

Measuring the Impact of Electronic Publishing on Citation Indicators of Education Journals

EUN-JA SHIN

Department of Communication Art, Sejong University, Seoul, South Korea

With the growth in electronic availability and distribution of scholarly journals, citation indicators of these journals may be expected to change. This study estimated how electronic publishing affects citation indicators, Impact Factors and Immediacy Indexes, from 1995 to 2003. Two citation indicators of 70 journals in education, educational research, and special education in *Journal Citations Reports* were analysed in this study. The result shows that Impact Factors remain essentially unchanged while Immediacy Indexes increased significantly. For all journals, 75% had their Immediacy Indexes increase

drastically recently and had higher Impact Factors than average. Because more journal articles are available in electronic form, both as part of complete electronic journals and within databases of separate articles, many more scientists access and use new articles without delay than in the past. Electronic publishing can be regarded as one of the factors affecting not only citation frequencies but also citation indicators. Digital access to scholarly journals promises to bring changes in citation indicators, especially Immediacy Indexes of well-established journals in education.

Introduction

Analyses of journal citations, examining both citing and cited papers, are helpful to gauge past usage of academic journals. As Impact Factors and Immediacy Indexes are based on citation analysis, these citation indicators are considered practical means to measure journal usage. The Impact Factor is a ratio between citations and citable articles published. In the case of *Journal Citations Reports* (JCR 2004), the Impact Factor is calculated by dividing the number of current citations to articles published in the two previous years by the total number of articles published in the same period. The Immediacy Index measures citations made during the year in which the cited articles were published. The Immediacy Index is calculated by dividing the number of citations to articles published in a given year by the number of articles published in that year. Thus the Impact Factor gives a measure of the frequency with which the “average article” in a journal has been

cited in a particular year, while the Immediacy Index shows a measure of how quickly the “average article” in a journal is cited.

These two indicators are expected to change as more journal articles are available in electronic form as part of complete electronic journals. It is certain that accessibility has significantly increased due to the shift from paper to electronic journals or parallel publishing. The improvement of accessibility can affect journal citation because current articles can be cited immediately and more frequently than before (Anderson, Sack, Krauss, and O’Keefe 2001; Hawkins 2001).

The evolution of academic journals’ citation patterns can be monitored via a year-by-year analysis of these two indicators. This study assesses whether the spread of electronic journals affects the citation indicators by analysing the Impact Factor and Immediacy Index from 1995, an early stage of electronic journal prevalence, through 2003, the prevalent stage of electronic journals.

Literature review

Although analyses of journal citations give valuable practical applications for libraries, publishers and researchers, there have been only a few empirical studies on citation analysis with online articles or electronic journals.

Lawrence (2001) showed a positive correlation between the number of times an article is cited and the probability that the article is online. His study showed that in the field of computer science, more frequently cited articles and more recent articles are significantly more likely to be online. The mean number of citations to offline articles was shown to be 2.74, and the mean number of citations to online articles was 7.03, a difference of 157%. Restricting this analysis to the top 20 publication venues in computer science by average citation rate yields an increase of 286% in the citation rate for online articles.

Shin (2003) found that the Immediacy Indexes in the fields of economics, law, and psychology increased notably over the recent two years while their Impact Factors were almost constant for eight years, 1995–2002. She pointed out that Immediacy Indexes in the three fields increased drastically during nearly the same period even though the fields are distinctive in terms of academic history, development, researchers' citation patterns and so forth. It is reasonable to conclude that the findings suggest that the change in the available medium and the rate of diffusion of online articles result in a striking increase of the Immediacy Indexes.

According to Glänzel and Moed (2002), a journal's Immediacy Index may be strongly affected by a number of technical conditions such as the frequency of publication, speed of indexing, publication delay, subject peculiarities (aging) and document type than the Impact Factor itself. Their view implies one may consider the fact that electronic journals avoid delays in publishing and delivery and allow scientists to communicate their research results more effectively and timely than paper journals. Online sites for electronic journals may even provide access to forthcoming articles before the release of the paper version of the journals.

Scientists in almost all disciplines read more articles and a higher percentage of current articles than before, according to Tenopir and King (2002).

Recently scientists have been using many online articles including institutional online database subscriptions, authors' Web sites and e-print services (Goodrum, McCain, Lawrence, and Giles 2001; Rao 2001). Many online databases add links from the bibliographic citations to the electronic full-texts, so scientists can access the latest articles easily. Hence there is a positive linkage between the prevalence of electronic sources and an increase in reading current articles (Bevan 2001; Garfield 2004; Tenopir 2001; Youngen 2001).

For purposes of understanding how the proliferation of electronic resources has changed scholars' information use, Herring (2002) conducted a citation analysis of research articles from scholarly electronic journals published in 1999–2000. The 175 articles were published in twelve journals that were selected to represent areas of active interdisciplinary research, such as library and information science and psychology. The findings show that more than half of the articles studied included electronic references and that 16 percent of the total references were to electronic resources. There is a growing reliance on electronic resources by scholars by comparison with Zhang's (1998) analysis that almost 7.5 percent of the sample articles in library and information science included references to online resources. When Harter and Kim (1996) analysed a sample of citations from scholarly e-journals two years earlier than Zhang, they obtained the result that 1.9 percent of the total references were to electronic resources.

Based on this literature review, it is reasonable to conclude that the available medium is one of the key technical conditions that affects citation indicators such as the Immediacy Index. Recently more scholars have been reading current articles with greater frequency because of electronic access; this change in reading pattern may be expected to affect citation indicators as well as citation frequencies.

Methods

Data collections

Two citation indicators used in this study, the Impact Factor and the Immediacy Index, are regularly published in the annual updates of the *Journal Citation Reports (JCR)*. For this study, they

were selected within the subject category of education, educational research and special education; they were extracted from the *Journal Citation Reports® – Social Sciences Edition* Databases of the Institute for Scientific Information®, Inc., ISI®, Philadelphia, Pennsylvania, USA, Copyright© 1995–2003.

Around 1995 many scientific journals started to publish in an electronic or in both a paper and an electronic version. In this study their indicators were analysed from 1995 to 2003, the last year for which Journal Citation Reports data were available. The total number of the three disciplines' journals in Journal Citation Reports had no great change, growing merely from 111 titles in 1995 to 117 titles in 2003. But it is notable that a title in a particular year can disappear in the next year, because Journal Citation Reports makes additions or deletions of the journal titles based on citation analysis. So for a time-series comparison it is necessary to exclude the titles that have a missing value for the indicators during the period. After eliminating these non-proper data, 71 journal titles remained.

One should consider that the Impact Factors of the 71 journals are not absolutely independent from each other. The Impact Factor of a given year can influence the next, so the Impact Factor of a certain year is calculated by dividing the two previous years' citation number by the number of articles. But the influence of the previous year may be seen to be similar for every year. Thus in this analysis the Impact Factor of each year has been treated as if it was an independent variable.

For assessing the impact of electronic journals on citation indicators, it is necessary to discard titles published strictly as paper journals. To remove titles published in paper form only out of the journals in the sample, Ulrich's Periodicals Directory (2004) was searched. It was found that every journal in the sample except one had an online version. As a result, in this study of the citation indicators, 70 journals were analysed for the nine-year period.

This analysis has some limitations. To measure the influence of electronic journals on citation indicators, it would be desirable to collect and analyse citation indicators of scientific journals that changed their publishing type from paper only to the electronic form only. But there are few opportunities in the field of education to observe

this phenomenon. Now most of the journals in the discipline publish both a paper and an electronic version. As a result, this study could only consider citation indicators of scientific journals based on parallel publishing not on electronic publication only.

Analysis process

This study showed a year-by-year analysis in three areas: (1) the Impact Factors and Immediacy Indexes, (2) Impact Factors between a high Impact Factor group and a low Impact Factor group, and (3) Immediacy Indexes between a high Impact Factor group and a low Impact Factor group. The reason why the study compares annual trends of Impact Factors and Immediacy Indexes between a high Impact Factor group and a low Impact Factor group separately is to identify the difference in citation indicators between journals actively used and journals hardly used.

Results

Seventy journals have Impact Factors for the nine years ranging from the highest ranking of 4.33 to the lowest ranking of 0.01. The mean Impact Factor for the journals during the period is 0.59 (SD 0.49), thus Impact Factors in the field of education are comparatively low. Only nine journals among them, about 13% of total, have mean Impact Factors higher than 1.0, and a great many of the journals have mean Impact Factors lower than 1.0. Except for several journals with higher Impact Factors, the difference across Impact Factors is not great.

The journals have Immediacy Indexes for the nine years ranging from the highest ranking of 100.00 to the lowest ranking of 0.00. The mean of Immediacy Indexes for the sample journals was 1.38 (SD 11.19) during the same period. Thirty-nine (39) items, about 56% of the total, have an Immediacy Index mean higher than 0.10, the other 31 journals (44%) have indexes lower than 0.10. The Immediacy Index mean is relatively high, so several journal titles with the highest Immediacy Indexes contributed decisively to increase the mean. Therefore citation indicators, especially the Immediacy Index, are observed to have a great variation depending on the journal title.

Figure 1: Annual changes of Impact Factor vs. Immediacy Index for the entire sample, 1995–2003

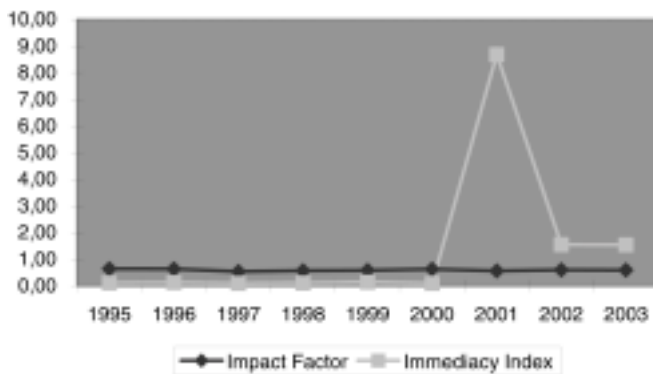
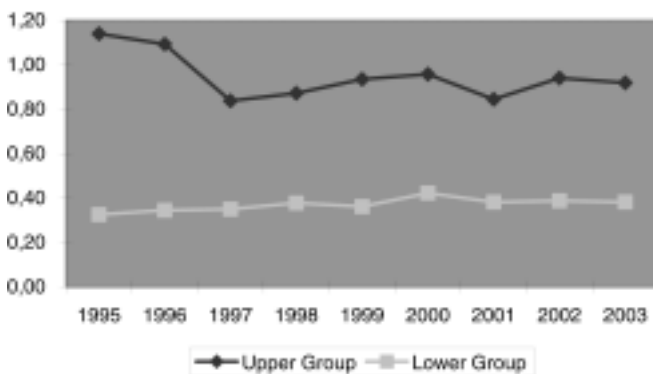


Figure 2: Time-series comparison of Impact Factors between the upper and lower groups, 1995–2002.

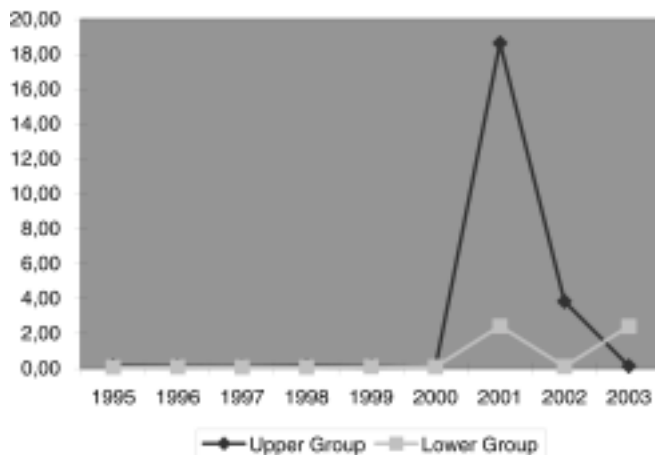


The currency of Impact Factor and Immediacy Index

As Figure 1 indicates, the means of the Impact Factors for the sample journals were almost unchanged from 1995, the early stage electronic journals arrived, through 2003. Their Immediacy Indexes, however, have illustrated a striking rise in current years, especially in 2001. The mean of the Immediacy Indexes increased rapidly from 0.09 in 2000 to 8.68 in 2001 and decreased to 1.55 in 2002. Also, the ANOVA (ANalysis Of VAriance between groups) indicated a significant difference between the Immediacy Indexes according to publishing year ($F=4.601, p<0.001$).

The 70 journals were divided into two groups according to their average Impact Factors: higher than average Impact Factors and lower than average Impact Factors. Twenty-seven (27) scientific journals had higher than average Impact Factors, i.e. a value greater than 0.59, so they remained in upper group; the lower group had 43 titles. Figure 2 shows a comparison of Impact Factor means for the upper group vs. those for the lower group

Figure 3: Time-series comparison of Immediacy Indexes for the upper and lower groups, 1995–2003.

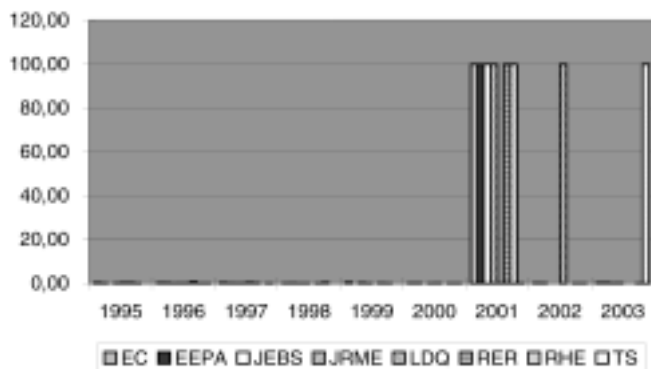


within the period. In the upper group the Impact Factor means have changed irregularly from 1.14 in 1995 to 0.92 in 2003, a decline of 19%. On the other hand, the lower group revealed little fluctuation for the whole period. The average Impact Factor increased from 0.33 in 1995 to 0.38 in 2003, a rise of 15% in the lower group.

Figure 3 presents the annual means of the Immediacy Indexes for the upper and the lower groups. Immediacy Indexes for the upper group showed rapid up and down variation for the current years while those of the lower group changed only slightly. The mean Immediacy Indexes in the upper group were lower than 0.2 until 2000, but their mean increased dramatically to 18.63 in 2001, then decreased to 3.84 in the next year, and finally changed to 0.14 in the following year, 2003. On the other hand the mean Immediacy Indexes in the lower group were 0.1 in 2000, but their mean increased to 2.43 in 2001, decreased to 0.11 in 2002, but rose once more to 2.42 in 2003. The ANOVA revealed a significant difference in Immediacy Indexes for the upper group according to publishing year ($F=4.729, p<0.001$), but there was no a significant difference in Immediacy Indexes for the lower group. Thus it can be said that the journals with high Immediacy Indexes showed dramatic “citation explosion” in recent years as compared to those journals that have low Immediacy Indexes.

Figure 4 shows that 8 journals had a rapid rise of their Immediacy Indexes in recent years; 6 titles experienced their biggest increases together in 2001, one title each increased in 2002 and 2003

Figure 4: Time-series comparison of highest Immediacy Indexes



Key: EC (Exceptional Children); RER (Review of Educational Research); EEPA (Educational Evaluation & Policy Annual); LDQ (Learning Disability Quarterly); JRME (Journal of Research in Math Education); RHE (Research in Higher Education); JEBS (Journal of Education and Behavioral Statistics); TS (Teaching Sociology).

respectively. To understand whether there was some disciplinary explanation for this phenomenon, the author consulted a colleague specialist in education. Dr. J.H. Shin, a professor in the Department of Education, Seoul National University, suggested that the dramatic increase in the Immediacy Indexes of these journals is likely caused by peculiarities in these sub-fields or in the characteristics of the specific journals. Thus, this study supports that opinion that peculiarities or characteristics of these scholarly journals caused their Immediacy Indexes to increase exceptionally to 100.0 in recent years as explained below.

One easy explanation could be that the topics of the published articles were especially interesting for scholars of education. High citation frequency for those articles might have accelerated heavily the increase of the corresponding Immediacy Indexes. For example, when one reviews the articles in two journals, one sees that *EC* (*Exceptional Children*) and *LDQ* (*Learning Disability Quarterly*) are addressing current key issues in the field of education, the trends in the scholarly community to promote interest in education for children with disabilities and learning disorders.

Another factor is funding for research. In several countries, including the United States, where some disciplines have rich funding, research in these disciplines has been especially active. *EEPA* (*Educational Evaluation & Policy Analysis*) and *JEBS* (*Journal of Educational and Behavioral Statistics*) focus on articles looking at cost-effectiveness, an

area where there is abundant research funding. Since many articles focusing on those issues were published in the two journals, we can see that the increase of citation frequency for such articles might have contributed to raising the Immediacy Indexes significantly.

Third, frequently issued journals have an advantage in increasing their Immediacy Indexes, because an article published early in the year has a better chance of being cited than one published later in the year. Compared to other education journals issued quarterly or bi-monthly, *RHE* (*Research in Higher Education*) is published more frequently, i.e. eight times in a year. *RER* (*Review of Educational Research*) consists of review articles, which are generally cited much more often than research articles. Thus it seems that a notable increase in these Immediacy Indexes might be due to features or characteristics of these scholarly journals.

It is difficult to conclude that features or characteristics of the journals and research currencies were the only major factors for explosive increases in several journals Immediacy Indexes in recent years. The Immediacy Indexes did not increase drastically in the 1990s but in more recent years, when the penetration of electronic journals and provision of digital articles would also be expected to make some impact on the Immediacy Indexes.

Later analysis

It is generally known that citation and Impact Factor can be affected by various factors such as subject characteristics, document type, language, age and available media (Case & Higgins 2000; Garfield 1976; Glänzel & Moed 2002). In particular, the number of citations received should be greatly affected by the size and age of the scholarly journals being compared. Though Harter (1998) reported that Impact Factors can be normalised by dividing the total number of citations received by the number of articles published, one cannot absolutely exclude the possibility that Impact Factors reflect the influence of those two factors.

These research findings led this study to analyse the effects of journal age on Impact Factors. Assuming more frequently issued scholarly journals and larger sized journals caused greater Impact Factors, another analysis of Impact Factor was conducted to assess the effects of frequency as an alternative measure for journal size. ANOVA was

Table 1. Analysis of Impact Factors according to age.

Year	DOF	F	Sig
1995 [*]	69	4.096	0.000
1996 [*]	69	3.266	0.001
1997 [*]	69	1.872	0.042
1998	69	0.833	0.708
1999	69	1.685	0.075
2000	69	1.201	0.309
2001 [*]	69	2.053	0.024
2002	69	1.014	0.493
2003	69	1.535	0.118

* means year showed a significant difference

Table 2. Analysis of impact factors according to frequency.

Year	DOF	F	Sig
1995	69	1.165	0.330
1996	69	0.762	0.519
1997	69	0.562	0.642
1998	69	0.238	0.870
1999	69	0.757	0.522
2000	69	2.038	0.117
2001	69	1.198	0.317
2002	69	0.012	0.998
2003	69	0.462	0.710

applied to measure whether annual Impact Factors are different depending on age and frequency. The longevity of the sample journals varied widely from 15 to 157, and the mean was about 46. Table 1 indicates that there was a statistically significant difference in Impact Factors for 1995, 1996, 1997 and 2001 according to journal longevity. This result implies that long-established journals were cited heavily in the early years of electronic journals but this tendency becomes weaker as digital access became more predominant.

Journals in the sample were published from once to sixteen times in a year, with most of them being quarterly or bi-monthly. Thirty (30) titles, about 43% of the total, were published quarterly, and 15 titles, about 21% of the sample, were issued bi-monthly. Table 2 shows that frequency of publication for these scholarly journals yields no statistical difference in Impact Factors during the nine-year period.

Conclusion

Citation indicators based on citation analyses are very useful to identify trends in scholarly journal usage. This study examined a change of Impact Factor and Immediacy Index for scholarly jour-

nals in the field of education for the nine years since 1995 when electronic journals began to be adopted. The findings of this analysis are as follows. First, Immediacy Indexes for the scholarly journals increased strikingly in 2001, while Impact Factors were almost unchanged for nine years, 1995–2003. Second, Immediacy Indexes for 75% of the eight journals that had higher than average Impact Factors increased drastically in recent years. Thus all sample journals did not contribute equally to the increase in the Immediacy Index in recent years, but several particular titles with high Impact Factors contributed disproportionately.

One of the causes for low average values of sub-discipline Impact Factors is the high rate of uncitedness. As Hamilton (1991) noted, more than 70% of all papers published in the social sciences covered by the *Journal Citation Reports® – Social Sciences Edition* Databases of the Institute for Scientific Information had no citations at all. Therefore the speed of citedness is a key factor in determining the Impact Factor of different scientific disciplines and sub-disciplines. Immediacy Indexes reveal the speed of citedness in part. Thus it is interesting that the Immediacy Indexes of several education journals in this analysis increased strikingly during the recent three years.

One can expect that an increase in their Immediacy Indexes might be due to some factor such as peculiarities or characteristics of scholarly journals. For example, frequently issued journals have articles published early in the year, which have a better chance of being cited than those published later in the year. After analysis it was found that only one out of the eight titles with high Immediacy Indexes was published frequently. In other journals published monthly or even 16 times per year there was no striking increase in the Immediacy Index during the same period.

It is reasonable to focus attention on other factors that might bring about an explosion of the Immediacy Index. In recent years easy access was expected to have impact on the Immediacy Index. It is certain that available media can be regarded as one of the factors that affect not only citation frequencies but also Immediacy Indexes. Previously Lawrence (2001) revealed that in the field of computer science more often cited articles and more recent articles are significantly more likely to be online.

This analysis did not include effects of subject category factors on the citation indicators. This study conducted an analysis in a specific field, education, where cross-field comparisons are not necessary. But this study did a later analysis on effects of age and frequency in order to gauge the effects of other factors. Impact factors for about half the years showed statistically significant difference in longevity, while there was no disparity with frequency for the whole nine-year period.

Digital access to scholarly journals promises to bring changes to citation indicators, especially the Immediacy Indexes of well-established journals in education. Further efforts need to be made to confirm more direct effects of electronic publication on citation indicators. For example, it would be important to understand why 2001 showed a spiked increase not sustained in 2002 and 2003 by determining patterns over a longer time-period. It is desirable that approaches similar to this study would be tried in the future when electronic journals and online articles are more widely used than at present. Finally, it will be most interesting to discover whether Impact Factors and Immediacy Indexes for online only journals differ significantly from paper only and paper-electronic titles.

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