



"Doing Science by the Numbers"

Society as a whole seems fascinated with attempts to quantify things. The emphasis (some would say overemphasis) on testing as a measure of both student success and quality of schools is one example. The *U.S. News* ranking of colleges and universities is another. It is little wonder that scientists would want a quantitative measure of the quality of a journal publication. A number of indices have been developed to do this, but the one receiving almost all of the attention these days is the impact factor (IF). A journal's IF for a given year is determined by counting the number of citations to articles published in that journal during the previous two years, then dividing this by the total number of articles the journal published during those two years.

There is nothing inherently wrong with such quantification. The problem arises when the IF (or any other number for that matter) becomes the *only* criterion by which quality or success is judged. It is becoming clear that the IF is beginning to have an impact of its own on science. Consider the following cited in a recent article in *The Chronicle of Higher Education*:¹

- According to Spanish law, researchers are rewarded for publishing in journals defined by ISI as prestigious, which equates to the upper third of the impact-factor listings.
- Scientists in China obtain cash bonuses for publishing in high-impact journals. In addition, physics graduate students at some universities are required to place at least two articles in journals with a combined IF of 4 to get their PhD.
- Hiring panels in the U.K. consider IF in reaching a decision.

Obviously, the IF only measures "impact" for the two previous years, not the enduring value of a contribution. Furthermore it says nothing about the value of a particular article or the quality of the science it describes, but provides only "a gross approximation of the prestige

of journals in which individuals have published," according to ISI's website.² (Note the use of the word "prestige," which surely tells us something about the factors motivating the overuse of the IF.) Nor does it indicate that the work is noticed by the community most interested in it. The fact is the correlation between IF and scientific quality is imperfect. ISI acknowledges these realities when it notes that the IF is being used for academic tenure evaluations by some institutions. "ISI does not depend on the impact factor alone in assessing the usefulness of a journal, and neither should anyone else," it cautions.

In spite of these acknowledged limitations, I've heard more than one of my colleagues say that, all other things being equal (which they rarely are), given a choice among several journals they would select the one with the higher IF as a venue for their work. No credible scientist would base any conclusion on a single number. I find this behavior puzzling as well as disturbing.

Several factors should be considered before selecting a journal. First and foremost, does it reach the community most interested in the work? Having a high IF doesn't necessarily mean the relevant community reads it. Work published in a "traditional" venue (which may have a lower IF) may be noticed and cited more quickly by the community. Second, does the journal have a history of publishing in the relevant technical discipline and are the reviewers qualified? Third, does the journal provide a format adequate to explain the work? Some rapid-communication journals with high IF have strict page limits. This can prevent a complete description of methods and data, inhibiting replication of the work by others. Fourth, are back issues of the journal accessible? Finally, factors such as time from submission to publication, page charges, and yes, IF should be taken into account.

As members of the scientific community, we have a choice about where we publish our work. Remember, we're *giving* our work to a publisher, so we have every right to

demand high standards. Furthermore, in most cases we're providing the documentation for publicly funded research, so public access to the information should be taken into account. In my view that means selecting a responsible publisher who strives to make the information available at an economical rate, guarantees that the publication is truly archival, and doesn't manipulate the market to eliminate competition.

Facilitating the scientific enterprise by disseminating information is among the most critical missions of ECS and its sister not-for-profit scientific societies. Our headquarters staff and editorial boards do everything possible to provide high-quality publications at an economical cost. This allows individuals to retain personal subscriptions and institutions to minimize the impact on their budgets. Our subscription prices are far below those of commercial publishing houses. In fact, both ECS journals have among the lowest per-page prices of any publisher.

I urge ECS members to resist the herd instinct to choose journals on the basis of a single illusory number. We all need to encourage responsible publishing through our personal actions and by our efforts within societies such as ECS. Making our voices heard within our home institutions, where decisions regarding which journals to retain are made annually, can have an impact too.

In short, let's not do science by the numbers.

Mark Allendorf
mdallen@sandia.gov

References

1. R. Monastersky "The Number That's Devouring Science," *Chron. Higher Educ.* October 14, 2005.
2. "The ISI Impact Factor," <http://scientific.thomson.com/free/essays/journalcitationreports/impactfactor/>, June 30, 2006.