

DISCUSSION

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1. Dr. Cartter first establishes that the percentage of doctorates among teaching faculty has increased during the past decade. The evidence from biennial NEA data, as Dr. Cartter says, is less than convincing. But he also has accumulated evidence from the American Council on Education quadriennial publication, American Universities and Colleges, which shows an increase of 7 percentage points AY 1951 to AY 1963 in 781 accredited institutions for all instructional staff. This evidence inadequately represents the universe of institutions. The 781 institutions in the volume for academic year 1963 were only 53% (781/1477) of degree-granting institutions in that year, and only 37% (781/2100) of all institutions beyond the high school.

To evaluate the quality of faculty in higher education, one must assess the quality of the full-time equivalent instructional staff for degree credit courses in all or as much of education beyond secondary school as can be assembled. This would include two-year as well as four-year institutions, the full-time equivalent of part-time instructional staff, the professional schools as well as the regular colleges, and the junior instructional staff as well as others. The COLFACS estimate of 50.6% doctorate among full-time employed teaching faculty in degree-granting institutions reflects only 73% of the full-time equivalent faculty in higher education. The ACE 1964 publication The American Junior College yields an estimate of 9.3% doctorates among teachers in junior colleges, which may be compared with 10% which Berelson estimated in his assessment of faculty supply and demand several years ago. The junior college must be considered, for its share of enrollments have increased from 11% to 18% during the past ten years.

The full-time equivalent of part-time, also must be considered, but for this segment no estimate of doctorate-holding is available. To estimate doctorate-holding among these categories of teachers we may use .5 (from COLFACS) for the full-time teaching staff of degree-granting institutions, .09 for junior college full-time teachers, and .3 for the full-time equivalent staff of part-time teachers, for AY 1963; the result is 41.2% with doctorates of FTE teaching staff. Using .4 for the part-time yields 42.5%, and using .5 for the part-time yields 43.8%. These values are 9 to 11 percentage points above Cartter's AY 1951 estimate (32.2%). If we assume the latter to be an upper limit, which I would take it to be, the twelve-year period has indeed witnessed an improvement in the quality of the teaching cadre in higher education.

A better measure of quality of instruction is ratio of students to teachers with the doctorate. Taking a few liberties with Ray Maul's data for AY 1955 provides an estimate of 39.7

full-time students per doctorate-teacher. The comparable AY 1963 estimate (from COLFACS and the USOE Faculty and Other Professional Staff Survey) is 36.0 students. By this index the quality of instruction has improved about 10% ($1 - 36/39.7 = 9.3\%$).

In his conclusions, Dr. Cartter points to the inconsistency between past estimates of shortages of doctorates in higher education and the situation 10 years later of an increase in the percent doctorates. Without cries of alarm, help would not have come. Help did come, as Orleans has shown, and the educational establishment today is better because of it. One important function of a prediction is to make possible an evaluation of a future situation.

2. The second important feature of Dr. Cartter's paper is the presentation of a model for the prediction of future teacher requirements for faculty and for doctorate teachers. He introduces a few elaborations which previous model-builders have overlooked, but in the main the variables are the same as others. His overview points to the additional statistics needed to adequately activate a reliable model.

The Bolt-Koltun-Levine model (Science, May 14, 1965) for evaluating the consequences of various levels of feedback of doctorates into higher education, was a distinct improvement over previous models because it applied to particular disciplinary fields. Dr. Cartter's model adds no new variables and does not attempt to control for field of study. Separate consideration of fields is important, since the market exogenous to the educational establishment most certainly is not uniform among fields, as David Brown has pointed out. To use this approach would require much additional processing of available information, but such is needed for sound educational planning and the formation of national policy.

In addition to separate consideration of homogeneous groups of fields, independent consideration of types of institution will make possible much more careful control of another important source of variance in estimates of future teacher requirements: the student-teacher ratio.

A third important element would consist of classifying enrollment both by institutional type and full or part-time status.

For those educators who may enter a cata-tonic state when anyone suggests that they supply new data, let me hasten to add that the above requires no new data. It only requires the appropriate ordering of data already collected.

I now want to review the values Dr. Cartter assumes for elements in his prediction equations, examining each factor separately.

m - mortality rate of present teachers. This is of minor importance relative to some other values. The most recent mortality rates by occupation are based upon 1950 data. This is not complementary to a statistical system which prides itself upon the advanced state of its technology. Not only can death registration data coupled with the Census be employed for this purpose, but matching of death records against the Doctorate Record File and/or the National Register File could produce more accurate mortality rates by field than now are available.

r - retirement rate. Also of minor importance, this factor, nevertheless, should be estimated more accurately. Cartter used the age distribution from the COLFACS survey, and assumed a schedule of retirement 0, 1, and 2 years after 65. This is a refinement over previous procedures. In applauding him, I also point out that an accumulation of information on retirement experience, perhaps through a more extensive retirement survey, through T.I.A.A., or through other means, is needed.

a, c - The rate of transfer out of higher education of doctorates and the in-transfer rate of doctorates to higher education from other employment. [Note: in Eq. (2) a is in-transfer, but below Eq. (3) a is out-transfer. The latter apparently is in error.] The net (loss or gain) is the significant statistic. Dr. Cartter estimates that .0011 of the doctorates are lost annually by transfer out to other employment. In the Bolt-Koltun-Levine model the net transfer rate is estimated for scientists, from 1960-1962 matched cases in the National Register of Scientific and Technical Personnel, at -.001. The negative sign is quite significant, for it connotes a net gain of doctorates to the educational establishment in the interchange, rather than a net loss. Cartter's assumption (re Eq. 3) that this statistic is stable is quite questionable. Doctorates employed outside of higher education are evidently responding to salary increases in higher education. For the 1960 cohort of scientists, the experience between 1962 and 1964 revealed a net gain to the educational establishment of 2.89% per year, rather than 0.1% per year. One defect in this statistic is that it includes transfers to and from educational institutions, irrespective of level and function of the doctorates. Dr. Cartter's estimate -- the basis for it is not adequately documented -- could be in the proper direction for the decade over which he makes it, but the National Register data on scientists, who, with the professions, undoubtedly have the highest employability outside the educational establishment, for the 1960-64 period, unmistakably record a net inflow to the educational establishment. I conclude that more adequate data is needed on in- and out-transfer of doctorates. If doctorate holders are sensitive to salary changes, annual or biennial data

are needed to make an accurate assessment of the flow, and this net interchange in Dr. Cartter's model should be more precisely scheduled over the future decades, perhaps upon the basis of assumptions on comparative salary levels.

b and q - Equation 2 estimates the number of doctorates in teaching. [In the first member of the right side of the equation, the subscript of D is t. Evidently, from the text above, this should be (t-1).] Omitted is the percent of new doctorates who already are teaching. Dr. Cartter may have intended that b include new doctorates continuing as well as those newly entering teaching, as the value of b (Equation 3) would indicate. However, allowance also should be made for new doctorates continuing in higher education in q, the percent of new teachers with the doctorate, in equation 3. The percent of non-doctorate teachers at (t-1) who achieve the doctorate by t should be introduced as a third member of the equation. Data of the Doctorate Record File, NEA, and USOE provide a basis for estimating that this may be 2% or 3% of the full-time equivalent instructional staff in higher education. Four to five thousand teachers may be so "upgraded" annually.

f - The ratio of the increment of faculty to the increment of students (the inverse of the incremental student-faculty ratio) is set at slightly less than 20 to 1. The greatest source of error in projections of teacher requirements, as may be shown by ex post facto examination of Ray Maul's 1959 projections is the student-faculty ratio. To hold it constant, as Dr. Cartter does, is to deny the trend during the past decade* as well as his own arguments (1st criticism of the "OE model"). A more advisable approach is to assume a continuation of present trends, an increase of approximately 0.25 annually in the student-teacher ratio, or, to provide schedules of alternative assumptions. (See item 4, below.)

3. Several factors affecting higher education, the quality of teaching, and future teacher supply and demand, are not elements of Dr. Cartter's formula. To enumerate them briefly:

1. The education of Americans abroad, estimated at 17,200 persons in AY 1964.

2. The provision of Americans as faculty and scholars to foreign institutions, estimated at 3,400 persons in AY 1964.

3. Foreign scholars in the U. S., a supply source, consisted of 8,400 in AY 1964 (Open Doors, 1964).

* Total enrollment per FTE instructional staff has increased from 16.6 in Fall 1958 to 18.3 in Fall 1965 (estimated).

4. The education of foreign students in the U. S., estimated at 36,000 undergraduate and 39,000 other students in 1964.

The latter educational endeavor is quite significant in promoting the diffusion of science and technology, and in developing the scientific manpower for resource and institutional cultivation among underdeveloped nations. Within this context the demand for teachers for the educational systems of our own and foreign countries must be viewed.

4. The student-teacher ratio in the model considers the total staff, instructor or above, and does not make allowance for part-time teachers nor include junior staff. The text says that this ratio, 15.3:1 today, may be expected to rise to 17.3:1 in 1985. It says, "The Office of Education choice of an 18:1 ratio, therefore, appears to overstate the expansion needs by nearly 10%." Cartter's ratio of 17.3:1 would set our sights at approximately 80,000 more instructional staff in 1985 than would result from using the USOE factor $\frac{(18.0-17.3)}{10,600,000}$. I believe he should have said that the USOE estimate understates rather than overstates expansion needs. Perhaps Dr. Cartter's criticism of the USOE choice of a student-teacher ratio should be reconsidered.

My preference is to use full-time equivalent instructional staff, as did Ray Maul. This ratio was 16.6:1 in 1958 and has risen to 18.3:1 today. In the interests of conservatism and accepting Cartter's four reasons for expecting an increase in the number of students per

teacher, I am inclined to project the ratio at a 0.25 incremental addition annually for about 10 years. Such a procedure would provide an increasingly conservative statement of teacher requirements.

5. An implication Dr. Cartter derives from the results is to question the wisdom of expanding the higher education system through new institutions entering the doctorate-granting field. Capacity of the higher educational system to produce doctorates is not a component of the model, although he estimates that 20,000 doctorates can be produced annually. I do not interpret the model as suggesting that the demand for new doctorates in teaching will decline or stabilize after 1968. There will be a continuing need to increase the percentage of teachers with the doctorate, and a continuing demand for doctorates in non-teaching positions.

6. The "deficit" of 120,000 which Dr. Cartter attributes to a USOE estimate is actually not an official USOE document, but rather a working memorandum, which cannot properly be attributed to the Office. To call this the current USOE model is not accurate.

7. Dr. Cartter considers his projections of doctor's degrees to be below those of Dr. Karel, who prepared projections published by the National Science Foundation. Karel's projections are confusing since they mix professional medical degrees with doctorates, but if the medical professional degrees are removed, Cartter's projections for AY 1970 are only 600 more than Karel's.