Fall 7-10-2018

Assessing Subject Areas of Worldwide Information Literacy Research and Practice: A Discipline Co-Occurrence Network Analysis Approach

Punit Kumar Singh
Banaras Hindu University, punitbhu@gmail.com

Prof. Ajay P. Singh
Banaras Hindu University, apsingh_73@yahoo.com

Assessing Subject Areas of Worldwide Information Literacy Research and Practice: A Discipline Co-Occurrence Network Analysis Approach

By

Punit Kumar Singh

Librarian

CMP Degree College, Allahabad -211002

(A Constituent PG College of Central University of Allahabad, Allahabad)

E-mail: punitbhu@gmail.com

Orcid ID: https://orcid.org/0000-0003-0266-1075

Scopus Author ID: 57197872928

&

Dr. Ajay P. Singh

Professor,

Department of Library and Information Science

Banaras Hindu University, Varanasi-221005

E-mail: apsingh_73@yahoo.com

Abstract

IL is important due to its potentiality to optimize the use of available information and to transform the novice into self-directed lifelong learners. It has gained ground and much attention in every field of knowledge which is assured by rapid increase in related literature. Since, the IL skills require subject-oriented approach not only to develop standard, guide, framework, tools, etc. but also to evaluate, assess, and impact of IL skills. Thus, measuring of the subject areas of IL publications and it co-occurrence is imperative and the objective of the present study. Based on data from Scopus database, network visualization technique is applied for the measure subject areas co-occurrence and related trends in the IL research articles published during 2001-16. IL publications show linear growth in the study period and trend is also in the same line. IL publications are spread into 26 out of 27 subject areas of Scopus database while there is research gap in Immunology and Microbiology. Social Science is observes as the core subject area while *Computer Sciences, Arts and Humanities, Engineering*, and *Medicine* are playing key role in IL research and practices. *Social Sciences* control the knowledge flow in the network i.e. every new ideas in the network is communicated through this. Highest co-occurrences are observed in *Social Sciences* and *Computer Science* followed by *Social Sciences--Arts and Humanities*; *Social Sciences--Business, Management and Accounting*; and *Social Sciences--Medicine*. The findings of the study are proxy of the current status and trend in the subject areas of worldwide IL publications thus provides panoramic view of IL publications in different subjects of world of knowledge.

Keywords:

Information Literacy, Digital Literacy, Social Network Analysis, Subject Co-Occurrence, Discipline Co-Occurrence Network Analysis

1 Introduction

Before 1980s, the information and knowledge were stored in printed documents. These documents are evaluated, collected, stored and retrieved from library and information centres in which different measures like abstracting, indexing, consolidation, repackaging etc. are applied in order to arrange and retrieve documents. However, these complicated mechanisms are difficult for users to understand and use. On other hand, finding the required information was very difficult due to lack of channels of communications, high cost and less precision and recall. For proper access to required information, library professionals used to provide user education to instruct and guide users. Recently, the advancement of ICT, improvements in sophisticated infrastructures, and use of digital devices and internet etc. have laid information overpopulation. Notwithstanding, the opportunities of ease in access to information come with the challenges to sort and select the right and quality information. Due to easy and flexible access to huge amount of information via variety of applications and channels used to process and distribute, the users are facing challenges to retrieve right information at right time from right source. It is required to be able not only to search the required information but also to evaluate the relevance, accuracy, reliability, and currency of the information and the source. The skills and knowledge to locate, retrieve, evaluate, and use relevant information constitutes information literacy (IL). Julien and Barker (2009) defined the term "information literacy" is as the set of skills required to identify information sources, access information, evaluate it, and use it effectively, efficiently, and ethically (Julien & Barker, 2009).

In present information society, everyone, from novice to expert, from layman to professional, from students/researchers to professors, from farmers to scientists, from buyers to lawyers, from bankers to businessmen, and from politicians to army, are required to be informed. Information became worth and wealth. One who is information literate have more powers than others. On other hand, individuals having no IL Skills have lack of information, dependency upon others to get information, and even to acute levels of information anxiety. IL is important due to its potentiality to optimize the use of available information and to transform the novice into self-directed lifelong learners. Thus, information literacy skill is required by all concerned with every quantum of knowledge worldwide like from farming and horticulture to business and commerce, from aviation to shipping, from banking to life insurance, from health care to court of law (Majumdar & Singh, 2007). IL researchers and practitioners are engaged in development of models, designs, tools, standards, guides and frameworks, course instructions, etc. for enhancing IL skills as well as evaluation, assessment and impact of these in every subject fields. The IL research publications are spread out in large number of major and minor disciplines. The present paper employs co-occurrence network analysis to examine the evolution, current trend and research gaps in respect of disciplines engaging in global IL research and practice as well as intellectual base of IL publications. The finding of the study might be beneficial not only for global perspectives of IL research, but also for librarians, researchers, practitioners and policy makers in order to planning for assessment and provision of IL for those concerned with any segment of world of knowledge.

2 Review of Literature

Bruce (2004) stated information literacy as "a natural extension of the concept of literacy in our information society, and information literacy education is the catalyst required to transform the information society of today into the learning society of tomorrow" (Bruce, 2004). Information literacy comes with several other literacies which are individually or collectively used for IL viz., computer literacy, digital literacy, hyper-literacy, information technology literacy, interactive literacy, Internet literacy, library literacy, media literacy, multiple literacy, network literacy, oral literacy, and visual literacy etc. (Bawden, 2001; Dhiman, 2006). The critical review of the IL publications in different disciplines is imperative for the present study. At the same line, Ferguson et al. (2016) assessed IL competence of biology students (Ferguson, Neely, & Sullivan, 2016) and recognized the importance of awareness about IL among students. Moreover, the same is assessed in the field of Agricultural Sciences (Singh, 2015), Engineering (Alii & Abu-hassan, 2009), Library and Information Science (Islam & Tsuji, 2010), and Biosciences (Biradar & Swapna, 2011) etc. Similarly, IL competence is found vital ability for professionals related to Medical Profession (Lata & Sharma, 2013), Management (Kirk, 2004), Disability (Nanda & Ramesh, 2012), Pharmaceutics (Bawden, Devon, & Sinclair, 2000), Company Audit (Cheuk, 2000), Statistics (Cliftlands, 2005), Firefighting (Lloyd, 2005).

Based on the classification of subject categories in the Journal Citation Report of WoS, Hariri, Shekofteh and Yekta (2008) conducted subject category co-citation network analysis of journals publishing medical sciences in Iran and concluded the strong relationship between Multidisciplinary Sciences and Medical Sciences (Hariri, Shekofteh, & Yekta, 2008). However, Yao et al. (2013) visualized the subject category co-occurrence network of publications of translational medical research and examined the graph-theoretical property of nodes and found Research & Experimental Medicine, Medical Laboratory Technology, General and Internal Medicine is outstanding. Meanwhile, Oncology, Neurosciences & Neurology, Pharmacology & Pharmacy, Cell Biology, Biochemistry & Molecular Biology, Immunology in most central position and playing key role in the development of translation medical research (Yao, Lyu, Ma, Yao, & Zhang, 2013). Similarly, Zhu and Guan (2013) critical examined the subject category co-occurrence network of innovative research and found 48 subject categories in the field in which Business and Economics, Engineering, Public Administration, Operations Research and Management Science, and Computer Science are recognized as the core subjects (Zhu & Guan, 2013). Consequentially, Yao et al. (2014) analysed subject categories co-occurrence network of the Health System Research publications and recognized Public, Environmental and Occupational Health, Health Care Sciences and Services, and General & Internal Medicine as core subjects while nursing, pharmacology and pharmacy, and surgery are also playing key role in the research field (Yao et al., 2014). Moreover, subject co-occurrence network analysis is also applied in Innovation System Research (Z. Liu, Yin, Liu, & Dunford, 2015), Agriculture (Bartol, Budimir, Juznic, & Stopar, 2016), and Global Value Chains (GVC) (L. Liu & Mei, 2016).

3 Data and Methodology Applied

3.1 Data Set

Besides of various data gathering techniques like questionnaires, interviews, observations, archival records, experiments, etc., archival records are most suitable for the studies based on both scientometrics and social network analysis (SNA) due to less labor-intensive and least confusing (Milojevic, 2014). Thus, data collected from records archived in bibliographic databases are found purposeful for the study. In this regard, within top three bibliographic databases viz. Web of Science (WoS) of Thomas Reuters, Scopus of Elsevier, and Google Scholar from Google, Scopus is claimed as the largest abstract and citation database of peer-reviewed literature e.g. scientific journals, books and conference proceedings ("About Scopus," n.d.). It is an international multidisciplinary database indexing over 19000 international peer reviewed journals in all subjects, besides more than 500 international conference/seminar proceedings. Due to its wider coverage to the work of knowledge, Scopus data is assumed to generate a better picture of IL literature in the global context and hence found suitable for this study (Gupta & Dhawan, 2009).

Since, IL is used for same concept with several other names worldwide. In order to get full coverage of the IL research and practice literature, we opted advance search method to retrieve IL research articles published during 2001-16. The search string used is:

(TITLE("information literacy" or "digital literacy" or "media literacy" or "computer literacy" or "infoliteracy" or "informacy" or "information empowerment" or "Information competency" or "information competence" or "information handling" or "information fluency" or "information mediacy" or "information mastery") AND PUBYEAR > 2000 AND PUBYEAR < 2017)

Total of 3859 records having information literacy or its synonymous words in article title are collected in which 3853 records are found suitable for the present study. Figure 1 shows year wise growth of IL publications with trend line in linear regression with $R^2 = 0.955$ which is the best fit and enough to depict the linear growth of the IL publications in future. Hence, the data retrieved from the Scopus database is found suitable for the study.

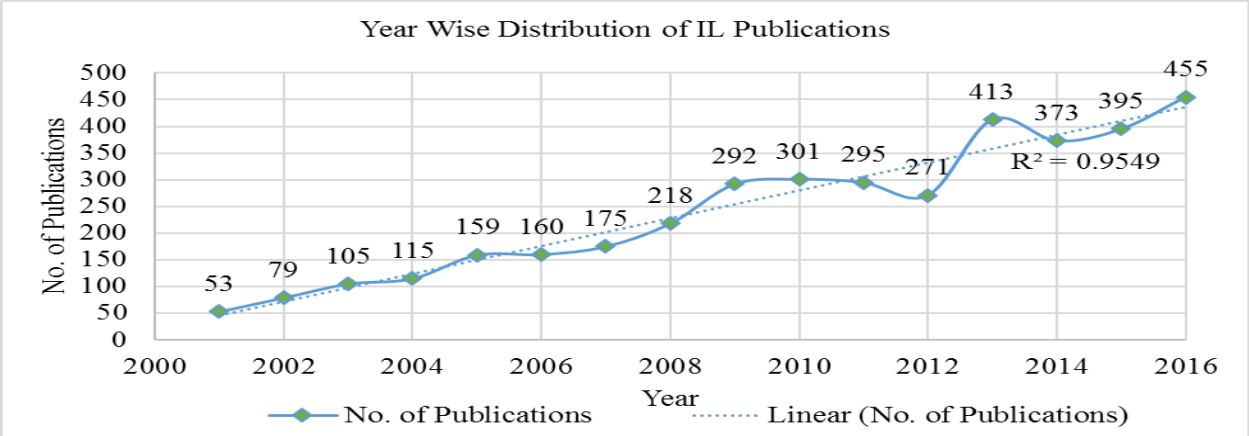

Figure 1. Year Wise Distribution of IL Publications

3.2 Discipline Co-Occurrence Network Analysis

The disciplinary composition of a given research field reveals extent to which the research field is shaped by confluence of disciplines and their respective roles (Ji, Liu, & Zhao, 2015). It can be used to describe the intellectual structure of subject areas by means of mutual relations between subject fields and referred as discipline co-occurrence analysis (L. Liu & Mei, 2016), subject co-classification analysis (Bordons, Morillo, & Gomez, 2004) and more specific in case of WOS data as Subject Category co-occurrence analysis (Yao et al., 2014, 2013). Such studies are based on the classification terms used by the databases to classify the documents published in different sources and channels of communications. These sources are classified by classification schemes adopted by databases.

Particularly, the classification scheme of Scopus database is used to classify the whole world of knowledge into 27 major subject areas which are represented alphabetically in table 1. Each and every document is assigned one or more subject areas according to the context of the source in which these are published. These subject areas are minutely observed for analysis and interpretation of the present study.

Table 1. Alphabetical List of Subject Areas Used To Classify Documents in Scopus Database

S. No.	Subject Area	S. No.	Subject Area	S. No.	Subject Area
1	Agricultural and Biological Sciences	10	Earth and Planetary Sciences	19	Medicine
2	Arts and Humanities	11	Economics, Econometrics and Finance	20	Multidisciplinary
3	Biochemistry, Genetics and Molecular Biology	12	Energy	21	Neuroscience
4	Business, Management and Accounting	13	Engineering	22	Nursing
5	Chemical Engineering	14	Environmental Science	23	Pharmacology
6	Chemistry	15	Health Professions	24	Physics and Astronomy
7	Computer Science	16	Immunology and Microbiology	25	Psychology
8	Decision Sciences	17	Materials Science	26	Social Sciences
9	Dentistry	18	Mathematics	27	Veterinary

3.4 Mapping and Visualization of Network

According to the subject area wise distribution of IL publications, a matrix of citing and cited subject areas are drawn manually and furthermore network file is created for use in mapping and visualization of subject areas co-occurrence network with the help of BibExcel ("BibExcel," 2016; Persson, Danell, & Schneider, 2009). Pajek (de Nooy, Marvar, & Batagelj, 2005) , an exploratory network analysis tool, is used for mapping and visualization of network along with

VOSviewer (Van Eck & Waltman, 2010, 2014). Different centrality measures are calculated through Pajek (Batagelj & Mrvar, 2003). According to Freeman (1979), centrality is an important structural factor influencing leadership, satisfaction, and efficiency (Abbasi, Hossain, & Leydesdorff, 2012).

3.5 Limitations

The present study is limited to the worldwide research papers which have Information Literacy or its synonymous words in the title published during the time period of 2001-2016. The subject analysis is fully based on the subject areas assigned by Scopus according to its own subject classification scheme. Macro level and micro level measures of Social Network analysis are applied in order to get insight from discipline co-occurrence network analysis.

4 Data Analysis and Interpretation

4.1 Ranking of Subject Areas

The ranking of subject areas in descending order of the IL publications, as shown in table 2 and figure 2, depicts that *Social Sciences* (2917) have highest number of IL publications while *Veterinary* (1) have least number of publications. Furthermore, the research gap is observed in the field of *Immunology and Microbiology*. In addition, it is interesting to observe that only 6 subject areas viz. *Social Sciences; Computer Science; Arts and Humanities; Engineering; Medicine; Business, Management and Accounting* constitutes more than 90% of IL literature (see fig 2) while other subject areas includes less than 10 %. It is also worth noting that 3859 publications related to information literacy have 5373 frequencies in the subject areas which indicates the presence of interconnections between the subject areas i.e. some publications have presence in more than one subject areas.

Table 2. Ranking of Subject Areas According to IL Publications during 2001-16

Rank	Subject Areas	No. of Publications	% of 5373
1	Social Sciences	2917	54.290
2	Computer Science	1042	19.393
3	Arts and Humanities	299	5.565
4	Engineering	242	4.504
5	Medicine	238	4.430
6	Business, Management and Accounting	148	2.755
7	Psychology	94	1.749
8	Nursing	65	1.210
9	Health Professions	59	1.098
10	Mathematics	53	0.986
11	Decision Sciences	38	0.707
12	Economics, Econometrics and Finance	30	0.558
13	Chemistry	26	0.484
14	Biochemistry, Genetics and Molecular Biology	24	0.447

15	Agricultural and Biological Sciences	15	0.279
16	Multidisciplinary	13	0.242
17	Environmental Science	12	0.223
18	Earth and Planetary Sciences	11	0.205
19	Chemical Engineering	10	0.186
20	Neuroscience	8	0.149
21	Pharmacology, Toxicology and Pharmaceutics	8	0.149
22	Dentistry	7	0.130
23	Energy	5	0.093
24	Materials Science	5	0.093
25	Physics and Astronomy	3	0.056
26	Veterinary	1	0.019
	Total	**5373**	

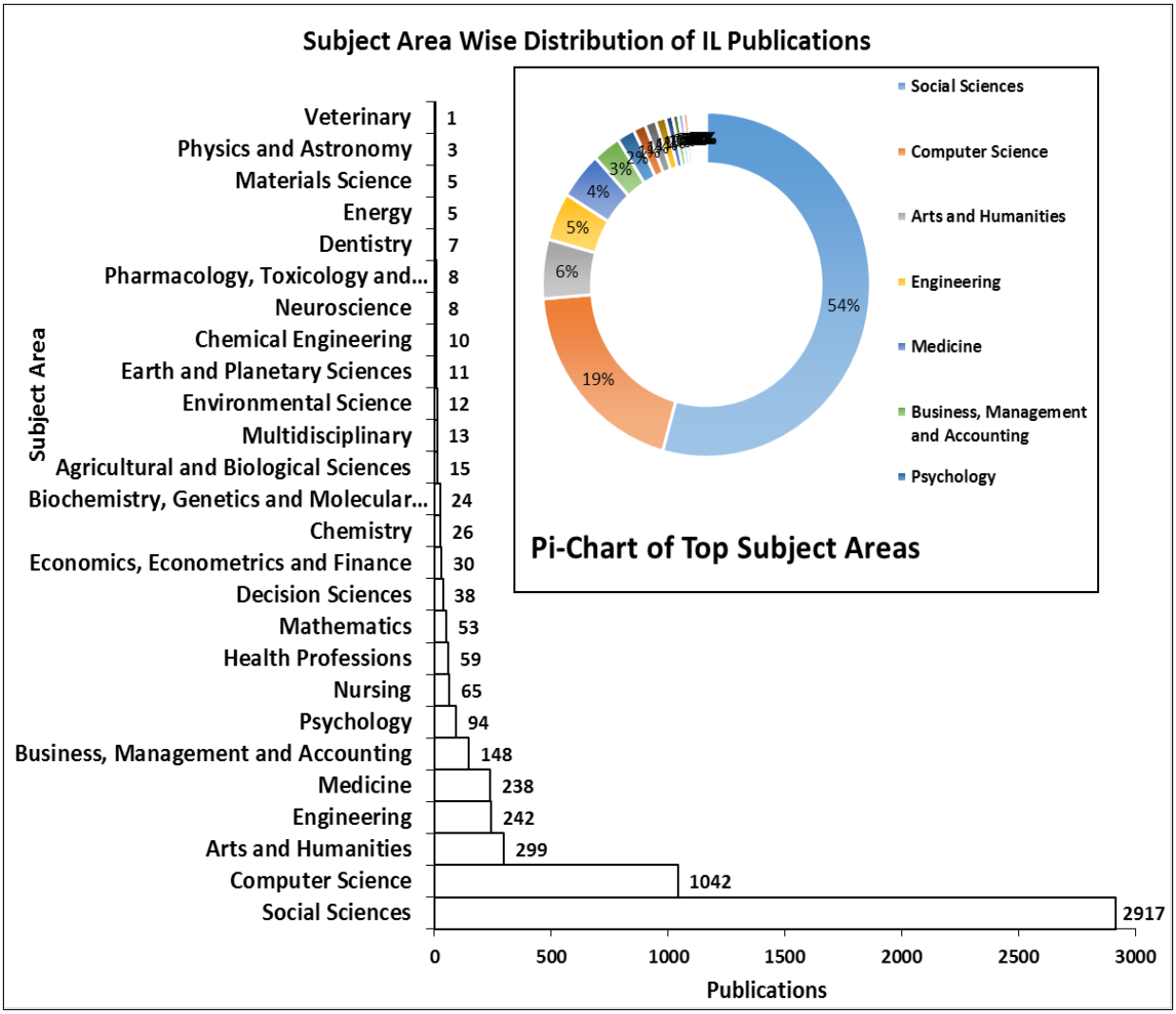

Figure 2. Subject Area Wise Distribution of IL Publications

4.2 Temporal Intellectual Progress of IL Research

The temporal distribution of subject areas wise IL publications during the research period as illustrated in table 3 and figure 3 is reveals the intellectual progress of IL research in different subject areas. This analsys clearly shows the dominance of *Social Sciences* followed by *Computer Science,* and *Art and Humanities* in the research field throughout the research period (see figure 3). From figure 2 and figure 3, It can be observed that the IL reasearch and practices surround aound the *Social Sciences* which includes Library and Information Science as a subject. However, *Computer Science* have prevalent literature on information literacy.

Table 3. Scopus Subject Area Wise Distribution of IL Publications during 2001-16

S.No.*	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1			1	1						11	5	1	3		1	2
2	2	7	2	10	2	11	13	10	22	8	10	25	50	29	24	74
3			2	1	2		5	4		2	1	1	5		1	
4	1	1	3	3	8	8	14	13	5	11	11	14	10	10	23	13
5																10
6							1			2	1	1			4	17
7	2	14	10	10	34	44	61	46	77	93	76	51	136	113	137	138
8		1			6	3		4	2	4	2	2	4	3	2	5
9		1			1	1	1		2			1				
10			1		1		2	2			1	1		2		1
11					1					2		3	1	6	15	2
12										2			1			3
13	4	4	4	11	8	15	5	13	10	23	26	15	33	28	21	22
14					1			1	1					1	1	7
15		1		2	3	6	6	7	6	3	5	3	2	6	5	4
16																
17	2									1	1	1				
18		1	2	3	2	2	3	5	4		1	4	1	5	11	9
19	1	3	10	5	10	22	14	17	23	20	24	20	13	21	15	20
20								1			2	1	3	1	4	1
21	1				1				1		1			1	1	2
22	2	2	3	3	5	5	1	4	5	8	5	3	6	3	7	3
23					1				1		1				1	4
24												1			1	
25	3		3	19	2	3		6	9	10	3	5	5	9	4	13
26	45	68	83	89	117	102	127	165	242	226	232	225	282	270	304	340
27											1					

***S. No. of table 1 for subject areas is used.**

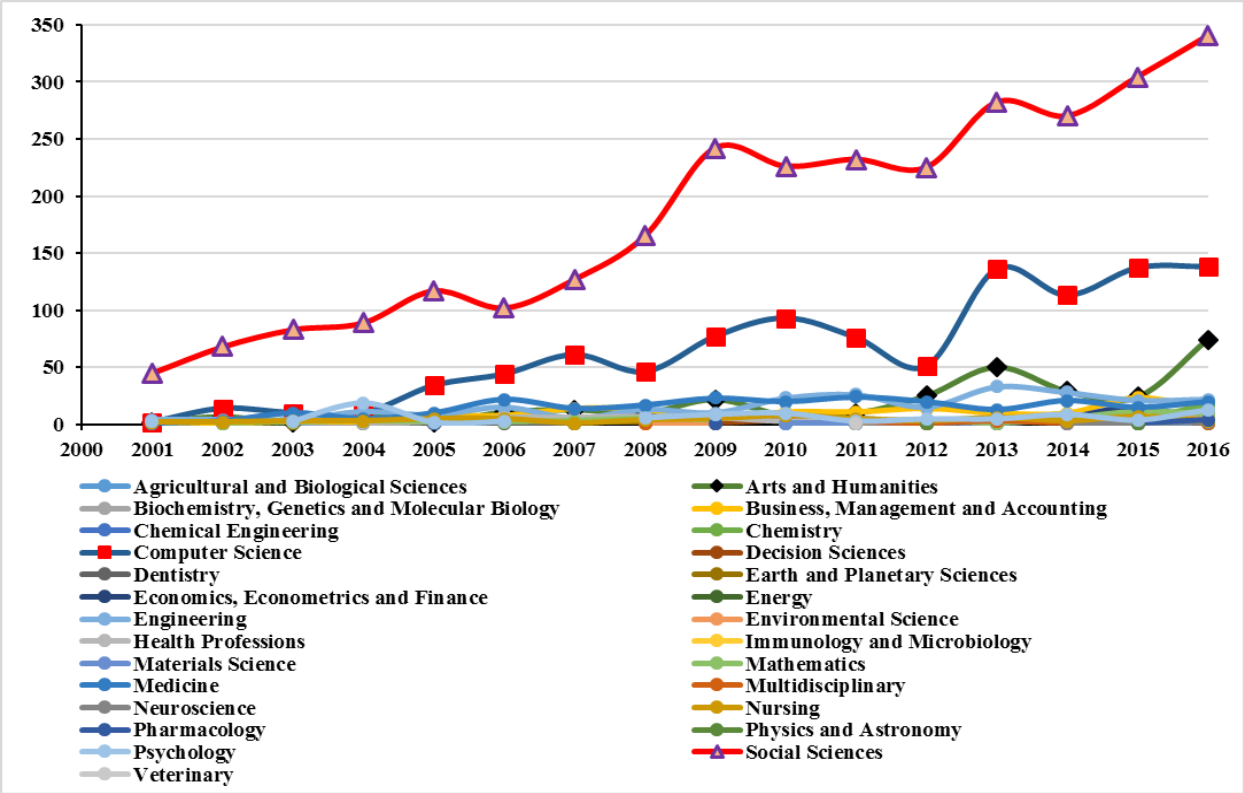

Figure 3. Evolution of IL Publications in Different Subject Areas

4.3 Subject Area Co-Occurrence Network Analysis

Liu et al. (2015) states that "co-occurrence analysis is based on the assumption that when two items appear in the same context, they are related to some degree" (Z. Liu et al., 2015). At this point, it can be expected that when two subjects appear in same article, they are related to some degree in the context of the article. Therefore, analysis of subject area co-occurrence network is the proxy of the subject co-occurrence which is significant in the detection of the disciplines involved in the development of intellectual structure of IL research and practices and can be visualized by social network analysis tools. Several measures of SNA like centrality measures i.e. degree, closeness and betweenness etc. can be applied in order to get close insights about the relatedness of the subjects in the specific research domain.

An undirected network is mapped and visualized with the help of Pajek and VOSviewer and represented in figure 4. Each node in the network represents a subject area, on other hand, each link represents the interconnection between subject areas involved IL research. The size of the nodes as shown in figure 4 are proportional to its link strength and colour of node reflects the clusters of nodes representing the affinity to interconnection to each other. In the meanwhile, the width of links are proportional to degree of relatedness. The details about macro level SNA measures of the network is illustrated in table 4.

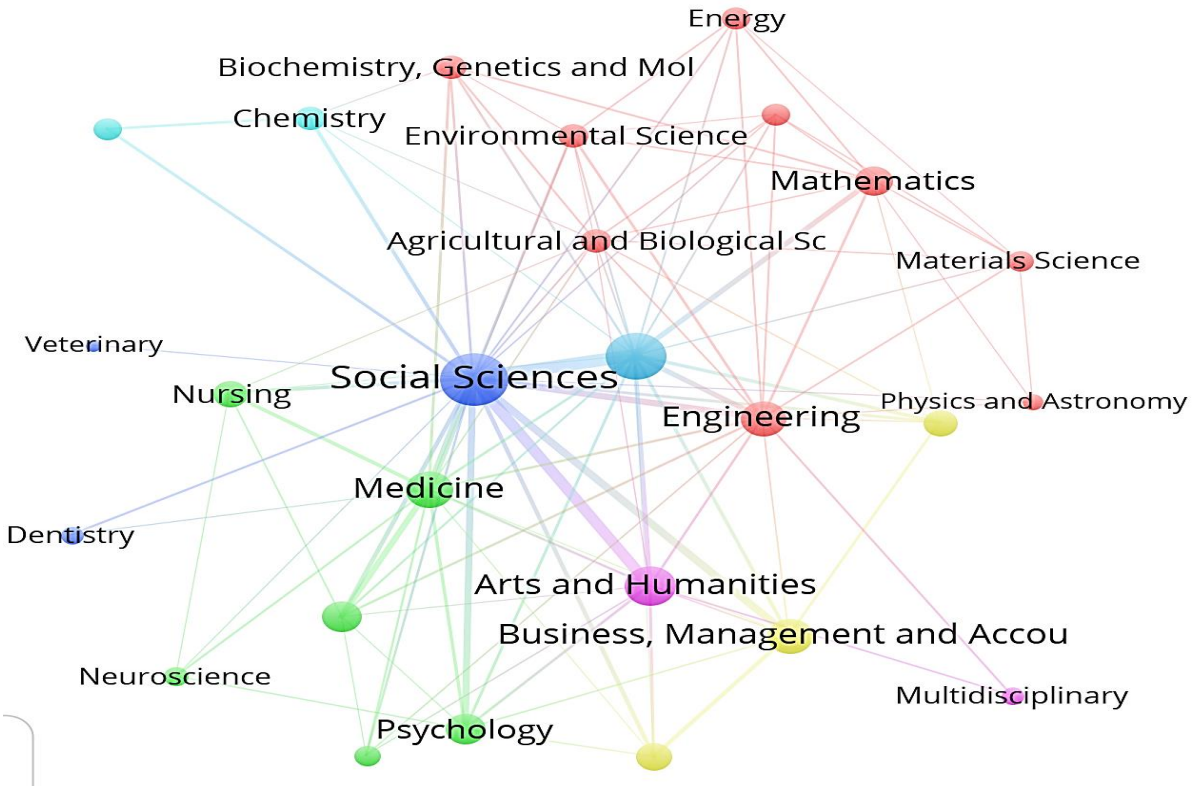

Figure 4. Visualization of Subject Area Co-Occurrence Network of IL Publications

As previously discussed, the present study is focused on the three basic centrality measures proposed by Freeman i.e. degree, closeness, and betweenness centrality measures for both point centrality and graph centrality i.e. micro level and macro level study.

4.3.1 Macro Level Analysis

Macro level analysis is also referred as network level analysis. The co-occurrence network of subject areas involved in IL research consist of 26 nodes which are interconnected with 105 links. It means that 26 out of 27 subject areas of Scopus database are linked to one another to form the network for intellectual base of IL research (see table 4). The network has only one component i.e. giant component of 100 % ratio. At this situation, the subject areas are linked to form a connected graph. Since, high density of network is indicator of high degree of knowledge flow in the nodes. The density (32.3%) of the network shows less density of the network and lower degree of knowledge flow.

Table 4. Macro Level SNA Measures of Subject Co-occurrence Network

SNA Measures	Output
Type of Network	Undirected
Number of Nodes	26
Number of Links	105
Density	0.3230
No. of Components	1
Size of Giant Component	26 (100%)

Average Degree Centrality	8.0769
Average Closeness Centrality	0.6370
Average Betweenness Centrality	0.3234

The degree centrality of a network acts as indicator of the level of centralization of nodes in the network and its collaboration rate. As mentioned in table 4, average degree centrality of the network (8) reveals 8 publications per subject area in whole network which show degree of centralization of subjects in the network and degree of relatedness. The feasibility of more co-occurrences among subjects is expected. 63.7% of closeness centrality of the network affirms that subjects are close to central node for knowledge sharing. Further, betweenness centrality of a network indicates the strength of ties among the nodes. In this context, the betweenness measure is relevant to provide insights about the relations among subjects in the sense of interdisciplinarity. In this analysis, 32.3% of average betweenness centrality is observed at the network level.

4.3.2 Micro Level Analysis

Micro level analysis is also referred as the node level analysis. At this level, the nodes and its features are analysed according to various metrics of social network analysis. In the present study, centrality measures (Freeman, 1978; Newman, 2001; Wasserman & Faust, 1994) like degree, closeness, betweenness and eigenvector are applied to get insight. Ranking of subject areas according to above mentioned four centrality measure has been attempted and shown in table 5.

Measuring the degree centrality of a node is also referred as point centrality measure (Freeman, 1978) and local centrality (Scott, 2000). Freeman (1978) described that an actor with high degree centrality in the network can withhold or distort the information flow in the group because of its role and position with strong relationship in the group (Abbasi et al., 2012). Thus, a node with high degree centrality can be considered as leader or broker in the group (Krackhardt, 2010).

Degree centrality based visualization of the subject co-occurrence network is sketched and provided in figure 5. The size of each node is proportional to the value of degree centrality of the respective subject area, and the colour of nodes are according to the cluster. The modes having same degree centrality have same colour and size. The line between two subject areas indicates the co-occurrence or relationship. The ranking of subject areas according to its degree centralities shows that *Social Sciences* (23) followed by *Computer Science* (18), and *Engineering* (16) have highest degree centralities and can be recognized as leaders in the network. On other hand, *Veterinary* (1) has least degree centrality (see figure 5).

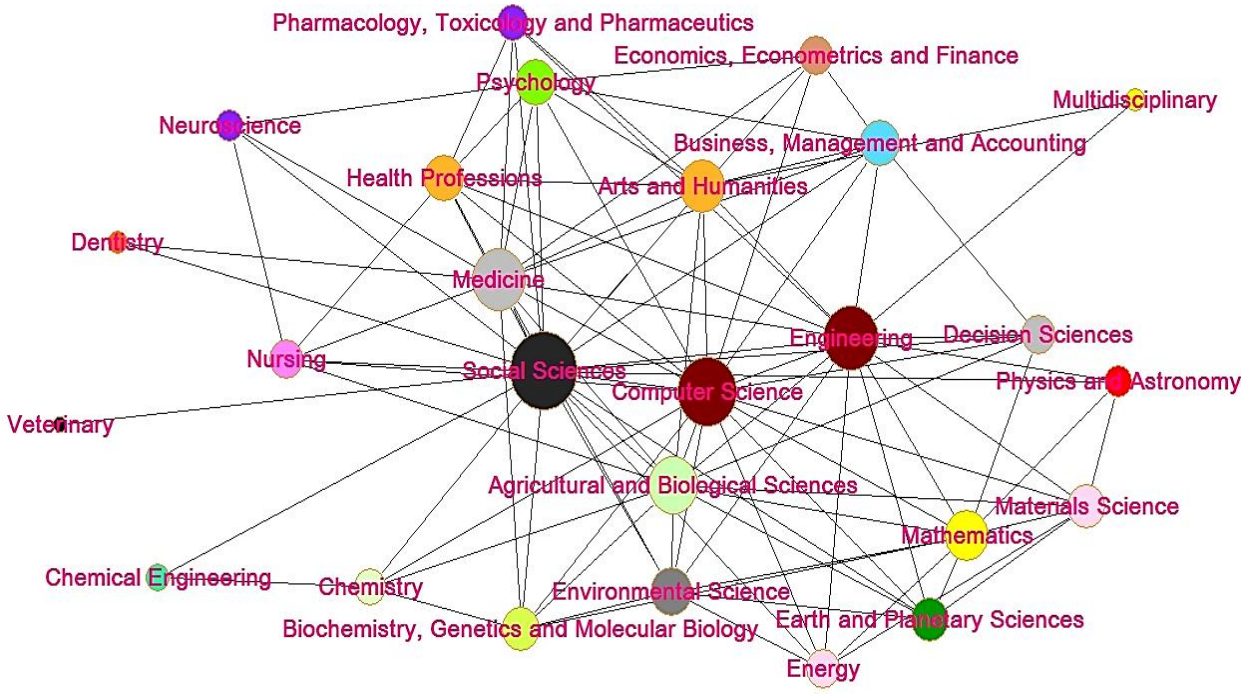

Figure 5. Degree Centrality Visualization of Subject Area Co-Occurrence Network of IL Publications

Further, closeness centrality is significant to assess the extent of independence of a node. Since, a node closer to all other nodes in the network does not depend on any node to access everyone (Zhang, 2010). Higher closeness centrality indicates greater ability to be heard more quickly in the network. Therefore, closeness centrality is proxy of efficiency for communicating with other nodes in the network (Abbasi et al., 2012). On other hand, Leydesdorff (2007) reported that closeness centrality measures fail to demonstrate the interdisciplinary aspects of journal ranked by subject categories (Leydesdorff, 2007) but it is obvious to show the central position of subject areas in the subject co-occurrence network. Table 5 depicts *Social Sciences* (.8929) is the top ranked subject areas lies on most central position in the network followed by *Computer Science* (.7813), *Engineering* (.7353), and *Medicine* (.7143).

Table 5. Centrality Measures of Subject Area Co-Occurrence Network of IL Publications

Rank	Rank by Degree Centrality		Rank by Closeness Centrality		Rank by Betweenness Centrality	
	Subject Area	DC	Subject Area	CC	Subject Area	BC
1	Social Sciences	23	Social Sciences	0.8929	Social Sciences	0.3412
2	Computer Science	18	Computer Science	0.7813	Engineering	0.1096
3	Engineering	16	Engineering	0.7353	Computer Science	0.1064
4	Medicine	15	Medicine	0.7143	Medicine	0.0726
5	Agricultural and Biological Sciences	13	Agricultural and Biological Sciences	0.6757	Agricultural and Biological Sciences	0.0409

6	Arts and Humanities	11	Arts and Humanities	0.641	Arts and Humanities	0.0395
7	Mathematics	10	Environmental Science	0.6098	Mathematics	0.0162
8	Environmental Science	9	Psychology	0.5952	Environmental Science	0.0076
9	Psychology	8	Business, Management and Accounting	0.5952	Psychology	0.0074
10	Business, Management and Accounting	8	Health Professions	0.5952	Health Professions	0.0058
11	Health Professions	8	Earth and Planetary Sciences	0.5814	Biochemistry, Genetics and Molecular Biology	0.0055
12	Biochemistry, Genetics and Molecular Biology	7	Biochemistry, Genetics and Molecular Biology	0.5682	Business, Management and Accounting	0.0048
13	Materials Science	7	Economics, Econometrics and Finance	0.5682	Materials Science	0.0044
14	Earth and Planetary Sciences	7	Decision Sciences	0.5682	Chemistry	0.0043
15	Energy	6	Energy	0.5682	Energy	0.0043
16	Economics, Econometrics and Finance	6	Mathematics	0.5682	Earth and Planetary Sciences	0.0043
17	Decision Sciences	6	Pharmacology, Toxicology and Pharmaceutics	0.5556	Nursing	0.0043
18	Nursing	6	Nursing	0.5556	Physics and Astronomy	0.0037
19	Chemistry	5	Physics and Astronomy	0.5435	Decision Sciences	0.0032
20	Pharmacology, Toxicology and Pharmaceutics	5	Chemistry	0.5435	Neuroscience	0.0007
21	Physics and Astronomy	4	Materials Science	0.5319	Chemical Engineering	0
22	Neuroscience	4	Neuroscience	0.5102	Economics, Econometrics and Finance	0
23	Chemical Engineering	3	Chemical Engineering	0.4902	Pharmacology, Toxicology and Pharmaceutics	0
24	Multidisciplinary	2	Dentistry	0.4902	Veterinary	0

25	Dentistry	2	Veterinary	0.4808	Dentistry	0
26	Veterinary	1	Multidisciplinary	0.4545	Multidisciplinary	0

Betweenness centrality, introduced by Linton C. Freeman (1977), measures the capacity of a node to help to connect components of a network otherwise that would be disconnected whether the node is removed. Accordingly, a node with high betweenness centrality acts as communicator as well gatekeeper that has power to control the information passes between others. It acts as intermediary between components (Bender et al., 2015; Van Eck & Waltman, 2014). As a further matter, it is the measure of the number of shortest paths in a network that passes through a node. It takes into account the connectivity of the node's neighbors by giving a higher value for nodes which bridge clusters (Ilhan, Gunduz-Oguducu, & Etaner-Uyar, 2014). *Social Sciences* (0.3412) followed by *Engineering* (0.1096), and *Computer Science* (0.1064) have highest betweenness centralities and can be recognized as communicators and gatekeepers in the network.

4.4 Ranking of Subject Area Co-Occurrences

An attempt has been made to analyse and rank co-occurrences of subject areas in consequence of intellectual structure of IL Publications during the research period. The result of this analysis is shown in table 7 for top 20 co-occurrences. Besides, the visualization of edge weight subject area co-occurrence network of IL publications is shown in figure 6. The width of the links in figure 6 is relative to the frequency of co-occurrences between nodes.

Table 6. Ranking of Top 20 Subject Area Co-Occurrences

Rank	Co-Occurrences	Frequencies
1	Social Sciences-Computer Science	509
2	Social Sciences--Arts and Humanities	265
3	Social Sciences--Business, Management and Accounting	114
4	Social Sciences--Medicine	94
5	Social Sciences--Engineering	91
6	Social Sciences--Psychology	65
7	Medicine--Health Professions	56
8	Computer Science--Engineering	47
9	Computer Science--Mathematics	45
10	Computer Science--Arts and Humanities	27
11	Social Sciences--Health Professions	24
12	Business, Management and Accounting--Economics, Econometrics and Finance	23
13	Social Sciences--Nursing	21
14	Social Sciences--Economics, Econometrics and Finance	21
15	Medicine--Nursing	20
16	Computer Science--Decision Sciences	19
17	Social Sciences--Chemistry	16
18	Computer Science--Business, Management and Accounting	14

19	Social Sciences--Decision Sciences	12
20	Social Sciences--Chemical Engineering	11

Clearly from table 6 and figure 6, the co-occurrence between *Social Sciences* and *Computer Science* (509) have highest value followed by *Social Sciences--Arts and Humanities* (265); *Social Sciences--Business, Management and Accounting* (114); and *Social Sciences--Medicine* (94). Out of top 20 co-occurrences, ten co-occurrences includes *Social Sciences* as one subject area. Thus Social Sciences is the core subject area of IL publications.

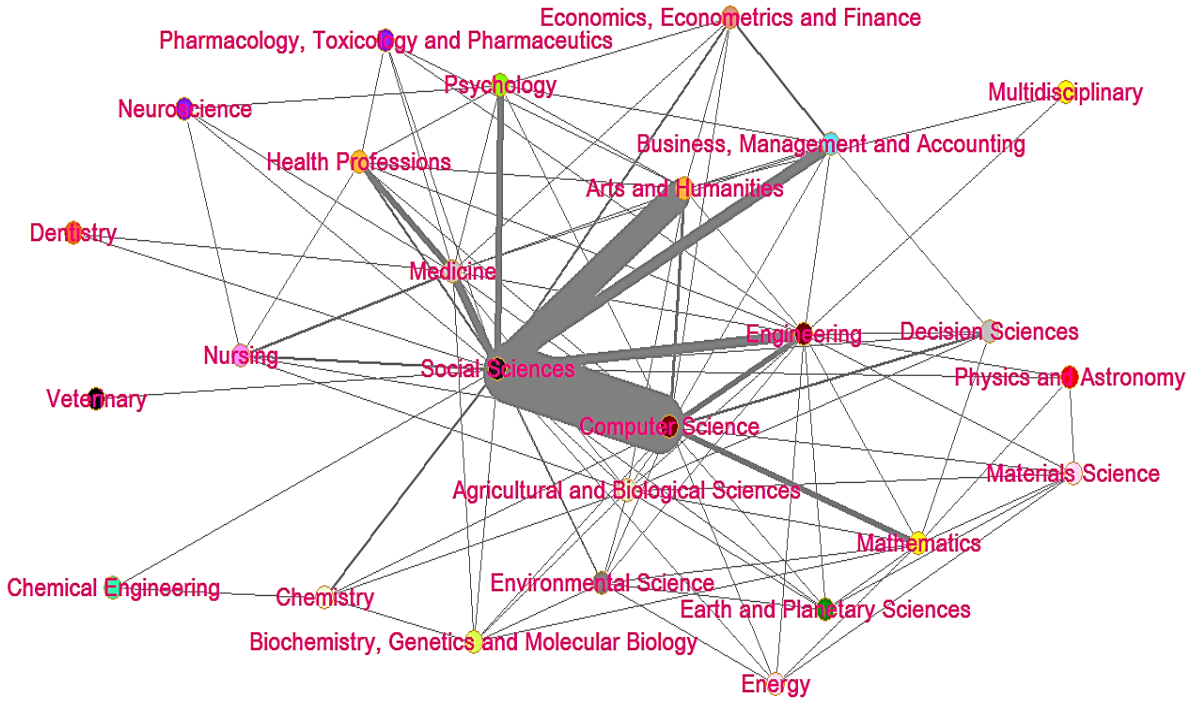

Figure 6. Edge Weight Visualization of Subject Area Co-Occurrence Network of IL Publications

5 Summary and Conclusion

The information literacy research articles published during 2001-16 is spread out in 26 subject areas of Scopus database while the research gap is observed in only one subject area viz. *Immunology and Microbiology.* Larger frequency of publications in subject areas than the actual publications is significant to deduce the existence of co-occurrence of publications in more than one subject areas. More general, subject areas of *Social Sciences, Computer Sciences, Arts and Humanities, Engineering*, and *Medicine* are playing key role in IL research and practices. The temporal analysis of subject areas reflects the growing trend in IL publications in each subject area, however, fast growth is observed in *Social Sciences*, *Computer Science*, and *Arts and Humanities.*

Specifically, *Social Sciences* is recognized as core subject area of IL not only having largest contributions but also leads in the network. *Social Sciences* lies in most central position in the network, so efficient to communicate quickly to others. *Social Sciences* is also acting as the communicator and gatekeeper in the network. Obviously, *Social Sciences* control the knowledge flow in the network. It means every new idea in the network is communicated through this. On other hand, *Computer Science*, *Engineering* and *Medicine* have remarkable position in the network after *Social Sciences*. Surprisingly *Arts and Humanities* having third position in the ranking of subject areas according to IL publications shows much lower position in the ranking of different centrality measures of subject area co-occurrence network (see table 2, figure 2 and table 5). Highest co-occurrences are observed in *Social Sciences* and *Computer Science* followed by *Social Sciences--Arts and Humanities*; *Social Sciences--Business, Management and Accounting*; and *Social Sciences--Medicine*. Consequentially, out of top 20 co-occurrences, ten co-occurrences include *Social Sciences* as one subject area.

Future Research

Subsequent amount of co-occurrence of subject areas and diversity of publications in different subject areas are sign of interdisciplinary characteristics of IL publications. Thus, the interdisciplinary characteristics of IL publications can be examined.

References

Abbasi, A., Hossain, L., & Leydesdorff, L. (2012). Betweenness centrality as a driver of preferential attachment in the evolution of research collaboration networks. *Journal of Informetrics*, *6*, 403–412. https://doi.org/10.1016/j.joi.2012.01.002

About Scopus. (n.d.). Retrieved March 9, 2016, from https://www.elsevier.com/solutions/scopus

Alii, R., & Abu-hassan, N. (2009). Information Literacy of Engineering Students : A Case Study. In *2009 International Conference on Engineering Education (lCEED 2009), December 7-8, 2009, Kuala Lumpur, Malaysia Information* (pp. 143–147).

Bartol, T., Budimir, G., Juznic, P., & Stopar, K. (2016). Mapping and classification of agriculture in Web of Science : other subject categories and research fields may benefit. *Scientometrics*, *109*, 979–996. https://doi.org/10.1007/s11192-016-2071-6

Batagelj, V., & Mrvar, A. (2003). Pajek- Analysis and visualization of large networks. In M. Junger & P. Mutzel (Eds.), *Graph drawing software* (pp. 77–103). Berlin: Springer.

Bawden, D. (2001). Information and Digital Literacies: A Review of Concepts. *Journal of Documentation*, *57*, 218–259.

Bawden, D., Devon, T. K., & Sinclair, I. W. (2000). Desktop information systems and services: A user survey in a pharmaceutical research organisation. *International Journal of Information Management*, *20*, 151–160.

Bender, M. E., Edwards, S., Philipsborn, P. Von, Steinbeis, F., Keil, T., & Tinnemann, P. (2015). Using Co-authorship Networks to Map and Analyse Global Neglected Tropical Disease Research with an Affiliation to Germany. *PLoS Negl Trop Dis*, *9*(12), 1–21. https://doi.org/10.1371/journal.pntd.0004182

BibExcel. (2016). Retrieved August 11, 2016, from http://www8.umu.se/inforsk/Bibexcel

Biradar, B. S., & Swapna, G. (2011). Information Literacy Competency : A Study of Bioscience Students of Kuvempu University. In *8th International CALIBER - 2011* (pp. 445–455).

Bordons, M., Morillo, F., & Gomez, I. (2004). Analysis of Cross-Disciplinary Research through Bibliometric Tools. In H. F. et al. Moed (Ed.), *Handbook of Quantitative Science and Technology Research* (pp. 437–456). Netherlands: Kluwer Academic Publishers.

Bruce, C. (2004). Information Literacy as a Catalyst for Educational Change. A Background Paper. In P. A. Danaher (Ed.), *"Lifelong Learning: Whose responsibility and what is your contribution?", the 3rd International Lifelong Learning Conference,* (pp. 8–19).

Cheuk, B. W. Y. (2000). Experiencing information literacy in the workplace: A process approach. , Centre for In. In C. Bruce & P. Candy (Eds.), *Information literacy around the world: Advances in programs and research* (pp. 177–191). Wagga Wagga, Australia: Charles Sturt University.

Cliftlands, A. (2005). Information literacy in the Office for National Statistics. *State Librarian*, 52–58.

de Nooy, W., Marvar, A., & Batagelj, V. (2005). *Exploratory Network Analysis with Pajek*. New York, NY: Cambridge University Press.

Dhiman, A. K. (2006). Information literacy and the role of librarian. In *4th International Convention CALIBER-2006, Gulbarga, 2-4 February, 2006* (pp. 390–398). Ahmedabad: INFLIBNET Centre.

Ferguson, J. E., Neely, T. Y., & Sullivan, K. (2016). A Baseline Information Literacy Assessment of Biology Students. *Reference & User Services Quarterly*, *46*(2), 61–71.

Freeman, L. C. (1978). Centrality in Social Networks Conceptual Clarification. *Social Networks*, *1*, 215–239.

Gupta, B. M., & Dhawan, S. M. (2009). Status of India in science and technology as reflected in its publication output in the Scopus international database , 1996 – 2006. *Scientometrics*, *80*(2), 475–492. https://doi.org/10.1007/s11192-008-2083-y

Hariri, N., Shekofteh, M., & Yekta, A. S. (2008). Co-citation scientific maps : A case study of medical sciences in Iran. *Journal of Paramedical Sciences*, *3*(1), 47–60.

Ilhan, N., Gunduz-Oguducu, S., & Etaner-Uyar, A. S. (2014). Introduction to Social Networks : Analysis and Case Studies. In S. Gunduz-Oguducu & A. S. Etaner-Uyar (Eds.), *Lecture Notes in Social Networks* (pp. 1–18). © Springer-Verlag Wien. https://doi.org/10.1007/978-3-7091-1797-2

Islam, M. A., & Tsuji, K. (2010). Assessing information literacy competency of Information Science and Library Management graduate students of Dhaka University. *International Federation of Library Associations and Institutions (IFLA)*, *36*(4), 300–316. https://doi.org/10.1177/0340035210388243

Ji, S., Liu, S., & Zhao, Y. (2015). Visualisation analysis of the international research of marine

spatial planning. In S. Zhou, A. Patty, & S. Chen (Eds.), *Advances in Energy Equipment Science and Engineering: Proceedings of the International Conference on Energy Equipment Science and Engineering, (ICEESE 2015), May 30-31, 2015*, (p. 2894). Guangzhou, China.

Julien, H., & Barker, S. (2009). How high-school students find and evaluate scientific information: A basis for information literacy skills development. *Library & Information Science Research*, *31*, 12–17.

Kirk, J. (2004). Information and work: Extending the roles of information professionals. In *Challenging ideas: Australian Library and Information Association 2004 biennial conference*.

Krackhardt, D. (2010). Social networks. In J. M. Levine & M. A. Hogg (Eds.), *Encyclopedia of group processes and intergroup relations* (pp. 817–821). Los Angles: Sage.

Lata, S., & Sharma, S. (2013). Information Literacy among Faculty and Students of Postgraduate Institute of Medical Education and Research , Chandigarh and Pt . B . D . Sharma University of Health Sciences , Rohtak. *International Journal of Information Dissemination and Technology*, *3*(4), 244–248.

Leydesdorff, L. (2007). " Betweenness Centrality " as an Indicator of the " Interdisciplinarity " of Scientific Journals. *Journal of the American Society for Information Science and Technology*, *58*(9), 1303–1309.

Liu, L., & Mei, S. (2016). Visualizing the GVC research: a co-occurrence network based bibliometric analysis. *Scientometrics*, *109*, 953–977. https://doi.org/10.1007/s11192-016-2100-5

Liu, Z., Yin, Y., Liu, W., & Dunford, M. (2015). Visualizing the intellectual structure and evolution of innovation systems research : a bibliometric analysis. *Scientometrics*, *103*, 135–158. https://doi.org/10.1007/s11192-014-1517-y

Lloyd, A. (2005). Information literacy: Different contexts, different concepts, different truths? *Journal of Librarianship and Information Science*, *37*, 82–88.

Majumdar, S., & Singh, R. (2007). Information Literacy and Competency Programme in Academic Libraries: A Case Study of DULS. In *5th International CALIBER-2007, Panjab University, Chandigarh, 08-10 February, 2007* (pp. 608–616). Ahmedabad: INFLIBNET Centre.

Milojevic, S. (2014). Network Analysis and Indicators. In Y. et al. Ding (Ed.), *Measuring Scholarly Impact* (pp. 57–82). Springer International Publishing Switzerland. https://doi.org/10.1007/978-3-319-10377-8

Nanda, A., & Ramesh, D. B. (2012). Assessment of Information and Communication Technology (ICT) Literacy among Teachers and Practitioners in the Field of Disability. *International Journal of Information Dissemination and Technology*, *2*(1), 54–61.

Newman, M. E. J. (2001). The Structure of Scientific Collaboration Networks. *Proceedings of the National Academy of Sciences of the United States of America*, *98*(2), 404–409.

Persson, O., Danell, R., & Schneider, J. W. (2009). How to use Bibexcel for various types of bibliometric analysis. In . F. Åström, R. Danell, B. Larsen, & J. Schneider (Eds.), *Celebrating scholarly communication studies: A Festschrift for Olle Persson at his 60th Birthday* (pp. 9–24). Leuven, Belgium: International Society for Scientometrics and Informetrics.

Scott, J. (2000). *Social network analysis: A handbook* (2nd ed). London: Sage Publications.

Singh, P. K. (2015). Assessing the Information Literacy among Agricultural Science Undergraduate Students of BHU. In *60th ILA International Conference (Diamond Jubilee) on Embedded Librarianship and Technological challenges of the Digital Age* (pp. 460–469).

Van Eck, N. J., & Waltman, L. (2010). Software survey : VOSviewer , a computer program for bibliometric mapping. *Scientometrics*, *84*, 523–538. https://doi.org/10.1007/s11192-009-0146-3

Van Eck, N. J., & Waltman, L. (2014). Visualizing Bibliometric Networks. In Y. et al Ding (Ed.), *Measuring Scholarly Impact* (pp. 285–320). Springer. https://doi.org/10.1007/978-3-319-10377-8

Wasserman, S., & Faust, K. (1994). *Social Network Analysis: Methods and Applications*. New York, NY: Cambridge University Press.

Yao, Q., Chen, K., Yao, L., Lyu, P., Yang, T., Luo, F., … He, L. (2014). Scientometric trends and knowledge maps of global health systems research. *Health Research Policy and Systems*, *12*(26). https://doi.org/doi:10.1186/1478-4505-12-26

Yao, Q., Lyu, P., Ma, F., Yao, L., & Zhang, S. (2013). Global informetric perspective studies on translational medical research. *BMC Medical Informatics and Decision Making*, *13*(77), 1–15. https://doi.org/10.1186/1472-6947-13-77

Zhang, M. (2010). Social Network Analysis : History , Concepts , and Research. In B. Furth (Ed.), *Handbook of Social Network Technologies and Applications* (pp. 5–21). Springer Science+Business Media, LLC. https://doi.org/10.1007/978-1-4419-7142-5

Zhu, W., & Guan, J. (2013). A bibliometric study of service innovation research : based on complex network analysis. *Scientometrics*, *94*, 1195–1216. https://doi.org/10.1007/s11192-012-0888-1