



INFORMATION SCIENCE AND ITS CORRELATED AREAS: A CASE STUDY AT THE FEDERAL UNIVERSITY OF MINAS GERAIS

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ABSTRACT

This research contributes to the understanding of what Information Science is and how it is evolving by verifying the disciplines Information Science interacts with at the present time, as well as the breadth and intensity of these relationships. The research uses two bibliometric studies of the scientific journals utilized by researchers in the field. In the first study, citation analysis assessed 433 journals cited in the bibliographies of 18 theses and 39 dissertations from the Graduate Program of Information Science of the Federal University of Minas Gerais. These were first examined to determine their distribution in nine categories representative of large areas of knowledge. Next, subareas to which each journal pertained were also identified. In the second study, 316 journals from the field of Information Science, which the CAPES Portal of Scientific Journals subscribed to, were identified and analyzed in terms of the other areas of knowledge to which they were also designated by the Portal. The results of the citation analysis revealed that 31.8% of 433 journals cited were interdisciplinary, 49.7% pertained to other areas of knowledge while 18.50% were classified solely as Information Science. The analysis of the data from second study revealed that 57% of the journals were classified solely as Information Science and 43% were classified simultaneously in more than one area. Results stemming from both studies show that computer science, administration and education are the disciplines most closely related to Information Science. The areas of knowledge to which Information Science most broadly relates are applied social sciences, human sciences and linguistics, literature and the arts.

Keywords: Information Science; Interdisciplinarity; Correlated Knowledge Areas; Bibliometric Study.

1 INTRODUCTION

Information Science is frequently presented as a new area of knowledge, which is still developing, which does not yet have its own identity. As it resorts to the

concepts and theories of other areas in order to solve its problems, it has been labeled as an interdisciplinary area. An issue that is correlated with the interdisciplinary nature of Information Science and its search for identity is that regarding the identification of the main disciplines which interface with the field. As Gomes (2001) puts it:

This reflection becomes fundamental not in order to confirm the interdisciplinary characteristic of Information Science, because its own subject of study points to the relevance of such a character, but in order to be able to verify which disciplines in fact interact with it at the present time, justifying the inclusion of these disciplines in the composition of the main nucleus of Information Science.

The importance of understanding the nature of Information Science and of the dynamic condition of the field was the motivation for the research reported here. The two studies conducted in 2009 were intended to demonstrate the areas Information Science is related to at the present moment and the breadth and intensity of these relationships. To this end, two different methods of data collection and analysis were used. In the first study, a citation analysis was performed to verify the utilization of scientific journals from other areas of knowledge in the theses and dissertations from the Graduate Program in Information Science at the Federal University of Minas Gerais, Brazil. The second study verified the attribution of other areas of knowledge to Information Science journals of the CAPES Portal of Electronic Journals, a portal of scientific information in Brazil which, at the time of this research, offered the full text of 12,365 titles from domestic and international scientific journals of which 316 were classified as “Information Science”.

In order to contextualize the studies and provide background notions, the next section briefly reflects on interdisciplinarity and related concepts. In this paper the term interdisciplinarity will be adopted as a general term to indicate the interaction of Information Science with other disciplines without attempting to indicate the degree of complexity of this relationship (i.e. the term will be used as a general term for multi, pluri, cross or interdisciplinarity).

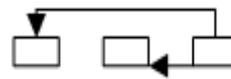
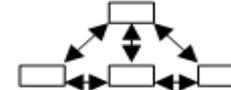
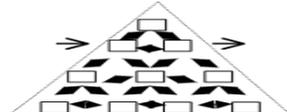
Following, there is a survey of interdisciplinarity in Information Science from the point of view of various currents of thought. After considerations on research about how Information Science meets other areas of knowledge, the paper presents

the methodology used, and the results obtained whilst discussing the findings of the studies.

2 CORRELATED CONCEPTS

The concept of interdisciplinarity involves the notion of interaction among disciplines or areas of knowledge which may occur at distinct levels of complexity. In order to differentiate among these variations, terms such as multidisciplinary, pluridisciplinarity, interdisciplinarity and transdisciplinarity were created. As shown in Figure 1, Jantsch (1972, p.108-109) enumerates five levels of disciplinary integration and coordination.

Figure 1: Levels of Disciplinary Integration and Coordination

General Description	Types of Systems	Configuration
Multidisciplinarity: Simultaneous disciplines with no outstanding relationships.	Single level and with multiple objectives. No cooperation.	
Pluridisciplinarity: Juxtaposition of disciplines at a single hierarchical level.	Single level and with multiple objectives. There is cooperation, but no coordination.	
Crossdisciplinarity: Imposition of a discipline at the same hierarchical level, creating polarization.	Single level and objective with disciplinary control.	
Interdisciplinarity: Disciplines connected in levels near each other with a common goal.	Two levels and multiple objectives. High level coordination.	
Transdisciplinarity: Disciplines coordinated from a common point of view.	Multiple levels and objectives. Coordination aimed at a general purpose.	

According to Jantsch (1972), these related concepts are differentiated by variations in three characteristics of the relationships among the disciplines involved: the presence or absence of control or coordination among the disciplines, the number of objectives they aim at achieving (single or multiple), and the number of levels of the relationships (single or multiple).

The coordination characteristic is related to the degree of mutual interaction that exists between the disciplines, that is to say, how much the disciplines affect each other. Thus, in multidisciplinary, the disciplines are simply juxtaposed, with no contact between them and a phenomenon is studied from various points of view. The focus is on “[...] the proximity of the disciplines rather than the transformative effort to produce new forms of knowledge” (HOLLAND, 2008, p.12). In pluridisciplinary, there is a certain approximation, but these results only in an accumulation or in a sum of the points of view and not in conceptual, theoretical or methodological alterations in any of the disciplines. In crossdisciplinarity, this influence takes place, but in only one direction, as questions are imposed by one discipline upon the others. Therefore, it is in interdisciplinarity, in which there is equilibrium of strength among the disciplines that the coordination occurs, resulting in reciprocal enrichment. Contrary to multidisciplinary, pluridisciplinary and crossdisciplinarity, interdisciplinarity implies the existence of coordination, at a high level, of the various disciplines related, resulting in exchanges and adjustments among the disciplines. In interdisciplinary research “[...] an integration of knowledge and/or methods from the various disciplines brought together to address an issue or problem” is required (HOLLAND, 2008, p.12). In transdisciplinarity, as the disciplinary borders dissolve, the coordination reaches an even higher level.

The number of objectives -single or multiple- is dictated by the disciplines involved. In pluridisciplinary and multidisciplinary, there are multiple objectives as each discipline seeks to respond to its specific issues. In crossdisciplinarity, there is a single objective, which emanates from the main discipline. Finally, in inter and transdisciplinarity, there are multiple though integrated objectives.

The number of levels refers to interaction among the disciplines and their object of study. A one level relationship is the most basic form of connection between science and the reality that it studies. Another level appears when, in addition to the interaction between the scientific knowledge and its object of study, there is the interaction between one body of scientific knowledge and another. There is a continuous succession of this. Thus, in multidisciplinary and pluridisciplinary there is just one level of interaction, for each of the isolated disciplines with its respective object of study. The same thing occurs in crossdisciplinarity, since the disciplines are

subordinate to the concerns of the main discipline. Only in interdisciplinarity can more than just one level be referred to, with the creation of a space of dialogue and of “influence” among the disciplines. This process is maximized in transdisciplinarity, in which the breaking of the disciplinary spaces leads to the creation of different levels of action among the concepts, theories and methods of the various disciplines involved, or that is to say that “[...] based on new levels of reality, [transdisciplinarity] works in the empty space between the disciplines and beyond them” (BARRETO, 2001, p.29).

Jantsch’s classification is not the only one there is. Piaget, for example, in 1972, enumerated three categories of concepts: multidisciplinary, interdisciplinarity and transdisciplinarity. However, it is Jantsch’s classification that is, usually, the most often cited as many other authors agree with his proposition (e.g.: JAPIASSU, 1976; GOMES, 2001; LE COADIC, 2004; BARRETO, 2007; CARLOS, 2007; and SILVA; LIMA; ARAÚJO, 2009).

3 INTERDISCIPLINARITY IN INFORMATION SCIENCE

It was in the 1960s that the first concepts of Information Science were proposed. One of the first definitions of the field was given during conferences at the Georgia Institute of Technology in October of 1961 and April of 1962:

[Information Science is] the science that investigates the properties and behavior of information, the forces governing the flow of information, and the means of processing information for optimum accessibility and usability. The processes include the origination, dissemination, collection, organization, storage, retrieval, interpretation, and use of information. The field is derived from or related to mathematics, logic, linguistics, psychology, computational technology, operations research, the graphic arts, communications, library science, management and some other fields (SHERA; CLEVELAND, 1977, p.264-265).

Due to its complex nature, there have been recurrent debates about the origins and founding theories of the field. Pinheiro and Loureiro (1995, p.43), when dealing with the nature of the conceptual evolution of Information Science, affirm that this Science fostered “[...] discussions that proceed from its scientific statute and

autonomy, passing through the object of study, information, by terminological problems, until arriving at interdisciplinary connections”.

Specifically regarding the debate on the interdisciplinarity of Information Science, there is agreement that Information Science derives from several fields and demands contributions from diverse disciplines. Early, in the first definition of Information Science given above, there appears a list of disciplines related to the field. In a classical article that defines the area, Borko (1968) presents it as an interdisciplinary science derived from and related to various fields. The list of disciplines compiled by Borko is the same as that presented in the definition above, from the event at Georgia Tech.

In 1970, Saracevic, in the important book *Introduction to Information Science*, presents the argument that Information Science is, by nature, interdisciplinary. Years later, the same author, confirming this argument, presented interdisciplinarity as one of three central characteristics of the area (SARACEVIC, 1992). Over the years, this characteristic has been reaffirmed as an element of the definition of Information Science in different geographical contexts, by different authors. Indeed, in Germany, Wersig and Neveling (1975) defended the interdisciplinary nature of Information Science as part of its social responsibility and, years later, as a characteristic of its nature of post-modern science (WERSIG, 1993). In the French context, Le Coadic (2004) was one of the defenders of the identification of Information Science as an “interdiscipline”. In the British context, McGarry (1999) is of note for the identification of various Information Science interfaces based on different component aspects of the information phenomenon. The discussion also appears in other contexts, such as the Chinese, as can be seen in the work of Yuexiao (1988) on the coordination of different levels of problems studied by various “Information Sciences”.

However, there is not a total consensus among authors about the presence of interdisciplinarity in the area and in the form in which it manifests itself. Discussed below are three different currents of thought on the theme. The first two consider Information Science interdisciplinary, although based on different arguments. The third regards Information Science as multi or pluridisciplinary, at best.

The first group of authors argues that since it borrows from several disciplines, Information Science is interdisciplinary of its own nature. For example,

Saracevic (1999, p.1059) justifies the interdisciplinarity of Information Science on the grounds of two factors. The first and most important factor is that “[...] the problems addressed [by Information Science] cannot be resolved with approaches and constructs from any single discipline – thus, interdisciplinarity is predetermined, as it is in many modern fields”. Rees and Saracevic (in a 1967 unpublished paper, cited in SHERA, 1980) further argue that Information Science is a branch of research that takes its substance, methods and its techniques from diverse disciplines to arrive at an understanding of information properties, behavior and circulation. The second factor is that “[...] interdisciplinarity in Information Science was introduced and is being perpetuated to the present by the very differences in backgrounds of people addressing the described problems” (SARACEVIC, 1999, p.1059). Furthermore, he points out that in Information Science the relationships with various disciplines are changing as interdisciplinary evolution is far from complete. In consonance with this idea, Rubin (2010, p.ix) argues that “[...] the boundaries of Library and Information Science continue to expand, the issues proliferate and grow in complexity, and the challenges we face are serious and relentless”.

Other authors may be mentioned who support this first current. For example, to Foskett (1980, p.64) Information Science is a discipline:

[...] that arises from a “crossed fertilization” of ideas that include the old art of library science, the new art of computing, the arts of new means of communication and those sciences such as psychology and linguistics, which, in their modern forms, are directly related to all communication problems – the transfer of organized thought.

Tang (2004, p.61) states that Information Science “[...] is a highly interdisciplinary field that attracts learned interests from a variety of disciplines from the domains of science, social science, and humanities”. Oliveira (2005, p.20) argues that “[...] the participation of other fields of knowledge in Information Science continues in function of the complexity of the problems that are to be resolved by the area, which requires contributions from different professionals and/or researchers”.

In a second current of thought, there are authors who argue in favor of the interdisciplinarity of Information Science on the grounds of the nature of information, its object of study. According to Tonini and Barbosa (2007), Information Science is interdisciplinary because “[...] the research object, information, permeates all fields of

human knowledge, and in order to achieve the goal of retrieving information this discipline utilizes resources from other disciplines”. Considering science a dynamic, continuous and cumulative social institution and, using this concept as a base, Targino (1995) establishes that Information Science emerged as a natural part of the evolutionary process of the field of librarianship and documentation, and is, thus, configured as a set of knowledge related to the production, collection, organization, storage, retrieval, interpretation, transference, transformation and utilization of information. In other words, it refers to the entire information cycle. Targino (1995, p.12) further argues that, “[...] as a result of its own object of study – information – present in all areas of knowledge, Information Science assumes an interdisciplinary and transdisciplinary character”. In the opinion of the author:

Information Science emerges as a metascience or suprascience, in the sense that it does not deal with specific segments of information – juridical information, technological information, scientific information, etc. – but rather with metainformation which traverses rigidly defined boundaries, in order to interact with other areas (TARGINO, 1995, p.14).

Bates (2007) reasons in a similar manner when she considers Information Science a metadiscipline. The author contends that all traditional academic research disciplines, as well as the applied professional disciplines, can be located at some point of a spectrum that goes from the arts, passing through the humanities, the social and behavioral sciences and arriving at the natural sciences and mathematics. In her vision, some disciplines are orthogonal to this continuum, not being located at a single point but going across it, as they are metadisciplines. According to Bates, the three metadisciplines are education, communication/journalism and information. The first one is related to the learning aspects of all subjects. The second, to the transmission of knowledge and the third, to the collection, organization, retrieval and presentation of information in all fields. Rubin (2010) reaffirms this thought saying that Information Science does not belong to any of the fields of the arts, the humanities, the social and behavioral sciences, the natural sciences or mathematics: “Information Science might be orthogonal to the conventional disciplines – that is, its concerns cut across them” (RUBIN 2010, p.273).

Finally, the third group of authors believes that Information Science bears no interdisciplinarity. Paim *et al.* (2001, p.20) say that it appears “[...] that, in the manner

that it is proposed and discussed, interdisciplinarity in the area comes down to multidisciplinary or pluridisciplinary practice, under the best of hypotheses". In the opinion of the authors, Information Science researchers have discussed the area's epistemological development at length and have judged it to be unsatisfactory. Information Science has imported a wide range of knowledge from other fields and has, therefore, been considered by theoreticians as an interdisciplinary science. However, for some, Information Science has not practiced its interdisciplinarity, as there is no "mutual fertilization of knowledge" in the process of assimilating knowledge from other areas (PAIM *et al.*, 2001, p.21). "What happens in the process is a juxtaposition of concepts from diverse disciplines" (PAIM *et al.*, 2001, p.21).

Gibbons *et al.* (1994, p.27-28) alerts as to the difficulties for achieving inter or transdisciplinarity:

[...] precisely because it is so universally acclaimed as something positive, everyone believes [transdisciplinarity] can be brought about just by aspiring to it. A closer look, however, reveals that much which is thought to be inter- or transdisciplinary in reality amounts to a mere accumulation of knowledge supplied from more than one discipline.

Accordingly, Holland (2008) identifies the existence of a semantic inconsistency for describing collaboration in Information Science. In his evaluation, although interdisciplinarity is valuable for innovation and theoretical development, it is difficult to be reached. For this author, the achievement of multidisciplinary can be regarded as considerable advance in the form of work of Information Science with other disciplines.

In line with the thinking of this third group, in a study that analyzed the references in 186 doctoral dissertations in library science completed between 1969 and 1972 at schools with programs accredited by the American Library Association, LaBorie and Halperin (1976, p.274) concluded that library science dissertations cite much more material within their own discipline (58% of the citations) and that this "[...] indicates that research of this type is less interdisciplinary than that within the social sciences in general". Additionally, Smith's study (1992), which had the goal of revising the works that tried to characterize the interdisciplinary nature of Information Science, concluded that there is a discrepancy between what is said (the interdisciplinary character in the area) and what is done (the isolation of research).

Additionally, she also noted that the contribution made by Information Science to other fields is very small and pointed out two issues that should be researched: the need to assess educational programs in order to evaluate which are truly interdisciplinary; and the issue around the fact that if Information Science intends to prosper as an interdisciplinary field, then more attention needs to be paid to the individual interdisciplinary characteristics of the field.

It should be noted that despite the discussions on the various levels of complexity in which the concept of interdisciplinarity can be manifested, ranging from multidisciplinary to transdisciplinarity, most of the authors who discuss the interdisciplinarity of Information Science do not make such distinction. Those who contend for the first current presented affirm that Information Science borrows from other disciplines but do not consider the existence of reciprocal changes in the disciplines and professionals involved, the presence of coordination, or the synchronization of objectives which make up the formal definition of interdisciplinarity. The authors in the second current argue only from the point of view of the pervasiveness of information in every area of knowledge but do not consider contributions of other disciplines to Information Science. On the other hand, the third current that analyzed the theoretical definitions of the concept of interdisciplinarity concluded that the field is multidisciplinary rather than interdisciplinary.

4 DISCIPLINES CORRELATED WITH INFORMATION SCIENCE

The issue of which disciplines contribute or relate to Information Science is present ever since the first attempts of definitions of the field. The Georgia Tech definition of 1962 and that of Borko of 1968 list mathematics, logic, linguistics, psychology, computational technology, operational research, the graphic arts, communications, library science, management and some other fields. Foskett (1980) lists librarianship, computing, communication, psychology and linguistics. Saracevic, in a 1992 article, lists librarianship, computer science, cognitive science and communication.

Although the lists above represent suggestions by various authors about the disciplines that interface with Information Science, the determination of these

disciplines has also been the object of interest of recent research studies. One significant example of such research is presented by Pinheiro and Loureiro (1995). In their work about the structure and limits of Information Science, the authors gave special attention to the issue of the interdisciplinary nature of the field. As a result of their study, the authors present a scheme where Information Science is divided into 12 subfields and, for each of these; the authors indicate the areas to which they relate. Pinheiro (1997) continued this work on her doctoral dissertation and analyzed the content of the articles published in the Annual Review of Information Science and Technology, from 1966 to 1995 to propose another scheme of the main subfields of Information Science. In this scheme, Information Science is divided into 17 subfields.

Ten years later, with the objective of identifying the fields of knowledge that interface interdisciplinarity with Information Science, Pinheiro (2006) delved deeper into the theoretical scheme and conducted a quantitative study. Her intention was to map the incidence of external disciplines in each subfield of Information Science. This time, the author analyzed 593 articles published from 1972 to 2004 in the journal *Ciência da Informação*, which is one of the main publications in the Information Science area in Brazil. In this study, 17 subfields were taken into consideration. Her results show that “information systems”, the most frequent subfield of Information Science in the articles analyzed is related to the external disciplines administration and computer science. The second subfield “information technology” relates to computer science. The third, “information retrieval systems” relates to librarianship, computer science and linguistics. The fourth, “information policy” relates to administration, political science and law. The fifth, “information needs and uses” relates to archival science, librarianship, museology and psychology. The sixth, “information representation” relates to archival science, librarianship, philosophy, linguistics and museology, and so on. It should be noted that the author considered librarianship and archival science not as subfields but as separate disciplines from Information Science. The final analysis shows that computing, business administration, librarianship, linguistics, political science, law, archival science, museology, psychology and philosophy would be the external disciplines that most frequently interact with Information Science. The author concludes that the area with the highest degree of interdisciplinarity with Information Science is computer science,

which is active in 8 of the 17 subfields, followed in second place by librarianship and business administration and, then, by economics and linguistics. The criterion used by Pinheiro (2006) to determine the strength of the connection of an external discipline with Information Science was the number of subfields of Information Science to which it relates.

A number of other studies, using different methodologies, attempted to trace the disciplines that interface with Information Science. In a study that analyzed works cited in 61 dissertations in the field of library and Information Science, Buttlar (1999) found that half of the citations belonged to the field while the other half came from other disciplines. The highest number of citations was received by education (11.45% of the citations), computer science (5.72%), health/medicine and sociology (each with 3.79% of the citations) and psychology (2.58%). Tang (2004) analyzed the citations to 150 works in the field of Information Science published from 1975 to 2000. In his research, Tang found that the citations came from a total number of 34 extra disciplines, that is to say, disciplines outside the field. The main citing extra disciplines were computer science (10.51% of the extra disciplinary citations), education (3.77%), communication (3.23%), business (1.89%), mathematics (1.89%) health/medicine (1.35%) and political science (1.35%). Chua and Yang (2008) analyzed the collaboration trends, authorship and keywords of all research articles published in the *Journal of American Society for Information Science and Technology* in the periods 1988-1997 and 1998-2007. Their keyword analysis showed that the 10% most cited keywords fell into 8 fields: Information Science (51.6%), computing technology (14.2%), sociobehavioral science (13.1%), statistics (9.2%), librarianship (6.2%), communication (3.1%), law & government (0.6%) e other (2.0%). Prebor (2007) examined all dissertations tagged on the ProQuest Digital Dissertations database in the years 2002-2006 under either or both "library science" and "Information Science" subject classification. The author concluded that only a third of the dissertations were actually conducted at library and Information Science departments. His 2010 research (PREBOR, 2010) examined the two-thirds of these works produced by non library and Information Science departments. His results showed that the departments responsible for most theses and dissertations that received the subject classification of "library science" and "Information Science" or

both in the ProQuest Digital Dissertation were business and management (22%), computer science (16%), education (15%), communication and service (13%) and engineering (5%).

In the current paper, two different methods were used to determine the relationship of a discipline with Information Science. Firstly, the number of citations of journals pertaining to these disciplines in Information Science theses and dissertations was considered. The second method analyzed the other areas, besides Information Science, to which Information Science journals in the CAPES Portal collection were assigned.

5 METHODOLOGICAL ASPECTS

The two different studies conducted will be called Study 1 and Study 2. Study 1 assessed 1,894 references to journals cited in the bibliographic references of 18 theses and 39 dissertations selected from among 25 theses and 67 dissertations defended at Graduate Program in Information Science at the Federal University of Minas Gerais in 2005, 2006 and 2007. Only works present in the Federal University of Minas Gerais Digital Theses and Dissertations Library were selected.

In the data collection activities, a master spreadsheet denominated Spreadsheet 1 was produced in Excel containing all the journals cited. The spreadsheet listed the titles of the journals cited in alphabetical order, indicated their presence in the CAPES Portal of Electronic Journals and the subject indexing/descriptive terms attributed to them by the Portal. In the event the journal was not listed in the Portal, it was researched in the National Union Catalogue, on Worldcat and in the United States Library of Congress catalogue. Finally, when the journal was not found in any of these databases, a search was conducted on the Internet in order to prove its existence and also to determine under which subject it should be indexed. The data collected showed five citations of journals which could not be located in the databases consulted nor in the Internet. These journals were excluded from the analysis.

In this first study, the 433 journal titles found in the citations analyzed were classified according to eight broad areas of knowledge (applied social sciences,

humanities, exact and earth sciences, health sciences, linguistics, literature and the arts, engineering, biological sciences, agrarian sciences) and the category others. For the definition of the areas of knowledge, the classification table of the National Scientific and Technological Development Council, Brazil, was used. The journals were later classified into their subareas with the goal of revealing to which disciplines the publications utilized by the Information Science researchers pertained.

In Study 2, an assessment was conducted of all the journals subscribed by the CAPES Portal of Electronic Journals in the Information Science area. Initially, 387 journals were found. After eliminating duplicate titles, due to their being distributed by more than one provider, a final result of 316 titles classified in the Information Science area of knowledge was obtained. A second spreadsheet (Spreadsheet 2) was created which listed these 316 journals.

Some of the Information Science journals on the Portal also pertained to other areas as shown in Figure 2. To demonstrate the degree to which Information Science relates to other areas, the data in Spreadsheet 2 was used to assess the number of occurrences of each discipline, other than Information Science, utilized by the CAPES Portal to index each journal.

Figure 2: Areas of Knowledge Attributed to the Journals on the CAPES Portal.

<p>Government Information Quarterly Area(s): Electrical Engineering. Electronic Engineering. Telecommunications Business Administration. Public Administration. Accounting Information Science Political Science Type of Material: Journals with complete text Means of Acquisition: Subscription Analyzed JCR 2007: yes Impact Factor: 0.810 (JCR-2007) Number of citations: 189 Publisher/distributor: Science Direct ISSN: 0740-624X Period available: 1995 - present</p>
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The analysis of the data showed the main areas related to Information Science and where it possibly seeks theories upon which to base and solve its problems and construct its theoretical body. In order to facilitate understanding, the presentation of results below was organized according to the two assessments conducted. That is to say, the journals cited in the theses and dissertations (Study 1)

and the journals from the Information Science area present on the CAPES Portal (Study 2).

5.1 Study 1: Analysis of the journals cited in the theses and dissertations of the Graduate Program in Information Science at the Federal University of Minas Gerais: Presentation and analysis of the results

Table 1 shows the distribution of the 433 journal titles found in the citations analyzed into the eight broad areas of knowledge and the categories “others” and “interdisciplinary”. This last category held the journals indexed with terms referring to two or more broad areas of knowledge in addition to those that had been indexed under the term interdisciplinary/multidisciplinary. Note that the most cited area, with 47.1% of the citations, was applied social sciences to which Information Science belongs, according to the National Scientific and Technological Development Council classification. Also of note are the following categories: interdisciplinary with 21.7% of the citations; human sciences with 15.3% of the citations and exact and earth sciences with 8.8% of the citations. The journals classified solely in the categories biological sciences, agrarian sciences and others did not have any direct citations.

Table 1: Journals Cited: distribution by area of knowledge.

Areas of Knowledge	Quantity	Percentage %	Cumulative %
Applied Social Sciences	204	47.1	47.1
Interdisciplinary	94	21.7	68.8
Humanities	66	15.3	84.1
Exact and Earth Sciences	38	8.8	92.9
Health Sciences	14	3.2	96.1
Linguistics, Literature and Arts	11	2.5	98.6
Engineering	6	1.4	100
Biological Sciences	0	0	100
Agrarian Sciences	0	0	100
Others	0	0	100
Total	433	100	100

In Table 2 the 204 journals in the applied social sciences were classified into their subareas and into the category named interdisciplinary, where the journals

indexed into more than one subarea were grouped. It should be pointed out that, in the citations analyzed, the Information Science subarea, (with 80 journals cited), had only one journal more than the administration subarea with 79 journals cited. Other categories of note were: interdisciplinary with 8.8%; economics with 5.9% and communication with 3.9% of the journals cited.

Table 2: Journals Cited: classification of the journals in the Applied Social Sciences into their subareas.

Subareas	Quantity	% (in relation to the 204 journals)	Cumulative %	% (in relation to the 433 journals)
Information Science	80	39.20	39.20	18.50
Administration	79	38.70	77.90	18.31
Interdisciplinary	18	8.80	86.70	4.10
Economics	12	5.90	92.60	2.69
Communication	8	3.90	96.50	1.89
Architecture and Urbanism	2	1	97.50	0.46
Museology	2	1	98.50	0.46
Law	1	0.50	99	0.23
Urban and Regional Planning	1	0.50	99.50	0.23
Tourism	1	0.50	100	0.23
Demographics	0	0	100	0
Industrial Design	0	0	100	0
Home Economics	0	0	100	0
Applied Social Service	0	0	100	0
Total	204	100	100	47.1

In Table 3, the 66 journals in the human sciences were classified into their subareas or as interdisciplinary, if they were indexed into more than one subarea. The subareas that stood out were: education with 30.30%, interdisciplinary with 24.20%; psychology and sociology with 13.50% each, anthropology with 6.60% and political science with 4.40% of the journals cited.

Table 3: Journals Cited: classification of the journals in the Human Sciences into their subareas.

Subareas	Quantity	% (in relation to the 66 journals)	Cumulative %	% (in relation to the 433 journals)
Education	20	30.30	30.30	4.61
Interdisciplinary	16	24.20	54.50	3.73
Psychology	9	13.50	68	2.10
Sociology	9	13.50	81.50	2.10
Anthropology	4	6.60	88.10	0.92
Political Science	3	4.40	92.50	0.69
History	2	3	95.50	0.46
Geography	2	3	98.50	0.46
Philosophy	1	1.50	100	0.23
Archaeology	0	0	100	0
Theology	0	0	100	0
Total	66	100	100	15.3

In Table 4, the 38 journals in the exact and earth sciences were classified into their subareas or as interdisciplinary, if they were indexed into more than one subarea. The results in this table show that, of the 38 journals analyzed, there were 4 interdisciplinary and the remaining 34 pertained to computer science. There were no citations for the other subareas.

Table 4: Journals Cited: classification of the journals in the Exact and Earth Sciences into their subareas.

Subareas	Quantity	% (in relation to the 38 journals)	Cumulative %	% (in relation to the 433 journals)
Computer Science	34	89.50	89.50	7.88
Interdisciplinary	4	10.50	100	0.92
Mathematics	0	0	100	0
Probability and Statistics	0	0	100	0
Astronomy	0	0	100	0
Physics	0	0	100	0
Chemistry	0	0	100	0
Geosciences	0	0	100	0
Oceanography	0	0	100	0
Total	38	100	100	8.8

In Table 5, the 14 journals in the health sciences were classified into their subareas or as interdisciplinary, if they were indexed into more than one sub-area at the same time. The most noteworthy sub-area was physical education with 4

citations, followed by collective health and interdisciplinary with 3 citations each, medicine with two citations, nursing and physiotherapy and occupational therapy with one citation each.

Table 5: Journals Cited: classification of the journals in the Health Sciences into their subareas.

Subareas	Quantity	% (in relation to the 14 journals)	Cumulative %	% (in relation to the 433 journals)
Physical Education	4	28.60	28.60	0.92
Collective Health	3	21.43	50.03	0.69
Interdisciplinary	3	21.43	71.46	0.69
Medicine	2	14.28	85.74	0.46
Nursing	1	7.13	92.87	0.23
Physiotherapy and Occupational Therapy	1	7.13	100	0.23
Dentistry	0	0	100	0
Pharmacy	0	0	100	0
Nutrition	0	0	100	0
Speech Therapy	0	0	100	0
Total	14	100	100	3.22

In Table 6, the 11 journals in the linguistics, literature and the arts area were classified into its subareas or as interdisciplinary, if they were indexed into more than one sub-area. A balance was seen in this broad area, as all the subareas were cited.

Table 6: Journals Cited: classification of the journals in the area of Linguistics, Literature and the Arts into their subareas.

Subareas	Quantity	% (in relation to the 11 journals)	Cumulative %	% (in relation to the 433 journals)
Linguistics	4	36.36	36.36	0.92
Arts	4	36.36	72.72	0.92
Literature	2	18.18	90.9	0.46
Interdisciplinary	1	9.10	100	0.23
Total	11	100	100	2.53

Finally, in Table 7, the 6 journals in the engineering area were classified into its subareas or as interdisciplinary, if they were classified into more than one sub-area at the same time. The production engineering sub-area and the interdisciplinary category were cited twice each, the civil engineering and electrical engineering were cited once each and there were no citations for the remaining subareas.

Table 7: Journals Cited: classification of the journals in the area of Engineering into their subareas.

Subareas	Quantity	% (in relation to the 6 journals)	Cumulative %	% (in relation to the 433 journals)
Production Engineering	2	33.30	33.30	0.46
Interdisciplinary	2	33.30	66.60	0.46
Civil Engineering	1	16.70	83.30	0.23
Electrical Engineering	1	16.70	100	0.23
Mining Engineering	0	0	100	0
Materials and Metallurgy Engineering	0	0	100	0
Mechanical Engineering	0	0	100	0
Chemical Engineering	0	0	100	0
Sanitary Engineering	0	0	100	0
Nuclear Engineering	0	0	100	0
Transport Engineering	0	0	100	0
Naval Engineering	0	0	100	0
Aerospace Engineering	0	0	100	0
Biomedical Engineering	0	0	100	0
Total	06	100	100	1.38

Table 8 summarizes the data from the previous tables. It shows how often the journals in each sub-area were cited in the theses and dissertations in an effort to demonstrate the main disciplines that help in the construction of the Information Science theoretical body or that are somehow related to it. Interdisciplinary was the category most often cited with 31.8% of the citations. As that is the category which brings together journals that pertain to more than one area/sub-area at the same time, it could be seen as an indicator of interdisciplinarity in the field of Information Science. Second place was held by Information Science itself, but with a low degree of representation of 18.5%, considering that the object of the analysis were the citations of journals from theses and dissertations in that area. Next places were held by administration with 18.3%, computer science with 7.9% of the titles cited, education with 4.6%, economics with 2.7%, psychology with 2.1%, sociology with 2.1%, and communication with 1.9%. The remaining 22 disciplines held approximately 10.1% of the titles cited.

Table 8: Journal Cited: classification of the journals according to all the subareas together.

Subareas	Quantity	% (in relation to 433 journals)	Cumulative Quantity	Cumulative % (in relation to 433 journals)
Interdisciplinary	138	31.8	138	31.87
Information Science	80	18.5	218	50.35
Administration	79	18.3	297	68.59
Computer Science	34	7.9	331	76.44
Education	20	4.6	351	81.06
Economics	12	2.7	363	83.83
Psychology	9	2.1	372	85.91
Sociology	9	2.1	381	87.99
Communication	8	1.9	389	89.84
Anthropology	4	0.92	393	90.76
Physical Education	4	0.92	397	91.69
Linguistics	4	0.92	401	92.61
Arts	4	0.92	405	93.53
Political Science	3	0.69	408	94.23
Collective Health	3	0.69	411	94.92
Architecture and Urbanism	2	0.46	413	95.38
Museology	2	0.46	415	95.84
History	2	0.46	417	96.30
Geography	2	0.46	419	96.77
Medicine	2	0.46	421	97.23
Literature	2	0.46	423	97.69
Production Engineering	2	0.46	425	98.15
Law	1	0.23	426	98.38
Urban and Regional Planning	1	0.23	427	98.61
Tourism	1	0.23	428	98.85
Philosophy	1	0.23	429	99.08
Nursing	1	0.23	430	99.31
Physiotherapy and Occupational Therapy	1	0.23	431	99.54
Civil Engineering	1	0.23	432	99.77
Electrical Engineering	1	0.23	433	100.00
Total	433	100	433	100.00

5.2 Study 2: Analysis of the journals tagged under Information Science subject classification on the CAPES Portal: presentation and analysis of the results

In Study 2, the 316 journals classified by the CAPES Portal in the Information Science area of knowledge were analyzed. As shown in Figure 3, it was observed that a little over half of the journals (181 titles) were classified solely in the Information Science area, with the remaining 43% of the journals (135 titles) being classified in the Information Science area and in at least one other, thus demonstrating the proximity of Information Science to other areas of knowledge.

Figure 3: Division of the Information Science journals on the CAPES Portal by area of knowledge.

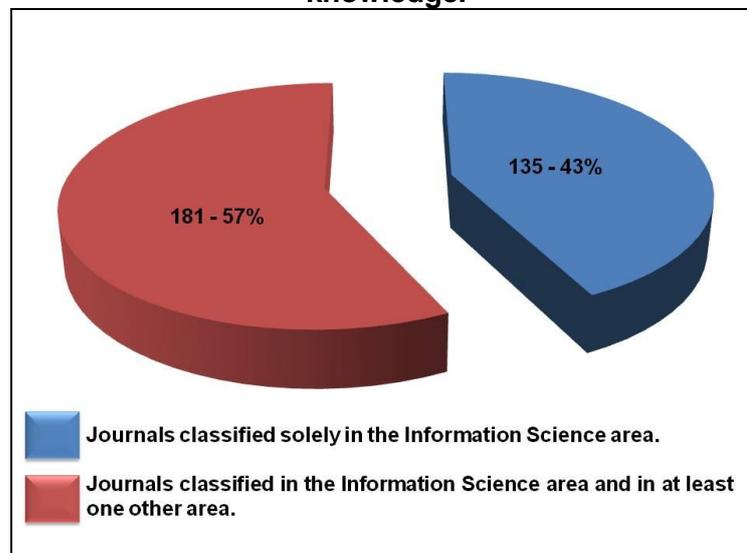


Table 9 shows the other areas in addition to Information Science in which the 135 interdisciplinary journals were classified, as illustrated by Figure 2. As already evinced, a journal may have been classified in more than one area or sub-area at the same time. Table 9 shows the number of occurrences of each of these. This table may be seen as a list of the main areas that possibly influence or assist Information Science to structure itself as a science and that have common objectives with Information Science. Of note are, as shown in Table 9, the following areas of knowledge with which Information Science relates according to the total number of occurrences: computer science with 50 occurrences; education with 31; business administration, public administration and accounting with 29 (under the heading

administration in Table 9); communication with 18; language and literature with 9; health sciences with 8; multidisciplinary with 7; sociology with 6; medicine, history, art and biological sciences with 5 occurrences each.

Table 9: Other areas in which the journals in Information Science were classified in the CAPES Portal.

Areas	No. of Occurrences
Computer Science	50
Education	31
Administration	29
Communication	18
Language and Literature	9
Health Sciences	8
Multidisciplinary	7
Sociology	6
Medicine	5
History	5
Art	5
Biological Sciences	5
Economics	4
Anthropology	4
Law	4
Engineering (general)	4
Agrarian Sciences (general)	3
Museology	3
Human Sciences (general)	3
Chemistry	3
Chemical Engineering	3
Electrical Engineering, Electronic Engineering and Telecommunications	3
Exact and Earth Sciences (general)	3
Philosophy	2
Literature	2
Biochemistry Biophysics	2
Applied Social Sciences (general)	2
Psychology	2
Political Science	2
Food Science and Technology	1
Agronomy	1
Nursing	1
Production Engineering	1
Occupational Hygiene and Safety	1

6 DISCUSSIONS AND CONCLUSION

The two studies presented here used different sources of data and different methods to reveal the areas of knowledge and disciplines to which the field is most related at the present moment and the intensity and breadth of these relationships, contributing to the understanding of Information Science and its evolution.

The results of the first study, summarized in Table 8, show that 138 (31.8%) journals were classified as interdisciplinary and 80 (18.5%) were indexed solely under the descriptor Information Science. The other main subareas to which the journals cited in the works analyzed belonged were administration with 79 (18.3%) journals, computer science with 34 (7.9%) journals and education with 20 (4.6%) journals. Other areas of note were economics with 12 (2.7%) journals, psychology and sociology with 9 (2.1%) journals each and communication with 8 (1.9%) journals. These totaled 389 (89.84%) of the 433 journals cited in the works analyzed. The remaining 44 journals were distributed among 22 subareas, each one of which had one to four journals cited.

The results of the second study showed that 43% of them were classified into more than one area simultaneously. In other words, they were interdisciplinary. Those areas that stood out the most in accordance with the data assessed on the Portal, as per their number of occurrences in the descriptors, were, respectively: computer science (50 occurrences), education (31), administration (29), communication (18), language and literature (9), health sciences (8) and sociology (6). Other 26 subareas were used to index the journals, all of them with less than 5 occurrences.

Regarding the interdisciplinarity of the field of Information Science, results presented by Study 2 (Figure 3), show that 43% of the journals in the Information Science collection of the CAPES Portal were classified in more than one area of knowledge simultaneously, and were regarded in the current research as inter or multidisciplinary. However, this is considered a low interdisciplinarity rate especially in the social sciences (LABORIE; HALPERIN, 1976), and points to a discrepancy between the widely held belief on the interdisciplinarity of the area and the isolation of research which is what seems to occur in fact. This finding seems to support the

third current of thought presented in the section “Interdisciplinarity in Information Science” of the current paper which defends the idea that Information Science is not interdisciplinary but at most multidisciplinary or pluridisciplinary.

On the other hand, a different conclusion is shown by the data in Table 8 for the citation analysis (Study 1). Considering that only 18.5% of the journals are classified solely as Information Science, it could be said that 81.5% of the journals cited were interdisciplinary or belonged to areas outside Information Science, which is a much higher result than that pointed out in the studies by LaBorie and Halperin (1976), and Buttlar (1999). One possible reason for this could be the specific characteristics of the graduate program from which the data emanates. It is probable that graduate programs in Information Science have variable degrees of interdisciplinarity. Therefore, to assess these variations in the interdisciplinarity of the field would require further research, utilizing other frames of time and data from other graduate programs.

To help in the analysis of the disciplines to which Information Science relates most intensely, Table 10 displays the results obtained through the two sets of data used in the current study and contrasts them with the findings from Pinheiro (2006) and also with the disciplines listed in the early definition of Information Science by Borko (1968). Pinheiro’s (2006) work was selected because it represents a recent research and analyzed more empiric data than other studies discussed earlier in this paper. In the first column are the top rows of Table 8 which show the disciplines to which the journals most cited in the theses and dissertations analyzed in Study 1 pertained. The second column shows the top rows of Table 9, which list the disciplines most frequent among the descriptors used to index journals in the Information Science journals collection of the CAPES Portal. The numbers in parentheses in both columns show the frequency of occurrences of each discipline in the descriptors used to represent the journals and can be considered indicators of the intensity of the relationship of Information Science with these disciplines. In the third column, the main findings from Pinheiro (2006), reported earlier, are displayed showing the top disciplines related to Information Science as found by her research. The numbers in parenthesis show the number of subfields of Information Science

with which the discipline relates. For comparison, the fourth column enumerates the disciplines mentioned by Borko (1968) in his early definition of Information Science.

In the analysis that follows, the disciplines of management (used in Borko's list) and administration (used by the other authors) were considered equivalent, due to their proximity. Likewise, the fields of computation technology (term used by Borko) and computer science (term used by the more recent studies) were regarded as equivalents. Additionally, the discipline librarianship/library science indicated by both Borko (1968) and Pinheiro (2006) as one of the disciplines most related to Information Science, were not listed in the first and second columns in Table 10 because in both Study 1 and Study 2 the discipline is classified as part of the field of Information Science and not as an external discipline with which Information Science interfaces.

Table 10: Disciplines most highly related to Information Science: Comparison of results from Phase 1, Phase 2, Pinheiro (2006) and Borko (1968).

Study 1 Citation Analysis (Table 8)	Study 2 Analysis of Information Science Journals in CAPES Portal (Table 9)	Pinheiro (2006) Analysis of subfields of Information Science	Borko (1968)
Administration (79)	Computer Science (50)	Computer Science (8)	Mathematics, Logic, Linguistics, Psychology, Computational Technology, Operational Research, The Graphic Arts, Communications, Library Science, Management, and some other fields
Computer Science (34)	Education (31)	Librarianship (5)	
Education (20)	Administration (29)	Administration (5)	
Economics (12)	Communication (18)	Economics (3)	
Psychology (9)	Language and Literature (9)	Linguistics (3)	
Sociology (9)	Health Sciences (8)	Linguistics, Law, Archival Science, Museology, Philosophy, Mathematics, Statistics, Communication, Sociology of Science, History of Science (2)	
Communication (8)	Sociology (6)	Political Science, Psychology, Philosophy of Science, Epistemology, Education, Ethics (1)	

For Studies 1 and 2, the first three rows, with the results of citation and journal analysis, have in common the subareas, which should have a higher degree of relationship with Information Science they being administration, computer science and education. In both sets of data, these disciplines by far surpassed the number of occurrences of all the others. The comparison of the results from the present research with Pinheiro's results, show that computer science and administration are among the first three positions in all the three analyses. These two disciplines were also present in the 1968 Borko's list. Other subareas that are common in the seven top rows of both Study 1 (Tables 8), after excluding the rows for Information Science and inter/multidisciplinary journals, and Study 2 (Table 9) are communications and sociology. Also in the first top seven rows are economics and psychology (only in the first column, for Study 1) and language and literature and health sciences (only in the second column, for Study 2).

It was surprising that, although journals pertaining to communications are relatively highly present in the Portal (4th position in Study 2 with 18 occurrences) only 8 journals cited in the theses and dissertations analyzed pertained to this discipline, which, since the inception of the field, is considered a main area of connection with Information Science. It was also unexpected that only 4 journals cited in the theses and dissertations pertained to linguistics, another area considered to be highly related to Information Science, and present in Borko's definition. A possible explanation could be that these disciplines, communication and linguistics, are addressed by the journals classified as interdisciplinary, a category which did not discriminate specific subareas to which the journals pertained. Other possible explanations are the specific characteristics of the program from which the works used for data collection emanate or the possibility that Information Science is emphasizing other directions not predicted initially. Also of note were the findings obtained by comparing results shown in the first two columns with the list of disciplines by Borko (1968). Of the 10 disciplines listed by Borko (1968) in his early definition of Information Science (last column of Table 10), there are only four in column 1 - for Table 8 (administration, computer science, psychology and communications) and three in column 2 - for Table 9 (administration, computer science and communications). Thus, the findings of the current study supports

Saracevic (1999) when he points out that in Information Science the relationships with various disciplines are changing as interdisciplinary evolution is far from complete.

The comparison of data presented in Tables 1 to 7 for the citation analysis reveals details of the variability in the breadth of the relationship between Information Science with each large area of knowledge. Table 11 summarizes the data in these tables showing the number of subareas cited in Study 1 for each large area of knowledge. For the subareas cited, it also shows the maximum number of journals cited. The breadth of the relationship of the area of Information Science with another area of knowledge was defined here as the relationship between the number of subareas cited and the total number of subareas in each large area of knowledge. It was calculated by the division of the number of subareas to which belonged the journals cited by the total number of subareas in the large area of knowledge. A relationship was considered broad if the breadth was above 70%, medium if it ranged between 30% and 70% and narrow if it was below 30%. The maximum number of journals cited in a sub-area of the area under analysis was taken as an indicator of intensity of the relationship of Information Science with that area and subarea.

Table 11: Breadth and Intensity of the relationships of Information Science to large areas of knowledge.

Area	Total No. of subareas (a)	Subareas cited (b)	Breadth (a/b) %	Maximum No. of journals cited (Intensity) in a subarea
Applied Social Sciences	14	10	71% (Broad)	79 (Intense)
Human Sciences	11	8	73% (Broad)	20 (Intense)
Exact and Earth Sciences	7	1	14% (Narrow)	34 (Intense)
Health Sciences	9	5	56% (Medium)	4 (Weak)
Linguistics, Literature and the Arts	3	3	100% (Broad)	4 (Weak)
Engineering	13	3	23% (Narrow)	2 (Weak)
Biological Sciences	13	0	0% (Null)	0 (Null)
Agrarian Sciences	7	0	0% (Null)	0 (Null)

In the case of applied social sciences, journals from 10 of its 14 subareas were cited in the bibliographies analyzed, with a maximum of 79 journals cited in the administration sub-area. This reveals a high breadth (71%) in the relationship with

the area which is notably intense with administration (79 journals cited). In the human sciences, journals from 8 of the 11 subareas are cited with a maximum of 20 journals cited (education) and a minimum of 1 (philosophy). Again, this shows an ample relationship with the area (73%) although intense only with one sub-area (education). In the exact and earth sciences, the data show an intense relationship (34 journals cited) with computer science and none with its other 7 subareas. Interestingly, the table dealing with the health sciences journals cited show relationships, with 5 of the 9 subareas. However, in spite of the above average breadth (56%) all of them have low intensity, with a maximum of 4 citations. Another interesting result is shown for linguistics, literature and the arts in Table 6. Information Science relates with all the 3 subareas of linguistics, language and the arts (100% breadth) but, contrary to expectations, there is a low degree of intensity in the relationship between Information Science and linguistics (only 4 journals cited) as discussed above, revealing a broad but weak connection with the area. In the case of engineering, there is a relationship of low intensity (a maximum of 2 journals cited) with only 3 of the 13 subareas, which shows a narrow and weak relationship with the area. There were no citations for journals in biological and agrarian science.

Although the data gathered show the breadth and intensity in the relationship of Information Science with each large area of knowledge and its subareas, it does not permit conclusions about the reasons the journals were cited which would reveal how interdisciplinarity is manifested in Information Science. It can be supposed that in the majority of cases in which the journals pertaining to administration, education, computer sciences and economics are cited, this occurs because theories, methods or concepts stemming from these disciplines are being utilized. There may be cases in which the other discipline contributes theoretically to the study of the information in isolated aspects (e.g. a specific line of research) and others in which there is a contribution towards the area as a whole (e.g., for the constitution of the concept of information itself). Especially in the case of applied social sciences and human sciences, there may be a greater contribution from different disciplines towards the study of information. This is in agreement with first current of thought about interdisciplinarity in Information Science, presented earlier in this paper, which argues that Information Science is interdisciplinary because it borrows from other disciplines.

In the case of citations of journals from the health sciences and engineering in the theses and dissertations, it seems more likely that these areas have been the subject of study in the field (information in medicine, in nursing, etc.) than as a result of their theoretical contribution to the field. It could be also presumed that works that cited journals belonging to most disciplines with a lower percentage of occurrences in Tables 8 and 9 refer to studies of information processes in these various areas, given that these processes are object of research and study in every area of knowledge. This is the form of interdisciplinarity advocated by authors in the second current of thought on interdisciplinarity in Information Science who say Information Science is interdisciplinary because its object of study, information and its processes, are pervasive in all areas of knowledge. To reveal the interdisciplinary form which occurs between Information Science and each sub-area of knowledge, further studies are needed.

In summary, the two sets of data used in the studies showed contradictory results for the degree of interdisciplinarity of Information Science. The citation analysis in Study 1 showed Information Science to be highly interdisciplinary as 81.5% of the citations were from journals which were interdisciplinary or were outside Information Science. The journal analysis in Study 2 concluded that the interdisciplinarity of Information Science can be considered low (43%) when compared to other disciplines in the applied social sciences, according to LaBorie and Halperin (1976). Both sets of data show that the disciplines that are most intensely related to Information Science are computer science, administration and education. The intensity of the relationships of Information Science to communications and linguistics were lower than expected. The citation analysis allowed the conclusion that the areas to which Information Science relates more broadly (that is to say that Information Science relates to a high percentage of the subareas pertaining to that area) are applied social sciences, human sciences and linguistics, literature and the arts. Some hypotheses were raised about variations in the kind of relationship Information Science have with the various subareas of knowledge to which Information Science related in various degrees.

Further research and bibliometric studies that compare the works produced in the various graduate programs in Information Science in different countries and

periods of time through citation analysis as well as other analysis of different Information Science collections of e-journals would reveal how Information Science is understood in various contexts, as well as how Information Science is evolving along the last decades.

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