Distributions of Ability of Students Specializing in Different Fields

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IT IS OF INTEREST TO KNOW how students who choose one field of specialization resemble or differ from those who enter another. It is now possible to compare different student groups in terms of their distributions of scores on standard tests of academic aptitude, for substantial data on this point have been developed by the Commission on Human Resources and Advanced Training in its studies of the current supply of people in each of the high-level fields of specialization and of students potentially qualified for work in those fields.

Table 1 gives test scores, converted to the Army General Classification Test scale, of students in each of a number of fields of specialization. On the AGCT scale the average person in the total population earns a score of 100. The standard deviation of the scale is 20 points, which means that 68 per cent of the total population makes scores between 80 (100 minus 20) and 120 (100 plus 20). Five scores are given for each field. These five represent the 10th, 25th, 50th, 75th, and 90th percentiles of each distribution. If there were 100 people in a group, and if they were lined up in order from the one with the lowest to the one with the highest score, the figures in the table would represent scores made by the 10th, 25th, 50th, 75th, and 90th persons in the line. For a single comparison of the fields, the 50th percentile, or median, score is the most useful. In each group half the members exceeded and half fell below this point. For most fields two, and for some fields three, sets of scores are given. The designation *AB* for a set of scores means that it applies to students who have recently received bachelor's degrees with major work in the field specified. The designation *graduate student* indicates scores for recently enrolled graduate students. The designation *PhD,* which appears only for some of the scientific fields, indicates the scores of students who have recently received doctorates.

Scores for the AB and graduate student groups printed in italics are weighted totals. The proportions of students in our samples who specialized in each field did not always match the total national proportions. In computing score distributions for total groups we weighted the separate fields in order to let each contribute to the total in proportion to the number of degrees currently being given in that field in the country as a whole. Table 1 therefore permits comparisons between general areas—e.g., natural sciences and social sciences—as well as comparisons between individual fields—e.g., chemistry and economics.

Before individual fields are discussed, it is worth while to compare the total groups with the general population. The average person earning a bachelor's degree scores about 126 on the AGCT scale. About 10 per cent of the total population earns a score this high. The average graduate student gets a score of around 129. About 7 per cent of the total population does as well. The average PhD in the sciences makes a score of approximately 138. Only about 2 per cent of the total population makes a score that high.

Students specializing in some areas make scores that average higher than the figures just given, whereas students specializing in other fields average lower, but all the groups are substantially superior to the total population. At the undergraduate level the difference between the highest field, physics, and the lowest, physical education, is less than the difference between physical education and the population average. At the PhD level, the spread between the highest field, physics, and the lowest, agriculture, is smaller than the difference between the average PhD in the sciences and the average AB.

Clearly, all the fields requiring college training attract students who average well above the general population. Yet there are consistent differences among the fields. In order, from top to bottom in terms of the median scores, students earning bachelor's degrees line up as follows: physical sciences (except chemistry), chemistry, engineering, law, English, foreign languages, psychology, economics, geology and the earth sciences, biological sciences, fine arts, nursing (nurses with AB degrees), history, agriculture, business and commerce, humanities (except English and the foreign languages), social sciences (except history and economics), education, home economics, and physical education. Students of physical sciences other than chemistry average two points higher than students of chemistry, the next field in line; and students of home economics and physical education are five and six points below students of education. In no other case is the difference between adjoining fields more than one point on the AGCT scale. The exact ranks, therefore, are not to be taken too seriously. Repetition of the study on a different group of students might well change some of the ranks, but it is unlikely that the changes would be very great. Standard deviations of the medians vary, but almost all of them are less than one.

Graduate students line up in approximately the same order. The largest change is for agriculture,

TABLE 1

APTITUDE TEST SCORE DISTRIBUTIONS OF STUDENTS SPECIALIZING IN DIFFERENT FIELDS OF STUDY

Field of specialization	Percentile scores (on AGCT scale) of each group				
	10	25	50	75	90
Natural Sciences					
AB	*114*	*121*	*128*	*135*	*143*
Graduate students	*118*	*125*	*133*	*140*	*147*
PhD (Including Agriculture, Engineering, and Psychology)	*122*	*130*	*138*	*148*	*158*
Chemistry					
AB	116	123	130	137	145
Graduate students	118	126	134	142	148
PhD	125	132	140	148	157
Physical Sciences, other					
AB	116	123	132	138	149
Graduate students	122	129	136	143	148
PhD	123	134	143	154	161
Earth Sciences					
AB	114	120	126	134	139
Graduate students	114	121	129	137	144
PhD	126	133	139	149	160
Biological Sciences					
AB	112	119	126	133	140
Graduate students	117	123	131	138	145
PhD	120	127	134	142	150
Psychology					
AB	113	119	128	135	142
Graduate students	123	130	137	143	149
PhD	125	133	142	155	163
Social Sciences					
AB	*110*	*117*	*125*	*132*	*139*
Graduate students	*114*	*121*	*129*	*138*	*145*
Economics					
AB	114	120	127	134	142
Graduate students	114	121	130	138	145
History					
AB	110	118	125	132	139
Graduate students	114	121	129	136	144
Other Social Sciences					
AB	108	115	123	131	137
Graduate students	114	121	129	138	145
Humanities and Arts					
AB	*113*	*120*	*127*	*134*	*141*
Graduate students	*115*	*122*	*130*	*139*	*146*
English					
AB	114	121	128	136	143
Graduate students	120	126	134	141	147
Languages					
AB	114	121	128	135	142
Graduate students	115	123	131	140	148
Philosophy and other Humanities					
AB	109	118	123	133	139
Graduate students	117	126	135	142	148
Fine Arts					
AB	112	119	126	132	140
Graduate students	112	119	126	135	143
Engineering					
AB	115	122	129	137	145
Graduate students	118	123	131	139	145
PhD	121	131	138	149	153
Applied Biology					
AB	*106*	*114*	*121*	*127*	*134*
Graduate students	*117*	*122*	*129*	*135*	*141*
Agriculture					
AB	114	119	124	130	137
Graduate students	121	127	132	138	144
PhD	113	121	130	137	144
Home Economics					
AB	100	110	118	124	130
Graduate students	110	116	121	127	130
Health Fields					
Graduate students	*116*	*123*	*130*	*137*	*144*
Medicine					
Medical school students	119	125	132	138	145
Dentistry					
Dental school students	112	118	126	134	142
Nursing					
AB	113	119	125	134	143
Other					
(Graduate students in all fields except Medicine and Dentistry)	116	123	131	138	145
Business and Commerce					
AB	111	117	124	131	137
Graduate students	112	119	126	133	140
Education					
AB	*105*	*114*	*122*	*129*	*135*
Graduate students	*112*	*119*	*126*	*133*	*138*
Education, general					
AB	107	116	123	131	136
Graduate students	113	119	127	134	139
Physical Education					
AB	99	110	117	124	134
Graduate students	108	115	120	125	129
Other Fields					
Law					
Law school graduates	117	120	129	133	140
Social Work					
Graduate students	112	119	126	132	138
All Fields Combined (weighted averages)					
AB	*112*	*119*	*126*	*133*	*140*
Graduate students	*114*	*121*	*129*	*137*	*144*

which moves up from fourteenth place on the undergraduate list to sixth place on the graduate list. Medicine, which is here classed with the graduate degrees, ranks in seventh place, between agriculture and engineering. Dentistry comes in sixteenth place, between education and business and commerce.

Our sample of people who have earned doctor's degrees is limited to students of the sciences. In chemistry, the earth sciences, engineering, physics, and psychology the distributions are much alike, with median scores ranging from 138 to 143. Students of the biological sciences average four, and students of agriculture eight, points below the general average.

There is overlapping among all the distributions. Students of the physical sciences are, in general, a superior lot, but some of them fall below the average student of home economics or physical education. Students in those fields are, in general, considerably less highly selected, but some of them score above the median student of physics.

Without exception, graduate students in a field are more highly selected than are undergraduates, but for some fields the differences are small. The median scores for AB's and graduate students in the fine arts are exactly the same, but the 75th and 90th percentile points are a little higher for graduates. Only two points separate the two medians for engineers and for students of business and commerce. At the other extreme, the two medians for philosophy and the other humanities (excluding English and the foreign languages) are 12 points apart. In some fields the typical graduate student is clearly much more superior to the typical student earning a bachelor's degree than is the case for other fields.

The discussion so far has centered around the students who specialize in a particular field. It is also possible to study the way in which students of a particular level of ability divide up among the fields of specialization. How, for example, are the very best students distributed among the different disciplines? The earlier discussion has demonstrated that the general quality level differs from field to field. We know, too, that some specialties attract many more students than do others. A large field may therefore include numerically more of the top quality students than does a small field, even though proportionally it includes fewer. The top fifth of all graduate students, in terms of placement on the AGCT scale, divide themselves up as follows: 18 per cent major in one of the natural sciences, 6 per cent in psychology, 8 per cent in the social sciences, 14 per cent in the humanities and arts, 9 per cent in engineering, 2 per cent in agriculture, 7 per cent in medicine, 4 per cent in the other health fields, 3 per cent in business and commerce, 17 per cent in education, and 13 per cent in other fields. Every field draws some of the top quality students and thus includes some men and women who are able to exercise the kinds of intellectual leadership indicated by high scores on tests of general ability.

The top 10 per cent of graduate students in all but four fields (home economics, education, physical education, and social work) of the 24 listed in Table 1 score at 140 or above on the AGCT. A score of 140 is earned by less than 2 per cent of the general population. In nearly every field, therefore, 10 per cent or more of the graduate students come from the top 1 or 2 per cent of the population.

The fields differ considerably, however, in proportion of their membership composed of these intellectually most gifted students. For each top quality student (upper fifth of all graduate students) in the natural sciences there are two others of lesser endowment. For each one in the humanities and arts there are three of lesser ability. In the social sciences the top level people are each working with four of lesser ability. In physical education the very bright graduate students must be pretty lonely indeed; for every student from the top group there are some 35 from lower levels.

It is also of interest to know where the poorest quality of graduate students go. Again the answer depends partly upon the size of the field and partly upon its differential attractiveness to students of different ability levels. The combined result is of this order: of the bottom one fifth of all graduate students, in terms of the AGCT scale, about 6 per cent are in the natural sciences, 1 per cent in psychology, 6 per cent in the social sciences, 10 per cent in the humanities and arts, 5 per cent in engineering, 3 per cent in agriculture and home economics, 4 per cent in medicine, 5 per cent in dentistry, 1 per cent in the other health fields, 8 per cent in business and commerce, 46 per cent in education, and 6 per cent in other fields. There are many more graduate students in education than in any other field, but even so, one of the sad effects of the low salaries and low prestige accorded to the nation's school teachers is the fact that nearly half of the lowest fifth of graduate students in the country are working for advanced degrees in education. They will be guiding the development and influencing the career choices of the next generation of students.

In considering the data presented above it is necessary to ask how representative our samples are of all students in the country. No one knows the characteristics of the entire student population, so a precise statistical answer is impossible. All that we can do is to describe our samples.

Data on persons receiving bachelor's degrees came from a study of recent graduates of 40 colleges and universities. Each of these schools supplied to the Commission a number of items of information for each student who enrolled in the fall of 1946. (Some schools also supplied data on 1944 and 1945 entrants.) Approximately 10,000 of these students have since graduated, and they constitute the population at the bachelor's degree level upon which we have reported. The 40 schools were widely scattered geographically and quite diverse in type of control, size, and characteristics of their student bodies. Some had high admission standards and some rather low standards. A separate analysis of returns from the first 18 schools gave results substantially similar to the results for the entire 40.

For the study of graduate students the University of Washington in Seattle supplied scores on the Miller Analogies Test of all applicants for admission to the graduate school during 1950. The University of Pittsburgh furnished scores on the same test for all recipients of graduate degrees during the period 1949–51. The Psychological Corporation gave us the scores of small samples of graduate students from 40 other universities. When these three sets of scores were analyzed according to the major fields of study, the distributions were sufficiently similar so that the data from all three sources were combined to give a total population of approximately 4500 graduate students.

Records of students earning doctor's degrees came from a more limited study. The Office of Scientific Personnel of the National Research Council provided the names of men and women who have earned PhD degrees in the sciences since 1940. Those whose undergraduate work had been done in an Ohio or a Minnesota college were selected for study, because from those two states it was possible to get test scores and other background information from high school and college years. Test scores were available for 1100 of the 1300 students included in this study.

Support for the assumption that our samples were reasonably representative comes from a comparison of our findings with other data. There have been scattered reports comparing the students in one field with those in other fields at the same college or university.

TABLE 2

Field of specialization	Median score of recent AB's (from Table 1)	Mean score of college seniors on SSCQT (converted to AGCT scale)
Physical sciences (including chemistry and earth sciences)	130	132
Biological Sciences	126	126
Social Sciences	125	128
Humanities	127	128
Engineering	129	132
Agriculture	124	122
Business and Commerce	124	126
Education	122	118
Total group	126	128

We have examined these reports and have also compared the data with analyses of the score distributions of students graduating with different majors during the past 30 years from the Ohio State University. The recently published analysis[1] of the scores made by different groups of students taking the Selective Service College Qualification Test makes it possible to compare our data with the scores of the 38,420 college seniors who took the SSCQT during 1951. Average scores for approximately comparable groups are given in Table 2.

[1] *A Summary of Statistics on Selective Service College Qualification Test.* Statistical Report 52–1. Princeton, N. J.: Educational Testing Service (Jan. 22, 1952).

The conversion of SSCQT scores to AGCT scores is an approximation; one column gives means and the other medians; the SSCQT sample consisted of a self-selected group of men, whereas our sample consisted of all men and women graduates from a selected list of colleges. Nevertheless, the agreement between the two sets of data, together with the other lines of evidence outlined above, indicates that the scores presented in Table 1 can be accepted as reasonably good estimates of the distributions of ability of students currently being trained in the United States for work in scientific and other fields of specialization. It seems reasonable to accept 126 as a fair estimate of the median score of graduates of colleges and universities. Other Commission data indicate, however, that if all types of degree granting institutions were included the median would be a few—perhaps five—points lower. But changing the estimated median would not affect the field-to-field comparisons. Those are so consistent from one set of data to another that they can be accepted with a good deal of confidence.

In conclusion, those fields which have reputations of requiring abstract and rigorous thinking (e.g., physics, chemistry, law) attract students who are, on the average, superior to those who major in traditionally "easier" subjects (e.g., business and commerce or education). But the distributions all overlap; every field attracts some of the mediocre students; every field attracts some of the brightest.

News and Notes

Scientists in the News

Nathan Birnbaum, associate professor of chemistry, has returned to the City College of New York after a three-year leave of absence, during which he was on active military duty as lieutenant colonel with the Chemical Corps, U. S. Army. Dr. Birnbaum will remain associated with the Chemical Corps as a consultant to the Research and Engineering Command, Army Chemical Center, Md.

Columbia University Engineering School's new Aeronautical Structures Laboratory has added **Bruno A. Boley** to its staff as associate professor of civil engineering. Dr. Boley goes to Columbia from Ohio State University, where he was in charge of the structures curriculum and research in the Department of Aeronautical Engineering.

Elias Cohen has been appointed instructor of pathology at the School of Medicine, University of Oklahoma, as well as assistant director of the clinical laboratories of the teaching hospital. He will extend the quantitative immunological studies that he was conducting at Rutgers University.

Horace C. Dudley, USN, has been relieved as head of the Allied Sciences Section, Medical Service Corps, by L. A. Barnes. For the past five years, Comdr. Dudley has also been chief of the Biochemistry Division, Naval Medical Research Laboratory, Bethesda, Md. His new assignment is as head of the Radioisotope Laboratory, U. S. Naval Hospital, St. Albans, N. Y.

Howard E. Evans, associate professor in entomology at Kansas State College, has resigned to accept a position at Cornell University, succeeding **J. C. Bradley,** retired (SCIENCE, **115,** 7 [1952]).

K. P. Ewing, who for 32 years has served as research entomologist with the USDA Cotton Insects