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Physics Department Ratings: Another Evaluation

Institutional ratings of physics departments by faculty can be predicted by using data in the public domain.

Charles F. Elton and Samuel A. Rodgers

Evaluation procedures in graduate education are mentioned briefly by authorities on higher education (*1*). Cartter's study (*2*) occupies a prominent place among the sparse comments usually devoted to this topic. Although the Cartter report has received its share of methodological criticism from various persons, mostly those who did not win, place, or show in the ratings, it has not been the subject of serious investigation. Roose and Andersen (*3*) have conducted a survey similar to but more comprehensive than Cartter's. Although scholars rated programs in their respective fields on a numerical scale, these ratings were not published. As might be expected, public comment was divided (*4*).

This study demonstrates that the institutional ratings of physics departments appearing in the Cartter study can be predicted by the use of simple data that are readily available to the general public.

Method

Graham (*5*) has provided aspiring graduate students with some objective data concerning graduate programs. From this volume, the following variables were arbitrarily selected for each graduate program in physics that was rated in the Cartter study: (i) the number of areas of specialization within a department, (ii) the number of faculty, (iii) the number of Ph.D.'s awarded between 1960 and 1964, (iv) the number of full-time students, (v) the number of

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Table 1. Means (M) and standard deviations (S.D.) for predictor variables.

	Extremely attractive ($N = 8$)		Attractive ($N = 11$)		Acceptable plus ($N = 29$)		Less than acceptable plus ($N = 14$)	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Number of areas of specialization	9.12	2.23	7.54	1.86	7.68	4.30	9.14	5.05
Number of faculty	44.12	16.10	36.64	10.04	24.57	7.36	13.00	3.21
Number of Ph.D.'s 1960-1964*	114.38	42.37	61.54	21.81	36.96	19.14	10.43	8.32
Number of full-time students	229.12	96.94	166.54	56.89	95.89	54.71	40.21	21.25
Number of first-year students	55.75	28.68	50.27	25.33	27.78	18.64	14.36	10.79
Ratio of part-time to full-time students	0.02	0.04	0.18	0.30	0.30	0.71	0.43	0.71

* This variable entered the stepwise analysis first and accounted for all of the significant variances.

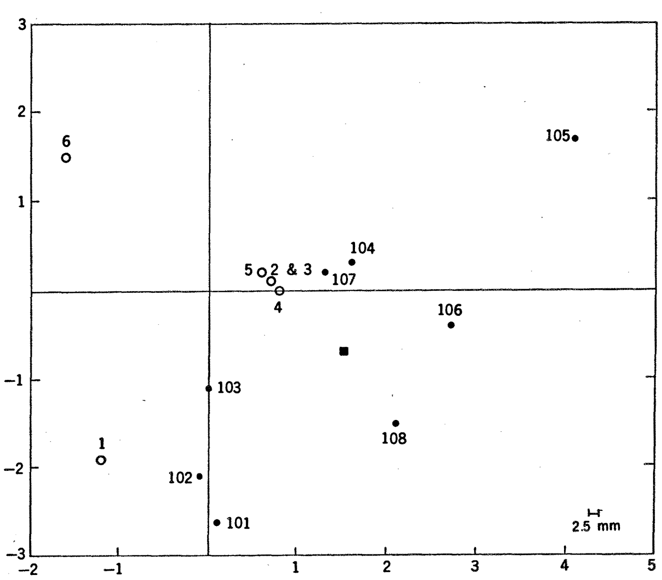
first-year students, and (vi) the ratio of part-time to full-time students. Although the publication date of the Graham book is 1965 and that of the Cartter study is 1966, we assumed that the data contained in the former represents fairly the quality inherent in the departments during the period of time covered by the Cartter investigation.

The six variables described above are used as predictor variables in a stepwise, multiple discriminant analysis in which the physics departments rated in the Cartter study as "extremely attractive," "attractive," and "acceptable plus" were the dependent variables. An additional dependent variable consists of 14 physics departments rated "less than acceptable plus" that we took, using a table of random numbers, from appendix E (*2*, p. 129) in the Cartter study. These departments were from the following institutions: University of Alabama, Boston University, University of Cincinnati, University of Connecticut, University of Delaware, University of Denver, Howard University, University of Kansas, University of Kentucky, University of Tennessee, Tulane University, Vanderbilt University, Western Reserve University, and West Virginia University.

We used the discriminant analysis to demonstrate that the arbitrary selection of predictor variables did indeed differentiate the departments in the same way that the Cartter ratings did. Although the discriminant analysis provides information about the relative importance of the predictors, it cannot visually show the relationships among the predictor variables. This can be accomplished by the spatial configuration technique developed and described by Cole and Cole (*6*). The primary purpose of the spatial configuration analysis is to allow the researcher to comprehend more easily the information contained in the intercorrelation matrix. Its secondary purpose is to summarize each department's profile of predictor variables in a single point. It is this latter purpose that is of major concern here.

Results

The means and standard deviations for each of the predictor variables are presented in Table 1. The overall F ratio approximation resulting from the discriminant analysis was 5.43; with d.f. = 18 and d.f. = 148, it was statistically significant ($P < .01$).



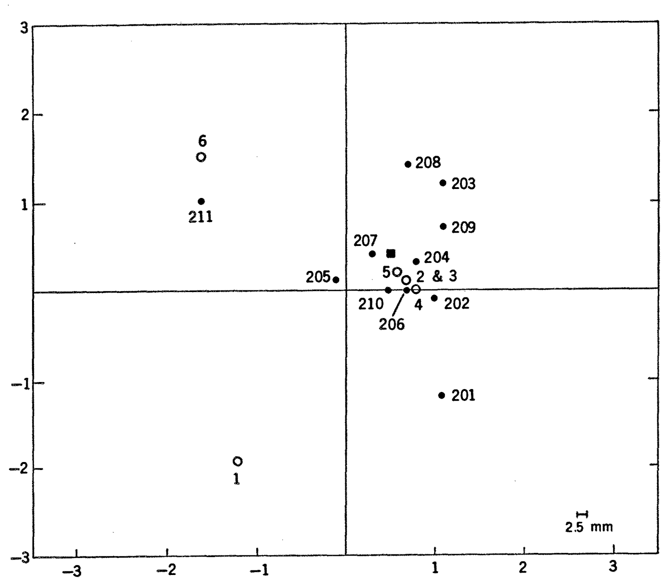


Fig. 1 (left). Spatial configuration of "extremely attractive" departments. Legend: Princeton University (101), California Institute of Technology (102), Stanford University (103), Harvard University (104), University of California (Berkeley) (105), Massachusetts Institute of Technology (106), Cornell University (107), University of Illinois (108); mean profile point for all departments in category (■); number of areas of specialization (1), number of faculty (2), number of Ph.D.'s awarded 1960–1964 (3), number of full-time students (4), number of first-year students (5), ratio of part-time to full-time students (6). Fig. 2 (right). Spatial configuration of "attractive" departments. Legend: University of Wisconsin (Madison) (201), University of Chicago (202), Yale University (203), Columbia University (204), University of Rochester (205), University of Michigan (206), University of Washington (Seattle) (207), University of Pennsylvania (208), University of Maryland (209), University of Minnesota (210), Johns Hopkins University (211); mean profile point for all departments in category (■); number of areas of specialization (1), number of faculty (2), number of Ph.D.'s awarded 1960–1964 (3), number of full-time students (4), number of first-year students (5), ratio of part-time to full-time students (6).

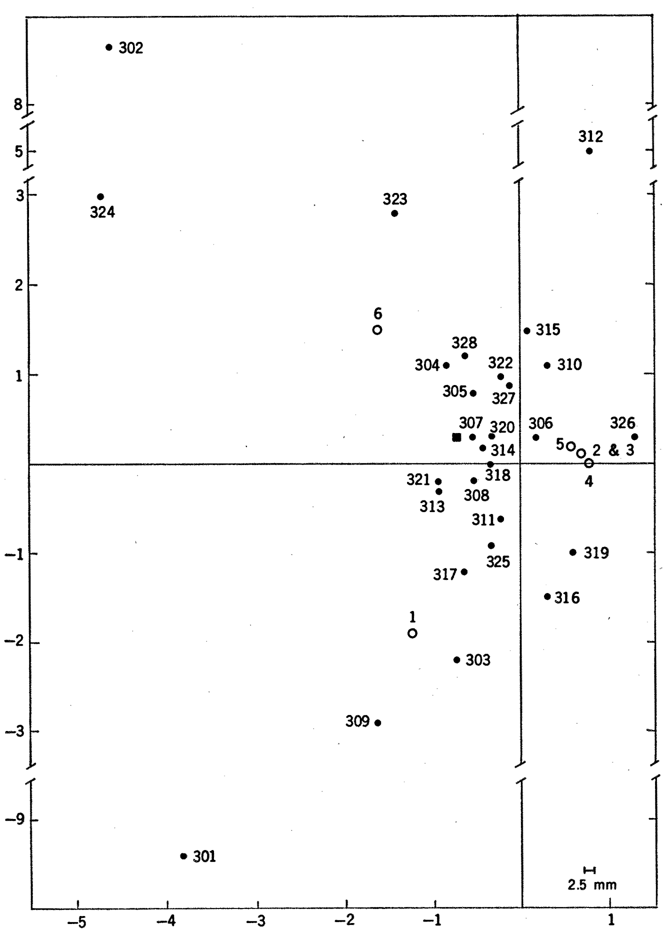
The effectiveness of the predictors in classifying the physics departments according to Cartter's categories is given in Table 2, the correct classifications being indicated by the numbers in boldface type. The overall efficiency of prediction in Table 2 is 75 percent, with those departments rated "less than acceptable plus" having the most nearly accurate prediction; the poorest prediction occurred for the "acceptable plus" departments.

Table 2. Predicted classifications of departments.

	Extremely attractive	Attractive	Acceptable plus	Less than acceptable plus
Extremely attractive	**6**	2	0	0
Attractive	1	**9**	1	0
Acceptable plus	0	5	**18**	5
Less than acceptable plus	0	0	1	**13**

The effectiveness of the predictors in six predictor variables are shown by circles in Fig. 1. These circles are projections of the deviations (from the mean) of the predictor variables of unit length (in six-dimensional space) onto the two-dimensional plane. This plane minimizes the variation among the six predictor variables (*6*). In this case, 83 percent of the variance accounted for in six dimensions is retained in two dimensions. Figure 1 also summarizes the profile of each "extremely attractive" department as a single point, based on a resolution of the six predictor variables. In addition, the mean profile for all "extremely attractive" departments is provided in Fig. 1. Similar data for "attractive," "acceptable plus," and "less than acceptable plus" departments are given in Figs. 2, 3, and 4, respectively.

Figures 1 through 4 show that, gen-



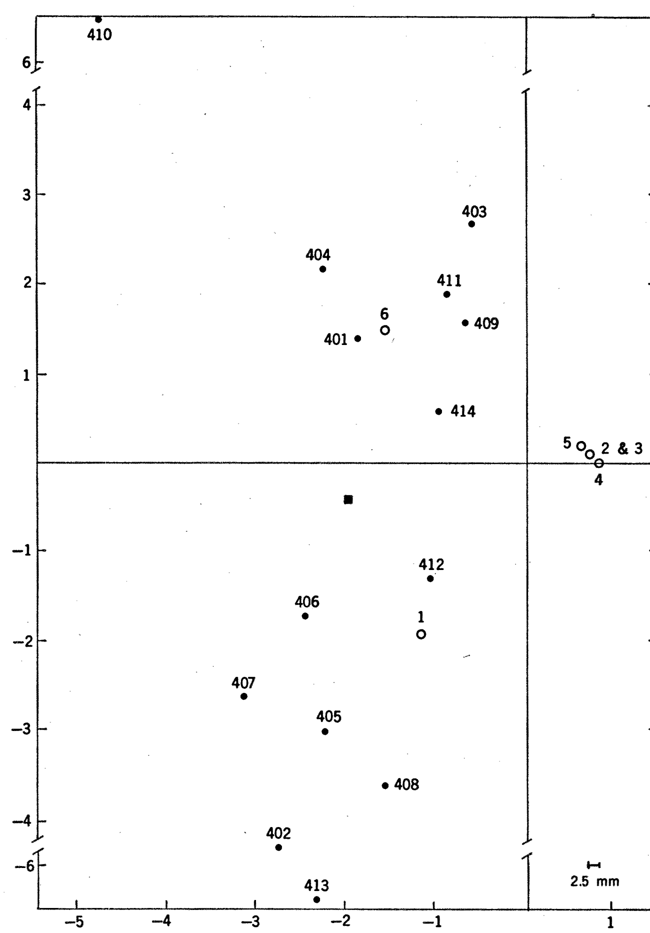


Fig. 3 (left). Spatial configuration of "acceptable plus" departments. Legend: Brandeis University (301), Brooklyn Polytechnic Institute (302), Brown University (303), Carnegie Institute of Technology (304), Case Institute of Technology (305), University of Colorado (306), Duke University (307), Florida State University (308), Indiana University (309), Iowa State University (Ames) (310), Michigan State University (311), New York University (312), University of North Carolina (Chapel Hill) (313), Northwestern University (314), University of Notre Dame (315), Ohio State University (316), Pennsylvania State University (317), University of Pittsburgh (318), Purdue University (319), Rensselaer Polytechnic Institute (320), Rice University (321), Rutgers University (322), University of Southern California (323), Syracuse University (324), University of Texas (325), University of California (Los Angeles) (326), University of Virginia (327), Washington University (St. Louis) (328); mean profile point for all departments in category (■); number of areas of specialization (1), number of faculty (2) number of Ph.D.'s awarded 1960–1964 (3), number of full-time students (4), number of first-year students (5), ratio of part-time to full-time students (6). Fig. 4 (right). Spatial configuration of "less than acceptable plus" departments. Legend: University of Alabama (401), Boston University (402), University of Cincinnati (403), University of Connecticut (404), University of Delaware (405), University of Denver (406), Howard University (407), University of Kansas (408), University of Kentucky (409), University of Tennessee (410), Tulane University (411), Vanderbilt University (412), Western Reserve University (413), West Virginia University (414); mean profile point for all departments in category (■); number of areas of specialization (1), number of faculty (2), number of Ph.D.'s awarded 1960–1964 (3), number of full-time students (4), number of first-year students (5), ratio of part-time to full-time students (6).

erally, three variables differentiate the various departments. Variable 1 (number of areas of specialization within the department) and variable 6 (ratio of part-time to full-time students) dominate the positions on the vertical axis. (It should be noticed that in each figure variables 2 and 3 occupy the same point on the plane.) Variables 2 through 5 are highly intercorrelated, and this intercorrelation is retained when the variables are projected onto a plane. The results of the discriminant analysis, however, suggest that, of these intercorrelated variables, it is variable 3 (number of Ph.D. degrees awarded from 1960 to 1964) that differentiates the departmental categories (Table 1). It is, therefore, variable 3 that appears to distinguish among the various departments on the horizontal axes in Figs. 1 through 4. The positions of the departments on the vertical axes in these figures apparently consist of the resolution of the influences of variables 1 and 6.

It is clear from an inspection of the mean profiles in Figs. 1 and 4 that those departments rated "extremely attractive" (Fig. 1) and "less than acceptable plus" (Fig. 4) occupy diametrically opposite positions when projected onto a plane. In those departments rated "attractive" and "acceptable plus" (Figs. 2 and 3, respectively), the mean profiles are closer to the origin. The mean profiles of departments rated "extremely attractive," "acceptable plus," and "less than acceptable plus" fall in quadrants IV, I, II, and III, respectively, a fact indicating that these departments differ on the predictor variables.

Discussion

Given the rating provided in the Cartter study, it is possible to differentiate four categories of physics programs by using data that are more objective than faculty ratings and that are in the public domain. The fact that the mean profiles lie in different quadrants indicates the effectiveness of the objective variables in separating the categories of departments.

The plot of the mean profiles in Figs. 1 through 4 supports Cartter's differentiation among departments categorized as "extremely attractive," "attractive," "acceptable plus," and "less than acceptable plus." However, the departmental profiles represented by dots in Figs. 1 and 2 do not agree in all cases with Cartter's ranking of departments in the "extremely attractive" and "attractive" groups. For example, in the Cartter ratings, the University of Chicago and Yale University were tied for tenth position in the "attractive" category. The variables used in our study indicate that Chicago (202) is more like the University of Michigan (206) or the University of Minnesota (210) than like Yale (203). The objective variables, however, do agree with the Cartter rankings of first and last departments within the "attractive" category. That is, the profile point of the University of Wisconsin (Madison) (201) is closest to the mean profile of the "extremely attractive" departments. Wisconsin, as Fig. 2 indicates, was ranked as the first department in the "attractive" category. On the other hand, Johns Hopkins University (211) was ranked last, and its profile point is more nearly similar to the mean profile of the "acceptable plus" departments than it is to the mean of the "attractive" departments.

Thus it would appear that both objective variables and faculty ratings can effectively differentiate at least four categories of departments. Furthermore, Roose and Andersen's (*4*) practice of reporting institutions alphabetically by category would appear to be superior to Cartter's method: the placement of a department within a category is apt to be more reliable than the ranking of departments from best to worst within a category.

The objective variables indicate that the "attractive" departments (Fig. 2) are more homogeneous than are the "extremely attractive" (Fig. 1), the "acceptable plus" (Fig. 3), or the "less than acceptable plus" (Fig. 4) departments. The most heterogeneous category, as might be expected, appears to be the "less than acceptable plus" departments (Fig. 4). It is interesting to notice the shift of the departmental locations (dots) on the horizontal axis from Figs. 1 through 4.

The effectiveness of the objective variables in separating departments into categories is not restricted to the discipline of physics. We have found similar results for other physical science departments, as well as for departments within the humanities, social sciences, and biological sciences.

It should be emphasized that the objective variables used in this study were arbitrarily chosen. Other variables might prove to be more effective in locating the individual departments by means of the spatial configuration technique; for example, median faculty salary, dollar support for graduate research, ratio of departmental budget to total institutional budget, frequency with which scholars nominate the institution that granted their Ph.D. as "extremely attractive," and the like.

In summary, this study found that objective variables provided a good approximation of the numerical ratings of the graduate programs in the Cartter study. Since the dividing line between "departmental reputation" and "quality" is, at present, mostly rhetorical, additional study of the correlates of departmental ratings appears warranted.

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