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The Impact Factor, 50 Years & Counting: Overview, Debate, Alternatives

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The Impact Factor

- Measure of *average* citation frequency to a particular journal
- Compiled & released annually by Thomson Scientific (formerly ISI)



Background

- 1955: Concept first described by Garfield
- Early 1960s: *Journal Impact Factor* created
- 1972: First published ranking by *Journal Impact Factor*
- 1975: *Journal Citation Reports* launched



Eugene Garfield, Ph.D.



Started Simple

Intended as *relatively simple* way to:

- Rank scientific journals
- Identify which ones mattered most to researchers (& librarians)
- *Quantify* what everyone knew, i.e., some journals are more prestigious



Morphed Metric

Now an *omnipotent* measure of:

- Journal status
- Journal quality
- Article quality
- Research quality
- Author quality




Devouring Science?

Undue influence on:


- Academic hiring
- Grants & funding
- Research agendas
- Editorial process



Mixed Blessing




"Like nuclear energy"
- Eugene Garfield




The Formula

- A = Number of *citations* to Journal X in *current year* to articles in Journal X during *previous 2 years*
- B = Number of *citable articles* in Journal X during *previous 2 years*
- A/B = *Impact Factor*



N Engl J Med 2006


- A = **32,009 citations** in 2006 to 2005 & 2004 NEJM articles
- B = **624 citable NEJM articles** in 2005 & 2004
- A/B = 32,009/624 = **51.296**
- In other words: "average" NEJM article cited **51.296** times in 2006



Medicine "Top Ten" 2006

1. N Engl J Med	51.296
2. Lancet	25.800
3. JAMA	23.175
4. Ann Intern Med	14.780
5. PLoS Med	13.750
6. Annu Rev Med	13.327
7. BMJ	9.245
8. Arch Intern Med	7.920
9. CMAJ	6.682
10. Medicine	5.167


Median: 1.188
(103 titles)



Nursing "Top Ten" 2006


1. Birth	2.058
2. Nurs Econ	1.810
3. Am J Crit Care	1.685
4. Nurs Res	1.604
5. Onc Nurs Forum	1.475
6. J Clin Nurs	1.430
7. Nurs Outlook	1.419
8. J Adv Nurs	1.342
9. Res Nurs Health	1.337
10. ANS Adv Nurs Sci	1.271

Median: 1.014
(36 titles)



Generalizations!

- Vary widely across disciplines
- Range from 0 to 60s
- Most are below 2, many below 1
- 4 & above regarded as "high"
- 10 & above are "stellar"



Debate



- *The Good*
 - Objective & useful?
- *The Bad*
 - Biased & flawed?
- *The Ugly*
 - Misused & abused?



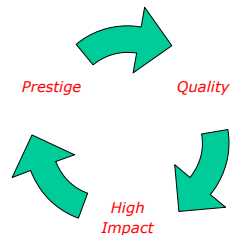
The Good

- A reasonable metric (in spirit)
- Simple quantitative measure
- Widely accepted & regularly updated
- Widely (though not freely) available
- Broad coverage



More Good

- Useful for evaluating, prioritizing, comparing
- Rankings *within disciplines* consistent
- Prestige = Quality = High Impact [Q.E.D.!]



The Bad

- Biased?
 - Coverage & discipline
- Flawed?
 - Algorithm & measurement
- Limited?
 - Time frame & content



Coverage & Field Bias?

- Uneven country coverage
- Mainly English language titles
- Favors high profile basic sciences



Algorithm Flaws?

- Includes citations in numerator to items *excluded* from denominator
- Includes self-citations
- Doesn't adjust for article type



Measurement Flaw?

- Reflects *average* citation rate *not typical* citation rate
- Small portion of a journal's articles account for *most* of its citations
- Not representative of individual articles in a journal



Too Limited?

- Inadequate temporal window
- Only journals (& some proceedings)
- Doesn't take into account:
 - Context of citations
 - Prestige of citing journals
 - Journals' many roles



Beyond the Impact Factor

- Impact Factor variants
- Webometrics
- Popularity plus prestige rankings
- H-index & variants
- Online usage counts
- Expert services
- EBM resources
- Core lists
- Traditional measures



Refinements & Variants

- Journal to Field Impact Score (JFIS)
- Adjusted Impact Factor (AIF)
- Cited Half-Life Impact Factor (CHAL-IF)
- Median Impact Factor (MIF)
- Disciplinary Impact Factor (DIF)
- Euro-Factor (EF)



Webometric Resources

- arXiv.org
- CiteSeer
- Google Book Search
- Google Scholar
- IOP Journal Archive
- MathSciNet
- NASA's Astrophysics Data System
- HighWire Press
- Physics Review Online Archive
- SciFinder Scholar
- Scitation/SPIN
- Scirus
- ScienceDirect
- Scopus



P & P Rankings

- Combine *popularity* & *prestige* metrics
- How many cites plus status of citers
- Use Google-type PageRank algorithms



Y-Factor

- Developed by Johan Bollen et al. @ Los Alamos Research Library
- **Weighted PageRank** = prestige metric
- **Weighted PageRank** combined with Thomson **Impact Factor** = **Y-factor**

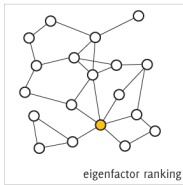


IF vs. WPR vs. Y-Factor

- | Thomson
Impact Factor | Weighted
PageRank | Y-Factor
(combination) |
|--------------------------|----------------------|---------------------------|
| • Ann Rev Immun | • J Biol Chem | • Nature |
| • Ann Rev Bioch | • Nature | • Science |
| • Physiol Rev | • Science | • NEJM |
| • Nat Rev MCB | • PNAS | • Cell |
| • NEJM | • Phys Rev Lett | • PNAS |
| • Nat Rev Cancer | • Phy Rev B | • J Biol Chem |
| • CA Canc J Clin | • NEJM | • JAMA |
| • Nature | • Astrophys J | • Lancet |
| • Nat Med | • Cell | • Nat Genet |
| • Ann Rev Neuros | • J Am Chem Soc | • Phys Rev Lett |



Eigenfactor



- Another P & P measurement
- Developed by Bergstrom Lab @ University of Washington
- Applies PageRank-type scheme to Thomson dataset
- "Eigenvector centrality methods"
- Rankings free at eigenfactor.org



H-Index

- Developed by physicist **Jorge Hirsch**
- Attempt to quantify impact & productivity of individual scientists
- **H-index** = highest number of papers a scientist has published that have each received that number of citations
- Example: H-index of 40 = 40 papers each cited 40 times



What's Your H-Index?

Physics

- Ed Witten = 110 (137 as of May 2007)
- John Ellis = 94
- Marvin Cohen = 94
- Philip Anderson = 91
- Manuel Cardona = 86

Biology & Medicine

- Solomon Snyder = 191
- Robert Lefkowitz = 164
- David Baltimore = 160
- Robert Gallo = 154
- Pierre Chambon = 153
- Bert Vogelstein = 151



H-Index Variants

- **G-index**: gives more weight to highly cited articles
- **Contemporary h-index**: gives more weight to recent articles
- **H1-index**: allows comparison among subject fields
- **H-b index**: judges impact in a particular field
- **Ca index**: evaluates creativity based on citation networks



Online Usage

- Usage & download counts
 - COUNTER
 - SUSHI
- "Most Viewed Articles"
 - BioMed Central
 - PLoS



Experts & Evidence

- Expert services
 - Faculty of 1000 Biology & Medicine
- Evidence-based resources
 - Cochrane & PIER
- Core lists
 - Key & Electronic Nursing Journals



Traditional Measures

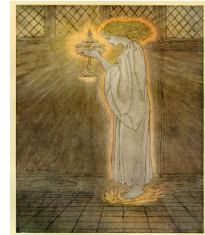
- Peer review
- Reputation of editor
- Editorial standards
- Percentage of research articles
- Inclusion in indexes & databases
- Online availability
- Timeliness
- Readership & circulation



Not The Holy Grail But ...

Useful for
journal comparison

- **Intra-disciplinary** indicator of status
- **Indirect** indicator of quality



Scientific Value ≠
A Single Metric



Thank You!

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Additional Readings

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Additional Readings

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Additional Readings

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