and the U.S. National Institutes of Health (NIH) on the relationship between mode of support for graduate study and subsequent career development (News & Comment, p. 806). The Medical Research Council of Canada (MRC) has looked for differences in post-training research productivity among groups of graduate students supported through different funding mechanisms. One of our studies examined three groups of students: those who had been awarded graduate support in a national competition, those who had been turned down in the national competition, and those who had received personal awards from other granting agencies. While there were statistically significant differences in the undergraduate records of the three groups, there were no significant differences in Ph.D. achievement, pursuit of postdoctoral training, employment sector, time devoted to research, publications, or role in training the following generation of students.

The critical issue is finding selection criteria that relate to the desired program outcome. Suppose that the objective of a training award program is graduates who make a useful contribution to the search for new knowledge during their subsequent career. Should awardees be selected on the basis of interest in research, academic achievement, research accomplished, or some other factor? If a variety of criteria are used, what weight should each criterion bear in the selection decision? To explore these questions, the MRC surveyed a large sample of former research trainees to obtain data on variables that might be expected to serve as useful criteria when recipients of research training funds are selected. Results suggested that personal qualities, such as a critical attitude, independence, inventiveness, and curiosity (a set of characteristics that we labeled "investigative personality" were correlated with research career activity. Likewise, a set of variables that we labeled "focused energy" (qualities of determination, organization, and energy) were good discriminators of levels of research activity. Of 11 other criteria that we examined for possible use in selecting students with a predisposition for careers involving research, only one, the research orientation of the graduate training environment, showed any promise. For the sample group, undergraduate academic grades were not correlated with post-training research activity, a finding that has sparked controversy in a community where grades carry a high weight in decisions as to who gets research training awards.

The MRC hopes to develop a graduate award selection process which facilitates assessment of qualities that relate to the spirit of investigation and search for new knowledge. We look forward with great interest to learning the results of the NSF and NIH studies.

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Science: The Broader Context

I applaud M. R. C. Greenwood's call to scientists to take on the responsibility "to be more civically inclined" (Editorial, 17 May, p. 933). She notes that we are in a period of skepticism about the importance of scientific research. One way that scientists can move past this skeptical period is to examine our own mythology about how science works—that science is always objective and apolitical, that the scientist is best understood as a modern-day hero, a pioneer struggling on the frontiers of

knowledge—and to consider rewriting our science stories to reflect more accurately how we produce scientific knowledge.

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I was somewhat astonished to read Greenwood's editorial decrying the alarming erosion of "informed friends of science [who] understand [the] importance of science, mathematics, and engineering research and education." The astonishment was not so much with what the editorial said, but rather by where it was published. For this compelling editorial, aptly entitled "Desperately seeking friends," came almost as an unintended commemoration of the tenth anniversary of the AAAS's divestment of its major initiative geared precisely toward addressing such concerns.

I refer, of course, to the decommissioning by the AAAS of the publication *Science 86*. This award-winning magazine, which had won the respect of the scientific community and the appreciation of the reading public at large, was precisely the sort of antidote to the "alarming anti-intellectualism" described by Greenwood and the kind of "public outreach" called for.

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Greenwood's editorial seems to arise from the new paradigm in the world of economics: exploitation of innovative knowledge and technology is what drives a free-market economy. This puts the scientist in a more central position in society than previously. In order to make the friends that Greenwood is seeking, and meet "the demand for efficiency and accountability in the use of public funds," new indices of science's contributions to society are needed. Greenwood states, "The United States leads the way in virtually all fields of scientific endeavor." This may be true on an absolute scale, but when the data are normalized to population base or a country's general expenditure on research and development (GERD), a different picture may emerge.

I propose that a country's scientific contributions in a given year can be assessed by the following four indices:

- productivity: the number of scientific publications per capita;
- impact (citations per capita): the average number of citations per paper multiplied by productivity;
- efficiency: the number of publications in relation to GERD; and
- effectiveness: the number of citations in relation to GERD.

The United States leads the Group of 7 countries in impact, but is third in the other three indices. Canada leads in productivity, efficiency, and effectiveness and is second only to the United States in impact. Germany, France, Italy, and Japan are not strongly competitive with Canada, the United States, and Great Britain.

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As a former scientist and current law student, I agree wholeheartedly with Greenwood that science in particular and society in general would benefit if law schools exposed their nascent lawyers and politicians to the quantitative methodology of science. It is deplorable that, as Greenwood points out, "most of the regulations governing the conduct of science are written by legislators who have graduated from law schools that do not require [such] sophistication."

As a current law student and former scientist, however, I see an equally pressing need to educate nascent scientists in the methodology of the law and, by extension, politics. Politics has always influenced science. Law is doing so more and more. The News & Comment article in the same issue about the Abbs case (J. Friedly, 17 May, p. 947) is a case in point. Society will suffer if politicians and lawyers are not familiar with the methodology of science. By the same token science will, and to a certain extent already has begun to, languish because its practitioners are not familiar with the broader context in which science exists, as well as the specific rules and regulations that govern them. This is not a price that science can afford to pay.

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Letters to the Editor

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