budget for travel. In the past you have divided the dollars equally between all faculty members. This year you have three new, nontenured faculty on your staff. Each of them has applied to attend three conferences for the upcoming school year to make presentations. If approved, these requests will adversely affect your senior faculty's ability to receive travel dollars. Although you recognize the importance of supporting new faculty in their travel needs, you know that your senior faculty will not only expect equal travel dollars, but, in fact, they will believe they are entitled to receive the most dollars for travel. How will you handle this situation?

Student case study: Plagiarism/ academic misconduct. Sam Clooney is a student in one of your department's online courses. Part of his final grade involved developing a research study and completing the literature review utilizing online resources. Mr. Clooney completed the assignment, and approximately 60% of the literature review reflected work from online sources. However, he appears to have borrowed too much from his online sources. When Mr. Clooney's professor discussed the issue of plagiarism with him, he denied that he had plagiarized material. The professor has given him a failing grade for this assignment. Mr. Clooney has apologized and stated that he was confused about what constituted plagiarism when dealing with materials found on the Internet. He does not think he should fail this assignment and wants to be allowed to redo the assignment. This is the first time online plagiarism has been an issue in your department. The continued success of online courses is important to the overall strategic plan for your department. Mr. Clooney has appealed to you and asked that you reverse the professor's decision. How will you handle Mr. Clooney's request?

Debriefing

The debriefing enables participants to reflect on the case studies and the overall simulation as a mechanism for examining their own situations and difficult contexts. Questions related to the leadership and decision-making processes provide some helpful insights on being a successful chair. The discussion usually leads to the sharing of other, more personal, case studies that participants are dealing with at their respective institutions.

Conclusion

Academic chair positions, roles, and responsibilities are situated in contexts that are always unique to the institution's culture and management philosophy. In order to be successful, the chair must understand this context to obtain resources and to advocate for faculty. Position descriptions for chairs, if available, are often vague, containing statements referring to managing budgets, evaluating faculty, and providing leadership in the academic area. The successful academic chair must please students, faculty, and administration by working within the complex maze of policies, personalities, culture, and institutional history. The simulation model can help chairs become more effective in dealing with the complexities of the position. ▲

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Measuring Research Productivity and Pareto's Law

by Robert Styer

Chairpersons and other administrators are under increasing pressure to quantify research and research expectations. As part of the departmental review process that we undergo every seven years, the Department of Mathematical Sciences at Villanova University prepared a detailed self-study in spring 2002. The instructions specifically ask for measures of research productivity. Given the growing importance for assessment of productivity, this article will share our findings with the hope that they might encourage others to carefully consider how to present results on research productivity. In particular, touting an "average number of publications" can seriously mislead higher administrators and rank and tenure committees. Although it is tempting to use a simple number such as a mean or median, publication data is so skewed that such numbers do not provide an adequate summary of the data needed for enlightened management.

To anticipate our conclusions, we discovered that publication rates obey a very strong form of the popular Pareto's Law: 20% of the people do 80% of the work. One person can heavily influence the average number of publications; there is no "typical" publication rate that can blindly apply to a faculty member. Chairs must individualize research goals for each faculty member.

To assist newly hired faculty members, our administration asked each department to quantify the typical or expected number of publications needed for tenure or promotion. As we will see, a single number or narrow range of numbers cannot hope to adequately summarize the skewed nature of the publication data. Defining "adequate" research productivity is as multifaceted

and difficult as defining adequate teaching or service.

We gathered publication data for a ten-year period, 1991–2000. In 1984, the National Research Council published a very influential report, *Renewing U.S. Mathematics.* This report noted that there are about 50,000 mathematically trained individuals with about 14,000 mathematical sciences faculty at U.S. universities and four-year colleges. Of these, 4,000 published "frequently." Quoting the footnote on page 64, this report: "...shows that 4,000 mathematical scientists publish at least three papers per five years. Numbers of papers per year are much smaller than in most sciences. Mathematical scientists of high quality will, with rare exceptions, publish at least three papers every five years."

This figure of three papers in five years has become the definition of "frequently published" in subsequent reports. Thus, we decided to use a ten-year period to give an idea of our publications in two five-year periods.

A 1997 report by the National Academy of Sciences, *International Benchmarking of U.S. Mathematics Research,* contains graphs indicating that about 23,000 Ph.D. mathematicians produced slightly under 4,400 research papers per year. This would give an average mean publication of one paper per five-year period. As we will see, however, the mean does not adequately convey the true state of research productivity.

The easiest way to investigate research output in the mathematical sciences is to use the American Mathematical Society reviews database, *MathSciNet.* There are, of course, problems in using this database to investigate math research output. For instance, in ten years, our department produced 155 publications but only 80 "hits" in *MathSciNet.* First, most statistical and pedagogically oriented mathematics journals are not in the database. For example, our faculty have published several expository articles in the prestigious *American Mathematical Monthly,* but these do not appear in *MathSciNet.* Similarly, our department has a mathematical physicist with 40 publications in the last ten years, but the *MathSciNet* reviewed only 13 of these. Even if one got fairly accurate publication counts from various institutions, the numbers would be hard to compare because departments have differing numbers of faculty at differing stages of academic life, some of whom are nontenure-track instructors. Nevertheless, lacking a better yardstick, we used this database to get a rough idea of how Villanova's Department of Mathematical Sciences compares with other institutions.

We decided to compare ourselves with schools from our admissions overlap group. Table 1 presents the number of *MathSciNet* listed publications in the ten-year period (1991–May 2001) for each faculty member listed on the web page at these institutions. This counts only the publications by that faculty member while at that school. In particular, Boston College (BC) recently hired three faculty at the full professor level, most of whose publications are attributed to their previous institutions and so are not in this data. Master's level instructors may or may not be included in the faculty lists on the web used to generate this data (for instance, BC's and Villanova's web pages include instructors).

Pareto's Law summarizes the importance of skewedness in data. In its most popular form, Pareto's Law says that 20% of the people do 80% of the work. Applied to publications, a couple persons produce most of the publications, a few more publish a significant number, while most produce very little. Our data demonstrate this extreme skewedness: Note that the top publisher often produces close to half the department's output. For instance, at Villanova, one person has 23 *MathSciNet* listed publications, the next has 13 listed, and the rest of the department only has 29 total, while 16 faculty members have no publications listed for this ten-year period (primarily instructors and senior faculty).

Note that the mean number of Villanova mathematical sciences publications in this ten-year period is just over three with a median of one, though if we eliminate the zeros, the mean is six with a median of three. If we eliminate the top two publishers, the mean is one with a median of zero. The distribution of publications is extremely skewed, much worse than 20% of people doing 80% of the work. Adding or removing one top researcher would greatly influence the mean value, while the median would not convey the impressive publication rate of the best researchers.

Jerrold Grossman (2002) confirms the skewedness of publication distributions. His data show that 42.7% of mathematicians in the full *MathSciNet* database have only one paper listed, 14.6% have exactly two, 8.0% have three, 5.3% have four, 3.9% have five, 10.0% have six to ten, 7.4% have 11 to

Table 1. *MathSciNet* Reviewed Publications

Institution	Numbers of *MathSciNet* reviewed publications for each faculty member																		
Boston College	6	5	4	3	3	3	3	2	2	2	1	1	1	1	0	0	0	0	0
(BC cont.)										0	0	0	0	0	0	0	0	0	0
Bucknell	54	18	10	6	5	3	2	2	1	1	1	1	0	0	0	0	0	0	
Fairfield	29	10	7	4	3	1	0	0	0	0	0	0	0	0					
Lafayette	20	18	15	12	9	6	4	3	3	2	2	0	0	0	0	0	0	0	0
Loyola MD	6	2	2	2	0	0	0	0	0	0									
Villanova	23	13	5	4	4	4	3	2	2	1	1	1	1	1	0	0	0	0	0
(Vill. cont.)									0	0	0	0	0	0	0	0	0	0	0

20, and 8.2% have more than 20. In particular, the median for published mathematicians is only two papers total, though the mean is over six.

We have evidence that this skewed distribution of publications applies to other academic fields. Villanova's Department of Economics saw our report and created a similar set of data (see Table 2). They obtained a list of faculty from the web pages of comparable schools, mostly Catholic, then used *EconLit* to find the total number of listed publications for each faculty member. As with *MathSciNet,* the data from *EconLit* has limitations. For instance, it does not include journals that lean more toward statistics or sociology or religion, nor does it take into account years of service. Nevertheless, it gives a rough picture of the relative publication rates for various institutions and displays the same extreme skewedness of faculty publication data. We decided to disguise the names of these institutions because names would invite a superficial ranking, which contradicts our central point that one should not use highly skewed publication data to make comparisons.

What should a chairperson conclude from such data? First, the average number of publications is not a good measure for the research productivity of the average faculty member. Adding or removing one top researcher can dramatically change the average publication rate. Thus, providing the mean number of publications to a rank and tenure committee would hurt most faculty members being considered. Nor is the median a good measure for most purposes: Publications enhance the reputation of a school, so the total number of publications is very relevant.

Second, chairs and administrators should consider the purpose that publications have for their unit. If the purpose is largely developmental, then resources such as travel funds should be allocated relatively uniformly, not on the basis of the number of papers. If the purpose, however, is simply to get the institutional name known in the research community, one could allocate funds based on publications, which in effect gives the lion's share of funds to a couple top researchers. Indeed, if one wishes to quickly increase the department's publications, one should simply hire a couple of superstars who will likely outpublish the rest of the department together.

From the viewpoint of managing a department, the skewedness indicates how varied the contributions of each faculty member are. Chairs need to individually tailor a plan and goal to each member, rather than use a single departmental standard. In preparing rank and tenure policies, chairs should resist the efforts of administrators and rank and tenure committees to quantify "typical" publication rates. Although research productivity seems easier to quantify and thus evaluate objectively than teaching or service, our data suggest that evaluation of research contributions must be carefully tailored to the individual and not naively based on comparison with an "average faculty member." ▲

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Table 2. *EconLit* Reviewed Publications

Institution	Number of *EconLit* reviewed publications for each faculty member																
Ivy League	100	64	55	53	44	38	35	35	27	26	24	23	19	15	15	13	13
(Ivy cont.)	9	7	7	6	5	4	4	3	2	1	1	1	0	0	0	0	0
Catholic 1	44	38	36	32	30	25	24	23	22	17	17	17	15	11	10	7	7
(Cath 1 cont.)								5	1	1	1	1	0	0	0	0	0
Private 1	54	33	15	12	10	10	9	7	2	1	1	0	0				
Catholic 2	32	27	24	21	20	18	18	16	14	12	11	10	10	9	9	9	7
(Cath 2 cont.)								7	6	4	2	2	1	0	0	0	0
Private 2	25	18	16	13	12	11	10	6	5	4	2	1	0	0			
Catholic 3	46	40	25	21	14	14	12	12	10	9	8	7	7	6	6	6	6
(Cath 3 cont.)							5	5	4	3	1	1	0	0	0	0	0
Villanova	25	20	20	15	12	10	8	6	5	5	3	2	0	0	0	0	0
Private 3	17	15	15	11	10	7	6	5	2	2	1	1	0	0	0	0	
Catholic 4	26	5	2	2	1	1	0	0	0								
Private 4	12	5	5	3	3	2	2	1	1	1	0	0	0	0	0		
Catholic 5	10	6	2	2	2	1	0	0	0	0	0	0	0	0	0	0	
Catholic 6	5	1	1	0	0	0	0	0	0								
Catholic 7	5	1	0	0	0	0	0	0									

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