Ranking the Physics Departments: Use Citation Analysis

Your "Washington Reports" story on *Research-Doctorate Programs in the United States*[1] (November 1995, page 67) leads off with the declaration that "few reports from the National Research Council are likely to arouse such frenzied reactions among academics as its rankings of the quality and effectiveness of the nation's doctoral programs."

What other reaction would be appropriate to evaluations based upon subjective (and mostly uninformed) opinion? Given that professors would not grade their students by reputational survey, how can they do that to their departments?

To evaluate the scholarly quality of any individual paper or scientist, there is no substitute for the judgment of an expert. To evaluate the average quality of work produced by an organization, one must appeal to an ensemble of experts who either have or have not found the work useful. The standard way to undertake such an evaluation is to employ citation analysis.[3]

The accompanying table shows the top 20 US universities by number of citations per physics paper to research papers published in the 14-year period from 1981 through 1994. Of these institutions, 13 are the "usual suspects" that placed in or very near the top 20 in the NRC's reputational rating (93Q)[1] of physics departments for scholarly quality of faculty. Seven are overachieving interlopers, the most intrusive being our own Tulane University, which ranked 3rd out of 101 in terms of citations per paper, but 116th out of 147 in terms of reputation. The average faculty size is 52 for the usual-suspect departments and 23 for the interlopers, while our Tulane department has only 12 faculty members. We obtained the data on citations and publications from David Pendlebury of the Institute for Scientific Information (the source of the NRC's raw citation

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US physics top 20 by number of citations per paper for papers published in 1981–94, compared with their NRC reputational ratings

Institution (and size of physics faculty)	Citations per physics paper	Rank (out of 101) by citations per paper	Rank (out of 147) by NRC's reputational rating system
Princeton University (47)	20.7	1	2
Harvard University (32)	20.4	2	1
Tulane University (12)	20.1	3	115.5
University of California, Santa Barbara (45)	19.3	4	10
University of Chicago (40)	18.8	5	7
Brandeis University (20)	18.5	6	42.5
University of California, Santa Cruz (18)	18.4	7	47.5
California Institute of Technology (39)	18.0	8	5
University of Pennsylvania (46)	17.7	9	17
Rockefeller University (5)	16.4	10	30
Stanford University (25)	15.9	11	9
Yale University (61)	15.8	12	13
State University of New York at Stony Brook (39)	14.4	13	22.5
Massachusetts Institute of Technology (83)	14.2	14	3.5
University of California, Berkeley (67)	13.8	15	3.5
Cornell University (54)	13.3	16	6
University of California, Riverside (32)	12.9	17	68.5
Michigan State University (55)	12.8	18	32
Tufts University (20)	12.8	19	77
University of Illinois at Urbana-Champaign (98)	12.7	20	8

We write in defense of the faculty and graduate students of small, high-quality physics departments slammed by what the NRC survey cochair Marvin Goldberger has called the "inverse halo effect,"[2] which diminishes the quality ratings of small schools. We wish to point out just how severe this effect can be, and to suggest some ways to eliminate it. These issues are critical in a time of constricting budgets, when an inverse halo may prove to be a noose.

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data), and the data on faculty size from the NRC report. The 101 universities in the ISI database are those that published at least 100 articles in physics journals in 1981–94. A higher cutoff, which filtered all the interlopers out of the "top 10 influential schools," was used in the ISI citation-impact study[4] mentioned in the "Washington Reports" story.

(As of November 1, the complete set of our citation-based physics rankings will be on the World Wide Web at www.phy.tulane.edu.)

Using the NRC's own correlation coefficients (see ref. 1, page 461) and a standard statistical method, we found that 51% of the variance in reputational ranking is due to faculty size alone, holding citations per faculty member fixed. There must be ways to make reputational rankings more meaningful for small departments. For example, each evaluation could be weighted in proportion to the number of faculty members in the department who share the evaluator's subdiscipline; also, each evaluator could be given information about the department's scholarly achievements and the honors received by its faculty.

Normalized data such as number of citations per paper and number of citations per faculty member can level the playing field, and we applaud the NRC for including the latter measure in its report. Pages 143 and 312 of the NRC report suggest that the NRC committee that prepared it counted citations in the 5-year period 1988–92 to papers published in the 12-year period 1981–92, using ISI data. Had the committee members actually used this 12-year period, the results might have provided a fairer assessment of all departments. Unfortunately, as one of us (Perdew) learned from James Voytuk, an NRC staffer who worked on the report, they actually counted citations in 1988–92 to papers published in the same 5-year period.

Citation analysis typically requires a more long-term perspective. For example, consider Steven Weinberg's 1967 paper on the unification of the electromagnetic and weak forces, for which he shared, with Sheldon Glashow and Abdus Salam, the 1979 Nobel Prize in Physics. Between 1967 and 1973, the number of annual citations to Weinberg's paper, which eventually became the most-cited paper in particle physics, were zero in 1967, 1968 and 1969, one in 1970, four in 1971, sixty-four in 1972 and one hundred and sixty-two in 1973.[5] By the NRC's measure of citations in a five-year period to papers published in the same period, Weinberg's paper would have been judged insignificant, whatever the initial year chosen.

To estimate where Tulane would rank in terms of long-term citations per faculty member, we divided each university's total number of physics citations for 1981–94 by the physics faculty size. We found that Tulane would rank 46th out of 101, preceded by Michigan State University (45th), the University of Utah (44th) and Yale University (43rd). We believe that this citation measure, or even the citation measure given in the table, is a far better estimate of the relative quality of academic departments than are the NRC's measures. The challenge is to measure quality, independently of size.

When asked if universities aggrieved by the NRC results could appeal their rankings, survey cochair Brendan Maher said, "Only in the way that someone without a parachute might want to appeal the law of gravity." One of us (Tipler), being an expert in general relativity, does not wish to appeal the law of gravity, but he does object to being pushed out of the airplane without a parachute.

References

1. National Research Council, *Research-Doctorate Programs in the United States: Continuity and Change* (National Academy Press, Washington, DC (1995).
2. W. Roush, Science **269**, 1660 (1995).
3. S. J. Liebowitz, J. P. Palmer, Quart. Rev. Econ. Bus. **28**, 88 (1988).
4. ISI Research Services Group, Science Watch **5** (10), 2 (1994).
5. S. L. Glashow, B. Bova, *Interactions: A Journey through the Mind of a Particle Physicist and the Matter of This World*, Warner Books, New York (1988), p. 207.

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The John Scott Award: What Really Happened

I was pleased to see your brief account of my having received the John Scott Award (June, page 73). Alas, the story is both incomplete and inaccurate in that—as you could not have known—the Goddard press release was distributed in uncorrected form and the original award citation was misleading.

I was not the sole recipient. Rather, I shared a John Scott Award with my friend Joseph Taylor of Princeton University, who was honored for his astoundingly precise tests of general relativity on binary pulsars. In addition, a John Scott Award was presented to Barry J. Marshall for his proof that *Helicobacter pylori* infections are the main cause of digestive tract ulcers.

The citation (quoted in part in your story) implied that, as project scientist of the Cosmic Background Explorer project, I was the leader on the cosmic background anistrophy measurements. Rather, the leaders were George F. Smoot and Charles L. Bennett; I was a coinvestigator.

Finally, the awards were presented by the Board of City Trusts of Philadelphia, and not by the American Philosophical Society, whose lovely building was used for the awards ceremony.

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How to Donate Books, Journals to Pakistani Universities in Need

This is a follow-up to Tatiana Divens's letter (April, page 84) on the developing countries' urgent need for donated scientific publications. I learned firsthand of that situation earlier this year, when I gave lectures to the physics departments of several Pakistani universities on behalf of the Association of Pakistani Scientists and Engineers of North America (APSENA). There, many able scientists are handicapped by a lack of books and journals, and dire economic conditions coupled with a shortage of foreign exchange make it very difficult for institutions to buy scientific publications.

We in North America can help by donating scientific and technical books, journals and magazines to APSENA for distribution to Pakistani universities and colleges. Donated items—covering any discipline, not just physics—can be sent to Dr. Mohammad Munir, Education Counselor, Embassy of Pakistan, 2201 R Street, NW, Washington, DC 20008. He will have them shipped by air (at no charge to the donors) to a central distribution center in Islamabad, Pakistan. Donors should be sure to tell him that their gifts are for APSENA.

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Corrections

September, page 120—The title of Stephen L. Adler's book is *Quaternionic Quantum Mechanics and Quantum Fields*. ■