THE PREDICTIVE VALIDITIES AND FACTORIAL CONTENT OF THE FLORIDA STATE-WIDE NINTH-GRADE TESTING PROGRAM BATTERY

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The purposes of this study are (1) to assess the role of each test in the Florida State-Wide Ninth-Grade Testing Program battery in predicting academic ability; and (2) to determine the factorial content of the Florida State-Wide Ninth-Grade Testing Program battery.

Introduction

The Tests

The battery of the Florida State-Wide Ninth-Grade Testing Program consists of the School Ability Test, Form 3A and five of the Iowa Tests of Educational Development, Form X-3. The tests are described briefly below:

1. School Ability Test - "Verbal." Sixty multiple-choice items which "measures developed ability in the verbal kinds of school learning."[1] (Code-SAT V)

2. School Ability Test - "Quantitative." Fifty-three multiple-choice items designed to yield a "measure of ability in certain quantitative skills of number manipulation and problem solving."[1] (Code-SAT Q)

3. Iowa Tests of Educational Development - "Test 3, Correctness and Appropriateness of Expression." One hundred-eight items "designed to give the teacher a reliable indication of the student's writing: punctuation, usage, capitalization, spelling, diction, phraseology, and organization."[2] (Code-ITED 3)

4. Iowa Tests of Educational Development - "Test 4, Ability to Do Quantitative Thinking." Fifty-three multiple-choice items in the broad area of general mathematics problem-situations such that "the typical man-on-the-street would

[1] The School Ability Test, Examiners' Manual, 1955, Educ. Testing Service, Princeton, N. J.

[2] The Iowa Tests of Educational Development, "How to Use Test Results," Fifth Revision, 1957 Edition, Science Research Associates, Chicago, Ill.

readily agree that each of the problems was a very practical one which every high school graduate should be able to solve."[1] (Code-ITED 4)

5. Iowa Tests of Educational Development - "Test 5, Ability to Interpret Reading Materials in the Social Studies." Eighty multiple-choice items based on "representative reading selections taken from social studies textbooks and references, from magazine and newspaper articles on social problems, and from the literature of the social studies in general."[1] (Code-ITED 5)

6. Iowa Tests of Educational Development - "Test 6, Ability to Interpret Reading Materials in the Natural Sciences." Eighty multiple-choice items based on "materials selected from textbooks and references used in the natural sciences, from scientific articles in newspapers and periodicals, and from relatively non-technical or popular and semi-popular scientific literature in general."[1] (Code-ITED 6)

7. Iowa Tests of Educational Development - "Test 7, Ability to Interpret Literary Materials." Eighty multiple-choice items which attempt to "measure most of the measureable understandings that high school pupils may be expected to derive from reading of literary materials."[1] (Code-ITED 7)

Sample

The sample was drawn from the 41,000 students who participated in the fall, 1957, Florida State-Wide Ninth-Grade Testing Program. Of these 41,000; 34,000 were white pupils and 6,700 were Negro pupils. A one-sixth random sample was drawn from each racial group. This procedure led to a sample of 5,130 white pupils and 990 Negro pupils. The means and standard deviations of the sample and the parent population were compared on each test. These comparisons in deviation units appear in Table 1.

[1]The Iowa Tests of Educational Development, "how to Use Test Results," Fifth Revision, 1957 Edition, Science Research Associates, Chicago, Ill.

Table 1

Deviations of Sample Means and
Standard Deviations from Population Values

Tests	Means		Standard Deviation	
	White	Negro	White	Negro
SAT				
V	0	0	0.3	0.5
Q	1	1	1.2	1.2
ITED				
3	1	1	1.1	1.6
4	1	1	1.0	0.8
5	0	0	0.3	0.4
6	0	0	0.9	0
7	1	1	1.2	1.8

Table 1 contains the deviations in raw score units of the means and standard deviations, respectively, between the sample and parent population for each test. The samples closely resemble the parent populations.

Prediction of Academic Ability

Criterion

For the purpose of this study, academic ability was defined to be the total score on the School Ability Test. It was assumed that the SAT-total score will have a significantly high correlation with other criteria of academic ability such as high school 4-year grade point average, scores on achievement tests taken in the twelfth grade, etc. On this basis it was assumed that from SAT-total score would be close agreement with predictions that might be made later on the basis of other criteria when they might be derived.

All correlations and other measures were computed on original test scores, not percentiles or standard scores. On each test, the score is the total number of correct responses.

Procedure

Product moment correlations were computed between SAT-total (the criterion variable) and each of the ITED tests, 3-7 (the predictor variables). These correlations are presented in Table 2.

Table 2

Correlations between SAT-total score and ITED tests, 3-7 for white and Negro pupils

Correlation of SAT-total with:	White N= 5130	Negro N= 990
ITED 3	.69	.54
ITED 4	.73	.41
ITED 5	.74	.49
ITED 6	.66	.35
ITED 7	.75	.47

The correlations of all tests with the criterion for both groups fall in a rather narrow range.

Table 2 reveals, especially for the white group, that each ITED test is highly related to the criterion, SAT-total. This holds for the Negro group too except that the average correlation is slightly smaller. This is probably due to the narrower range of variability of scores characterizing the Negro group.

Due to the relatively high association between each of the predictor tests and the criterion, multiple correlations between several combinations of the predictors and the criterion were computed to determine the best predictor combination and to determine the relative contribution of each predictor as it becomes part of the multiple correlation. The multiple correlations appear in columns titled "R" in Table 3 below. The correlations between each predictor and the criterion are also included to permit ready comparison of the difference between them and the multiples. The columns titled "R^2" contain entries stated as percentages which indicate the percentage of variation in the criterion test, i.e., SAT-total, which is accounted for by the predictor test or combinations of predictor tests.

Table 3

Correlations between SAT-total Score and ITED 3-7 and Selected Multiples of ITED 3-7

Correlation of Sat-total with:	White R	White R^2	Negro R	Negro R^2
ITED 3	.69	48%	.54	29%
ITED 4	.73	53%	.41	17%
ITED 5	.74	55%	.49	24%
ITED 6	.66	43%	.35	12%
ITED 7	.75	56%	.47	22%
ITED 3,4,5,6,7	.87	76%	.66	43%
ITED 3,4,5,6	.86	74%	.65	42%
ITED 3,4,5	.86	74%	.64	41%
ITED 3,4	.81	66%	.60	36%
ITED 3,5	.80	64%	.60	36%
ITED 3,6	.77	59%	.58	34%
ITED 3,7	.80	64%	.60	36%
ITED 4,5	.83	69%	.54	29%
ITED 4,6	.79	62%	.48	23%
ITED 4,7	.85	72%	.53	28%
ITED 5,6	.76	58%	.52	27%
ITED 5,7	.79	62%	.53	28%
ITED 6,7	.78	61%	.52	27%

From Table 3, it can be seen that for white students ITED 3 correlates with SAT-total at .69 which, in turn, indicates that $.69^2$ or 48% of the variation in SAT-total can be accounted for by ITED 3; furthermore, it can be seen that the correlation between SAT-total and ITED 4 is .73 which indicates that ITED 4 accounts for 53% of the variability in SAT-total. It is apparent that each of these ITED tests is highly related to SAT-total, or, in other words, to some appreciable extent SAT-total and ITED 3 and 4 measure the same abilities or achievements. When ITED 3 and 4 are combined in accordance with their best weights for predicting SAT-total the resulting correlation is .81, which is another way of saying that together ITED 3 and 4 account for 66% of the variation in SAT-total. If the other three predictor tests, ITED 5, 6, and 7, are added in their best predictive weights to ITED 3 and 4, then the resulting correlation is .87. When this correlation is squared, it is apparent that all

ITED tests taken together account for .76 of the variation in SAT-total. But the addition of ITED 5, 6, and 7, to ITED 3 and 4 increased our prediction of academic ability by only about 10%.

It is apparent that for both white and Negro groups that two or three combinations of two different ITED tests would be almost as capable of accounting for variation as would all five ITED tests taken together. Using additional tests with the best two or three test combinations does not give substantially more information about the academic ability of a student. For example, for white students, the addition of ITED 6 to the 3-4-5 combination fails to increase at all the variation that can be accounted for; for the Negro students, only a small additional amount of variation is accounted for. Then if ITED 7 is added to the 3-4-5-6 combination, only 2% more variation is accounted for in the case of white students and only 1% in the case of Negro students.

Due to the slight amount of additional variation that is accounted for in SAT-total on the basis of using three-, four-, and five-test combinations of ITED, it was decided to factor analyze the SAT and ITED battery to determine the extent to which the tests measure relatively independent factors.

Table 4

Battery Intercorrelations* - White

Tests	1	2	3	4	5	6	7
1. SAT V		58	64	59	73	64	75
2. SAT Q	58		58	73	55	52	54
3. ITED 3	64	58		54	60	53	62
4. ITED 4	59	73	54		56	57	54
5. ITED 5	73	55	60	56		72	76
6. ITED 6	64	52	53	57	72		67
7. ITED 7	75	54	62	54	76	67	

*Decimal points are omitted--all entries are in 100ths.

Table 5

Battery Intercorrelations* - Negro

Tests	1	2	3	4	5	6	7
1. SAT V		54	49	30	44	30	45
2. SAT Q	54		46	44	42	32	37
3. ITED 3	49	46		28	46	26	43
4. ITED 4	30	44	28		39	25	38
5. ITED 5	44	42	46	39		40	62
6. ITED 6	30	32	26	25	40		29
7. ITED 7	45	37	43	38	62	29	

*Decimal Points are omitted--all entries are in 100ths.

Factorial Content of the Battery

Procedures

Raw scores as described previously for School Ability Test-Verbal, School Ability Test-Quantitative, and ITED Tests 3, 4,5,6, and 7 were used in the factor analysis. Intercorrelations between the seven variables were computed by the product moment method. The resulting matrices for the two groups are presented in Tables 4 and 5. Because the reliabilities of the tests were not known, the highest correlation of the test with any other test was considered to be equal in magnitude to the test reliability and was used as the diagonal entry.

The centroid method of factoring a matrix of intercorrelations was employed for both groups. Since the number of variables was small, the communalities obtained in the first application of the centroid method were substituted for the guessed communalities and the centroid method was applied the second time. Two factors were extracted for white pupils and three for Negro pupils. The centroid axes were rotated in accordance with the principles of simple structure, orthogonal structure being maintained. The rotated factor loadings appear in Table 6.

Table 6

Rotated Matrices

White			Negro			
Tests	First Factor	Second Factor	Tests	First Factor	Second Factor	Third Factor
SAT-V	.836	.122	SAT-V	.727	.004	.167
SAT-Q	.624	.596	SAT-Q	.579	.012	.507
ITED-3	.695	.237	ITED-3	.681	.060	.103
ITED-4	.643	.527	ITED-4	.320	.253	.440
ITED-5	.888	-.036	ITED-5	.576	.531	.204
ITED-6	.792	.041	ITED-6	.319	.232	.284
ITED-7	.871	-.011	ITED-7	.562	.628	.018

Interpretation of Factors

Examination of the rotated matrix for white students shows the loadings each test has on the two factors that were extracted. Factor 1 had highest loadings on the SAT-verbal, ITED-5, the Interpretation of Reading Materials in the Social Studies test and ITED-7, Interpretation of Literary Materials test; and loadings almost as high on the other four tests. This factor was called "Reading Ability." It is evident from an examination of the battery that reading ability would play an important part in determining the scores for an individual. It also follows that the smallest amount of reading ability would be required on the SAT-quantitative and ITED-4, Quantitative Thinking. Of all the tests, these two had the lowest loadings on the first factor. But even in the case of these two tests, reading plays an important part because many of the problems are "story problems;" i.e., arithmetic problems presented in words.

The second factor has its highest loadings on SAT-quantitative and ITED-4, Quantitative Thinking test. This factor is called the "Quantitative" factor. The only other loading of appreciable size is on ITED-3, the Correctness of Expression. A probable explanation for the existence of a loading of this size on ITED-3 lies in the type of thinking needed to analyze questions which are presented in the test. This type of thinking would be similar to the type of thinking needed to analyze a mathematical problem.

To the extent that reading ability, and general mental ability are regarded as being somewhat synonymous, the first factor could probably be called a "general mental ability." This first factor would be interpreted in the same way as Spearman's G factor.

Three factors appear in the rotated factor matrix for the Negro students. The first factor has its highest loadings on the SAT-verbal, ITED-3, Correctness of Expression, ITED-5, Reading Interpretation of Materials in the Social Studies, and ITED-7, Interpretation of Literary Materials. There are also substantial loadings on the SAT-Q, ITED-4, Quantitative Thinking test, and ITED-6, Interpretation of Materials in the Natural Sciences. As with the white students, this factor might best be called "general mental ability."

The second factor has its highest loadings on ITED-5, Interpretation of Materials in the Social Studies and ITED-7, Interpretation of Literary Materials. These tests involve verbal skills of a highly complex nature. ITED-3 and -5, Quantitative Thinking, and Interpretation of Materials in the Natural Sciences, call for these verbal skills to some degree but not nearly so much as do ITED-5 and -7. This factor might be called a "verbal" factor.

The third factor has its highest loadings on SAT-Q and ITED-4, Quantitative Thinking. This factor would best be called the "quantitative" factor.

When the factor loadings for white and Negro students are compared it is apparent that the factors are common for both groups. The "general mental ability" or "reading" factor accounts for the greatest amounts of variance. A "Quantitative" factor appears for both groups and its loadings are almost entirely confined to SAT-Quantitative and ITED-4, Quantitative Thinking. The analysis of the results of Negroes brought to light a third factor, which was called "Verbal" and was confined chiefly to ITED-5 and -7, Interpretation of Reading Materials in the Social Sciences, and Interpretation of Literary Materials respectively. It appears that this factor represents the complex manipulation of verbal materials, or high-level reading comprehension. It is possible that this factor did not appear for white students because their educational experiences have tended to make complex verbal ability, and reading comprehension almost synonymous with general mental ability. Because arithmetical skills are approached as separates in the education of both groups, the Quantitative factor does appear for both groups.

Summary and Conclusions

Two samples, one white and one Negro, were drawn from the participants in the Florida State-Wide Ninth-Grade Testing Program. Each sample on each test had a mean and standard deviation approximately the same as occurred in the parent population. For each group the School Ability Test-total score was regarded as a measure of academic ability, and zero-order and multiple correlations were computed between it and tests 3-7, of the Iowa Tests of Educational Development. Two-test combination from the ITED were about as predictive of SAT-total as were all five ITED taken together. This phenomenon indicated redundancy in the ITED tests. A centroid fac-

tor analysis was computed to determine the factors which were measured by the SAT and ITED, 3-7. For white students two factors appeared which were named "general mental ability," and "quantitative." All tests were heavily loaded on the former. Three factors appeared for Negro students; the two mentioned earlier and a third factor, called "verbal," which appeared substantially on ITED-5 and -7. It would appear that ITED-3, -6, and -7 could be omitted from the battery without sacrificing much information at all.