A Local Citation Analysis in China: From Wuhan University Faculty in Surveying and Mapping

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Available online 15 July 2005

Citations in journal articles published by Faculty in Departments of Surveying and Mapping at Wuhan University between 1994 and 2003 are counted and analyzed to form several available citation lists. The study discusses the importance of journal material and interdisciplinary journals to the field and is used for guiding collection development decisions.

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Introduction

There is no doubt that computer technology has developed very rapidly in recent years. It has affected almost every field of scientific technologies, and surveying and mapping are no exception. Among the newest computer-driven technologies available to assist surveying engineers in their work of developing and processing spatial data are (1) total station instruments, including robotic systems; (2) global positioning systems (GPS); (3) digital photogrammetry and light detection and ranging (LIDAR) systems; (4) satellite remote sensing; and (5) geographic information systems (GIS). Surveying and mapping are thus in the midst of perhaps the most exciting period of its existence. Never before have so many modern high-speed technologies been available for performing the work of collecting and processing data about planet earth. As a consequence, the manner, breadth, and scope of surveying and mapping have changed dramatically in recent years, and many in the field have concluded that the name ''surveying'' no longer adequately reflects the expanded and changing role of their profession. A new name ''geomatics'' has appeared, and this term has been adopted by several international bodies including the International Standards Organization (ISO).[1]

In China, there are fifty surveying and mapping faculties distributed in over twenty universities, with 20,000 students. The Wuhan Technical University of Surveying and Mapping (WTUSM) was from the beginning the largest education base in China for surveying and mapping, having the most disciplines of surveying and cartography in the world, and was merged into one new comprehensive university ''Wuhan University'' on August 2, 2000. The original staff of surveying and mapping are distributed in four schools and one state laboratory attached to the new university.[2] These faculty are the most representative researchers and scientists in this subject in China. According to our investigation, their literature needs reflect similar changing trends with researchers around the world. Researchers in this discipline frequently cite literatures from related fields, such as geography, astronomy, geophysics, geology, oceanography, space science, environment, various engineering sciences, computer and communication technology, etc., demonstrating the increasingly interdisciplinary nature of the field. To know which materials they need most is a challenge for librarians.

On the other hand, for academic librarians with selection responsibilities it is an ongoing concern that the number and cost of serials continue to escalate, while the increase of funds in their materials budgets does not keep pace. This has been an issue of particular concern in China since China joined World Trade Organization (WTO) from October 2001, Chinese libraries began to observe WTO's regulations. This meant that photocopied print journals which had served teaching and research for many years were now a thing of the past. Chinese libraries were required to abandon their previous nonstandard behavior and subscribe to foreign journals in the original and authorized edition. Because the original journals cost ten times as much as the cost of photocopied journals, in our library foreign journals subscriptions have been decreasing in recent years. So to know which journals our clientele prefer is a very important issue for librarians.

Librarians have used several different quantitative methods to understand patrons' needs, including circulation and shelving data, the analysis of interlibrary loan requests, citation analysis, etc. But citation analysis has advantages over the others. First, the citing of a publication may be used as the best indication of its importance since citation implies that researchers read the publication and obtained assistance from it. Secondly, the management of a citation study is relatively simple; a single person can conduct a citation study. Furthermore citation study is a reliable, valid, rapid, and economical method, and the data are obtained unobtrusively. Probably most important for an academic librarian is the fact that a citation is a component of the most important product of the academic enterprise—the scholarly publication. Any attempt to determine for a given field the journals that are important for an academic library is suspect unless it includes analysis of citations.[3]

Citation analysis methods may be divided into global and local. Librarians often rely on local citation data rather than global citation data, despite the ease of gathering global citation data and the ability to manipulate them electronically, This is because global use may vary greatly from local, depending on a given institution's research or teaching focus. Global studies provide only an average measure of literature use, with local conditions leading to departures from the average. A library must serve its local users, not a subject field. Thus, the librarian needs to know what is being used and cited by those who use the library, not what is being cited by those who publish in a particular set of journals.

Graduate students and faculty are all important users of the university library. Graduate students may be the most active users of library collections, but some graduate students may rely primarily on the sources that are local or conveniently available in the library collection, and their reference lists may reflect that. Then a weak collection could lead to an inadequate study of citations. Faculty members, in contrast, often have personal subscriptions and extended professional networks, so they are less likely to depend on the convenience of their local collections. Faculty are clearly the more vocal and more stable users, often influencing library collection development decisions. Therefore, any useful local citation study must consider faculty research needs.[4]

Accordingly, over the summer vacation in 2004 the authors conducted this study of citations from Wuhan University faculty publications in the surveying and mapping field. Citation data were collected from databases on the campus Web site, creating several usable citation lists. The results of this research were intended to assist collection development and contribute to the work of faculty liaison librarians by offering faculty data on publication use.

Literature Review

Many citation analyses appear in the recent library literature. Laurel A. Haycock analyzed 4542 citations from forty-three education dissertations completed in 2000–2002 at the University of Minnesota for collection development purposes. The aims of the citation analysis were to ensure that the most frequently cited journals were retained on subscription, to evaluate the serial/monograph ratio in citations in comparison with other studies, and to explore this in the context of funding ratios.[5] Dulle, Lwehabura, Matovelo, and Mulimila analyzed 33,922 citations from 295 MSc theses, twenty-one PhD theses, and 309 conference papers and made a list of citation patterns of agricultural scientists in Tanzania. A list of local core agricultural journals was established by using citation analysis and user opinions.[6] Paul Kelsey and Tom Diamond counted and analyzed citations in articles published from 1990 to 2002 by faculty teaching at selected southern universities in the United States to form a core list of the most highly cited journals in the field of forestry. This core list of journals is compared with the list of primary forestry serials compiled by the Cornell Core Agricultural Literature Project. The authors analyzed similarities and differences between the studies and discussed the importance of ecological and interdisciplinary journals for forestry research.[7]

Such studies cross fields and institutions. Claudia Lascar and Loren D. Mendelsohn conducted a bibliometric analysis of publications emanating from a small number of structural biologists sampled from multiple institutions. The citations analyzed covered a very large subject range and revealed the importance of interdisciplinary journals to the field. The results were used to compile a short list of specialized titles for supporting structural biology.[8] Watson introduced a collection evaluation method that the Association of Vision Science Librarians (AVSL) used to create two core lists of materials, drawn from citations in the reference book, *Duane's Clinical Ophthalmology* (1998 edition), for the purpose of evaluating the collections in the libraries of AVSL members.[9]

Methodology and Data Collection

The authors analyzed publications from surveying and mapping faculty members teaching in Wuhan University, in four schools and one attached state laboratory, namely, the School of Surveying and Mapping, the School of Remote Sensing Information Engineering, the School of Resources and Environment, the School of Urban Studies, and the State's Key Laboratory of Cartographical, Remote Sensing, and Information Engineering. A total of 168 key faculty members were selected by searching the university's Web pages or examining the telephone directories from these schools and laboratory. Among the faculty selected there are fifty-one doctoral tutors (senior faculty allowed to supervise PhD students) and 117 general teachers. In the current study articles by faculty in journals published from 1994 to 2003 and indexed in VIP Database of Chinese Science and Technology Periodicals were sought. In order to avoid repeating co-author titles, 1091 articles retrieved by first author were reduced to 1025 articles

with citations, which were retained as the sample of the present study. The articles contained 7228 references.

To determine the characteristics of the materials cited by faculty and to establish a list of the cited material format, every citation was coded and tallied based on the format of the material: journal, monograph, conference proceeding, thesis/dissertation, or other. If the correct formats of citations were uncertain, then they were verified by standard sources such as the Union Service System of Chinese National Science Digital Library (USSCNSDL) and OCLC. If the formats still could not be verified, they were counted in the ''other'' category, which also included materials such as technical reports, standards, Web pages, etc. In order to ascertain how long the journal cited is useful to readers, the years between when the original journal article was published and when it was cited were listed separated by Chinese or foreign for each cited journal.

To yield a list of the top fifty foreign journals most cited by faculty, and analyze title dispersion, each title cited was recorded and counted. If the title was uncertain, for example, an abbreviated title, previous title, etc., it was also verified, using the sources of USSCNSDL and OCLC. In this current study the 2003 edition of *A Guide to the Core Journals of Science and Technology in Foreign Countries* (GCJSTFC) published by Beijing World Publishing Corporation[10] was used as the source of the global core journal data, which was compared with the list of top fifty foreign journals. Also, from GCJSTFC, a core journal selection of titles in surveying and mapping was created, using the synthetic filter method of citation, abstract, impact factor, and specialist check. Forty-eight core journals were selected and formed a ranked list in the discipline field.

In order to determine the local availability in Wuhan University library of the foreign journals cited by faculty, all titles cited twice or more were cross-checked with the library holdings on the OPAC and the Full Text Foreign Electronic Periodical Guidance on the library Web site. The holding status was tallied according to three formats, ''journal held,'' ''journal not held,'' and ''journal once held, canceled.'' ''Journal held'' means a print subscription for 2004 is held or is available online as electronic full text on the library Web site. ''Journal not held'' covers journals never subscribed to and unavailable online now. ''Once held, canceled'' shows the journal was once subscribed to, but was canceled later and is unavailable online now.

Subjects for journals cited twice or more were determined by titles, classification symbol, and foreign original fascicle numbers that were retrieved from USSCNSDL. In the subject dispersion list the authors divided the titles cited into twelve classes, which included surveying and mapping, geophysics, computing, geography, space science, astronomy, communication technology, oceanography, geology, engineering, architecture, and the environment. If the cited journal did not fit anyone of the twelve categories listed above, the designation ''other'' was assigned.

Results and Discussion

The 1025 articles by faculty generated a total of 7228 citations. The total number of references cited in 527 doctoral tutors' articles was 4449, ranging from a low of 5 to a high of 122, and averaged 8.44 citations each. The total number of references cited in 498 general teacher's articles was 2779, ranging from a low of 3 to a high of 31, and averaged 5.58 citations each. The average number of references for each doctoral tutor's and general teacher's article overall was 7.05. Comparatively, the average citation numbers in the present Chinese study are much fewer than forty citations per article of Lascar and Mendelsohn in structural biology research in the United States.[11]

Six tables display the results of the citation analysis. Table 1 lists citation frequency and percent of the material formats cited for the two faculty ranks.

Journals accounted for 50.03 percent of the citations by doctoral tutors and 45.84 percent by general teachers, for an overall journal citation rate of 48.43 percent. Monographs accounted for 30.21 percent of the citations by doctoral tutors and 40.34 percent by general teachers, for an overall monograph citation rate of 34.10 percent. Conference proceedings are cited far less, accounting for 9.96 percent of the citations by doctoral tutors and 5.36 percent by general teachers, for an overall rate of 8.19 percent. It is evident that doctoral tutors are more likely to cite journal and conference proceedings than general teachers and less likely to cite monographs than general teachers. These results are consistent with other studies that show journal articles as the most heavily cited type of material. For example, Vishwanatham reported an overall journal citation rate of 56.9 percent and 23.4 percent for books (monographs) in his study of the medical informatics field.[12] Similarly, Dulle et al. found that in agricultural science theses and dissertations, journals constituted 44.3 percent of the items cited, followed by books, at 25.1 percent.[13]

Tables 2 and 3 provide profiles of the age of Chinese and foreign journals, respectively, analyzed according to the number of years between the publication date of the Wuhan faculty article and the publication date of the cited journal article.

Table 1
Frequency of Material Type Cited

Type of Citation		Journals	Monographs	Conference Proceedings	Thesis/Dissertation	Other	Total
Doctoral tutor	Count	2226	1344	443	151	285	4449
	%	50.03	30.21	9.96	3.39	6.41	100
General teacher	Count	1274	1121	149	97	138	2779
	%	45.84	40.34	5.36	3.49	4.97	100
Total	Count	3500	2465	592	248	423	7228
	%	48.43	34.10	8.19	3.43	5.85	100

Table 2
Age of Chinese Journals Articles Cited

Years	Count	%	Cumulative Percent
0	85	4.12	4.12
1	365	17.69	21.81
2	423	20.50	42.32
3	352	17.06	59.38
4	270	13.09	72.47
5	155	7.51	79.98
6	90	4.36	84.34
7	73	3.54	87.88
8	50	2.42	90.31
9	40	1.94	92.24
10	41	1.99	94.23
11	31	1.50	95.73
12	24	1.16	96.90
13	21	1.02	97.92
14	6	0.29	98.21
15	8	0.39	98.59
16	9	0.44	99.03
17	5	0.24	99.27
18	3	0.15	99.42
19	2	0.10	99.52
20	3	0.15	99.66
21–30	5	0.24	99.90
31–40	1	0.05	99.95
41–50	1	0.05	100

It appears that the use of foreign journals is much less time dependent than the use of Chinese journals. To cover 30 percent of the citations required four years for foreign journals, but only two years for Chinese. To cover 50 percent of the citations required six years for foreign journals, but only three years for Chinese journals. To cover 99 percent of the citations required thirty years for foreign journals, but only sixteen years for Chinese. Faculty members relied most heavily on foreign journals published in the past two to seven years but Chinese journals published in the past one to five years. The overall average cited journal ages was 7.8 for foreign journals and 3.9 for Chinese journals. A similar study by Smith reported the distribution of cited works by age; approximately 30 percent of total citations were to materials published within five years of completion date, 50 percent of citations were covered by ten years, and around 80 percent of citations were covered by twenty years.[14] Apparently, useful life of literature to foreign readers was longer than for Chinese faculty, although this will also be affected by discipline.

Of cited journals, 319 are foreign. The top fifty titles of the foreign journals most cited by faculty are given in Appendix A. The list contains 978 citations, accounting for 68.13 percent of the total 1437 foreign journal citations. The top twelve journals produce over 40 percent of the total citations in this list. The top twenty journals cover 50 percent of the citations. The result is a higher dispersion than Gooden's citation analysis in chemistry[15] and Walcott's local citation study in biology.[16]

In addition, Appendix A displays the status of journals cited by faculty at Wuhan compared with the global core journal list. Five journals, including *Journal of Geodesy*, *Photogrammetric Engineering and Remote Sensing*, and *International Journal of Geographical Information Science*, appear synchronously in the top ten of the two lists. Of the global core list of journals, twenty-one journals appear in Appendix A listing, accounting for 42 percent of the total number of the most cited foreign journals. Apparently the global core journal list is different from the most cited foreign journals in present study. These differences show that the global core journal list does not completely reflect the local use of journals. Therefore, it should be used cautiously.

Table 3
Age of Foreign Journal Articles Cited

Years	Count	%	Cumulative Percent
0	17	1.18	1.18
1	90	6.26	7.45
2	163	11.34	18.79
3	143	9.95	28.74
4	112	7.79	36.53
5	163	11.34	47.88
6	102	7.10	54.98
7	112	7.79	62.77
8	76	5.29	68.06
9	65	4.52	72.58
10	43	2.99	75.57
11	55	3.83	79.40
12	34	2.37	81.77
13	24	1.67	83.44
14	38	2.64	86.08
15	30	2.09	88.17
16	23	1.60	89.77
17	19	1.32	91.09
18	22	1.53	92.62
19	18	1.25	93.88
20	11	0.77	94.64
21–25	43	3.00	97.63
26–30	18	1.25	98.89
31–35	5	0.35	99.23
36–40	4	0.28	99.51
41–45	4	0.28	99.79
46–50	1	0.07	99.86
50–	2	0.14	100

Table 4 represents the subject distribution of foreign journals cited twice or more for twelve main subjects listed. The total number of the journal citations was 1159 from a total of 110 journal titles. In the table non-surveying and mapping subject citations cover 63.5 percent of citations. The top two non-surveying and mapping subjects most cited are geophysics and computing, accounting for 17 percent and 14.4 percent, respectively. *Journal of Geophysical Research*, ranked second, is a non-surveying and mapping journal. It had 100 citations, accounting for 8.6 percent of foreign journals cited twice or more. Walcott pointed that geoscience has high subject dispersion and 41–49 percent of literature cited by geoscientists are from fields other than geoscience.[17] A comparison of this finding with the results of the study reported here suggests that that surveying and mapping faculty also heavily rely on interdisciplinary journals for their research.

Finally, the authors conducted an analysis of Wuhan University library ownership of the 110 foreign journal titles cited twice or more. Table 5 shows that eighty-four foreign journals were found in the Wuhan library. For fourteen journals only partial sets were available, and twelve journals were not available at all in the library. The library thus was found to own 76.36 percent of the foreign journals cited, 12.73 percent had once been subscribed to but were not currently held, and 10.91 percent had never been collected. Library ownership could therefore satisfy more than 88 percent of faculty needs. To compare with a similar study, Sylvia's journal collection evaluation in the psychology field,[18] the library current collection development policies appear to be appropriate. However, in the data analysis, the authors found that *Computer Vision, Graphics, and Image Processing*, eleventh out of the top thirty journals cited by faculty, had once been subscribed to and was later canceled, and that *GeoWorld*, ranked twenty-fifth, had never been subscribed to by the library. These matters were deserving of attention.

Table 4
Subject Distribution of Foreign Journals Cited Twice or More

Subject	No. of Journals Cited	No. of Citations	Percent of Citation
Surveying and mapping	25	423	36.49
Geophysics	13	197	16.99
Computer	26	167	14.41
Geography	4	79	6.82
Space science	4	78	6.73
Astronomy	7	62	5.35
Communication technology	6	28	2.42
Oceanography	3	25	2.16
Geology	4	17	1.47
Various engineering	4	17	1.47
Architecture	2	15	1.29
Environment	2	5	0.43
Others	10	46	3.97
Total	110	1159	100

Table 5
Library Ownership Status of Foreign Journal Cited Twice or More

Ownership Status	No. of Journals Cited	Percent of Journals Cited	No. of Citation	Percent of Citation
Journals held	84	76.36	1020	88.01
Once held, canceled	14	12.73	97	8.37
Journals not held	12	10.91	42	3.63
Total	110	100	1157	100

In analyzing citations of conference literature the authors found that the conference proceedings *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences* had the highest citation frequency (fifty citations), accounting for approximately 10 percent of the cited conference literature. The library has a virtually complete holding of this major international conference.

A similar analysis for Chinese journal citations was also carried out in the study. In the interests of brevity, the analysis and lists of Chinese journals were omitted here. Anyone interested is invited to contact the authors. Readers wishing to see the complete lists of cited foreign journal may contact the authors too.

Conclusion

This citation analysis of the publications of faculty at Wuhan University has been very important for the university librarians with responsibility for journal subscriptions and may provide useful information for collection development. Now we know, with some confidence, that journals are a resource of paramount importance in the surveying and mapping field, and that a significant percentage of the materials budget for this field should continue to be spent on journals. Through evaluating the library's holdings, we can understand the gaps in the library's collection. The journals that were of higher citation frequency and lacking in the collection should be considered for subscription, and those of lower citation frequency should be considered for cancellation. We also learned how the library can subscribe to a relatively smaller number of well-targeted journals to satisfy more user needs in the context of the increasing costs of journals, the creation of new journals, and the limitations in funding. The study substantiated the interdisciplinary nature of the research field and demonstrated the importance of collaborating with other discipline selectors during journal selection and cancellation projects.

The citation analysis results will be helpful to librarians, faculty, and students on campus. The librarians may liaise and confer with faculty in offering the results. The list of the most cited foreign journals may serve as a guide for faculty to identify journal titles for potential publications. At the same time, during this consultation process, the library staff may obtain beneficial views about collection development from faculty. The list will also be given to future surveying and mapping students as a guide for material for literature reviews

for theses, research papers, and dissertations. The result could also be useful in stock management. Back volumes of journals, which will hardly be used, should be considered for closed stack to save limited space.

The study has shown that it is appropriate to consider citation analysis in combination with other quantitative measures, such as circulation, and in-house use data, interlibrary loan statistics, and survey data in order to develop a more comprehensive picture of users' research needs. Because local citation analysis is used here for the first time in the field of surveying and mapping, and in China, the research method can serve as a useful example of the value and process of citation analysis. Though we recognize that our local use patterns may be specific to our institution, we hope that the results of this study can help other researchers in the field to identify useful references, and that the study has general applications for other institutions attempting to develop similar collections.

Appendix A
Top Fifty of the Most Cited Foreign Journal Titles

Rank	Cited Journal Title	No. of Citations	Percent of Total Citations	Cumulative Percent of Citation	Global Rank
1	Journal of Geodesy	109	7.588	7.59	3
2	Journal of Geophysical Research	100	6.96	14.54	47
3	Photogrammetric Engineering and Remote Sensing	88	6.12	20.67	2
4	International Journal of Geographical Information Science	64	4.45	25.12	5
5	Cartography and Geographic Information Science	42	2.92	28.05	
6	International Journal of Remote Sensing	39	2.71	30.76	1
7	GPS World	37	2.58	33.33	25
8	ISPRS Journal of Photogrammetry and Remote Sensing	30	2.09	35.42	8
9	Remote Sensing of Environment	29	2.02	37.44	46
10	Cartographica	23	1.60	39.04	16
11	Computer Vision, Graphics, and Image Processing	23	1.60	40.64	
12	IEEE Transactions on Pattern Analysis and Machine Intelligence	22	1.53	42.17	
13	Geophysical Journal International	21	1.46	43.63	
14	Pattern Recognition	18	1.25	44.89	
15	IEEE Transactions on Geoscience and Remote Sensing	18	1.25	46.14	10
16	Geophysical Research Letters	17	1.18	47.32	48
17	Cartographic Journal	16	1.11	48.43	36
18	Zeitschrift fur Vermessungswesen (ZFV)	16	1.11	49.55	4
19	Photogrammetric Record	13	0.91	50.45	24
20	IEEE Transactions on Knowledge and Data Engineering	13	0.91	51.36	
21	Marine Geodesy	12	0.84	52.19	18
22	Physics of the Earth and Planetary Interiors	12	0.84	53.03	
23	IEEE Journal of Oceanic Engineering	11	0.77	53.79	
24	Computers, Environment and Urban Systems	10	0.70	54.49	
25	GeoWorld	10	0.70	55.18	
26	Optical Engineering	10	0.70	55.88	
27	Science	10	0.70	56.58	
28	Bollettino di Geodesia e Scienze Affini	9	0.63	57.20	
29	Computers and Geosciences	9	0.63	57.83	
30	Geophysical Journal of the Royal Astronomical Society	9	0.63	58.46	
31	Nature	9	0.63	59.08	
32	Physical Review Letters	9	0.63	59.71	
33	Tectonophysics	9	0.63	60.33	

APPENDIX A (*continued*)

Rank	Cited Journal Title	No. of Citations	Percent of Total Citations	Cumulative Percent of Citation	Global Rank
34	IEEE Computer Graphics and Applications	9	0.63	60.96	
35	ACM Transactions on Database Systems	8	0.56	61.52	
36	Automatica	8	0.56	62.07	
37	Geoinformatica	8	0.56	62.63	13
38	Computer Graphics	7	0.49	63.12	
39	Geo-Informations-Systeme	7	0.49	63.61	
40	Nachrichten aus dem Karten-und Vermessungswesen	7	0.49	64.09	30
41	Navigation	7	0.49	64.58	
42	Geomatica	6	0.42	65.00	14
43	IEEE Transactions on Signal Processing	6	0.42	65.41	
44	IEEE Transactions on Systems, Man, and Cybernetics	6	0.42	65.83	
45	Pattern Recognition Letters	6	0.42	66.25	
46	Radio Science	6	0.42	66.67	
47	Journal of the Japan Society of Photogrammetry and Remote Sensing	6	0.42	67.08	33
48	GPS Solutions	5	0.35	67.43	15
49	GIM International	5	0.35	67.78	19
50	Communications of the ACM	5	0.35	68.13	

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