Interdisciplinary Outreach of Library and Information Science Research as Reflected in *"*Essential Science Indicators*"*

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Abstract

This paper investigates the contribution of LIS research to intellectual growth of other disciplines. 209 highly cited papers has been analyzed to reveal the interdisciplinary patterns. Interdisciplinary journals seem more promising in producing highly cited papers.

1. Introduction

As an "information-providing discipline, Library and Information Science (LIS) has always been interacting with other "information-seeking disciplines" (Beghtol 1995, 30). These interactions has brought up an interdisciplinary reputation for the field, resulting in a consensus among LIS scholars that this field is "an interdisciplinary field in nature" (Kärki 1996, 323; Saracevic 1994, 3). As an interdisciplinary discipline, LIS absorbs parts of the other disciplines' ideas and functions as an integrated research entity (Holmes 2002); Though LIS interaction with other disciplines is always changing, "interdisciplinary evolution is far away from over" (Saracevic 1994, 3).

Interdisciplinary interaction between LIS and other disciplines is dynamic, stimulating and constructive. We need to reach out for other disciplines' ideas and knowledge to ensure that we connect with them and we require to influence other disciplines with what we have found in our own discipline.

In 1962*, Weinberg* in a classical paper proposed some criteria for scientific merit, among which one of them is closely related to this paper:

> That field has the most scientific merit which contributes most heavily to and illuminates most brightly its neighbouring scientific disciplines (Weinberg 1962, 166)

This paper will investigate the contribution of LIS research to intellectual advancement and knowledge growth of surrounding disciplines. We would like to seek if LIS research publications had "sufficient scientific impact to break through" the LIS intellectual borders and attract citations from neighbouring disciplines (Guerrero-Bote and et al 2007, 425).

2. Interdisciplinary Nature of LIS Discipline

The interdisciplinarity nature of LIS discipline has been repeated in some theoretical studies; e.g. (Borko 1968; Harmon 1971; Smith 1992). Some bibliometric studies explored LIS disciplinary communication further and attempted to determine the disciplines on which LIS research draws or LIS research contributes to their in-

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tellectual growth (Borgman and Rice 1992; Cronin and Pearson 1990) (Holmes 2002; Meyer and Spencer 1996; Peritz 1971; Tang 2004a). In addition, a few studies made an analogy between what is absorbed and what is exported to examine if intellectual trade of LIS field is balanced or not (Cronin and Meho 2008; Large and Koshman 1993; Tang 2004b).

As part of the results of the above-mentioned studies, the following characteristics of LIS interdisciplinary endevours have been emphasized:

2.1 Poor Communication

LIS research poor interaction with other disciplines has been reported in previous studies; In 1971, Peritz suggested that LIS had very little interaction with other fields ; and in LIS literature, there is no trend towards opening up to outside influences (Peritz 1971). Similarly, Saracevic and Perk in 1973 assigned "a limited, close and non-interactive nature" for LIS research which "inhibits this discipline from borrowing research tools from other disciplines and results in a poor interaction" (Saracevic and Perk 1973).

2.2 Intellectual Isolation

The relative isolation of LIS research has also been reflected in previous studies. In 1981, Small suggested that "at least in the context of the social and behavioural sciences, information science appears somewhat isolated. It certainly is not the central discipline with strong linkages to many other fields, that many would like it to be" (Small 1981, 49)

Pettigrew and McKechnie who focused their study on the use of theory in information science, concluded that outside information science field, IS theories are not heavily cited, except by IS authors publishing in other literatures (Pettigrew and McKechnie 2001).

2.3 Intellectual Trade Balance

As a reflection of the nature of LIS field in terms of strength and credibility, *Cronin and Pearson's* analysis proved that 90% of the within information science generated ideas 05/04/2008 "is not formally acknowledged by, or incorporated into, the scholarly apparatus of other disciplines", making LIS field "a net importer of ideas from other disciplines (Cronin and Pearson 1990, 381). This assertion was later confirmed by *Large and Koshman* study ; They concluded that "LIS journals were cited infrequently or not at all" in non-LIS journals, suggesting that "while information scientists exploit the literature of diverse fields, their own work is little used by those outside the LIS domain"(Large and Koshman 1993, 298).

In a very recent study, *Cronin and Meho* focused specifically on the intellectual trading between information studies and other disciplines. Contrary to *Cronin*'s first study (Cronin and Pearson 1990), this study showed that "the field has become a more successful exporter of ideas as well as less introverted than was previously the case" (Cronin and Meho 2008, 551).

3. Highly Cited Papers

Highly cited papers provide an interesting context for investigation because highly cited articles are assumed to have higher research quality than others. (Levitt and Thelwall 2008)

Essential Science Indicators (ESI) database provides the list of Highly Cited Papers for 22 broad fields during the last 10 years (from 1997-2007). *Information Science and Library Science* category is merged ino Social Sciences, General broad category.

Essential Science Indicator has set its selection policy to take into account the fact that older papers are cited more frequently than recent papers and citation rates different significantly across different fields. As the first step towards selecting highly cited papers, citation distributions is constructed for each field and year based on which selection thresholds are set for the same field and year. Then citation data for each paper "are cumulated from the year of publication through the current year", leading to the citation cutoffs specific to each field and

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year to select top highly cited papers for each year and field (Essential Science Indicators 2008). The time span of ESI database is limited to 10 years.

4. Method and Data

This study used journal-to-journal citation data to identify patterns of interdisciplinary outreach of LIS research. Scholarly journals provide a significant communication channel for scientific fields and can act as surrogates for presenting scientific fields in bibliometric studies.

The concept of interdisciplinarity have been defined using ISI subject categories "established by ISI editors over time" in different subject areas. "The process is ongoing and categories are evolving" (Nick Andrews Consultancy 2007) ; each category reflects the overall content of each journal. ISI editors use topical relevance and also citation relevance as the main indicators in determining each journal's subject category (Nick Andrews Consultancy 2007).

A number of previous studies used ISI subject categories as the representative of scientific disciplines for evaluation of science purposes (Guerrero-Bote and et al 2007; Moya-Anegon et al. 2004; Podlubny 2005; Sombatsompop and Markpin 2005; Van Leeuwen et al. 2003; van Leeuwen and Moed 2002). Others used "citations outside category as an indicator of cross-disciplinary research activity" (Porter and Chubin 1985, 161) (Gu 2004; Rinia et al. 2002; Rinia, Van Leeuwen, and Van Raan 2002).

The data used correnspond to 53 *Information Science and Library Science* (IS&LS) category journals, accessible through *Journal Citation Reports Social Science Edition*; Since in *Essential Science Indicator (ESI)* database, there was a general social science category which included IS&LS category journals, we had to search *ESI Most Cited Papers* with all the 53 IS&LS caategory journals, using *ESI's* list of abbreviated titles.

Our search retrieved 209 highly cited papers published in 18 LIS journals, implying that the rest 35 LIS journals (which are among ISI list of journals) didn't produce any highly cited papers during the last 10 years, based on the ESI criteria. *Table one* summerizes the number of highly cited papers produced by each journal title during the last 10 years. In addition, this table demonstrates the total number of citations made to the highly cited papers published in each journal.

For each highly cited paper (published between 1997 and 2007), total citing articles were retrieved through ISI Web of Knowledge (published from 1997 onwards) and the results were analyzed based on the ISI subject categories. Then total number of citations for each ISI subject category were aggregated in each 18 journals level ; number of ISI subject categories in which each LIS journal was cited has been illustrated in *Table one.*

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Table 1. List of 18 LIS journals which produced 209 highly cited papers during the last 10 years

Rank in ESI	Journals	N. of highly cited Papers	Total N. of citations	Total N. of Citing Subject Categories	Impact Factors (2006)	Rank in Impact Factor (2006)
1	Journal of the American Medical Informatics Association	60	3297	120	3.979	2
2	MIS Quarterly	36	3016	61	4.731	1
3	Information System Research	27	1931	58	2.537	3
4	Scientometrics	18	528	67	1.363	12
5	Information & management	11	708	52	2.119	4
6	JASIST	10	850	65	1.555	6
7	Journal of Management Information Systems	9	666	59	1.818	5
8	International Journal of Geographical Information Science	6	462	70	1.36	13
9	Information Processing & Management	6	535	41	1.546	7
10	Journal of Health Communication	6	145	49	1.387	10
11	Annual Review of Information Science & Technology	5	188	28	1.385	11
12	Journal of Documentation	5	462	30	1.439	9
13	Journal of Medical Library Association	4	105	52	1.209	15
14	Journal of Information Science	2	77	22	0.852	19
15	Government Information Quarterly	1	57	12	0.448	33
16	College & Research Libraries	1	32	11	1.164	16
17	ASLIB Proceedings	1	11	2	0.444	34
18	Interlending and Document Supply	1	3	2	0.841	20

Finally, all the citing subject categories were aggregated in 18 LIS journals level and the most highly citing subject categories were identified. The results have been provided in *table three*.

5. Results and Discussion

5.1. Journal Impact Factors (JIFs)
During the last 10 years, only 18 journals out of 52 IS&LS category journals produced highly cited papers listed in *Essential Science Indicators*; We found a 0.885 correlation at the 0.01 level between journals' impact foactors (JIFs) and the number of highly cited papers and a 0.954 strong correlation between JIFs and the number of total citations that these highly cited papers received during the last 10 years. The result have been graphed in *Figure one* and *two*.

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Figure 1. Correlation between JIFs and number of highly cited papers (r=0.885)
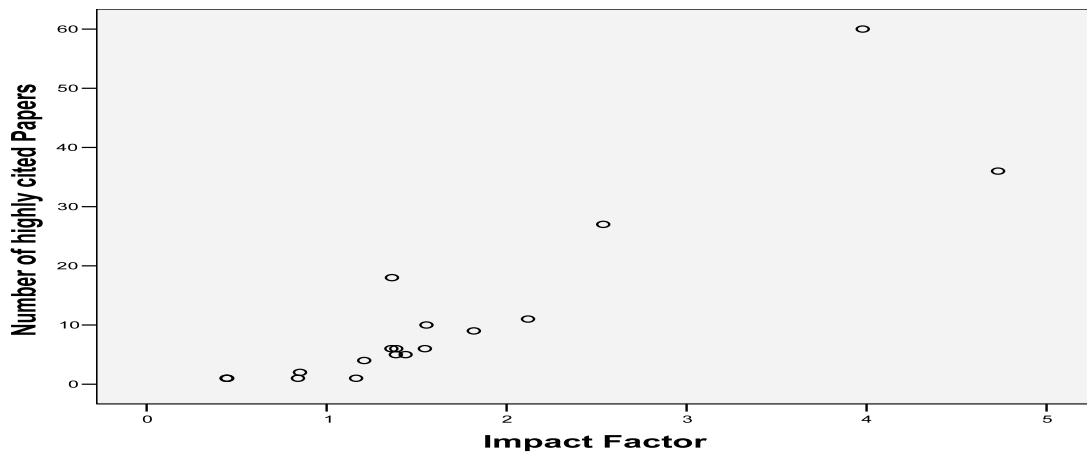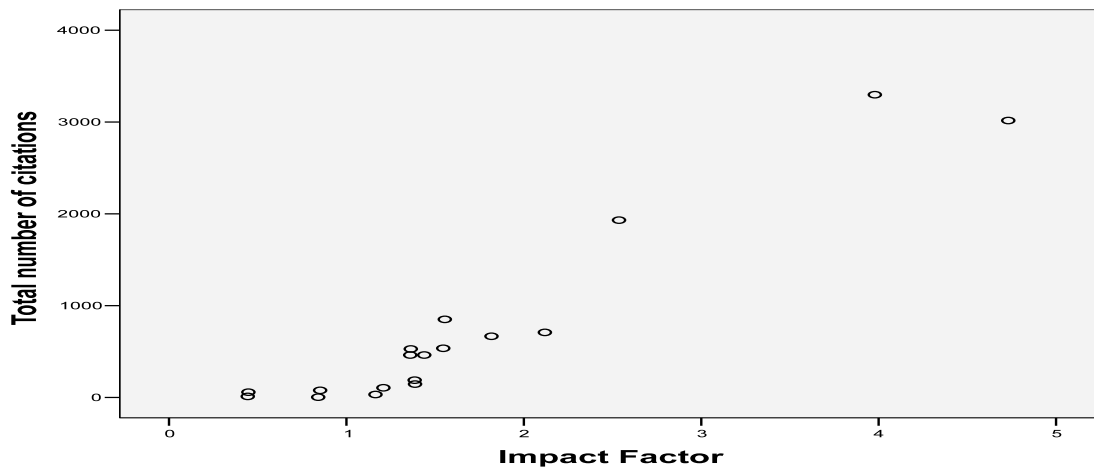

Figure 2. Correlation between JIFs and total number of citations received (r=0.954)

These findings contradicts what Guerrero-Bote et al found in their study ; They rejected the hypothesis that "journals with a greater JIF also have a higher export rate and vice versa" (Guerrero-Bote and et al 2007, 428) ; still suggesting in the abstract that exporting character of subject categories influences journal impact factors (Guerrero-Bote and et al 2007). We believe that this contradiction may be associated with the time span of Guerrero-Bote & et al study which " considered only citations made in 1997 to papers published in 1995 or 1996"(Guerrero-Bote and et al 2007, 425). Another explanation would be related to the different pattern which emerges from highly cited papers.

As it is inferred from *Table one*, all of the 12 first ranked highly cited IS&LS journals were also among the 12 first ranked high impact factor IS&LS journals, which is in accordance with illustrated correlations.

5.2. Interdisciplinarity Level of Journals
Attributions of Journals to multiple ISI subject category as an indicator of interdisciplinarity level of journals has been investigated in previous studies. Rinia compares this approach to co-classification of papers, but with a different level of aggregation (Rinia 2007). Morillo and et al. Studied "ISI multi-classification of journals in catego-

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ries" (Morillo, Bordons, and Gomez 2001, 203) as a bibliometric indicator for measuring interdisciplinarity in Chemistry discipline, though they cautioned against the application of this indicator in broad categories, such as Chemistry or Physics (Morillo, Bordons, and Gomez 2001, 219).

As it has been illustrated in *table two*, the more journals have been attributed to multiple ISI subject categories, the more chance that they have produced highly cited papers. *Journal of the American Medical Informatics Association* ranks first in publishing highly cited papers, and it's the only journal in IS&LS subject category which have been assigned to five ISI subject categories. It's also interesting to note that this journal have been cited in 120 different subject categories and it has the received 267 citations for one of its 1999 articles which is the highest rate of citations even among the highly cited papers.. We tend to interpret this phenomenon as the association between interdisciplinarity publications and exposure to receiving more citations. *Levitt and Thelwall* focused on " the link between multi-disciplinarity and high citation" and suggested that " the promotion of interdisciplinary research in IS&LS may be conductive to improving research quality" (Levitt and Thelwall 2008, 1).

Table 2. Journals and their associated subject categories

Journals	Subject Categories
Journal of the American Medical Informatics Association	IS&LS; Computer Science-Information systems;Computer science-interdisciplinary Applications; Mathematical & Computational biology; Medical Informatics
MIS Quarterly	IS&LS; Computer Science-Information systems; Management
Information System Research	IS&LS;Management
Scientometrics	IS&LS
Information & management	IS&LS; Computer Science-Information systems; Management
JASIST	IS&LS; Computer Science-Information systems
Journal of Management Information Systems	IS&LS; Computer Science-Information systems; Management
International Journal of Geographical Information Science	IS&LS; Computer Science-Information systems; Geography
Information Processing & Management	IS&LS; Computer Science-Information systems
Journal of Health Communication	IS&LS;Communication
Annual Review of Information Science & Technology	IS&LS; Computer Science-Information systems
Journal of Documentation	IS&LS
Journal of Medical Library Association	IS&LS
Journal of Information Science	IS&LS; Computer Science-Information systems
Government Information Quarterly	IS&LS
College & Research Libraries	IS&LS
ASLIB Proceedings	IS&LS; Computer Science-Information systems
Interlending and Document Supply	IS&LS

5.3. Interdisciplinarity Outreach
Our analysis identified the main citing ISI subject categories that IS&LS journals contribute to their intellectual growth. As it has been illustrated in *table three*, *computer science, information systems, IS&LS, management and computer science, interdisciplinary applications* revealed to be the top ISI subject categories which import knowledge and ideas from IS&LS subject category.

In a similar study, *Meyer and Spencer* recognized *computer [science], social sciences, medicine, psychology, and the general science* among the top fields which cite library science literature more frequently" (Meyer and

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Spencer 1996). In a 2004 study, Rong Tang named *Computer science, communication, education, and management science* as the main importers of IS&LS subject category journals (Tang 2004b). In a very recent study, *Cronin and Meho* identified *computer science, business & management, health/medical sciences, education, literature, engineering, history, psychology, law and arts and humanities* as the top 10 importers from information studies (Cronin and Meho 2008, 562).

Table 3. The most highly citing subject categories which cited IS&LS subject category journals

Subject Categories	Percentage of Total citations
COMPUTER SCIENCE, INFORMATION SYSTEMS	21.47%
INFORMATION SCIENCE & LIBRARY SCIENCE	19.74%
MANAGEMENT	10.19%
COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	5.70%
MEDICAL INFORMATICS	5.19%
HEALTH CARE SCIENCES & SERVICES	2.81%
OPERATIONS RESEARCH & MANAGEMENT SCIENCE	2.47%
BUSINESS	2.33%
COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	1.99%
MEDICINE, GENERAL & INTERNAL	1.98%
ENGINEERING, INDUSTRIAL	1.46%
COMPUTER SCIENCE, THEORY & METHODS	1.37%
PSYCHOLOGY, MULTIDISCIPLINARY	1.36%
COMPUTER SCIENCE, CYBERNETICS	1.35%
ERGONOMICS	1.34%
COMPUTER SCIENCE, SOFTWARE ENGINEERING	1.32%
Other Subject Categories	17.94%

5.4. LIS Intellectual Isolation

The question of intellectual isolation of LIS and its situation over time has been a long-running debate among LIS scholars. In 1990, it was suggested that "more than 90% of the ideas generated within the field is not formally acknowledged by, or incorporated into, the scholarly apparatus of other disciplines" (Cronin and Pearson 1990, 385). In 1996, it was shown that "approximately 13 percent of the citations to articles in library science journals come from articles published in non-library science journals" (Meyer and Spencer 1996, 31). In 2008, a 52% striking increase in the export rate from IS to other disciplines over time was reported(Cronin and Meho 2008). This export rate was 42% higher than the previous contribution rate, reported by *Cronin and Pearson* in 1990 (Cronin and Pearson 1990).

As can be seen from *Table three*, IS&LS subject category data has attracted only 19.74% share of the knowledge generated in IS&LS highly cited papers. The rest if it has been absorbed by other disciplines, mostly computer science, management and medical informatics. We tend to limit our findings to highly cited papers, but it still seems a striking increase in other disciplines' citations to the IS&LS knowledge, confirming a less introverted situation which was reported by *Cronin and Meho*.

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6. Conclusion

Clare Beghtol in a paper presented to 1995 CAIS conference criticized information researchers: "we don't make sure that others know what we do, what we can do, or what we have done" (Beghtol, 1995, 37).

Our analysis revealed that at least in the context of highly cited papers, we are contributing more significantly to other disciplines compare to the past. Our generated ideas are more acknowledged in neighbouring disciplines such as computer science and management.

In addition, as it is reflected in the rate of the citations of interdisciplinary journals, we need to strive and encourage more interdisciplinary research, as it seems that interdisciplinary research may be more conductive to highly cited papers, as it was also suggested by *Levitt and Thelwall*.

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