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AN ANALYSIS OF THE INFORMATION USAGE PATTERNS OF ACADEMICS AND PRACTITIONERS IN THE COMPUTER FIELD: A CITATION ANALYSIS OF A NATIONAL CONFERENCE PROCEEDINGS

MARY J. CULNAN
Graduate School of Management (Room 5350A), University of California, Los Angeles, Los Angeles, CA 90024, U.S.A.

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Abstract—The citation practices of academics and practioners who have published papers in the proceedings of a national computer conference are analyzed in order to measure how the two groups differ in their use of published information. The comparison is based upon types of documents cited, age of cited literature and core journals cited. The study found that both groups cited the same group of core journals and cited documents of approximately the same age. Both groups cited journals most frequently and when document types are ordered according to citation frequency, the rankings are identical. However, the actual citation frequencies by type of document are not the same and these differences are attributed to unequal levels of awareness and access to specific categories of documents.

INTRODUCTION

This study analyzes one aspect of scientific communication in the computer field. The citation practices of academics and practitioners who have published papers in the proceedings of a national conference are compared in order to measure how these two groups differ in their use of published information.

Scientific communication refers to the process by which an individual or team disseminates the results of research to other researchers and practitioners in a field of knowledge (ROBBINS[1]). During the course of a research project, a scientist will seek feedback informally from colleagues by means of discussion or by limited dissemination of a preliminary document. Final results may be disseminated formally through a presentation at a national conference and publication in the proceedings of the meeting. An individual may also present results at a meeting without proceedings in which case the findings are eligible for publication in a journal. Finally, an individual may choose to publish results in a journal without prior presentation at a national meeting. In all cases, published findings are subject to additional peer evaluation by way of being cited in subsequent publications.

The scientific communciation process is represented graphically in Fig. 1. This diagram is based on a framework which was developed at the Johns Hopkins University and was subsequently found to be valid for disciplines representing natural sciences, social sciences and applied fields (LIN[2], p. 25). The framework was modified during this study to include published conference proceedings.

The main purpose of this paper is to examine how academics and practitioners interact within this framework based upon their use of published information. Academics are responsible for developing much of the theory in a discipline. In order for this theory to be applied to the problems of organizations, the theory must first be communicated to the practitioners in these organizations in a form that the practitioner can readily understand. One way in which this communication can occur is through the formal communication channels represented by published documents. The transfer of information through these channels may be analyzed in terms of three variables: document type, document title and document age. For example, if practitioners do not read the same journals where academics have chosen to publish, the theory

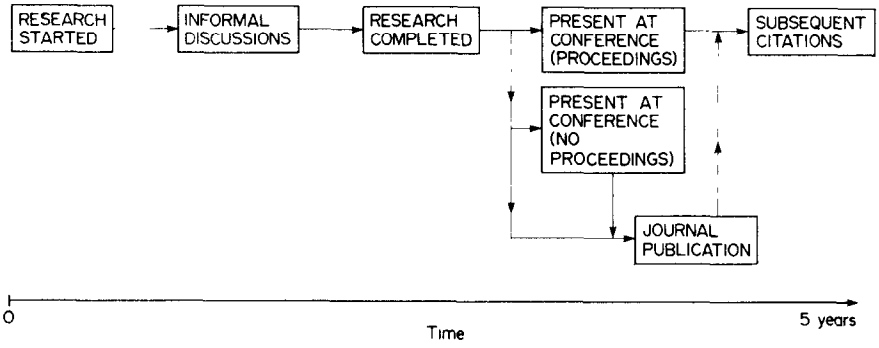

Fig. 1. The scientific communication process.

in these journals is unlikely to reach the practitioner. If, however, it can be shown that both of these groups have similar patterns of information usage in terms of these variables, then there is a probability that knowledge is actually being transferred between these two groups through the communication channels represented by published information.

A secondary purpose of this paper is to consider the role of the conference proceeding in the scientific communication process. Prior studies of formal scientific communication as measured by the use of published documents have focused on the scientific journal. In the computer field, however, the conference proceeding also represents an important means for disseminating research findings and its role in the communication process has largely been ignored.

An understanding of the scientific communication process has implications for scientists who are creating and disseminating knowledge and for librarians who in times of limited resources must make intellegent acquisition decisions. Derek de Solla Price has stated that different fields may in fact be different social systems; each system "must have its own special machinery for handling the process of publication and communication among people at the research fronts and behind those fronts too". He further states that "a proper understanding of science as a social system will wipe away a lot of naive misunderstanding which shrouds the business of science information and makes us hope for the wrong sort of expensive solutions to what seem to be the problems" (PRICE[3], p. 22).

Previous research

Three issues which have received attention in the literature are especially relevant to this study: the use of citation analysis to study scientific communication, the role of the national conference in the scientific communication process and the relationship of academics to practitioners in a discipline.

Measurement of formal scientific communication

When statistical and mathematical techniques are applied to the analysis of the published literature in a field of knowledge, the resulting measurements allow inferences to be drawn concerning the transfer of information within that field and between related fields. This form of analysis, known as bibliometrics, generally involves counting citations appearing in a body of literature, or citations to a body of literature and using these counts to develop statistical distributions. Price analyzed a million citations from the *Scientific Citation Index* and determined that on the average, a sceintific paper had fifteen references to other publications; 80% of these citations were to journal articles, the remaining 20% were to books, technical reports and theses, etc. Ten percent of the papers did not reference any other publications (PRICE[4, 5]), Subramanyam analyzed bibliographic citations appearing in *Computing Reviews*, a secondary review journal and the *IEEE Transactions on Computers*, a primary journal, during 1970 and 1971 to determine how these citations were distributed across various types of documents. References to journal articles accounted for nearly 50% of the total citations in each publication while conference proceedings and books accounted for the other half (SUBRAMANYAM[6]).

The role of the national conference

While the national conference represents one of the earliest opportunities for formal dissemination of research findings, it has received little attention in the literature when compared to the number of studies on the use of scientific journals. Paisley and Parker conducted a survey during the 1966 meeting of the American Association for Public Opinion Research and found that preferences for information sources were correlated with attendant characteristics. Attendants of senior rank who were active in behavioral research preferred contributed papers as an information source while attendants of senior rank who were inactive in research and who had many professional memberships preferred informal conversations with colleagues. No findings were given for other types of attendants (PAISLEY[7]). The Johns Hopkins studies examined the national meetings of nine professional societies representing the social sciences, the engineering sciences and the physical sciences and gathered data on the subsequent fate of material presented at the meetings. Two years after the meetings, 46% of the presentations, or 835 manuscripts, had been published (LIN[2]). Only one of the organizations studied published formal conference proceedings and no reports on the role of published proceedings in scientific communication were identified in the literature.

Academics versus practitioners

Applied fields require cross-fertilization by academics and practitioners in order to grow, yet conflict often arises when these individuals utilize common channels of communication due to differing interests and needs. The dichotomy can in part be attributed to the time required before "research results become of practical use" and "the difficulty in getting research people to tackle the problems which really need solution via new concepts and techniques" (SAMMET[8], p. 310). The majority of studies have analyzed formal scientific communication without regard for the author's profession. Only one study was identified which attempted to measure the flow of information between academics and practitioners in a field, based on citation practices. McCrae divided seventeen accounting journals into three subnetworks: the academic network, the management accounting network and the professional/general network. He subsequently analyzed the citations appearing in each journal. Each bibliographic citation was used to represent a message transmitted from one network to another or to itself. His analysis revealed a congruent flow of messages among the three subsystems meaning that the number of messages sent by one subsystem to each other subsystem is similar to the number of messages received by that subsystem from the corresponding subsystems based upon similar numbers of citations (MCCRAE[9]).

In summary, studies of the formal communication of scientific information have concentrated on patterns of journal usage as determined by analyses of citations and have largely overlooked differences in the formal communication practices of academics and practitioners. Practitioners, in fact, may not be well represented in scientific journals because "they have not contributed enough or because what they had contributed was not of sufficient value to be published" (KOVER[10], p. 339). The national meeting, on the other hand, often brings practitioners and academics together. As one attendant at the 1977 National Computer Conference observed, "The NCC is still the world's best watering hole of ideas, people and machinery—it is quite literally the entire computer industry under one roof.... It is a time of spirited exchanges on most every germaine topic" (STREVELER[11], p. 21).

EXPERIMENTAL DESIGN

This study addresses the research question how do academics and practitioners who have published papers in the proceedings of a national conference differ in their usage of published information with respect to document type, document title and document age. In order to measure patterns of information usage, citations from the bibliographies of papers in a conference proceeding will be examined and classified according to the type of author of the *citing* paper and the type of document being *cited*. The resulting distributions will be analyzed statistically in order to test the set of hypotheses which follows.

This study is predicated on the assumption that bibliographic citations are an acceptable surrogate for the actual influence of various types of documents on a research project. In fact, much that is read is not cited, and citation behavior can be biased by the accessibility or

nonaccessibility of various classes of documents. Nonetheless, citation is a measure of scholarly dependence upon previous work (KAPLAN[12]). As a form of measurement, citation analysis is attractive because it is unobstrusive; analysis always occurs after a paper has been published and without any direct contact with the author.

For the purposes of this study, an academic will be defined as an author who is affiliated with an educational institution, excluding non-teaching organizations that are affiliated with educational institutions. Practitioners will be defined as all authors who are not academics. Papers with multiple authors will be included only if all authors are of the same type; papers with mixed authorship will be excluded from the analysis.

A citation will be defined as a single bibliographic reference in a paper; multiple references to the same citation will not be counted nor will citations which are not specifically referenced in the body of the paper. Citations will be classified into six categories based upon document type: (1) journals, (2) books, (3) conference proceedings, (4) technical reports including working papers, (5) dissertations including master's theses, and (6) miscellaneous including patents, private communication, any unpublished manuscripts which had not been accepted for publication in a specific journal, and technical manuals published by computer equipment manufacturers. Theses which were also cited as a technical report in the same citation were classified as a technical report.

The first two hypotheses will be tested to determine if academics and practitioners are equally represented in the sample both in terms of the number of papers and the number of citations. As the study is predicated on this assumption, it is expected that the following two null hypotheses will not be rejected.

(1) H_0: academic authored 50% of the papers in the sample.

(2) H_0: papers authored by academics contained 50% of the citations in the sample.

The next three hypotheses will be used to study the differences between the citation practices of academics and practitioners who have authored papers in the proceedings of a national conference. First, the types of documents cited will be compared. Theoretically, there is no reason to expect that there would be significant differences in the types of documents cited by academics and practitioners; for example, the ratio of the number of journals cited to the total number of citations should be the same for both groups because published documents are accessible to both populations. In reality, however, it is likely that academics and practitioners will cite categories of documents with unequal frequencies as patterns of information usage are dependent, for example, upon knowledge of the existence of a document and accessibility. Thus it is expected that the third null hypothesis will be rejected.

(3) H_0: There is no difference between the distributions of citations by type of documents cited for academics and practitioners.

One would also expect that there would be differences in the actual titles cited by each group within each type of document as academics and practitioners have differing needs and interests that may be served by different publications. Academic research is often directed toward the development of theory while practitioners are concerned with application. Each group, then, is likely to select those documents whose orientation is congruent with their own respective interests. Further, academics and practitioners operate within different informal communication networks and thereby become aware of the existence of different titles within the same categories of documents. Therefore, it is expected that the fourth null hypothesis will be rejected.

(4) H_0: There is no difference between the distributions of citations to journal titles for academics and practitioners.

Finally, the age of the literature cited by each group will be compared. Price found that the age of cited literature is one indication of how rapidly a field is growing. He defined the research front as published findings which are at most five years old and developed Price's Index as the ratio of the number of citations to the research front to the total number of citations. Price's Index for a large sample from the *Science Citation Index* was just over 50% meaning that half of the citations were to the research front while the other half were to archival material. He concluded that a Price's Index of over 60% was indicative of a field characterized by rapid and orderly growth (PRICE[3]). As stated previously, in theory both academics and practitioners have access to a common pool of documents; however, the

patterns of access to this pool are not necessarily congruent. Because the computer industry is based upon rapidly changing technology, one would expect both types of authors to cite very current literature. As academics are more likely than practitioners to engage in theoretical research, one would also expect academics to also cite less recent works which form the theoretical basis for their current work. Therefore, it is expected that the fifth null hypothesis will be rejected.

H_0: There is no difference in the distributions of citations by age of literature cited for academics and practitioners.

The sample upon which this research is based consists of all papers published in the 1972 *Proceedings of the Fall Joint Computer Conference*, which became the National Computer Conference in 1973. These proceedings were selected because of the eclectic subject coverage and because academics and practitioners are both represented among the contributing authors. All papers published are refereed, thereby insuring a minimum level of quality. Finally, because the conference was sponsored by the American Federation of Information Processing Societies (AFIPS) rather than by a single professional organization, it is believed that the papers included are more likely to be representative of the computer field as a whole rather than being biased due to ths solicitation of papers from only that segment of the field which is represented by the membership of a single organization.

RESULTS

In 1972, 139 papers were published in the *Proceedings of the Fall Joint Computer Conference* (FJCC); sixty-four of the papers were authored by academics, 70 papers were authored by practitioners and five papers were authored by practitioners in collaboration with academics. The latter group of five papers was excluded from further analysis. The remaining 134 papers contained 1438 citations. Academic papers accounted for 49% of the citations and practitioner papers accounted for the remaining 51%. This data as well as the mean number of citations per paper is summarized in Table 1.

Table 1. Citation distributions by type of author

	ACADEMICS	PRACTITIONERS	TOTAL
# OF CITATIONS	697 (49%)	741 (51%)	1438
# OF PAPERS	64 (48%)	70 (52%)	134
MEAN CITATIONS PER PAPER	10.9	10.6	10.7

The binomial test was used to test the first two null hypotheses concerning the representation of academics and practitioners in the sample (CONOVER[13], p. 96). The number of papers authored by academics ($57.48 \leq 64 \leq 76.52$, $\alpha = 0.10$) and the number of citations contributed by academic papers ($688 \leq 697 \leq 750$, $\alpha = 0.10$) both fell within the critical regions. Therefore, we cannot reject the first two hypotheses that academics accounted for 50% of the data in the sample. The sample is representative of both academics and practitioners.

The number of references to other works has been used by Price and others as a general indication of the scholarliness of a paper. Nineteen (14%) of the papers in this study contained no citations to other papers which is slightly higher than the 10% figure which Price found for the *Science Citation Index* (PRICE[4]). Eight of the citationless papers were authored by academics (13% of the subgroup) and the other eleven were authored by practitioners (19% of the subgroup). Table 2 reflects the distribution of citations adjusted for citationless papers.

Table 2. Citation distributions for papers having at least one bibliographical reference by type of author

	ACADEMICS	PRACTITIONERS	TOTAL
# OF CITATIONS	697	741	1438
# OF PAPERS	56	59	115
MEAN CITATIONS PER PAPER	12.4	12.6	12.5

The mean number of citations per paper for each subgroup and for the sample as a whole is consistent with Price's guideline of 10–20 references per paper as a norm of scholarship (PRICE[4]). Using this guideline, there is no distinction based on scholarship between the papers authored by academics and practitioners in this proceeding.

Table 3 represents the distribution of FJCC citations according to the types of documents cited by academics and practitioners. Observation reveals that both types of authors cite journal articles more frequently than any other type of document. Practitioners cite conference proceedings more often than academics, while academics cite books and technical reports more often than practitioners. When the third null hypothesis, that there is no difference between these two distributions, was tested using a χ^2 statistic ($\chi^2 = 32.8$ with 5 d.f.), we subsequently reject the hypothesis at $\alpha = 0.001$ level. Subsequently, books and conference proceedings were excluded from the distributions in an attempt to determine if the differences could be attributed to usage patterns of specific types of documents. The result of this analysis is summarized in Table 4. In all instances, we reject the hypothesis that there are no differences between the distributions of citations by document type for academics and practitioners meaning that academics and practitioners cite different types of documents.

Table 3. Distribution of citations by type of document and type of author

AUTHOR TYPE	JOURNALS	BOOKS	TECH. RPTS	CONF. PROC.	THESES	MISC.	TOTAL
ACADEMIC	207 .30	120 .17	144 .21	165 .24	25 .04	36 .05	697 1.00
PRACTITIONER	263 .35	79 .11	108 .16	234 .32	15 .02	42 .06	741 1.00

Table 4. Summary of chi-square tests by type of author. (H_0: no differerence in the distributions by document type of author)

DOCUMENTS INCLUDED	CHI SQUARE	WITH D.F.	RESULTS
ALL TYPES OF DOCUMENTS	33.842	5 D.F.	REJECT ALPHA = .001
EXCLUDE CONFERENCE PROCEEDINGS	22.636	4 D.F.	REJECT ALPHA = .001
EXCLUDE BOOKS	21.004	4 D.F.	REJECT ALPHA = .001
EXCLUDE BOOKS AND CONFERENCE PROCEEDINGS	14.598	3 D.F.	REJECT ALPHA = .001

The fourth null hypothesis, that there is no difference between the distributions of citations to journal titles by academics and practitioners, is used to analyze the differences in usage by actual title cited and by type of citing author. Journal titles were selected for this analysis first because this type of document was cited most frequently by both types of authors and therefore represents the interests of both academics and practitioners. Second, of the types of documents cited in the FJCC, journals are the most readily available to academics and practitioners on a direct basis. Many authors, no doubt, receive personal copies of certain journals and use, therefore, does not depend on the individual having ready access to a library. As part of the data analysis of this study, a record was kept of journals that were cited and the number of citations each received. Citations were distributed among 117 journal titles with a small number of titles accounting for the majority of citations.

Table 5. Citations per journal title

NBR OF TITLES	NBR OF CITATIONS TO EACH TITLE
20	5 OR MORE
4	4
4	3
21	2
68	1

Table 6. Citations to the five most cited journals

TITLE	CITATIONS ACADEMIC	CITATIONS PRACTITIONER	TOTAL CITATIONS AND % OF JOURNAL CITATIONS
COMMUNICATIONS OF THE ACM	50	54	104 (22%)
IEEE TRANSACTIONS ON COMPUTERS	20	18	38 (8%)
DATAMATION	9	24	33 (7%)
IBM SYSTEMS JOURNAL	11	14	25 (6%)
JOURNAL OF THE ACM	8	12	20 (4%)
TOTAL	98	122	220 (47%)

Five journals accounted for 220 (47%) of all journal citations and this phenomenon of the majority of citations clustering around a small number of titles is consistent with Bradford's Law.

Based on the author's prior experience as a technical librarian, these five titles are believed to be representative of journal literature in the computer field; Fig. 2 is a graphic presentation of the author's perception of the orientations of these five publications. Further, the distribution of citations between academic and practitioner authors was sufficient for all five titles so as to allow statistical testing of the distributions. It made no sense in this case to aggregate citations for additional titles because there was no basis for determining that certain titles shared enough similarities to be evaluated as a unit.

A χ^2 statistic was used to test the fourth hypothesis that there is no difference in the distributions of citations by journal title for academics and practitioners. At $\chi^2 = 5.687$ and 4 d.f., we cannot reject the hypothesis that there is no difference between the two distributions at the $\alpha = 0.05$ level. These five journals, therefore, appear to serve both academic and practitioner audiences as represented in the 1972 FJCC.

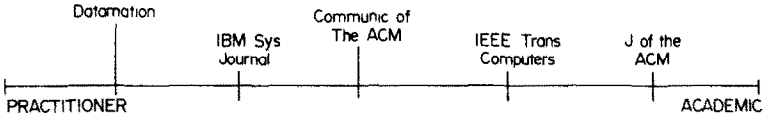

Fig. 2.

Age of literature cited serves as the final measure that will be used in this study to compare the citation practices of academics and practitioners. Age data was available for 1367 (95%) of the 1438 citations. From this pool of citations, distributions by age were generated for the 1972 FJCC as a whole as well as for academics and practitioners. All three distributions had a Price's Index of greater than 75% meaning that more than three-fourths of all citations were to the research front with the remainder to the archive. The median age of literature cited for all three distributions was two years.

Table 8 contains the distributions of literature cited by age for practitioners and academics. Using the Kolmogorov–Smirnov two-sample test ($T(0.103) > \omega(0.066)$, $\alpha = 0.10$), we reject the hypothesis that there is no difference between the two age distributions (CONOVER[13], p. 309–310). When the test is repeated for citations to the research front (1967–72), ($T(0.040) < \omega(0.0719)$, $\alpha = 0.10$), we cannot reject the hypothesis that there are no differences between these two modified distributions. Patterns of citation to the research front, then, are similar for academics and practitioners. When the total age distributions for academics and practitioners are plotted on a single graph (Fig. 3), it appears that the main differences in the complete

Table 7. Summary of citations based on age

AUTHOR TYPE	# OF CITATIONS ARCHIVE (PRE-1967)	# OF CITATIONS RESEARCH FRONT (1967-1972)	TOTAL	PRICE'S INDEX
ACADEMIC	100	568	668	.85
PRACTITIONER	158	541	699	.77
TOTAL	258	1109	1367	.81

Table 8. Distribution of citations by age of document and type of author

AUTHOR	PRE 1950	1950–1954	1955–1960	61	62	63	64	19-- 65	66	67	68	69	70	71	72
ACADEMICS n = 668	6	4	11	5	12	8	13	17	24	35	66	71	106	165	125
PRACTITIONERS m = 699	8	15	29	16	16	9	16	27	22	55	54	76	89	147	120
TOTAL N = 1367	14	19	40	21	28	17	29	44	46	90	120	147	195	312	245

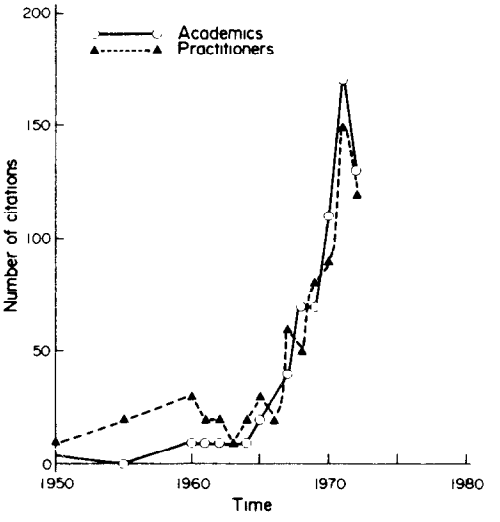

Fig. 3.

distributions can be attributed to the citations by practitioners to literature published before 1962. When the distributions by age for 1962–72 are tested using a Kolmogorov–Smirnov two-sample test ($T(0.053) < \omega(0.068)$, $\alpha = 0.10$), we cannot reject the hypothesis that there are no differences between these two distributions. Patterns of citation by age of literature, then, are similar for academics and practitioners with the exception of citations by practitioners to literature published before 1962.

SUMMARY AND CONCLUSIONS

Bibliographic citations serve as surrogates for the sources of information which have influenced a research project. The process of identifying documents which are to be cited in a paper may be viewed as selection with replacement from the total pool of documents which have been published. Theoretically, once a document is published, it is available to all individuals who interact within a discipline.

This paper compared the citation practices of academics and practitioners who had published papers in the 1972 proceedings of a national computer conference. Distributions of citations were compared using non-papametric statistics to determine if there were differences between the usage patterns of these two groups based upon types of documents cited, titles of cited journals, and the age of documents cited.

First, it was determined that academics and practitioners were equally represented in the sample used in this study. Neither the hypothesis that academics contributed 50% of the papers in the 1972 FJCC nor the hypothesis that academic papers were responsible for 50% of the references in the 1972 FJCC could be rejected.

Analysis revealed second that the information usage patterns of academics and practitioners are different based upon statistical testing of distributions of citations; the hypothesis that there was no difference in the citation patterns of academics and practitioners was rejected. While the actual frequencies of use are different for academics and practitioners, the rankings based on citation frequency as shown in Table 9 are identical for the two groups. This means that both groups in this sample appear to have equal preferences for various types of documents based upon citation patterns.

Table 9. Document types by citation frequency

DOCUMENT TYPE	RANK ACADEMIC	PRACTITIONER
JOURNALS	1	1
CONFERENCE PROCEEDINGS	2	2
TECHNICAL REPORTS	3	3
BOOKS	4	4
MISCELLANEOUS	5	5
THESES	6	6

Two closely related factors could account for the differences in the relative citation frequencies for all types of documents as was shown in Table 3. The first factor is accessibility of the document. For example, academics are more likely to receive examination copies of technical books and have ready access to libraries, while most practitioners are not as likely to personally acquire a large number of technical books and may not have easy access to a library. These differences could account for the fact that academics cite books more often than practitioners. The second factor which could account for some of these differences is awareness; prior to using a document, one has to know of its existence. Academics cite technical reports more often than practitioners. While both universities and private organizations generate working papers, because reports originating in the private sector may contain proprietary data, their use and distribution may be limited to individuals who are employed by that organization. Academics, on the other hand, often distribute working papers to their colleagues in other academic institutions; they, therefore, have greater awareness of (and access to) this type of document which may in part account for the higher rate of citation by academics. Practitioners are unlikely to be part of the informal dissemination networks that exist in academia and therefore would have lower awareness of the existence of academic working papers. Both academics and practitioners receive journals and attend conferences which publish proceedings thereby resulting in high levels of use for both types of documents and subsequently for the fact that these two types of documents account for more than 50% of the citations for each group.

Third, analysis revealed that the distributions of citations to five core journals were similar for academics and practitioners and we could not reject the hypothesis that these distributions were the same. This result is surprising since it was expected that academics would cite theoretical journals more often than practitioners while non-academics would cite practitioner-oriented journals more frequently than academics. It may be inferred, therefore, that academics and practitioners in this sample have interests which are served equally well by the same journals.

Fourth, the hypothesis that there were no differences in the citation patterns of academics and practitioners based on the age of literature cited was rejected. It was determined that the majority of citations for both groups were to the research front, 1967–72. However, the patterns of citation based upon age for literature published between 1962 and 1972 were also the same for academics and practitioners. This was not expected and it indicates that both groups are citing archival as well as current material related to current research. Based on the data, there is no apparent reason why practitioners cited literature that was more than ten years old more frequently than academics. Citation patterns based on age as well as the mean number of citations per article indicates that the research conducted by both groups is scholarly in a very general sense.

Based on these similarities in the patterns of information usage, we may conclude that the interests of academics and practitioners who present papers at the FJCC are well matched. This conference, therefore, represents one instance where information may be freely exchanged between academics and practitioners.

This study was intended as a preliminary investigation of what appears to be a potentially

productive area for research. Because the study was based on a relatively small sample of 1438 citations from a single volume, extensive generalization of results is therefore unwarranted. Analyses should be conducted of the citation practices in the conference proceedings of the major computer professional societies, the Association for Computing Machinery and the Institute of Electrical and Electronic Engineers, to see if patterns of information usage are comparable to those found in the FJCC. Analyses should also be conducted to determine if similarities exist between the citation patterns in the FJCC and a representative sample of core journals from the computer field.

Finally, this study represents a single "snapshot" of one aspect of the scientific communication process at a particular point in time; numerous other "snapshots" have been reported in the literature. Little work has been done, however, to connect the isolated "snapshots" into a motion picture of the entire process. A promising area for future research would be to trace the flow of citations through the system in order to measure the diffusion of research results and their effect on different populations of users.

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