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ABSTRACT

The present study stems from the concern that recent employment trends among scientists will result in a drop in the ability of students entering scientific fields. In an attempt to provide some indication of whether such is the case, the history files of the Graduate Record Examinations were used to construct a history of aptitude test statistics for the years 1970-71 through 1974-75. The chief focus of the study was the examination of possible regular changes or trends in aptitude test mean scores over the observed period, but the study indicates that no such trends of practical significance occurred over the period. The major differences observed in scores were those between students in different fields, and these differences occurred consistently over the whole period under examination. In quantitative ability, candidates in the Sciences averaged more than one standard deviation higher than candidates in Nonscience fields and, within the Sciences, examinees in the Physical and Math Sciences averaged nearly one standard deviation higher than those in the Life and Basic Social Sciences. In verbal ability, the Science and Nonscience candidates did not differ on the average, but within the Science group, Engineering candidates averaged noticeably lower than the others. (Author)

TRENDS IN APTITUDE OF GRADUATE STUDENTS IN SCIENCE

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TRENDS IN APTITUDE OF GRADUATE STUDENTS IN SCIENCE

Introduction

Although traditionally the supply of doctoral candidates in the sciences has been inadequate to meet the needs of a technologically burgeoning society, some speak of the disenchantment of students with science, and others believe that the more promising students do not choose scientific careers. Such attitudes may stem from a growing concern about projections indicating that the vast numbers of Ph.D.'s to be produced in the next decade will far outstrip any increase in open positions. Some forecasts of manpower needs in the sciences and at the Ph.D. level indicate that there will be an overabundance of persons with new doctorates in the sciences now and for some time. It is also possible that the market for technically educated personnel at the doctorate level will be further reduced because of the decision of private industry to recruit personnel at lower academic levels and to train them in their own laboratories.

If such is the case--and certainly if it is widely held that such is the case--one would scarcely expect the vocational choices of the more able students to remain unaffected. Students must, of course, speculate on the most rewarding career in terms of their interests and the activities they enjoy the most, but one would also expect a fairly high proportion of the more able students to respond to the realities of possible employment and income. In order to realize that the long run effect for the country could be quite unfortunate if these students choose not to go into science, one need only accept the premise that those who are the most able in terms of tested abilities are also those who are most highly aware of employment trends and best able to act on the basis of that knowledge. It is, therefore, important to note and detect trends in the quality of students going into the sciences.

With ample resources one could probably conduct a comprehensive evaluation study of students entering the sciences, using measures that seem particularly relevant and taking measurements periodically in a fashion designed to sense trends of importance in the data. As an initial step, however, it seems much more reasonable to use easily accessible data, both for assessing the past as a baseline and for monitoring future trends. Then, if hints of serious problems are detected, more energetic action could be taken on a real time basis. One set of data which might serve this purpose is the historical file of scores on the Graduate Record Examinations.

Brief Statement of Purpose

Concern that economic conditions might discourage the most able students from undertaking careers in science motivates an examination of trends in aptitude test scores of students applying for admission to graduate study in the sciences. It would be preferable to obtain a sampling of the scores of students actually entering graduate study in the sciences over the years for the purpose of observing trends in aptitude, but such a survey is impractical. It was, therefore, decided in this study to compare the aptitude test average scores of students who indicated an intention to study in science departments with those of students whose intended fields of study fell in non-science areas. The data for the study were taken from the GRE aptitude scores of candidates tested in fiscal years 1970- 1, 1971-72, 1972-73, 1973-74, and 1974-75, which are available in the historical files of the GRE test program.

The Graduate Record Examinations (GRE)

The Graduate Record Examinations (GRE) consist of tests of scholastic aptitude (which yield a Verbal and a Quantitative score) and a series of specialized achievement examinations in nineteen subject-matter areas. The data accumulated and tabulated in connection with these examinations are voluminous. A high proportion of examinees take only the aptitude tests, however, since many American graduate schools and scholarship programs require these scores (Lannholm, 1971) and not those of the subject-matter achievement examinations.

One might wish to restrict the population of interest to those who have taken an achievement test and examine the trends in these scores. The concerns of the present study, however, deal in part with the comparisons of trends in science with trends in other areas. Clearly, comparisons are at issue, and such comparisons must be made on comparable scores. We are not as interested in the trends of physics achievement scores for those entering physics as we are in the trends in academic aptitude of those who enter physics in relation to the academic aptitude of those who enter other fields (whatever their preparation in those fields). In order to make these comparisons it was necessary to know the intended fields of study of the subjects of the research.

Since the main focus of this research was on aptitude, the use of subject-matter achievement examinations as a means of identifying students by field was rejected. Classification by field was possible from information given by the candidate at the time he registered for the examination, when he was asked to designate the institution and department to which he wanted his scores sent. This department information was used as the means for arriving at the field classification of each student. The departments for which codes exist are listed on pages 7 and 8. In this listing, the groups are those used in the present study.

The GRE Population

The purpose of the GRE is to provide a graduate school with evidence that the candidate seeking admission has the aptitude for graduate study and has achieved a mastery of the subject matter relevant to his intended field of study, or of some subject matter material which is related to his undergraduate field of study.

In order to provide an adequate service to the candidate and his potential graduate school, a candidate's scores are supplied to score users as the candidate requests within the administrative policy of the testing program. Scores are also recorded on magnetic tape, along with information which identifies the candidate, gives a record of his test-taking history, and a partial listing of the departments to which his scores have been sent. The latter record is not complete because it is only used yearly in the course of regular test program operations, and to store more than is needed on a regular basis would expand a tape file which is already unwieldy. Also there is an erasing of a candidate's department codes in the event that he takes an examination at more than one sitting. The reasons for this erasure are related to program policies regarding

Sciences and Engineering

Physical Science
- Astronomy
- Chemistry
- Geology
- Metallurgy
- Oceanography
- Physics
- Other Physical Sciences

Math Science
- Applied Mathematics
- Computer Sciences
- Mathematics
- Statistics

Engineering
- Engineering, Aeronautical
- Engineering, Chemical
- Engineering, Civil
- Engineering, Electrical
- Engineering, Industrial
- Engineering, Mechanical
- Mining
- Engineering, Other

Life Sciences
- Agriculture
- Anatomy
- Audiology
- Bacteriology
- Biochemistry
- Biology
- Biophysics
- Botany
- Entomology
- Forestry
- Genetics
- Microbiology
- Nutrition
- Parasitology
- Pathology
- Physiology
- Zoology
- Other Biological Sciences

Basic Social Sciences
- Anthropology
- Economics
- Educational Psychology
- Geography
- Government-Political Science
- Linguistics
- Psychology
- Social Psychology
- Sociology

Nonsciences

Health Professions
- Dentistry
- Medicine
- Nursing
- Occupational Therapy
- Optometry
- Osteopathy
- Pharmacy
- Physical Therapy
- Public Health
- Veterinary Medicine

Education
- Education
- Physical Education

Arts and Humanities
- American Studies
- Archeology
- Architecture
- Art History
- Classical Languages
- Communications
- Comparative Literature
- Dramatic Arts
- English
- Far Eastern Languages and Literature
- Fine Arts, Art Design
- French
- German
- History
- Italian
- Journalism
- Music
- Near Eastern Languages and Literature
- Philosophy
- Religious Education and Bible
- Russian
- Slavic Studies
- Spanish
- Speech
- Theology
- Other Foreign Languages
- Other Humanities

Applied Social Sciences
- Guidance and Counseling
- Industrial Relations and Personnel
- International Relations
- Public Administration
- Social Work

Nonsciences (continued)
   Urban Development (Regional Planning)
   Other Social Sciences
Other Nonsciences
   Business and Economics
   Home Economics
   Law
   Library Science

score reports, not to the purpose of this study. What is important for this study is that the department codes available to the researcher for classifying a candidate are those supplied by him at his last sitting.

The files of interest to this study are developed from the historical files preserved for the convenience of candidates who may want to supply scores to an institution not designated at the time of the candidate's initial registration for the examination. The GRE historical file does not contain a complete history of all GRE testing for the obvious reason that the size of such a file would be completely impractical. Until very recent years, when the file system was converted from tape to discs, the historical file tapes were reconstituted each year in October. In carrying out this reconstitution, only those cases were retained for which there had been activity during the three preceding years. For example, the new file created as of October 1, 1972, contained those cases entered in the file during the period October 1, 1969, to September 30, 1972, and the file from which this new file was copied contained the information from October 1, 1968, through September 30, 1971. The sampling frame for the present study was taken as all those records for years 1970-71, 1971-72, 1972-73, 1973-74, and 1974-75 for which there was department code information and for which aptitude scores exist.

Originally it was intended to stratify the frame by year of graduation since, even though the cases are obtained by year of testing, the classification of most direct interest is that of candidates who would be part of the same cohort. That is, the study is interested in the scores of people who would appear at the graduate schools by year, rather than in a grouping by year tested. However, the testing year was adopted as the variable to be used for classification in this study because of the difficulty in constituting comparable groups by year of expected college graduation. The difficulty stems from the fact that the testing years studied, although adjacent, must have a first year and a most recent year, and while the middle years studied may be fairly well represented by people tested as juniors, say, from the year before, the earliest year will not have people who were tested as juniors the year before. Although the division by year is not the best possible, it should reflect marked trends in the data which might be more closely related to year of graduation and is at least an operationally reproducible criterion.

Score Comparability

One additional point should be made concerning the comparability over years of the aptitude test scores. Those familiar with the GRE aptitude tests know that the actual questions in these tests are not always the same. Every year, in fact, a completely different GRE Verbal Test (GRE-V) and Quantitative Test (GRE-Q) are constructed and administered as part of the operational testing program. This is necessary as a precaution against the possible compromise of the tests and is a feature of a number of testing programs which provide data that bear on admission decisions and which must be available on a large scale. This change of test items, however, introduces a need for assuring that scores obtained on different forms of the test are comparable, since candidates who have taken different questions will receive scores that purport to be comparable. To meet this need, a procedure called "score equating" is implemented with the introduction of each new form. In intent, the procedure used for the GRE aptitude examinations is to develop two similar populations which are representative of the tested population and transforms the formula scores (the formula is the number right minus one-fourth of the number wrong) so that they have the same average and standard deviation in the sample taking the new test as the scores obtained on the sample who took the old test. To produce the two matched samples, a practice called "spiralling" has been adopted in which new forms are alternated in the test shipments. That is, when the tests are actually handed out at the testing center, after the students are seated and have no further opportunity to change seating arrangements, the adjacent students actually take different examinations. The two halves of the populations are considered to be quite comparable, and the size of the populations involved are so large (on the order of tens of thousands), that random errors of sampling are negligible. Then, given the scores on the GRE scale from the old form and the raw scores from the new form, the formulae given by Gulliksen (1950, p. 274) may be used to get constants for converting raw scores on the new form to scores on the GRE scale. A more complete discussion of this procedure is given by Angoff (1971, p. 578 and beyond).

Sample

A preliminary examination of historical data was deemed necessary for the following reasons. First, one can see by inspection of the list of possible graduate departments that the number of fields by which a candidate might be classified is potentially quite large. An attempt to study trends by department would require a huge sample in order to get enough cases for any reliance on the statistics of a department, and, failing a study by department, a classification of departments would be necessary so that there would be a sufficient number of cases, at least by type of department. Second, there is a known source of confusion in the information supplied by candidates about the department to which the score reports are to be sent. The confusion results from the fact that some candidates may mistakenly use the source list for advanced test codes as the key to the department codes. Since all of the test codes correspond to a department code, if the coded number is one of those on the test code list, there is no cue to whether the source of the number was from the department code list or the test code list. If it came from the test code list, it is an error. For determining the extent of such errors, a sample of historical data was also needed.

Accordingly, a sample of five thousand cases was selected from the 1970-71 historical tape file. The cases were sorted by the configuration of department codes, and the number of cases for each configuration was counted. The configurations referred to arise because a number of candidates have their scores sent to more than one graduate department. Clearly, the sampling plan would need to take such multiple applications into account, and their existence is a third reason for the preliminary sample. Examination of the tape indicated that in no more than 15% of the cases had more than two kinds of departments been designated and that in most cases the departments designated came from the same groups used in the classifications defining the groups of departments. Furthermore, since none of the groups used was essentially empty, the sample indicated that each group would be well represente[illegible]ation of the cases where a department code was the same as a subject-matter test code indicated that, in instances of multiple classification of a candidate in terms of the types of departments to receive scores, the test code was more consistent with other departments indicated than was the department code. For example, a candidate might have taken the Chemistry Test, test code 27, and have indicated department codes 27 and 64. However, as a department code, 27 is American Studies and 64 is Chemical Engineering. Rather than believe that the candidate took the Chemistry Test and then wished his grades to be sent to an American Studies department as well as a department of Chemical Engineering, it seems more reasonable to suppose that the department code 27 is an uncorrected error made by using the Chemistry Test code in the department code space. It is the agreement between the substantive interpretation of the 64 as a department code and the 27 as a test code that leads one to believe that a copying error has occurred. Such agreement was found in all other cases of obvious disparity between types of departments coded when one of the codes was identical to a test code. Accordingly, it was concluded that indeed such errors were being made. However, since these errors were noted in less than 1% of the cases, it was concluded that they were not being made frequently enough to have an appreciable effect on the study.

The considerations noted above led to the conclusion that a simple sampling rate would be sufficient to yield the required sample. A one-to-fifteen sampling was made, and all cases with a missing aptitude score or no departmental designation were eliminated. For each candidate, the group of each department code was recorded, the candidates were sorted on the configuration of the group codes, and counts were made for each configuration for each year of the study. These counts indicated that the number of candidates sending scores to departments from only one group were, for each year, as follows: 1970-71 89.4%; 1971-72 88.4%; 1972-73 91.5%; 1973-74 92.5%; and 1974-75 91.8%.

At the outset of this project, it was not known to what extent application to different departments or types of departments is common. It appears that a small minority of students make such application, but it is not common by any means. Furthermore, it is certainly not clear how to categorize a student who makes such application for the purposes of this study. Therefore, the students who have made multiple applications are omitted, and this study focuses on the larger number who stay within one departmental group.

Results

With the exclusion of cases with multiple group application, the remaining students are the subject of this study. Table 1, which gives the data on which the results of this study are based, contains, by departmental group and by year, the number of cases, means, and standard deviations for both Verbal and Quantitative scores, as well as the correlations between these scores.

Table 2, which presents the significance tests made on the Verbal scores, contains a significant main effect for Year but not for Science vs. Nonscience. Estimates of the main effects[1] for Year are, rounded to the nearest integer, 3, -5, 2, 1, and -1, for 1970-71 through 1974-75, respectively. These differences are quite small, and their

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[1] It is common to abstract various components that represent an average score deviation associated with various ways the scores are classified in a study. Scores in this study can be classified in three ways: by Year, by Science or Nonscience, and by Group Within Science or Nonscience. Where components are associated with only one of these classifications, they are called "main effects." The numerical values of these main effects are given as deviations from some reference point; for the classification by Year, or by Science or Nonscience, this reference point is the average of all the entries in Table 1 (though the figures used for the calculations were not rounded to integer values as are the ones in Table 1). For example, the main effect of the Year 1970-71 is the average of the means for 1970-71 less the average of all the means in Table 1. Where the text gives a negative number for the main effect, the average of those means that are associated with the effect is below the overall average.

For the Group Within Science or Nonscience main effects, the reference points are the average of the Science group means, or the average of the Nonscience group means. For example, the Physical Science main effect is given as the difference between the average of the Physical Science means and the average of all the Science means, including the Physical Science means.

Defined as above, the sum of the main effects of a type of classification is zero. For example, the main effect of Science is the negative of the main effect of classification of Nonscience. Tests of the significance of main effects, such as are given in Tables 2 and 4, index the credibility of the hypothesis that the calculated effects could have arisen by chance, by testing whether the sum of squares of the main effects is significantly different from zero.

It should be understood that all of the computations mentioned above which reference means in Table 1 refer either to the Verbal means or the Quantitative means. No averaging process was used including both Verbal and Quantitative scores. The same restriction applies to the discussion in Footnote 2.

siz.\, together with the nonsignificance of the Science vs. Nonscience main effect and the Year by Science vs. Nonscience interaction suggest that no trend in the verbal ability of the candidates in the broad curriculum classifications has been detected. But when one tests the effects of the more narrow classifications of data, the Science or the Nonscience groups, one finds differences. The main effects of the Science groups are 10, 10, -51, 3, and 28, for Physical Science, Math Science, Engineering, Life Sciences, and Basic Social Sciences, respectively. For the Nonscience groups, the main effects are -8, 10, 2, 0, and -4, for Health Professions, Education, Arts and Humanities. Applied Social Sciences, and Other Nonsciences, respectively. The salient feature of these estimates is that those going into engineering receive much lower verbal scores, on the average, than do those going into the basic social sciences.

Table 3 contains estimates of the Year by Group interactions[2] for

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[2] Interactions are similar to main effects, being numerical values of components of the variable under study. Interactions differ from main effects in that they are concerned with classification by more than one factor at a time, and because they are measured from a more complex system of reference points. In the present study, scores can be simultaneously classified by Year and by Science vs. Nonscience, or by Year and by Group Within Science vs. Nonscience (no interaction involving both Group and Science vs. Nonscience is possible because classifications such as nonscientific Physical Science do not exist).

The 1970-71 by Science interaction is calculated by subtracting the average of the entries in Table 1, the main effect of 1970-71, and the main effect of Science, from the average of the Science means for 1970-71. Other Year by Science vs. Nonscience (Y x S) interactions can be calculated in analogous ways.

The 1970-71 by Physical Science interaction is calculated by subtracting the average of the entries in Table 1, the main effect of 1970-71, the main effect of Science, the main effect of Physical Science, and the Science by 1970-71 interaction from the 1970-71 Physical Science mean. Other Year by Group Within Science vs. Nonscience (Y x G) interactions can be calculated in an analogous fashion, but one must keep in mind that if the Group is in the Nonscience category, it is the Nonscience main effect and the Nonscience by Year main effect that must be subtracted.

Verbal scores. Among the entries that appear in the upper half of Table 3 one may notice a consistent upward trend for Life Sciences, and some tendency for Basic Social Sciences scores to decline; among the Nonscience entries in the lower half of the table, one may notice some decline for Education. None of these trends suggest that the hard sciences are receiving candidates with decreasing verbal scores and, since the estimates are made in GRE scale score points, one may observe that the trends do not involve large score differences on the average.

Table 4, which contains the analyses of variance of the quantitative scores, indicates that all of the effects are significant, though the level of significance of the Year by Science vs. Nonscience interaction is questionable because it falls slightly short of the traditional 5% standard. Since that interaction is crucial to the interests of the

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2(continued)

As these components are defined, certain sums are zero, as was the case with the main effects. When two-classifiction interaction components are used, the sum over components associated with one of the classifications is zero if the other classification is held constant. For example, in the Y x S interactions, the Nonscience component for a given year is the negative of the Science component for that year. In addition, in the Y x G interactions, the sum of Science components for a given year is zero, as is the sum of Nonscience components for that (or any other) year. As with the main effects, the credibility of the hypothesis that these values arise by chance is tested by finding whether the sum of squares of the components is significantly different from zero.

It can be seen that the intent of these two-classification interactions is to abstract the quantitative advantage or disadvantage of being in a particular pair of classifications, after removal of the advantage of the single classifications (main effects). The interactions involving Years would indicate changes in differ nces by curriculum classification as the years proceed; status trends over years would be indicated by significant interactions involving Years. Since the interactions in the present study were of borderline significance or were small in magnitude, one is justified in concluding that no important time trends have been detected.

present study, the values of the estimates follow: 0, -2, 1, 2, and -1, for 1970-71 through 1974-75, respectively; the corresponding estimates for Nonscience are the negatives of the values listed above. The main effects for Year are 2, -1, 3, 1, and -5. Clearly, even though the effects of the time trends may be significant, they are neither systematic nor large. The main effect of Science, 64, and its negative for Nonscience, are in absolute value the largest effects estimated in this study; they convey the very reasonable results that high quantitative ability is characteristic of those pursuing advanced academic work in the sciences. Similarly there are large differences within the broad curriculum groups as follows: for Science, the estimated values of the effects of groups are 32, 60, -45, -49, and -88, for Physical Science, Math Science, Engineering, Life Sciences, and Basic Social Sciences, respectively; the effects for the Nonscience groups are 21, -33, 8, -10, and 14, for Health Professions, Education, Arts and Humanities, Applied Social Sciences, and Other Nonscience. These group differences, too, are quite substantial and indicate a large advantage in quantitative ability for those entering the physical sciences, math, and engineering.

Table 5 contains the Year by Group interactions obtained for the analysis of the Quantitative test scores. The upper half of this table indicates a slight tendency for the quantitative scores of Physical Science and Math Science to decline as the scores of Life Sciences increase. This finding is relevant to the interests in the present study since it relates to aptitude trends in the hard sciences. Trends may also be noted for the Nonscience groups; the Health Professions interactions increase and the Education interactions decrease.

Discussion

The present study was undertaken in order to identify systematic trends in the aptitude of graduate students for 1970-71 through 1974-75. Since the examination scores used in the study were those of GRE candidates rather than those of actual entrants to graduate school, the results of the study do not reflect precisely the characteristics of graduate school entrants. The research, however, might be expected to give some indication of emerging problems if any such problems exist. The study indicates that test score variation occurs chiefly from one curriculum or field group to another; systematic changes or trends over time within a field group are much smaller in terms of GRE score points. The strongest such trends occurred for quantitative ability within the Science fields and consisted of decreases on the order of ten points over five years for Physical and Math Sciences, with an increase on the order of 20 points for Life Sciences. Even with these trends, the students in the hard science have a considerable advantage in quantitative ability.

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Table 1

Number of Cases, Means, Standard Deviations, and Correlations

for Verbal and Quantitative Scores by Curriculum Group and by Year

		1970-71				1971-72				1972-73				1973-74				1974-75			
Science		#	Mean	S.D.	Corr.	#	Mean	S.D.	Corr.	#	Mean	S.D.	Corr.	#	Mean	S.D.	Corr.	#	Mean	S.D.	Corr.
Physical Science	V	499	512	136	.54	323	500	134	.44	474	519	130	.56	454	502	126	.40	526	508	133	.57
	Q		650	106			643	109			648	105			648	113			630	110	
Math Science	V	425	517	141	.64	248	495	135	.56	362	510	131	.53	404	513	139	.57	384	506	126	.56
	Q		675	104			673	91			676	96			675	97			661	104	
Engineering	V	665	444	132	.46	372	448	122	.39	544	455	132	.53	573	449	133	.49	594	440	127	.55
	Q		656	98			651	97			665	93			663	100			649	103	
Life Sciences	V	1036	491	122	.56	716	491	122	.58	1069	504	117	.57	1202	508	121	.55	1347	509	116	.57
	Q		556	120			553	122			570	118			569	117			568	118	
Basic Social Sciences	V	2085	533	117	.53	1570	527	116	.50	2176	522	120	.61	2153	525	119	.56	2185	521	120	.57
	Q		530	118			526	120			521	125			521	127			518	128	
Nonscience																					
Health Professions	V	358	500	114	.44	256	502	108	.44	376	509	107	.44	471	508	113	.53	597	502	103	.51
	Q		496	119			501	117			508	120			507	120			513	119	
Education	V	2993	472	110	.54	2120	463	112	.54	2988	452	113	.58	2953	449	113	.58	2745	454	113	.59
	Q		462	120			457	119			450	119			442	120			445	120	
Arts and Humanities	V	2686	546	118	.53	1659	534	117	.53	2571	537	120	.60	2574	541	125	.57	2405	542	121	.57
	Q		494	118			492	116			493	122			494	121			490	120	
Applied Social Sciences	V	983	492	113	.54	694	482	111	.56	1038	484	121	.64	1180	493	121	.60	1270	488	118	.63
	Q		480	121			475	123			475	126			477	122			464	123	
Other Non-Sciences	V	880	496	124	.46	580	490	124	.39	961	501	125	.45	917	498	124	.47	901	496	125	.48
	Q		498	123			500	119			502	121			495	128			498	126	

Table 2

Analysis of Variance of Verbal Scores by Year, Science vs. Nonscience, and Group Within Science or Nonscience

Source	df	Sum of Squares	Mean Square	F	Probability of Larger F
Year (Y)	4	188,821.9578	47,205.4894	3.3180	0.0119
Science vs. Nonscience (S)	1	5,356.1394	5,356.1394	0.3765	0.5223
Group Within Science/Non-Science (G)	8	55,929,498.0250	6,991,187.2531	491.3969	0.0
Y x S	4	57,824.2218	14,456.0554	1.0161	0.3701
Y x G	32	1,506,267.6586	47,070.8643	3.3085	0.0
Error	59,482	846,260,487.1271	14,227.1693		
Total	59,531				

Table 3

Year by Science vs. Nonscience Interactions

for Verbal Scores

	Year				
Science	1970-71	1971-72	1972-73	1973-74	1974-75
Physical Science	3*	-3	7	-7	0
Math Science	8	-7	-2	3	-2
Engineering	-5	7	4	0	-6
Life Sciences	-11	-4	-1	6	10
Basic Social Sciences	5	7	-8	-2	-2
Nonscience					
Health Professions	-8	1	5	3	-1
Education	10	8	-5	-9	-4
Arts and Humanities	2	-3	-2	0	3
Applied Social Sciences	9	-3	-3	5	1
Other Non-Sciences	-4	-3	5	1	1

*Entries are rounded to the nearest integer.

Table 4

Analysis of Variance of Quantitative Scores by Year, Science vs. Nonscience, and Group Within Science or Nonscience

Source	df	Sum of Squares	Mean Squares	F	Probability of Larger F
Year (Y)	4	265,115.0507	66,278.7627	4.6716	0.0013
Science vs. Nonscience (S)	1	143,632,278.3079	143,632,278.3079	10,123.8557	0.0
Group Within Science/Non-science (G)	8	87,405,154.3717	10,925,644.2965	770.0891	0.0
Y x S	4	117,172.22[illegible]8	29,293.0557	2.0647	0.0831
Y x G	32	1,289,070.2183	40,283.4443	2.8394	0.0000
Error	59,482	843,901,319.6431	14,187.5075		
Total	59,531				

Table 5

Year by Science vs. Nonscience Interactions

for Quantitative Scores

	Year				
	1970-71	1971-72	1972-73	1973-74	1974-75
Science					
Physical Science	5*	2	0	0	-7
Math Science	1	3	0	0	-4
Engineering	-3	-3	4	3	-1
Life Sciences	-9	-7	2	2	12
Basic Social Sciences	6	5	-6	-5	0
Nonscience					
Health Professions	-10	-5	2	3	10
Education	9	5	-2	-8	-4
Arts and Humanities	0	-1	-1	3	-1
Applied Social Sciences	4	0	-1	4	-7
Other Non-Sciences	-3	1	2	-2	2

*Entries are rounded to the nearest integer.