Letters

Jobs for Mathematicians

Although I am in general agreement with much of what is contained in Gina Bari Kolata's article "Communicating mathematics: Is it possible?" (Research News, 28 Feb., p. 732), one statement attributed to me appears to be neither a correct reflection of the situation nor an accurate interpretation of my comments. As I explained to Kolata, the employment situation for mathematicians is certainly not bleak. In fact, it was reported at a news conference at the national mathematics meetings in Washington, D.C., in January that the unemployment rate for Ph.D. mathematicians was only 1 to 2 percent and the unemployment-underemployed rate for mathematicians was only 3 to 6 percent.

The tighter job market for mathematicians, particularly in the academic world, has indeed given the mathematical community reason to be concerned. Whereas approximately 80 percent of mathematicians previously had academic employment, new programs are now being developed to prepare mathematicians for jobs in business, industry, and government. The general concern within the mathematical community for the present employment situation and for general societal problems has provided the impetus for the development of significant new applied mathematics programs in our universities across the country. With the development of relevant programs in mathematics and with the need for applicable mathematics continuing to grow, the employment picture for mathematicians in the years ahead looks promising.

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Religion and Scholarship

Kenneth R. Hardy's analysis (9 Aug. 1974, p. 497) of the differential origins of American scientists and scholars in terms of the value orientations of religious and other groups appears to be valid up to the period which his data cover (about 1960). However, he does not account for more recent trends which reflect current developments.

Thus, in 1957, a national survey of high school students showed no observable differences between religious groups with regard to their attitudes toward science (*1*). Similarly, Greeley (*2*) found that, among college students who plan to go on to graduate work, "there is virtually no difference between Catholics, Protestants, and Jews in their choice of the physical sciences. Catholics are a bit behind Protestants and a bit ahead of Jews in choosing biology. Jews are slightly ahead of both groups in the choice of social sciences, and Catholics ahead of the others in the choice of humanities." These attitudes are of course not directly translated into the production of Ph.D.'s—there are any number of intervening variables. The point is that religious and other values no longer have the impact of earlier times, or in other words, there is a general trend toward their secularization (*3*). In addition, Catholic colleges and universities have been very concerned about their lack of productivity in science and have made considerable efforts to catch up with other educational institutions.

Hardy does not discuss social class differences specifically, but they are relevant to his thesis. It is significant that, increasingly, holders of doctorates have been drawn from the lower socioeconomic strata. During the period 1935 to 1940, the number of professional workers among the fathers of holders of doctorates was eight times as high as it was for the general population; by 1960, the proportion had dropped to 5 to 1. The respective ratios for the unskilled labor population are 1 to 20 and 1 to 6. About 1960, 25 percent of science Ph.D.'s had fathers who were laborers (*4*). The "democratization" of science and other features of "big science" has caused some observers of the *o tempora, o mores* persuasion to assert that contemporary scientists no longer have a real commitment to the ethos of science—it's just a way of gaining prestige and making money. No doubt this is true for some segments of the "scientific community." An equally plausible hypothesis is that the underlying value system has lost its original religious impetus and that its secularized version is becoming more widespread. Whether or not the recent antiscientific manifestations will have more than a passing effect remains to be seen.

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2. A. M. Greeley, *Religion and Career; A Study of College Graduates* (Sheed & Ward, New York, 1963), p. 90.
3. R. Vaughan, G. Sjoberg, D. H. Smith, *Soc. Forces* **44**, 519 (1966).
4. W. Hirsch, *Scientists in American Society* (Random House, New York, 1968), p. 12.

Although Hardy's article on "Social origins of American scientists and scholars" is interesting in its descriptive statistics, it seems inadequate in its attempt to ascribe differential productivity in scholars among various American geographic regions, social classes, religious denominations, and educational institutions to presumed social values characterizing these subpopulations.

From where are the cultural value categories in Hardy's table 7 derived? From analysis of the religious documents of the various denominations, the uttered statements of their functionaries, questionnaire sampling of their members, or Hardy's intuitive feeling that scientists and scholars, or possibly certain religions, tend toward naturalism, liberalism, and seriousness?

The statistics demonstrate only a correlation between certain subpopula-

tions and Hardy's "productivity index," and it would seem superfluous to point out that correlation does not imply causation. Hardy mentions, but does not further deal with the lack of control for differences between the academic aptitude of the student bodies of the various denominational institutions. Also mentioned, but not further incorporated into the analysis, is the fact that the adult religious affiliation of the scholar served as a basis of comparison in the study by Lehman and Witty (*1*), without reference to family of origin affiliation. The fact that the same study reported a listing of religious affiliation of any kind only half as often for scientists as for nonscientists in the 1926 to 1927 edition of *Who's Who in America* would seem to deserve notice in any attempt to forge a causal link between religious belief and choice of a scholarly career. That denominational schools "present to the student a campus culture which reflects the value system of the denomination, and . . . generally attract students who are sympathetic toward that system even when they are not actively affiliated with the denomination" remains an unsubstantiated assertion on Hardy's part.

In his attempt to attribute differences in subpopulational scholar productivity to cultural value variables, Hardy ignores one variable fairly well correlated with academic success, namely IQ. This becomes particularly noteworthy in view of the evidence from Army tests of regional differences within the United States in mean IQ, the correlation between IQ and social class, and the correlation between social class and denominational membership in the United States.

Hardy's failure to adequately treat potentially relevant variables and possible sources of error weakens his interpretation of the data.

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1. H. Lehman and P. Witty, *Sci. Mon.* **33**, 544 (1931).

Hardy asks whether scientists and scholars "come disproportionately from selected segments of the citizenry." It is important to note that his analysis considered only religious and regional "segments of the citizenry." He omits at least two factors—time and extent of urbanization—which could account for his finding high correlations between region and religious affiliation and productivity. Hardy's index of productivity does not take into account certain variations over time, such as the proportion of Ph.D.'s produced relative to the size of the general population. Price (*1*) has pointed out that the exponential growth of Ph.D.'s is rapidly overtaking that of the general population, resulting in a saturation period. Hardy's correlations could conceivably stem, not from some actual relationship between religious affiliation or regional location and productivity of Ph.D.'s, but from a spurious relationship of both these factors with the time of founding of the various schools. Thus, the more productive northern states and Protestant schools are older and have therefore produced more Ph.D.'s than the less productive and younger southern and Catholic schools. Similarly, the role of urbanization could account for the apparent correlations between the arts and professions and the older regions of the nation. Professionals and artists find employment, stimulation, and patronage of their work primarily in the urban context. And, like universities, cities do not grow overnight.

In addition, Hardy fails to validate his religious categories empirically. He says that, although all persons attending a denominationally sponsored school do not subscribe "to the faith of the controlling denomination," they will presumably be similarly affected by the "campus culture which reflects the value system of the denomination." Hardy does not operationalize "campus culture" or the "value system[s] of the denomination[s]." Rather he relies solely on the formal religious doctrines of the various religions as presumably valid indicators of their respective "campus cultures." Hardy assumes that "campus cultures" somehow reflect these doctrines, as they probably do, but this reflection needs to be empirically demonstrated.

Hardy suggests that "there is a set of cultural values that promote scientific and scholarly activity and that these are found most clearly in those groups highest in the production of scientists and scholars," but his article does not indicate what these "values" might be. His theoretical conclusions and analyses have little to do with his empirical research. Hardy did

not do a study on the "values" of scientists and scholars; instead he did a demographic study of regions and religious affiliations of universities and their productivity of Ph.D.'s. Ex post facto he applied his own distillation of scientific and scholarly cultural values to the correlations he found.

Hardy's final suggestion is cause for some concern. He says that "to the extent that scientific-scholarly pursuits are valuable to a society, then that society should provide the conditions which promote such pursuits." This statement completely overlooks the important work of science policy analysts (*2*) that demonstrates a Ph.D. glut. More seriously, given the religious and regional variables which Hardy exclusively uses, it implies that some social support should be given to specific religious or regional groups so that they would presumably produce even more Ph.D.'s. Hardy also implies that science has some value, sui generis. Recent human power projections (*3*) indicate the need for fewer Ph.D.'s, not more, in many fields. Hardy's tacit endorsement of increased Ph.D. productivity does not reflect this need. Science is but one sector of the economy whose role has too often been overestimated.

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2. A. Cartter, *Science* **172**, 132 (1971).
3. *Manpower Report to the President* (Government Printing Office, Washington, D.C., 1973).

Hardy states that "Care must be taken in evaluating the comparisons that follow. Some denominations (for example, Unitarian, Episcopal) are not represented because they do not operate colleges."

Listed below are three Episcopalian colleges, their locations, and the dates of their founding.

1) University of the South, Sewannee, Tennessee, 1857.

2) Kenyon College, Gambier, Ohio, 1824.

3) Hobart College, Geneva, New York, 1822.

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First of all, let me note an error in the printing of the formula for the productivity index (see my article, p. 500). The error lies in the misplacement of the parentheses in the denominator. As published, it reads

$$PI_S = \frac{N_{tt} \text{ from } S \times 10^3}{(M_t + F_t) \times W_{tt}}$$

The formula should have read

$$PI_S \frac{N_{tt} \text{ from } S \times 10^3}{M_t + (F_t \times W_{tt})}$$

Hirsch is correct in that my analysis covers only the period from about 1920 to 1960. A number of correspondents have criticized my article because it does not "account for more recent trends."

The article does not purport to cover the last 15 years; and in my last paragraph, I specifically call attention to the fact that contemporary social changes may have affected productivity rates. It would be most regrettable for my research to be perceived as discouraging or ignoring concerted efforts in recent years to stimulate the contribution of Catholic institutions to the fields investigated here. My data, rather, may serve as a baseline from which changes in productivity can be measured. As doctorate output data become available, research should be done which might link temporal changes to the conditions which may have produced them, for example, value shifts resulting from Vatican II.

Merker and Davis ask whence came the cultural value categories which I used. They derive in part from the previous research of Weber (*1*), Merton (*2*), and Knapp and Goodrich (*3*), all of whom discuss the "Protestant ethic" (see my article, p. 498). Since my research indicates that portions of the Jewish community are high producers and suggests, as well, that there are great differences within the Protestant groups, I tried to redefine and extend the list of cultural factors considered by these investigators to include those which cut across the "high producing" groups and which differentiate them from the "low producing" groups. This identification was facilitated by Strodtbeck's analysis (*4*) of value differences between Jewish and Southern Italian immigrants, by geographical variations (South and non-South) even within the same religious denomination (Presbyterian, Methodist, Baptist), as well as the more formal statements of the

religious ethos of the sects involved. Also, interview data (*5*) and questionnaire responses (*6*) from scientists themselves provided some of the basis for the value set. I make no brief that I have "proved" a causal connection between the particular set of values mentioned and the production of scholars; I have only inferred one. The set simply represents my best effort, for the moment, to identify the factors common to the high producers as contrasted with those of the low producing groups.

Merker raises the question of IQ differences between regions, social classes, and denominations. The nature and stability of whatever it is that IQ tests measure is a well-known and controversial question. However, it should be noted that my productivity index is a (modified) ratio of doctorate scholars to baccalaureate degree recipients. In other words, college graduates are the base from which the index is derived. This means that we are dealing with a restricted range of "intelligence," thus mitigating the influence of this variable in producing the effects studied in my article.

Davis suggests two factors—time and extent of urbanization—which need to be considered. The time variable (time since the founding of the various schools) she feels is important because, in her opinion, the southern and Catholic schools may be younger and haven't had a chance to produce as many Ph.D.'s. My study of colleges was based *only* on baccalaureate institutions which had been sources for 100 or more doctorates granted during the period 1920 to 1961. Within this group of colleges, differences in productivity were based on the relative proportion of baccalaureate recipients who later earned the doctorate, and not upon the absolute number of baccalaureate degrees granted. If we consider these facts, and the time period covered by my study, the time of founding is probably irrelevant.

I agree with Davis that urbanization or something associated with it (a cultured gentility) may be associated with scholarly choice within the arts and professions, but this may be the only one of the five broad fields studied for which that association exists. Knapp and Goodrich (*3*), for example, stressed the *rural* lower middle class as a major source for scientists from the highly productive colleges in their study. Thorndike's high producing states were certainly not highly urbanized (*7*). Neither do my data give support to urbanization per se as an important factor.

Although I alluded to social class (or socioeconomic) differences several times in the article, I did not give this factor sufficient weight, in the view of a number of readers. Social class has been a most impressive empirical variable in sociology, as it correlates with many things. I feel it is inadequate to account for certain data. For example, it is very difficult to explain the scientific-scholarly productivity (and other accomplishments) of American Jews by reference to social class, since the immigrant generation came here impoverished (by and large), yet within two generations their families had exceeded the average socioeconomic status of Americans generally (*4*).

I believe that certain value orientations must be invoked to account for the explanation of this phenomenon. It was not, I feel, "middle-class" values which produced their achievements, but a set of values which propelled them to the education, hard work, and persistent striving which resulted in their becoming, largely, members of the middle class or lower upper class. In other words, they did not prosper because they were middle class. They became middle class because they studied, worked hard, and prospered, and this occurred because of their achievement ethic and the other aspects of their value system. I believe that a similar analysis is applicable to Unitarians, Quakers, Mormons, and perhaps others. In short, I think that it is preferable to look beyond social class to the particular values, opportunities, life orientation, and so forth, which this construct may represent.

Regarding Greville's question concerning Episcopal colleges, in defining denominational control, I relied on information (supplied by the institutions themselves) in the 1957–58 edition of the *Education Directory* published by the U.S. Office of Education. There were no institutions in my study which were listed as controlled by the Episcopal church. An authoritative Episcopal source (*8*) reveals that there is, in fact, one college, the University of the South (not included in my study) which is controlled by that faith. Financial support is given to a number of colleges, but the Episcopal church is chary of sectarian control. In this regard, I believe it is generally safe to assume that those faiths which have retained active control of colleges have sufficient involvement so as to ensure that the cam-

pus culture does reflect the value orientation of that faith, a question raised by both Merker and Davis.

Davis and others express some concerns centering around the overproduction of scientists, the granting of special support to certain religious and regional groups, and overvaluation of science. I do not believe that we should necessarily have more scientists. Neither do I believe that scientists are better than other people. Nor do I believe that producing scientists-scholars is the only index or necessarily the best index of the value of a school or a religious group. My study dealt only with the origins of these particular persons and is not meant to imply that others are inferior or unworthy. I personally value science and believe that a good and viable society must have a solid scientific-scholarly community (as well as many other things). But it is up to the community-at-large to decide what role science is to have within it.

I did suggest an "if . . . then" proposition: If society does value science, then it must provide the conditions which will nurture and sustain science. My research was not fundamentally concerned with colleges, religious groups, or geographical regions as such. I studied all of these in an effort to identify some of the conditions which lead to the career choice of science or scholarship; and I was led to the conclusion that a set of cultural values may well undergird the selection of such a vocational pathway. In this regard, I am somewhat sympathetic to Hirsch's comment that the democratization and secularization of American science may mean that scientists today are less committed to the ethos of science and are drawn to its ranks more for prestige and money. To the extent that this is the case, it may be that the quality of scientific work suffers while the quantity increases. Many would maintain that the knowledge explosion is not all knowledge, but that much of it, produced under "publish or perish" and other incentives, will have little lasting value. Perhaps the changing values and motives to which Hirsch alludes, as secularization progresses, are indeed changing the appeal and character of science-scholarship as a life pathway from that of a zealous cognitive quest toward satisfaction of the needs Hirsch suggests.

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5. A. Roe, *The Making of a Scientist* (Dodd, Mead, New York, 1952).
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7. E. L. Thorndike, *Science* **92**, 137 (1940).
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History of "Ecology"

The history of ecology is certainly largely unstudied, but please correct the hoary myth perpetuated by M. W. Rossiter (Book Reviews, 20 Sept. 1974, p. 1040) that E. H. P. A. Haeckel founded ecology. He was one of the early publishers of the word (7 years earlier than Rossiter claims), but he made little use of it and should not even be credited as having coined the term.

Hans Reiter published a book with "Oekologie" in the title (*Die Consolidation der Physiognomik als Versuch einer Oekologie der Gewaechse*) as early as 1885, and Conway MacMillan published the term in North America in 1897 in his studies of the vegetation of Minnesota. The earliest use of the term "ecology" so far discovered was in the United States in 1858 by none other than Henry David Thoreau (*1*). Reiter, MacMillan, Thoreau, and Haeckel all used the word almost in passing, which suggests it was in wide use.

A much stronger case can be made for proposing J. E. B. Warming as the founder of ecology, since he published a whole text (*Plantesamfund. Grundtrak af den Økologiske Plantegeografi*) on the subject in 1895. It is curious that neither the Ecological Society of America nor the British Ecological Society are enthusiastic in according recognition to Warming, who died 50 years ago last year.

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Notes

1. H. D. Thoreau, letter, New Year's Day 1858. "Mr. Hoar is still in Concord, attending to Botany, Ecology, &c. with a view to making his future residence in foreign parts more truly profitable to him."