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A multivariate analysis of variance was conducted on student achievement, scholastic ability, and socioeconomic status scores. 1,345 boys and 1,607 girls were evaluated in grade 7, in grade 9, and again in grade 11. The measure of achievement was the Sequential Tests of Educational Progress, (STEP). Ability was measured by the School and College Ability Test (SCAT). The socioeconomic status (SES) measure was derived from several items in a background and experience questionnaire. A three factorial design was used in which 18 high schools, 5 curriculum groups, and the two sexes formed the design parameters. Dependent variables included 6 STEP, 2 SCAT, and an SES score. Results were used to establish a performance baseline with grade 7 data, and an indication of change at grades 9 and 11 by observing through the use of covariance control, what new differences or performance attributes were not predictable from grade 7 data. Sizeable and important differences were found among students betinning at grade 7 and these are usefully descriptive of their ongoing educational achievement and scholastic ability. The intellectual growth of students in non-academic programs was less general and much lower than that of students in academic programs. (PS)

EDUCATIONAL ACHIEVEMENT PRIOR TO AND DURING HIGH SCHOOL[1, 2]

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Because school guidance workers assist students in making educational and vocational plans for the manifest purpose of facilitating their intellectual and vocational development, it would seem useful to have more systematic knowledge of both the nature and on-going pattern of their prior educational achievement. This research was undertaken to investigate the educational achievement, scholastic ability and socio-economic status of a group of students who, by grade 11, were enrolled in a specific curriculum and attending one of 18 high schools. The endeavor was prompted by an earlier and informal analysis (Patton and Morse, 1967) in which substantial differences in achievement were noted at grade 7 among students who later enrolled in various curricular programs and high schools.

Because the significance of these differences could not be documented in the earlier study, and also because the nature of group differences could not be specified, a multivariate analysis of variance (MANOVA) was conducted on achievement, ability, and socio-economic status scores. MANOVA is a natural extension of a one-way analysis of variance to the case with more than one dependent variable. Linear composites of the dependent variables, called discriminant functions, are used to test the hypotheses about interactions and main effects. The discriminant functions take into account the intercorrelation among the dependent variables, and thus avoid the problems of multiple dependent tests. The sample included 1,345 boys and 1,607 girls who were in grade 7 in 1961, grade 9 in 1963, and grade 11 in 1965. The measure of achievement was STEP (Sequential Tests of Educational Progress) which includes six tests in four major academic areas: math, science, social studies, and communications (reading, writing and listening). The ability measure was SCAT (School and College Ability Test) which includes a verbal and a quantitative scale. The measure SES was derived from several items in a background and experience questionnaire that had been administered to these students at grade 11.

The longitudinal sample used in this research includes students from 18 public high schools. To examine the on-going performance of these students retrospectively by curriculum, sex and high school beginning at grade 7, group identity was established from grade 11 data. A three-factorial design was used in which 18 high schools, 5 curriculum groups (e.g., undecided, vocational, business, general and academic) and the two sexes formed the design parameters. Nine dependent variables were used in the analysis: 6 STEP scores, 2 SCAT scores and a measure of the SES of the student's family. Grade 7 STEP and SCAT scores were introduced as covariates in the MANOVA of grade 9 scores, and both grade 7 and 9 scores were used as covariates in the MANOVA of grade 11 scores. The major analyses to be reported here were used to establish a performance baseline with grade 7 data, and an indication of change at grade 9 and 11 by observing, through the use of covariance control, what new differences or performance attributes were not predictable from grade 7 data.

Preceeding the major analyses, checks were made on the SES and SCAT variables to assess their contribution to the findings. The SES variable was included as a covariate in a re-analysis of grade 7 STEP scores to determine whether achievement differences that had been found among curriculum groups and among school groups would remain. The results of both analyses were practically identical suggesting that in this research, at least, SES does contribute to differences among groups, but sizeable differences of practical importance remain when the effect of SES is controlled. Incidentally, this result appears to be contrary to what Coleman concludes about the nature of school differences in the EOS study. Analogously, STEP and SES were included as covariates in a re-analysis of grade 7 data in which the two SCAT variables were investigated. Even though sizeable correlations had been found between STEP and SCAT in the first

analysis the results of the re-analysis indicated that all but one of the significant effects from the prior analysis had been duplicated.

Significant but small two-way interactions were noted between school and sex at grades 9 and 11, between curriculum and sex at grades 7, 9 and 11, and between school and curriculum at grades 7, 9 and 11 (see Table 1).

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Because of the dubious practical importance of these differences little interpretive weight has been given to them. All three sets of analyses are summarized in Table 1. The effects being tested are listed in the left-hand column. The next three columns give the multivariate F ratios, degrees of freedom and significance level, respectively, for the analysis of grade 7 data. The analysis of the grade 9 data with the grade 7 scores used as covariates is summarized in the next three columns, and the last three columns summarize the grade 11 analysis with grade 7 and 9 scores used as covariates.

The most interesting effects at all three grades were the main effects of curriculum and school. The titles given to the corresponding significant discriminant functions are reported in Table 2. Let me first consider the curriculum effect at all three grades. The main effect of curriculum at grade 7 suggested that the performance of the students is best described as

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positively weighted general achievement and ability dimension, and on this dimension the Academic students were distinguished from all the non-Academic groups. A more specific dimension at grade 7 distinguished the Vocational from the other non-Academic groups in terms of a dimension with science weighted

positively and SES weighted negatively. When grade 7 STEP and SCAT were controlled in the MANOVA of grade 9 the results now indicated that performance was such that Academic students were to be further distinguished from non-Academic students in terms of a Quantitative, SES, and general achievement dimension. A dimension with a positive weight for Listening and negative weight for Reading, and a Social Studies dimension further characterized these students at grade 9, and these dimensions located the Vocational group at the top of the former and the bottom of the latter. Grade 11 results, with grade 7 and 9 STEP and SCAT scores treated as covariates, indicated that performance is characterized by a positively weighted SES and Writing dimension on which the Academic group is again distinguished from all the non-Academic groups.

The on-going superiority of the Academic group is to be noted, and while differences between this group and the others generally become smaller over time, the gap is still of considerable practical import at grade 11 (e.g., in some cases 2 and 3 years difference in STEP or SCAT scores[3]). In addition, the difference is characterized generally by the Academic group's superior performance on an overall or general achievement-ability-SES dimension. Only secondarily is it possible to speak of dimensions that characterize the performance of the non-Academic groups, and these are less general and also less discriminating, although still significant. The need to re-think what kind of education and performance is to be sanctioned for non-Academic students is underscored. The need for vocational and educational guidance that is more often concerned with intellectual growth than with filling course sequences is also evident.

As might be expected with data of this kind, sex differences occurred at grades 7, 9 and 11, and these were most notable on STEP Writing where the girls clearly continued to exceed the boys. Conversely, the boys attained higher means at grade 11, and greater gains from grade 9 to 11 on STEP Math and STEP Science. These differences are, however, small.

Turning now to the school effect, the significance of this factor at all three grades adds considerably to the description of the achievement, ability and SES attributes of this group of students. At each grade, several discriminant functions were significant, but only the first few have been noted here because the differences they represent are more likely to be of practical significance than would those associated with the smaller multivariate F ratios. If, under the curriculum effect, it can be said that a general achievement and ability dimension best represents the performance of the groups at grade 7, the same can be said under the 7th grade school effect if SES is added to this picture (see Figure 1). In adding the SES

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feature, the school-groups scoring higher on this variable are thus located at the corresponding ends of the discriminant score distribution. While this latter dimension provides maximum discrimination among the groups at grade 7, at least the next three dimensions are such that the groups are also well dispersed. Independently of the first dimension, a dimension of Reading or Verbal Performance with SES receiving a negative weight, describes the sample by locating some lower SES school groups (3, 6, 8 and 18) at the top of the distribution. A Listening dimension adds to the description as does a Quantitative minus SES dimension.

At grade 9, a Listening, SES, and Science dimension provided maximum

discrimination among the groups indicating that some school groups made greater gains from grade 7 to 9 than others. A second dimension positively weighted on SES and negatively on Listening also discriminated, as did a dimension weighted negatively on Quantitative and positively on Reading.

When grade 7 and 9 STEP and SCAT scores were included as covariates in the MANOVA of grade 11 scores, further descriptive differences are seen to occur among the groups. On this occasion it appears that in general, some of the lower SES school groups, while still achieving lower means, make greater gains between grades 9 and 11 relative to some of the higher SES school groups. This is illustrated by noting that the first discriminate function is negatively weighted on SES, and positively weighted on Science dimension. However, on the second dimension made up of positively weighted Social Studies, Math and Science, all levels of SES appear distributed across the range of discriminant scores.

As was the case with the curriculum groups, general achievement and ability, including SES, appears to best describe the performance of the school groups. This general dimension is complimented by more specific dimensions at grade 7 that include first, the verbal and then the quantitative areas. Differences at grades 9 and 11 beyond those predictable from grade 7 results would suggest that the educational achievement of these students reflects sizeable gains in specific areas at specific schools.[4]

In conclusion, sizeable and important differences among students are found beginning at grade 7 and these are usefully descriptive of their on-going educational achievement, and scholastic ability. The intellectual growth of students who enroll in non-academic curriculum programs during high school is seen to be considerably less general and dramatically lower than their

Academic peers. Both the education and the kind of guidance offered to such students must be held in question. In addition, these findings point to the need for further research on the nature of these observed differences and the earliest point at which they can be detected. It is of little value to state that these results can assist one in more accurately predicting later educational experience and achievement when such a predicted state-of-affairs is, for so many students, hardly to be in their best interests. More importantly, such findings as these high-light the need for school guidance personnel to assist the student in avoiding some of the 11th grade outcomes observed here.

FOOTNOTES

[1]Data analysis for this study was completed while the author was associated with Educational Testing Service. Special thanks are due to Charles E. Hall, Thomas L. Hilton and William E. Coffman of ETS for their assistance and encouragement.

[2]The study was supported by a grant from the U. S. Office of Education to Educational Testing Service, and a more formal report to the former agency is now in preparation as an ETS Research Bulletin.

[3]A difference of one year on the STEP and SCAT Scales is roughly five (5) points. (See STEP or SCAT Technical Manuals, ETS, 1957.)

[4]This is particularly true at grade 9 for school groups 15, 9 and 11 in STEP Science; for groups 9, 18, 1 and 5 in STEP Listening; and for groups 3, 11, 8 and 2 in STEP Writing at grade 9; At grade 11 larger gains over grade 9 and 7 are made by groups 11, 3, 8, 7 and 6 in STEP Science; by groups 9, 10, 18 and 4 in STEP Social Studies, Math and Science; and by groups 7, 5 and 11 in SCAT Quant., and STEP Math.

Table 1

Significant Multivariate F Ratios at Grades 7, 9 and 11

Source	Grade 7 F	Grade 7 df	Grade 7 p less than	Grade 9* F	Grade 9* df	Grade 9* p less than	Grade 11* F	Grade 11* df	Grade 11* p less than
Curriculum x Sex x School	NS	-	-	NS	-	-	NS	-	-
School x Sex	NS	-	-	1.290	153/22,798	.009	1.734	153/22.734	.001
							1.382	128/22,442	.003
Curriculum x Sex	2.241	36/10,693	.001	1.558	36/10,663	.018	2.131	36/10,663	.001
School x Curriculum	1.182	243/24,454	.028	1.693	243/24,386	.001	1.768	243/24,317	.001
				1.475	208/24,309	.001	1.523	208/24,241	.001
				1.309	175/24,221	.004	1.367	175/24,153	.001
							1.234	144/24,053	.030
Curriculum	28.218	36/10,693	.001	8.998	36/10,663	.001	5.530	36/10,633	.001
	1.655	24/ 8,311	.023	3.104	24/ 8,311	.001			
				2.355	14/ 5,692	.003			
Sex	94.776	2/ 2,853	.001	51.847	9/ 2,845	.001	46.005	9/ 2,837	.001
School	14.127	153/22,862	.001	13.441	153/22,798	.001	13.666	153/22,734	.001
	7.331	128/22,569	.001	8.400	128/22,505	.001	10.106	128/22,442	.001
	4.995	105/22,227	.001	5.713	105/22,165	.001	7.259	105/22,103	.001
	3.579	84/21,829	.001	4.338	84/21,768	.001	5.160	84/21,706	.001
	2.451	65/31,362	.001	3.630	65/21,302	.001	3.130	65/21,242	.001
	2.097	48/20,812	.001	2.866	48/20,754	.001	2.015	48/20,696	.001
	1.845	33/20,163	.002	2.149	33/20,107	.001			

*Grade 7 STEP and SCAT included as covariates in grade 9 MANOVA; both grade 7 and 9 included as covariates at grade 11

Table 2

Titles For Discriminant Functions Associated with

Significant Effects at Grades 7, 9 and 11

Source	Grade 7	Grade 9	Grade 11
School x Sex		1. Science	1. Listening plus Math 2. Science
Curriculum x Sex	1. Science	1. Science minus Verbal	1. Science
School x Curriculum	1. SES, Quant.	1. Verbal, Reading 2. Writing and SES minus Social Studies 3. Listening	1. Math 2. Science 3. Quantitative 4. SES, plus Writing
Curriculum	1. General Achievement and Ability 2. Science minus SES	1. Quant., SES, and General Achievement 2. Listening minus Reading 3. Social Studies	1. SES, Writing
Sex	1. Writing	1. Writing	1. Math and Science minus Writing
School	1. SES, General Achievement 2. Reading, Verbal Achievement minus SES 3. Listening 4. Quant., minus SES 5. Social Studies minus Writing 6. Quant., Verbal 7. Math	1. Listening, SES and Science 2. SES, minus Listening 3. Writing and General Achievement 4. Quant., plus Reading 5. Social Studies plus Science 6. Verbal 7. Science	1. SES, plus Science 2. Social Studies, Math and Science 3. Listening minus SES 4. Quant. and Math 5. Social Studies plus SES 6. Writing

Figure I

Plot of Discriminant Scores for 7th Grade School Effect