reviews by Julien (1996), Julien and Duggan (2000), and Julien, Pecoskie, and Reed (2011) presented an overview of almost twenty years of research. Likewise, Case (2012) presents an extensive and comprehensive overview of the foundations of user research over more than half a century. Aside from bibliographical reviews, content analysis or monographs, however, adopting a bibliometric focus and network analysis would help provide a general map of this specific field by clarifying and visually illustrating its intellectual basis.

There is little research that has analyzed the international literature published on IB using bibliometrics and network analysis, with notable exceptions such as the study by McKechnie, Goodall, Lajoie-Paquette, and Julien (2005). They analyzed the citations in 155 important articles published in this field between 1993 and 2000 and conducted a co-citation analysis of references included in the citing articles. The co-citation network obtained from their research reveals the existence of a central nucleus made up of the most commonly cited authors and a periphery consisting of the latest research, which due to its recentness has received few citations. This study also revealed a sub-discipline related to the internet and electronic communication. More recently, Li-Ping (2010), using specialized literature retrieved from the LISA database up to 2008, studied co-authorship networks as well as the position that particular researchers occupy within it, identifying the most prominent among them as well as the theoretical models used and the contexts in which they carry out their research. For this investigator (2010), the most prominent authors that represent the mainstream research in this area include Amanda Spink, Reijo Savolainen, David Nicholas, Tom D. Wilson, David Ellis, Carol C. Kulthau and Gary Marchionini. Similarly, Chang (2011) compared the characteristics of research articles on information needs and information seeking published from 1962 to 2009 and found on the Web of Science. Their analysis shows a high percentage of studies published in medical journals as well as low levels of collaboration among authors (average between one and two authors per work) and of international collaboration. Finally, Jamali (2013) carried out an analysis of citations and bibliographic coupling with the aim of establishing what constitutes the core knowledge, the origin and the diachronic development of the theories used, using as material 51 of the 108 theoretical works identified by Houston (2009). The origin is basically situated within LIS, but some theories also sprung from other fields such as psychology and sociology.

With this in mind, the objective of our study is to elucidate the structure and intellectual basis of IB research, presenting an up-to-date and complete overview of the field that answers the following research questions:

(1) Which researchers have contributed to producing the current body of knowledge on IB studies?

(2) What is the intellectual basis of IB research at the beginning of the 21st century?

The results obtained in answer to these research questions can provide a general overview of a field that, as noted above, is characterized by the diversity of researchers who have contributed to its development and of the theoretical and methodological approaches that support it. The resulting research map can serve as a reference both to researchers who are new to the field and veterans who want to contextualize their own work and explore lines of future research.

Materials and methods

A bibliometric and network analysis was carried out on IB research published with respect to both authorship and co-authorship, and citations and co-citations in these works. The study of co-citation enables the intellectual basis of a field to be obtained by means of analyzing the works cited, as opposed to other procedures such as bibliographic coupling, which shows the research fronts by observing the cited references that are shared between two papers (Persson, 1994).

The works analyzed were obtained from the Social Sciences Citation Index (SSCI) and the Conference Proceedings Citation Index - Social Science & Humanities (CPCI-SSH) databases of Thomson Reuters' Web of Science (WOS). The latter was included to ensure that all proceedings papers of significant relevant conferences in the field were included. The search strategy that was used to identify the publications (table 1) included a very broad range of topics in order to present a wide perspective of information user research, following Wilson's information behavior model. Wilson's information behavior model provides a comprehensive view of user research on three dimensions: user interaction with information (information behavior), user interaction with information systems (information seeking behavior) and user interaction with information retrieval systems (information searching-behavior). They are widely accepted expressions by the scientific community that properly represent the object of study, and along with other similar expressions included in the search profile minimize the possible existence of false negatives (relevant papers that were non-retrieved by the query). Furthermore, the interpretation of results by experts in the area reduces the incidence of false positives or noise (retrieved documents or research nuclei that are inconsistent with the object of study) (Wilson, 1999). At the same time, this conceptual model produced results related to a line of research, not a reflection of disciplines or academic communities.

Limiting the search to the area of Information Science & Library Science and to qualitative interpretations of the results helps to reduce possible bias in the analysis. Moreover, the methodology used in the study identifies homogeneous nuclei of documents, excluding the studies whose content and bibliographies deviate from the rest; these are left out of the graphic representations and the interpretation of results.

Only the articles, reviews, proceedings papers and meeting abstracts that were considered to include research results were selected. A total of 2,386 bibliographical references were collected and downloaded on 30/11/2013. The material downloaded was incorporated into a relational database, the contents of which were then trawled for the fields Author (AU) and Cited References (CR). For the field AU, all variants of a name designating the same author were combined.

Table 1. Search strategies

Field	Strategy
Topic (TS) (title, abstract, author keyword and keyword plus)	*"Information seeking" or "Information behavior" or "Information behaviour" or "Information seeking behavior" or "Information seeking behaviour" or "user studies" or "user study" or "information practice*" or "information sharing behavior" or "information sharing behaviour" or "information searching behavior" or "information searching behaviour" or "information use behavior" or "information use behaviour" or "information needs"*
Document type (DT)	Article or review or proceeding papers or meeting abstracts
Publication year (PY)	2000-2012
Subject category (SC)	Information Science and Library Science

For the study of co-authorships, the number of works with single and multiple authors and the average number of authors collaborating per document were analyzed. Finally, a network of co-authors was produced, taking into consideration the total number of authors and applying a threshold of four or more papers signed in co-authorship. This threshold was used to determine the most frequent co-authorships, which were considered stable during the study period.

The co-authorship network was generated using Bibexcel (Persson, Danell, & Schneider, 2009) and Pajek (Batagelj & Mrvar, 2003). In addition, the most important authors were identified according to the measures of centrality, understood as the differential properties of some actors in the network with a high number of connections to other actors and a position that enables them to be between or near those actors, that is, who have more influence within the social structure (Freeman, 1979). The three most common centrality measures were used in this study: degree, closeness and betweenness. Degree is the number of ties that a vertex has to other vertices in its network. Yan and Ding (2009) relate this to the ability of an actor to influence others. Closeness refers to the speed with which an actor can interact with other actors in the network, either directly or indirectly through intermediaries. According to Knoke and Yang (2008), the closeness of an actor is a function of their geodesic distance from all other nodes (the shortest distance between two actors). Finally, betweenness refers to the means by which an actor influences or intervenes in the relationships between other actors, and thus is the measure of how actors connect in the geodesic path between pairs of actors who are not themselves directly connected (Knoke & Yang, 2008).

In order to study the citations in the 2,386 works analyzed, the frequency with which citations occurred in each of them was obtained. Subsequently, studies that were cited 20 times or more were selected. Using these, a co-citation network was generated using Bibexcel and Pajek. A cluster analysis was then performed using Persson's Party Clustering algorithm (Persson, 1994; Persson et al., 2009). This analysis is based on identifying similar nodes that constitute homogeneous groups with a high degree of relationships between them and which are unlike other groups. Finally, the contents of the most frequently cited bibliographical references were checked, as were the references in each cluster, in order to determine the main subject. This required an examination of the title, abstract, and if necessary, the contents of each document.

The concepts of component and cluster were used to describe the co-authorship and co-citation networks. Component refers to a group of directly or indirectly interconnected nodes in a network. Normally, in co-authorship networks, there is a giant or principal component, that is, one which groups together the largest number of the nodes which make up the network. Smaller components may also exist, and even some isolated nodes. The concept of cluster is used in this study to designate sub-components or identifiable groups in the co-citation network into which a component can be divided, based on cluster analysis. In the presentation of the co-authorship network, the size of the nodes refers to the number of papers published by each author, and the thickness of the ties to the intensity of the collaboration. In the co-citation network, the size of the node refers to the frequency of citation, and the thickness of the ties between nodes to the frequency of co-citation.

Results

Authorship and co-authorship

The 2,386 works were published by a total of 3,603 individual authors. Of those, 2,871 authors published only one work (79.7% of the total), 374 (10.4%) published two, 142 (3.9%) published three, 184 (5.1%) published between 4 and 9, and finally, only 32 authors published 10 or more works, which makes 0.9% of the total number of authors.

With regard to the authorship of each of the 2,386 works, 856 (35.9%) are by a single author, while 1,530 (64.1%) are by multiple authors. Of the co-authored documents, 741 (31.1% of the total number of documents) are by two authors, 390 (16.3%) are by three authors, 193 (8.1%) are by four authors, and 206 (8.6%) are by five or more authors. The ratio of co-authorship for the entire period analyzed is 2.3 authors per work, while the changes in the ratio over the period analyzed are shown in figure 1. The ratio increased perceptibly from 2 authors per work in 2000 to 2.4 in 2012.

Figure 1. Evolution of the average number of authors collaborating per document
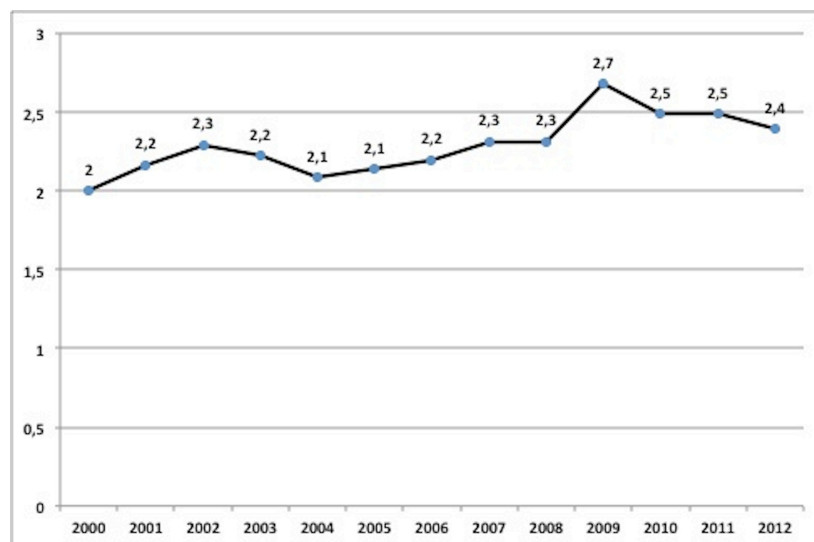
Co-authorship network

The co-authorship network is made up of 3,603 vertices that all represent single authors. Of these, 409 (11.4%) are isolated vertices, or authors with no co-authors, while 3,194 (88.6%) vertices represent authors who collaborated with others during the study period. The latter are organized into 656 separate components; the largest has 581 vertices, which represent 16.2% of all authors (figure 2).

If we raise the threshold with which co-authorship is analyzed, the number of components and authors who make up the network is reduced. Thus, if only those co-authors who appear in four or more instances are considered, the network is reduced to 66 authors (1.8% of the total number of authors) and 21 components, and of those, the largest component consists of 12 authors (Figure 3).

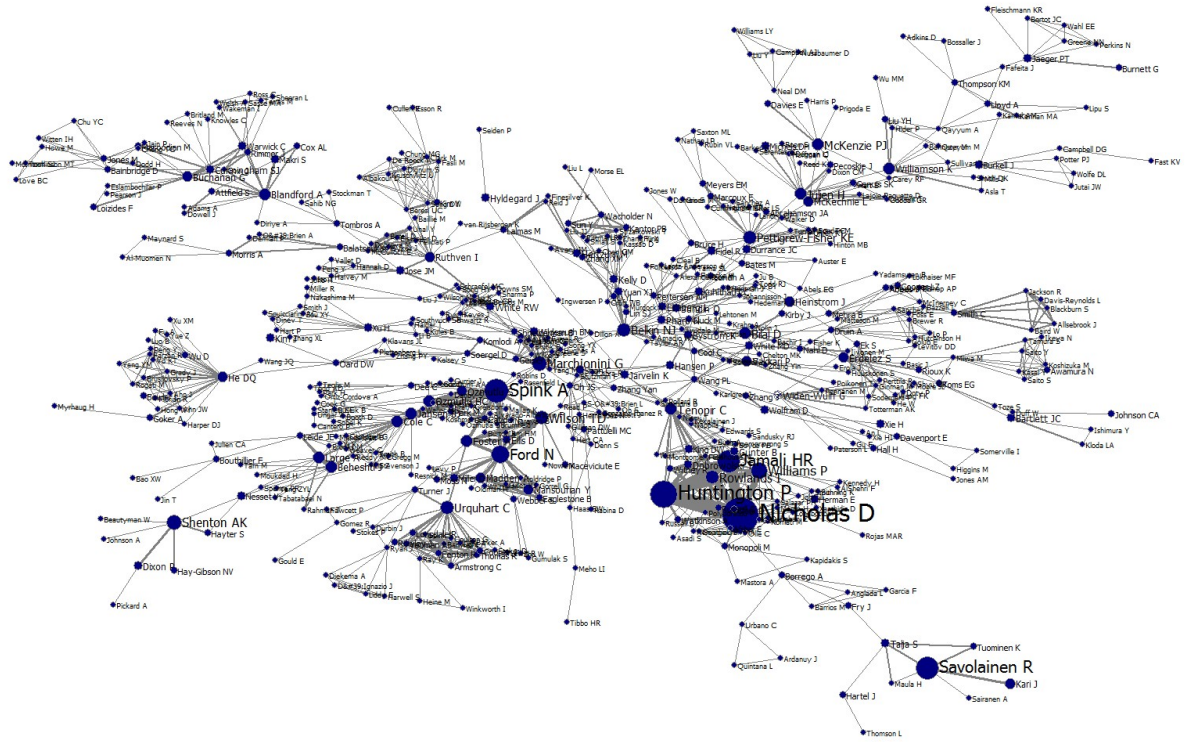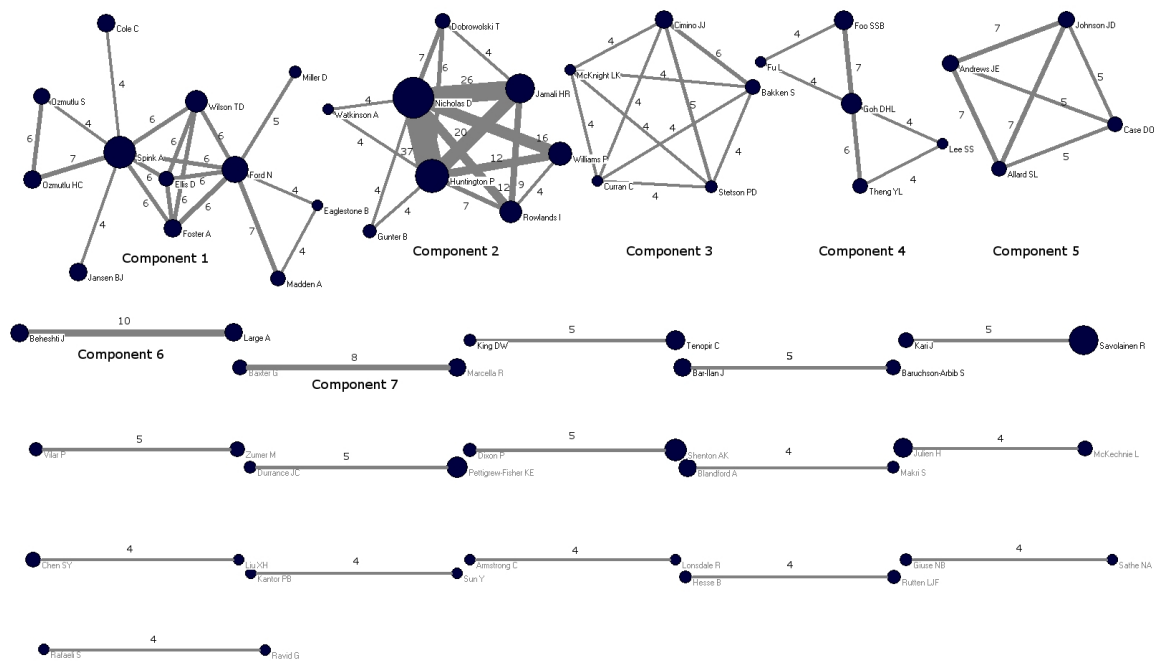*Figure 2. Largest component of co-authorship network*

Figure 3. Co-authorship network of authors with four or more works in common

Looking at the number of co-authorships, component 2 is noteworthy, as it includes authors such as Huntington and Nicholas, with 37 works in collaboration; Jamali and Nicholas, with 26; and Huntington and Jamali, with 20. Williams, Rowlands and Dobrowolski are also important authors in this component for their collaboration with the three authors mentioned above. Important co-authorships also appear in component 6 between Beheshti and Large, and in component 7 between Marcella and Baxter.

In component 1, the 7 co-authorships of the following pairs of authors are of note: Ford and Madden, Ford and Foster, and H C Ozmutlu and Spink. In component 3, there are six co-authorships of note between Bakken and Cimino; in component 4, there are seven between Foo and Goh. Finally, in component 5, there are seven co-authorships of note between Allard, Andrews and Johnson. In the remaining components made up of two authors, there are only four or five co-authorships.

Centrality: degree, closeness, and betweenness

Table 2 lists the first 25 authors ranked according to centrality (degree, closeness, betweenness) in the co-authorship network. Of these, only three are highly ranked according to all three measures. Spink heads the ranking by degree, and occupies the third position in closeness and betweenness. Marchionini occupies the second position in degree, and is the first in closeness and betweenness. Belkin occupies the tenth position in degree, but the second in closeness and betweenness.

Table 2. The top 25 authors based on centrality measures

Rank	Author	Degree	Author	Closeness	Author	Betweenness
1	Spink A	31	Marchionini G	0.0472688	Marchionini G	0.0196523
2	Marchionini G	27	Belkin NJ	0.0445729	Belkin NJ	0.0120946
3	Nicholas D	25	Spink A	0.0411804	Spink A	0.0106572
4	Hesse B	23	Dillon A	0.0405941	Kuhlthau CC	0.0075393
5	Fox EA	21	Zhang Yan	0.0404230	Pettigrew-Fisher KE	0.0072762
6	Cimino JJ	21	Bystrom K	0.0402227	White RW	0.0069129
7	Pettigrew-Fisher KE	21	Kuhlthau CC	0.0399637	Tenopir C	0.0062066
8	He DQ	21	White RW	0.0398730	Bilal D	0.0052945
9	Tenopir C	21	Pejtersen AM	0.0398129	Ruthven I	0.0052432
10	Belkin NJ	20	Capra R	0.0395591	Zhang Yan	0.0042599
11	Urquhart C	20	Pharo N	0.0395443	Tombros A	0.0040557
12	Jamali HR	19	Oh JS	0.0393525	Blandford A	0.0036688
13	Goncalves MA	18	Robins D	0.0393085	Julien H	0.0036219
14	Williams P	18	Rosenfeld L	0.0392939	Wang PL	0.0033436
15	Ford N	17	Stutzman F	0.0391336	Foster A	0.0031356
16	Ruthven I	17	Wang PL	0.0389027	Soergel D	0.0029299
17	Huntington P	17	Cool C	0.0389027	Bystrom K	0.0028215
18	McTavish F	17	Limberg L	0.0387313	Cole C	0.0027400
19	Jansen BJ	16	Sundin O	0.0387171	Williamson K	0.0026397
20	Bandy M	16	Shah C	0.0386038	Erdelez S	0.0025388
21	Ruecker S	16	Soergel D	0.0384350	Oard DW	0.0025182
22	Rutten LJF	15	Bilal D	0.0382400	McKechnie L	0.0024271
23	Hawkins RP	15	Komlodi A	0.0382123	Urquhart C	0.0023165
24	Julien H	15	Wildemuth BM	0.0376935	Jose JM	0.0022470
25	Rowlands I	15	Shneiderman B	0.0376935	He DQ	0.0022256

Other authors rank in only two of the centrality measures, such as Pettigrew-Fisher, He and Tenopir in degree and betweenness, or Zang, Kuhlthau, and White in closeness and betweenness. Some only rank in one, including Nicholas, Hesse, Fox and Cimino in degree; Dillon, Pejtersen, Capra, and Pharo in closeness; and Tombros, Blandford, and Julien in betweenness.

Citation

The 2,386 documents analyzed contain 84,205 bibliographical references, of which 85.5% are found in articles. This represents an average of 35.3 citations per work. A total of 54,695 of the citations are to individual works. The 20 works most cited are shown in Table 3. Analysis of these works shows that 15 of them present various different theoretical IB models. Kuhthau's Information Seeking Process (1991, 1993, 2004) stands out as one of the most influential, as three of the most cited works refer to that model, and there are a total of 365 direct citations to it. In addition to those theoretical works, there are two on qualitative methodology, one review, one monograph and one empirical work.

Table 3. Most frequently cited references

Times cited	Publication	Main content
193	Wilson TD. 1999. V55. P249, J Doc	Theoretical: Problem-Solving Model
180	Kuhlthau CC, 1991, V42, P361, J Am Soc Inform Sci	Theoretical: Information-Seeking Process
126	Dervin B, 1986, V21, P3, Annu Rev Inform Sci	Literature review: system/user oriented paradigms
116	Wilson TD, 2000, V3, Informing Science	Conceptual & theoretical: basics concepts in IB research
115	Savolainen R, 1995, V17, P259, Libr Inform Sci Res	Theoretical: Everyday Life Information-Seeking
106	Case DO, 2002, Looking Information	General monograph on concepts, theories and methods in IB research
106	Marchionini G, 1995, Inform Seeking Elect	Theoretical: Information-Seeking Process in electronic environments
105	Kuhlthau CC, 1993, Seeking Meaning Proc	Theoretical: Information-Seeking Process
103	Ellis D, 1989, V45, P171, J Doc	Theoretical: the Ellis model
92	Wilson TD, 1981, V37, P3, J Doc	Theoretical: the Wilson model of 1981
91	Glaser B, 1967, Discovery Grounded T	Methodological: Grounded Theory
90	Belkin NJ, 1982, V38, P61, J Doc	Theoretical: Anomalous State of Knowledge
86	Leckie GJ, 1996, V66, P161, Libr Quart	Theoretical: General Model of the Information-Seeking of Professionals
82	Taylor RS, 1968, V29, P178, Coll Res Libr	Theoretical: Question-Negotiation
82	Dervin B, 1983, Int Comm Ass Ann M D	Theoretical: Sense-Making
80	Kuhlthau CC, 2004, Seeking Meaning Proc	Theoretical: Information-Seeking Process
79	Bystrom K, 1995, V31, P191, Inform Process Manag	Theoretical: Activities in Work Tasks
77	Jansen BJ, 2000, V36, P207, Inform Process Manag	Empirical: user queries on the web
77	Wilson TD, 1997, V33, P551, Inform Process Manag	Literature Review &theoretical: the Wilson model of 1997
76	Guba E, 1985, Naturalistic Inquiry	Methodological: qualitative methodology

Co-citation

The co-citation analysis was based on documents that received 20 citations or more in the 2,386 documents analyzed in this study. A total of 193 studies met this criterion. In the resulting co-citation network, independent components are difficult to perceive, as there is a great deal of overlap. Nevertheless an analysis of the clusters reveals groups of references with similarities (Figure 4). From this analysis, seven distinct clusters emerge. These are shown in Table 4, where they are ranked according to the number of documents they contain and the total number of citations. The first two of these are the most prominent, jointly representing 81.3% of the documents in the co-citation network and 84.4% of the citations obtained. The titles, abstracts, keywords and (if

necessary) content of the documents in each of the clusters identified by the program were reviewed and labeled according to the main research topic studied.
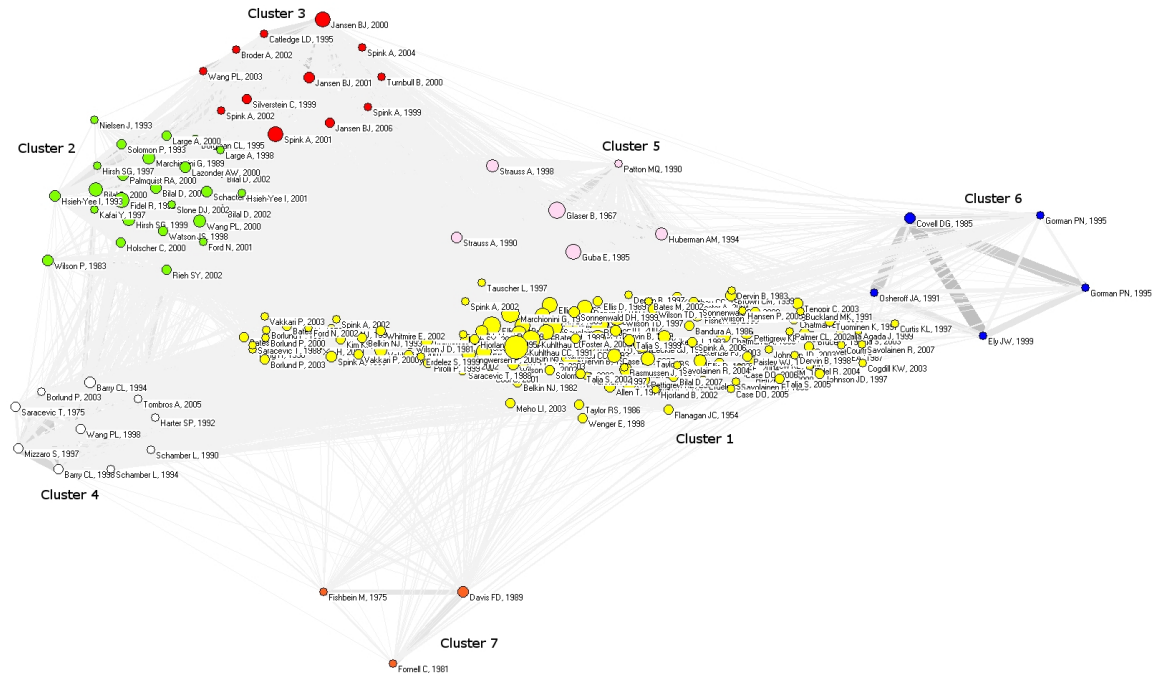
Figure 4. Co-citation network

Table 4. Documents, citations, and main subject of clusters in co-citation network

Cluster	Nº of documents	% of documents	Nº of citations	% of citations	Main subject
1	131	67.9	5,583	73.0	Core literature /theoretical
2	26	13.5	872	11.4	User-IR system interaction
3	12	6.2	399	5.2	Web search
4	10	5.2	254	3.3	Concept of relevance
5	6	3.1	325	4.3	Qualitative methodology
6	5	2.6	136	1.8	Medical IB
7	3	1.6	78	1.0	Technology user acceptance
Total	**193**	**100.0**	**7,647**	**100.0**	

Cluster 1 includes 17 of the 20 most cited works listed in Table 3. They are grouped on the basis of the five references most cited, and these, in turn, are the most frequently co-cited documents in the cluster. First is the article by Wilson (1999), in which some of the theoretical models proposed by other researchers are summarized and a new problem-solving model is presented. The second is by Kuhlthau (1991), which presents a model of the Information Seeking Process. This is followed by the review by Dervin and Nilan (1986), in which they present the User and System Oriented paradigm. The fourth is another work by Wilson (2000) that also presents various different theoretical models and defines the concepts implicit in the observation of information behavior. Finally, there is an article by Savolainen (1995) that presents the model of Everyday Life Information Seeking.

The main characteristic of this cluster is its theoretical nature. Among the theories and models included in the highest ranking works (45 or more citations), other than those already described in the direct citations, are the following: Berrypicking (Bates, 1989), Cognitive Theory for Interactive Information Retrieval (Ingwersen,

1996), Chatman's theories, such as Information Poverty or Life in the Round (Chatman, 1996, 1999), Integrated IS&R Research Framework (Ingwersen & Järvelin, 2005), Information Use Environments (Taylor, 1991), Ecological Model of Information Use (Williamson, 1998), Krikelas's model (1983), Information Practices In Accounts (Mckenzie, 2003) and Information Grounds (Pettigrew, 1999).

References to theoretical works by researchers in other social sciences can also be found in this first cluster. In order of greatest to fewest citations, are: The Strength of Weak Ties Theory (Granovetter, 1973), The Information Foraging Theory (Pirolli & Card, 1999), The Communities Practice Approach (Wenger, 1998), Bandura's Theory of Social Cognition (Bandura, 1986) and Rasmussen, Pejtersen, and Goodstein's (1994) Cognitive Systems Engineering (CSE) framework.

The main subject of study in Cluster 2 is the interaction of users, mainly students, with automated information retrieval systems. It also includes three more specific themes. The first is observing how users search and construct search strategies in various media, for example websites in general (Fidel, et al. 1999), search engines (Bilal, 2000), CD-ROM (Marchionini, 1989), and other library catalogs (Borgman, Hirsh, Walter, & Gallagher, 1995). The second aspect is the criteria applied to evaluate the obtained information (Rieh, 2002), including the work of Wilson (1983), which refers to the concept of cognitive authority. The third is the study of individual differences in how information is searched, with regard to the degree of skill or knowledge of the matter searched (e.g. Lazonder, Biemans, & Wopereis, 2000) and the influence of cognitive styles of the user in information searching (e.g. Palmquist & Kim, 2000).

Cluster 3 is focused on observing searches made by web users. Of these, five of the most often cited works describe various aspects of the project led by Amanda Spink and Bernard J. Jansen, which studied the searches made using four large search engines by analyzing their logs. These all appear in the monograph by Spink and Jansen (2004). Most of the papers are along the same lines, both with regard to the system studied and the method used. The exceptions are Wang, Berry and Yang (2003), who study transactions using a university website, and Broder (2002), who also interviews the users. In addition, it is important to note that this cluster also includes an article by Choo, Detlor and Turnbull (2000), in which a behavioral model of information seeking on the web is presented.

The 10 documents grouped in Cluster 4 share the concept of relevance and user judgment to determine efficacy in retrieval from an information system. This is the main subject of the most frequently co-cited works in the cluster (e.g. Barry, 1994). Other works examine relevance and adopt a conceptual (e.g. Saracevic, 1975), bibliographical (e.g. Mizzaro, 1997) or empirical (e.g., Wang and Soergel, 1998) focus. The latter also proposes a model of document selection by real users of a bibliographic retrieval system.

Cluster 5 is mainly methodological in nature, as it brings together six works that are important in qualitative methodology in the social sciences. Furthermore, two are among those with the most frequent direct citations in published IB research (Table 4). It should be noted that half of them refer to Grounded Theory, in particular, to the book by Glaser and Strauss (1967) that popularized this approach, and to the two editions of the book by Strauss and Corbin (1990) in which they developed the "Straussian" version of it.

The common nexus of the documents grouped in Cluster 6 is the study of the information behavior of doctors. Specifically, four of the five works in the cluster observe the clinical questions that arise when doctors deal with patients (e.g. Covell, Uman & Manning, 1985). The fifth element consists of Gorman's study (1995), which classifies the information used by doctors, along with various literature reviews that focus on the information needs of doctors.

Finally, Cluster 7 is centered on user acceptance of technology. The main document on this subject is the text by Davis (1989) in which a series of scales to measure this are developed and validated. This is accompanied by the methodological work of Fornell and Larcker (1981) and the study by Fishbein and Ajzen (1975), which deals with the psychological theory of reasoned actions.

Discussion

This study is intended to present an overview of international research into IB studies during the first thirteen years of the 21st century from two complementary standpoints: the first focused on co-authorship networks of researchers who have contributed to creating the current corpus of knowledge in this field, and the second on the intellectual basis that has underpinned this field of research. The terms included in the search strategy enabled an exhaustive retrieval of published research on IB. We assume that the use of expressions such as "information searching" caused the retrieval of papers that could potentially be included as part of the Information Retrieval area. However, this strategy was also useful to explore the connections and boundaries between IB and information retrieval, as some previous studies have indicated. In short, both areas share a common goal: to understand how relevant information is identified and used and to design more effective and easy-to-use information retrieval systems (Alhaji, 2012). A possible limitation stems from our study of a diverse range of fields, with different degrees of collaborative work and citation patterns; this may have generated some bias in the results in favor of the areas with a higher average number of co-authorships per paper, particularly in the area of information retrieval. We opted to maintain a developed methodological focus in order to obtain a broad vision of user-information interaction, going beyond identifying or analyzing academic communities. In any case, we have tried to avoid author rankings based on productivity or citation indicators, focusing our analysis instead on the identification and analysis of existing research clusters or nuclei.

The results indicate that, during this period, user research has been led by a few prominent investigators. In fact, only three rank highly in all of the aspects studied, namely Spink, Belkin and Marchionini, all three of whom are strongly associated with the field of information retrieval, and are noted researchers in LIS in general. Besides these, a small group can be defined in terms of their productivity, and a large group for publishing only occasionally. This pattern is in line with the data obtained by Larivière, Sugimoto and Cronin (2012) for LIS in general; these researchers attribute it to the existence of authors from other fields, and to the increase in doctoral students. For Schubert and Glänzel (1991), however, the existence of a group of transient authors in any discipline is, although natural, not healthy if the total number of them is high, as that constitutes an obstacle to the flow and exchange of information, and therefore impedes scientific progress. That said, the lack of publishing continuity is a common pattern in social sciences and the humanities, as noted by Ioannidis, Boyack and Klavans (2014), who suggest that this trend might be attributable to a lack of scientific infrastructure and financing. These conditions do exist, for example, in medical research, where a higher number of researchers published throughout the study period and as a result enjoyed a higher degree of citation.

In general, the data on co-authorship in IB research are similar to those for LIS (Sin, 2011), confirming the trend of enlarging research groups in this discipline (Larivière, et. al, 2012) and in the social sciences in general (Wuchty, Jones & Uzzi, 2007). Although collaboration is on the rise, it is unstable, given that only one group of researchers have published together continuously during these thirteen years. This is the group consisting of Nicholas, Huntington, Jamali, Williams, Rowlands, and colleagues. This instability in collaboration could indicate a low level of institutional involvement in the field of research, and it may favor the existence of many small and dispersed groups in the resulting networks or a small group of researchers attached either directly or indirectly. Thus, the size of the largest component in the IB co-authorship network is smaller than that obtained by Yang and Ding (2009) for LIS in general (20.8%), much smaller than that obtained by Liu, Bollen, Nelson, and Van de Sompel (2005) for digital-library research (38%), and of course, minute when compared to fields with a high level of experimental research, such as physics, biomedicine or computer science, whose largest component that makes up 80–90% of the network (Newman, 2004). In the case of physics, Lee, Goh, Kahng, and Kim (2010) state that co-authorship networks develop from nuclei of small isolated components into a component with linked paths on a large scale. Although this study did not examine the development of the co-authorship network, the point that best defines its structure is the beginning, which presents the image of a largely undefined field. Chang (2011) reported a limited amount of international collaboration in this field, which is necessary to achieve more cohesion within the research community.

With regard to ranking the members of this research community as a whole, the centrality measures provide an additional and complementary perspective. Again, the highest ranked are Spink, Marchianoni and Belkin. As

noted by Yan and Ding (2009), they are the authors who collaborate the most frequently (degree), widely (closeness), and diversely (betweenness), and are therefore those with the greatest influence. Other authors who rank highly in degree are those who simply have more direct collaborations. A notable example is, again, the group made up of Nicholas and colleagues. They all occupy high positions in degree centrality, but not in closeness and betweenness, which indicates their insular nature, as they interact little with the rest of the research community. Thus, those researchers with high levels of betweenness and closeness can be inferred to be those most able to establish collaborative links with other groups, collaborate with influential authors, or form a group with others. There is not, however, a consensus on the exact importance of each of these measures. They can be related to a greater amount of productivity (Yan & Ding, 2009; Badar, Hite, & Badir, 2013), or could be evidence that they are "links of preference" when incorporating new authors (Abbasi, Hossain, & Leydesdorff, 2012). These factors could serve to advance the development of the co-authorship network, as two authors not linked, but with contacts in common, may collaborate in the future, although it is unlikely that those with a large number of intermediaries would do so. These issues would, however, need to be studied in conjunction with other variables, for example their academic status, interdisciplinarity, geographical location, or the role of each author in relation to the mainstream research community, among other possible criteria.

Although the IB research community is dispersed, its intellectual basis is not. The co-citation network shows a series of highly connected clusters, which Gmür (2003) saw as the main indicator of the existence of a school of research at the heart of a scientific field. For it to be properly considered a school, however, this researcher also states that the degree of citation should be balanced rather than disproportionate, which is not the case here.

As noted above, in this group of highly linked clusters, the first is notable for its size, but also for its clearly theoretical nature. The analysis of the contents of the works examined here, however, demonstrates the diversity of the sources that feed into the theories proposed in these works. Together with some works that have a constructivist focus, using references to Dewey, Kelly, Bruner and Vigotsky (e.g., Kulthau, 1991, 1993), others mention sociological concepts, such as Bourdieu's *habitus* (Savolainen, 1995). Several adopt a constructionist-discursive focus (McKenzie, 2003), whereas some, such as Chatman (1996, 1999), who can in general be described as using an ethnographic perspective, stand out for the quantity and diversity of references to social research (Case, 2012). This presence of various forms of discursive affiliation could indicate, at best, the existence of an internal debate among various positions. At worst, however, it could indicate more mundane citation practices, such as authors citing a prestigious work in the belief that it will increase the cognitive authority of their own work, a fact observed by Case and Higgins (2000).

With regard to theories belonging to other disciplines detectable in the co-citation network, the presence of some is notable, while the absence of others is glaring. Among those detectable, for example, is the focus on practice in Wenger (1998), although Cox (2012) notes the low level of acceptance of this theory in IB research. On the other hand, there is a notable absence, among those most cited, of most of the theories of other disciplines that are nevertheless present in research published in the last decade of the 20th century, according to McKechnie, et al. (2001). Thus, most of the theoretical references included in general texts on IB theory published in recent years (Fisher, et al, 2005; Talja, et al, 2005; Wilson, 2013), have not taken root in the intellectual basis of this research field. A study of the research fronts by means of bibliographical coupling may be able to shed more light on this problem.

In addition to this theoretical basis, the other most visible aspect is methodology, mainly qualitative and with a marked presence of Grounded Theory. Although McKechnie, et al. (2001) categorize this as theory, a more in-depth analysis of its use in the study of IB (Gonzalez-Teruel & Abad-García, 2012) demonstrates the frequency with which references to it are limited to the use of codification and/or sampling procedures, rather than constituting a reference to the complete theory. Given, however, the orientation of Grounded Theory to the generation of theory emerging from data, it is not surprising that it appears among the most cited in a corpus of theoretical literature.

Together with the importance of theory and a focus on qualitative methodology, other results build on the findings of previous reviews. First of all, in contrast to the study of McKechnie, et al. (2005), in which the

authors highlight the absence in their citation network of one of the most cited reviews on the information needs of doctors (Gorman, 1995), this document does appear in our results, together with the work of other researchers. Indeed, it pertains to an independent cluster centered on the information behavior of doctors. Secondly, the importance of research that observes the interaction between users and information retrieval systems is highly visible, and it is examined from two points of view: first, from the user perspective by means of observing how they construct search strategies and how they evaluate the information obtained, and secondly, from the system perspective, by means of analyzing the transaction log. This sphere of research, which in Wilson's (1999) model would correspond to research on "information searching behavior," is situated in the gray area along the border between information retrieval and information behavior. However, mapping the research in information behavior in a way that could inform other research examining the interaction between the user, the information, and the information systems requires navigating the blurry line that separates this field from others. In that sense, it is revealing that papers such as Kelly and Sugimoto (2013), which carries out a systematic review of the area "Interactive Information Retrieval" acknowledges the contributions of three different research areas: information retrieval, information behavior, and human computer interaction. Thus, exploring the common ground is inevitable from both the area of IB and IR, although the two academic communities may have different patterns of publishing, an important aspect that should be considered when interpreting results.

Conclusion

Our study has identified a few researchers who have been more prominent than others in IB research since the beginning of the 21st century. At the same time, the field is anything but cohesive, with many dispersed groups of minor researchers who have also contributed to the field's development. With regard to the intellectual basis, although there is cohesion here, it does not necessarily indicate the existence of a single paradigm, given the theoretical diversity we found. Starting from this intellectual basis, it is important for an analytical and critical approach to be used in the generation of new knowledge. For this to be achieved, however, an exhaustive view of this intellectual basis must be obtained. The present study represents a contribution to this process and is also intended to provide a point of departure for future bibliometric research, whose emphasis on networks and qualitative analysis may reveal other characteristics of IB research.

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