Judging Journals:
How One Measures Impact

The Journal Impact Factor has troubled me for some time. People who use it to measure the quality of journals often add the admonition that the Impact Factor represents only one view of quality. But such admonitions are easily forgotten when analyzing data—simple numerical scales are seductive. More importantly, the admonition misses the point: The problem is not the narrow view of the measurement but rather what is being measured.

The Impact Factor is computed from data gathered by the Institute for Scientific Information (*ISI*), which publishes the Science Citation Index. *ISI* indexes many thousands of scientific journals, adding information about each article and its references to its database each year. Using that information, one can determine how often a particular article is cited in subsequent articles, at least for those that are indexed by *ISI*. (While *ISI* indexes many mathematics journals, it does *not* index all.)

For a given year, the Impact Factor for a journal is computed by calculating for articles published in the preceding two years the average number of citations in all journals published in that given year (and indexed by *ISI*) —that is, by dividing the total number of citations to the journal in the given year by the number of articles published in the preceding two years. If the Impact Factor of a journal is 1.5 in 2000, it means that on average articles published during 1998 and 1999 were cited 1.5 times in the collection of all journals published in 2000.

Impact Factor for Journal X, 2000

A= # citations in all *ISI* articles during 2000 to papers published in X during 1998-99

B = # number of articles published in X during 1998-99

Impact Factor = A/B

For 1999, here is a small sampling of mathematics journals with their Impact Factors.

	Impact Factor
Annals of Math	1.539
Jour of AMS	1.262
Inventiones	1.207
Duke Jour	0.895
Amer J Math	0.663
J Reine Angew Math	0.627
Trans of AMS	0.623
Math Annalen	0.596
Pacific Jour	0.354
Proc of AMS	0.311
Indiana Jour	0.304
Illinois J Math	0.295

There are some obvious problems with this measure of quality. Comparing journals in different fields, for example, may be meaningless—the traditions and cultures of citing other work (including one's own!) vary greatly between disciplines or even between sub-disciplines. Also, the two-year limitation may be misleading: In some fields (mathematics?), citations to important papers frequently follow several years after publication. Nonetheless, even with such limitations, most people agree that judging how often a paper is cited gives a measure of its value to the body of scientific literature.

The *essential* problem with the Journal Impact Factor, however, is that it is misnamed—it measures the quality of papers published in the journal rather than quality of the journal itself. Does that sound like pettifoggery? It's not. Which would you rather have, a single meal at a five-star restaurant or three meals at a three-star? Which collection would you rather own, the nine symphonies of Beethoven or the 250 cantatas of Bach? And which is better, writing one paper with twenty outstanding theorems or writing twenty papers, each with one? Not everyone would agree on answers to these questions, but it makes clear that judging something by evaluating component parts requires knowing both the number of parts and what the whole is meant to accomplish.

In the case of the Impact Factor, it is clear that short papers have less content, and should be cited less often than longer ones. Is it better to publish many short papers with lower Impact Factor or a few long papers with Impact Factor slightly higher? In the extreme case, would you rather publish a journal with a single thousand-page paper that was cited twice (IF=2.0), or a journal with a hundred ten-page papers, each cited once (IF=1.0)?

If one believes in using citations to measure quality, then the Impact Factor is a fine way to measure the quality of *articles* in a journal. A prospective author might want to look at the Impact Factor before submitting a prized paper to a journal. But if one wants to measure the quality of the *journal*, then surely it makes more sense to consider the number of citations per thousand pages (or, more accurately, per thousand characters). This gives a measure of the scientific value per unit of content.

	Citations/Thousand Pages
Proc of AMS	41
Jour of AMS	39
Inventiones	35
Annals of Math	34
Duke Jour	29
Math Annalen	28
Trans of AMS	27
J Reine Angew Math	27
Amer J Math	24
Illinois J Math	19
Pacific Jour	16
Indiana Jour	11

Is there much change? Of course there is. Journals with a tradition of publishing short articles *uniformly* have smaller impact factors (although the converse is certainly not true!) Ranking journals by the number of citations per thousand pages gives a very different picture than ranking by Impact Factor, and one can argue it is a more accurate way to judge the quality of the journal as a whole rather than its individual articles.

There is less variation for the four journals in applied mathematics:

Impact Factor	
SIAM J Num Anal	1.119
Math of Comp	0.981
Numerische Math	0.968
SIAM J Math Anal	0.920

Citations/Thousand Pages	
Math of Comp	57
SIAM J Num Anal	54
SIAM J Math Anal	49
Numerische Math	39

What's the conclusion? Surely not the Impact Factors is useless—it provides valuable information. But it's important to recognize that it is only a measure of the quality of articles within a journal, and that judging the journal itself requires more information and a thorough understanding of the journal's mission.

John Ewing
September 2001

Postscript

Of course, there are those who might want to measure cost-effectiveness rather than quality. In that case, one can count the number of citations per thousand dollars of cost. The ranking is then:

Citations/Thousand Dollars	
Annals of Math	602
Proc of AMS	425
Jour of AMS	406
Amer J Math	276
Trans of AMS	232
Pacific Jour	215
Indiana Jour	208
Illinois J Math	208
Duke Jour	149
Inventiones	70
J Reine Angew Math	66
Math Annalen	58

Measuring cost-effectiveness is even trickier than measuring quality, however, since the value of a journal is clearly more than generating citations.