DOCUMENT RESUME

ED 064 377 TM 001 622

AUTHOR Marshall, Jon C.; Powers, Jerry M.
TITLE Correlates of Achievement: Prediction and Cross-Validation for Intermediate Grade Levels.
NOTE 20p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Academic Achievement; Age; Arithmetic; *Correlation; *Data Analysis; Elementary School Students; Financial Support; *Instructional Program Divisions; Intelligence Quotient; Language Proficiency; Multiple Regression Analysis; *Predictive Validity; Reading Ability; Sex Differences; Social Mobility; Testing; Vocabulary
IDENTIFIERS *Iowa Tests of Basic Skills

ABSTRACT

A study was conducted to: (1) determine the simple and multiple correlation coefficients between selected educational/personal variables and academic achievement at intermediate grade levels as measured by the Iowa Tests of Basic Skills; (2) determine the multiple linear regression equations for predicting individual student achievement as measured by ITBS subtests; and (3) cross/validate the regression equations determined in this investigation. The general method used was the determination and cross-validation of multiple linear regression equations for predicting achievement of intermediate level children from individual and school based data normally available. Variables used were: (1) Dependent: vocabulary, reading, language, and arithmetic; (2) Independent: achievement level, Intelligence, Sex, Social Mobility, Aid for Dependent Children (ADC), age, race, years in school, and learning rate. Sample population consisted of public school children in grades five through eight. Data analysis procedure was Step-Up Multiple Regression Analysis. The SPSS regression routine was used. The highest correlations with post-and pre-achievement scores were on the same scale and intelligence. There was a low relation between learning rate and achievement. In cross-validation, there were five instances of correlations equal to or higher than those originally obtained. Variables that emerged as significant predictors in multiple regression were: pre-achievement, IQ, Sex, and ADC. (Author/CK)

CORRELATES OF ACHIEVEMENT: PREDICTION AND CROSS-VALIDATION FOR INTERMEDIATE GRADE LEVELS

Jon C. Marshall
University of Missouri-St. Louis

Jerry M. Powers
St. Louis Public Schools

Despite the pros and cons of standardized testing, most school systems annually administer one or more standardized tests to students, especially at the elementary and junior high levels. The realistic interpretation of individual and group scores, however, is by no means a simple matter.

Results of standardized achievement tests are used for tracking students by achievement grouping, homogeneous grouping within classrooms, diagnostics of students' strengths and weaknesses, and so forth. Occasionally these results are used for curriculum and instruction evaluation. However, a number of difficulties have arisen from this practice. Among these difficulties is the ignoring of basic differences among student groups which affect achievement but are beyond the control of the teacher. This can be partially alleviated by determining the relations of selected variables to achievement and taking the variables into consideration when analyzing individual and group achievement test scores.

The relations between some educational-personal variables and educational achievement have been well documented in the literature. Perhaps one of the most frequent predictors used is that of intelligence as measured by some form of IQ test. Gnauck, Johanna, and Kaczkowski (1961) in testing 180 Milwaukee students in 7th and 8th grades found correlations between .56 and .79 when comparing Lorge-Thorndike verbal IQ scores with various subsets of the Iowa Tests of Basic Skills. Comparisons with the L-T non verbal IQ scores showed lower coefficients ranging from .44 to .64.

In a study involving sixth graders in a rural central school in New York State, Churchill and Smith (1966) found the L-T verbal and L-T non-verbal to have correlation coefficients of .84 and .65 respectively with the composite ITBS scores. In this same study, they found that third and sixth grade composite ITBS scores had a correlation coefficient of .79 for a longitudinally matched sample of 56 students.

Knief and Stroud (1959) in a study involving 344 students showed values nearly identical to those found by Churchill and Smith when comparing L-T verbal and L-T non-verbal to ITBS composite scores of fourth graders. These researchers also found a correlation of .34 between social class (as measured by the Warner Index of Status Cnaracteristics) and ITBS scores. Multiple correlation techniques employed by Knief and Stroud generally showed little increase in coefficient values over that between L-T verbal and ITBS scores. The effect of sex on academic achievement seems considerably less dramatic than that of some previously mentioned variables. Parsley et. al (1963) found no differences between the sexes in grades two through eight on tests of reading-vocabulary, reading comprehension, arithmetic reasoning, arithmetic fundamentals, and IQ. However, he did cite other sources who claimed differences between the sexes on similar achievement measures.

The use of fifth grade ITBS subset scores (reading, language, arithmetic, etc.) to predict corresponding eighth grade scores was the basis for a study by Dyer, Linn and Patton (1969) in which 9,972 New York students were compared on these measures. Correlation coefficients betw en corresponding subset scores ranged from .73 to .83. A major finding of this study was that longitudinal studies of classes which because of mobility are unmatched across time and cross-sectional comparisons between two different grade levels of students did not provide comparable results to those obtained in the longitudinal matching of individual students.

Based on the latter study, the authors did suggest that subsequent studies of a similar nature control for the general effect of student mobility on those students who remain in the program. This suggestion is based on their findings of greater discrepancies between actual and predicted scores for those students in schools with high mobility rates.

Based on these and other research results as well as practical considerations within the school system, the investigators of this study selected several of these variables in addition to a few others as a basis for predicting fifth through eighth grade student ITBS subtest scores. The specific foci of this study are summarized in the following section.

PURPOSE

The purposes of this study were to (1) determine the simple and multiple correlation coefficients between selected educational-personal variables and academic achievement at intermediate grade levels as measured by the Iowa Tests of Basic Skills; (2) determine the multiple linear regression equations for predicting individual student achievement as measured by ITBS subtests; and (3) cross-validate the regression equations determined in this investigation. An additional concern of this study was the examination of the potential for using aggregates of individual results for group predictions.

PROCEDURE

The general method for this study was the determination and cross-validation of multiple linear regression equations for predicting achievement of intermediate level children from individual and school based data normally available.

Variables

Of interest in this study was the prediction of achievement level of children from information available in school records. The variables are listed below.

Dependent Variables

1. Vocabulary (Voc2) -- vocabulary grade equivalent scores on the ITBS, post-test scores.
2. Reading (Rd2) -- composite reading grade equivalent scores on the ITBS, post-test scores.
3. Language (L2) -- composite language grade equivalent scores on the ITBS, post-test scores.
4. Arithmetic (Art2) -- arithmetic grade equivalent scores on the ITBS, post-test scores.

Independent Variables

1. Achievement level -- pre-test scores on respective ITBS subtests. These scores were obtained one year prior to the post-test scores. Test data were obtained during the springs of 1970 and 1971.
2. Intelligence (IQ) -- Lorge-Thorndike verbal intelligence test scores were obtained at the same time as the pre-test achievement scores.

Independent Variables (cont'd.)

3. Sex (S) -- Sex of student with 0 = Male and 1 = Female.

4. School Mobility (SM) -- Percentage turnover of students as determined by the formula: $\frac{\text{No. transferred in or out}}{\text{End of year enrollment}} \times 100$.

5. Aid for Dependent Children (ADC) -- ADC data on each child was not available from school records. However the percent of school enrollment from families receiving ADC was easily obtained. Therefore the school percentage ADC was taken as the value for each child in that school.

6. Age -- The age of the child at time of pre-test was obtained from the children when they took the Lorge-Thorndike Intelligence Test.

7. Race -- The race of individual students was not available. However, a racial count reported as the percentage of caucasians was obtainable for each school. This school data was entered for each student.

8. Years in School (YS) -- The number of years the child had been in school at the time of pre-test.

9. Learning Rate (Rate) -- The rate of achievement growth as determined by the formula: $\text{Rate} = \frac{\text{Pre-test achievement level}}{YS + 1}$.

Sample

The population from which the samples were drawn was all the public school children in grades five through eight in the St. Louis City Public School System. For each grade level a master computer tape containing all the needed data on each child was generated from the data available through the system's Data Processing Center and Division of Research and Evaluation. At that time the data tapes were edited so that students with partial information were discarded. Approximately 20 percent of the population was lost at this stage.

Two 25 percent samples of subjects were drawn from each edited data tape and written on separate tapes. The process for selection was that for one tape every fourth student was selected starting with the first student and for the other tape every fourth student was taken starting with the second student. This procedure resulted in samples with complete data of the following sizes: grade five, 1680; grade six, 1620; grade seven, 1680; and grade eight, 1432.

At each grade level one of the tapes was used for data analysis and the other tape was used for cross-validation.

Data Analysis

As noted previously, the purpose of this study was to determine the best set of predictors for school achievement in grades five through eight. Data were obtained for samples of about 1500 students. The data analysis procedure was Step-Up Multiple Regression Analysis. The SPSS regression routine was used.

The data analysis consisted of two steps. In the first step all independent variables, with the exception of learning rate were run against post-test achievement scores. This consisted of four runs at each grade level, one run each for Vocabulary, Reading, Language, and Arithmetic. In total, 16 runs were made. At this point, the relations exhibited were examined to determine the subset of variables which most consistently aided in prediction.

After identification of the best set of predictors, the analyses were repeated using only the identified independent variables. In a few cases in the initial analyses variables that were eliminated from further consideration had loaded in equations prior to some of the retained variables. Therefore it was necessary to run the step-up regression analyses a second time using only the final set of variables to determine the actual contribution of each variable with respect to the other variables being used.

Cross-Validation

The regression equations were validated using the second sample of students at each grade level. Cross-validation took three forms: relation between predicted and actual scores; significance of differences between mean predicted and actual scores for subsamples of students; and significance of differences between distributions of predicted and actual scores for subsamples of students.

The first of these consisted of determining the product-moment correlations between predicted scores and actual scores for each of the 16 equations. The standard errors of estimate were determined using the following formula.

$$\text{Standard Error} = \sqrt{\text{Total Variance} - \text{Predicted Variance}}$$

One of the primary concerns for this study was the development of equations which could be used to determine at the beginning of a school year the achievement levels which could be expected in a given classroom at the close of the school year. The equations were based on individual student and school data. Predictions could then be made for individual students and aggregated for the students in a given class. Therefore of interest in the cross-validation was estimates of the congruence of predicted and actual scores for simulated class groups. Congruence was determined by similarities in means and form of distribution. Significant differences between means were tested using t-tests and between distributions using Chi-squares. The significance level was set at .05. The simulated classroom groups consisted of 35 students selected from the cross-validation tapes. Fifteen of these samples were selected and analyzed for each of the 16 equations.

RESULTS

When calculating the step-wise regression, the simple correlations between the independent variables and each dependent variable were obtained. These correlations are presented in Table 1. In a few instances, no

---

TABLE 1 ABOUT HERE

---

correlation is presented in the table. In these cases the variables added so little to the predictions that they did not load into the equations and no simple correlation was obtained from the computer program. However interpretations are still possible from the general levels of the coefficients in the classes.

The highest correlations with post-achievement were pre-achievement scores on the same scale and intelligence, with median correlations of .7767 and .6543, respectively. Interestingly the only other two variables which demonstrated even a moderate relation were ADC and racial count of the school, with median correlations of .3054 and .2967, respectively.

The relatively low relations between learning rate and achievement are worth noting since the learning rate is a commonly used statistic. The median correlation was .1495, accounting for only about 2 percent of the variability in achievement scores.

The results of the initial regression analyses are presented in

Table 2. Pre-achievement and intelligence were the first two

TABLE 2 ABOUT HERE

---

variables to load into the multiple-regression equations for predicting post-achievement with median correlations of .7767 and .7898, respectively.

The median loading orders for the remaining variables were as follows: Sex, 4; School Mobility, 4.5; ADC, 5; Race, 5; Age, 6; and Years in School, 7.5. The first four of these variables tended to be highly similar in loading order, with sex loading most often as variable number three. Years in school was usually the last variable to load.

The pre-achievement scores accounted for about 60 percent of the variance. Intelligence generally picked up about an additional 1 percent, and any of the remaining variables less than one percent. As these figures indicated, very little predictive efficiency was added after the second variable. Statistically significant additions to the equations were usually found for the first three or four variables.

For further analysis, it was decided by the researchers to examine the four independent variables which would provide the best equations and for which the data could be easily and rapidly obtained. The first two variables were pre-achievement and intelligence. The other two variables were sex and ADC.

Sex was selected as one of the final set of variables since it was the one that most often loaded third in the regression equations. ADC was selected over race and school mobility even though it loaded slightly higher(5) than the latter (4.5) and about the same as the former (5). ADC was deemed the most appropriate variable since it was the simplest and most economical of the three measures to obtain. Furthermore, for utilization in a city school system it was important to include a poverty index in any system predicting success. ADC served this function.

Learning rate was added as the fifth variable to this final set. Thus the final set of predictor variables included the cognitive variables of achievement level, ability, and learning rate; sex of the student, and ADC level of the school.

The results of the final regression analyses are presented in Table 3.

TABLE 3 ABOUT HERE

Examination of the table indicates that the variables generally loaded in the following order: pre-achievement, intelligence, sex, ADC, and learning rate. Learning rate loaded significantly ($\alpha = .10$) on only three analyses and even in these instances it was the fourth variable, adding very little to the prediction efficiency. Therefore, the variable was eliminated from further consideration.

For the remaining variables, the criterion for inclusion into equations was a regression coefficient significantly different from zero as determined by the analysis of variance at a .10 confidence level. Thus, an F-value of at least 2.71 with $1/\infty$ degrees of freedom was required for a variable to be included in a regression equation. The final regression equations were as follows.

<u>Fifth Grade</u>

Voc2 = .63182 (Voc1) + .02761 (IQ) - .00375 (ADC) - .20406 (S) + .18109

Rd2 = .53769 (Rd1) + .02771 (IQ) - .00294 (ADC) + .50885

L2 = .70583 (L1) + .02200 (IQ) + .13306 (S) + .29268

Art2 = .59338 (Art1) + .02329 (IQ) - .00162 (ADC) + .61040

Sixth Grade

Voc2 = .62483 (Voc1) - .00498 (ADC) + .03039 (IQ) - .25166 (S) + .04537

Rd2 = .58858 (Rd1) + .03126 (IQ) - .00265 (ADC) + .04957

L2 = .83019 (L1) + .01735 (IQ) + .09640 (S) + .12835

Art2 = .72892 (Art1) + .02099 (IQ) + .30606

Seventh Grade

Voc2 = .60383 (Voc1) + .03744 (IQ) - .06501

Rd2 = .63257 (Rd1) + .03467 (IQ) - .00510 (ADC) + .09338

L2 = .88087 (L1) + .01810 (IQ) + .23276 (S) + .12270

Art2 = .78030 (Art1) + .01924 (IQ) - .00282 (ADC) + .14655 (S) + .81162

Eighth Grade

Voc2 = .52831 (Voc1) + .03763 (IQ) + .01095 (ADC) + .82748

Rd2 = .60646 (Rd1) + .03757 (IQ) - .00218 (ADC) + .12794 (S) + .07078

L2 = .77128 (L1) + .02112 (IQ) + .303134 (S) + .70806

Art2 = .74545 (Art1) + .01603 (IQ) + 1.46276

CROSS-VALIDATION

The regression equations were validated using non-overlapping samples of students drawn from the same populations as the original data producing samples. The cross-validation samples consisted of 1680, 1620, 1680, and 1432 students from grades five through eight, respecti[illegible]y.

The first set of analyses was the determination of the correlations between predicted and actual scores and the standard errors of estimate. The results of these analyses are presented in Table 4. The cross-validation

---

TABLE 4 ABOUT HERE

---

correlations are just about as high as the original ones. In five instances the correlations were equal to or higher than those originally obtained. Even though the correlations were relatively high, considerable error was present in individual predictions. Most of the standard errors were in the .80's and .90's. Thus the 68 percent confidence interval would have a range of over 1.5 grade equivalents.

Of particular interest was the utilization of the data to predict achievement levels for specific classes, buildings, special learning groups, or other aggregates of students. Thus, a cross-validation concern was an estimate of the error when using aggregated scores.

For this segment of the study 15 subsamples of 35 students were drawn from each cross-validation tape. Thirty-five students were chosen because this number is similar to the number of students that might be expected to be in a class at the intermediate school level. Two types of statistical analyses were done on each subsample. The first analysis was the dependent samples t-test to determine if significant differences could be expected between mean predicted and actual test scores. The second analysis was Chi-square to determine if the actual score distributions could be expected to be significantly different from the predicted score distributions. For this latter set of analyses the test scores were placed in frequency distributions of five classes with the middle intervals .5 points in width. For all tests, the significance level was set at .05. A summary of these analyses is presented in Table 5.

TABLE 5 ABOUT HERE

None of the median t-values were significant. To one-tenth a grade level, there were no differences between the predicted and observed means for

10 of the 16 median t-tests. Similar results were obtained when testing the significance of the distributions. None of the median Chi-squares were significant. These results indicate that when aggregating scores for groups of 35 students the actual and predicted distributions could be expected to be highly similar with little if any differences between the mean grade equivalents.

However further examination of Table 5 indicates that there was considerable variability of results in that 16.25 percent of the t's were significant and 24.17 percent of the Chi-squares were significant. Some of this variability may be inherent in the statistical techniques used in that estimates of error were determined for each group separately even though they were drawn from the same population of students. The use of a common estimate of error may have reduced the number of significant tests. Nevertheless, no systematic errors were noted in that the median t-values were always close to zero, alternating about equally between plus and minus; and major differences in the distributions were the under prediction of extreme values, a situation inherent in the utilization of the regression model.

Of primary concern in these analyses was the estimation of standard errors of the differences between means for the aggregate groups. For the median t's, these standard errors ran from a low of .096 of a grade equivalent to .320 grade equivalent. The median value was .149.

DISCUSSION

The primary purpose of this investigation was to determine and cross-validate regression equations for predicting ITBS achievement test scores for students in grades five through eight. The independent variables were (1) Pre-achievement scores, (2) IQ, (3) Sex, (4) School Mobility, (5) ADC level for school, (6) Age, (7) Racial makeup of school, (8) Years in school, and (9) Learning rate.

The largest single correlate of post-achievement scores was pre-achievement with a median correlation of .7767. The second highest correlate was IQ with a median correlation of .6543. The two school characteristics of ADC and race were the only other variables which related even moderately with post-achievement scores.

This latter result was particularly interesting since the variables were fairly gross measures based on school data rather than individual student information. These results indicate that the poverty level of the school as reflected in its ADC percentage and the racial makeup as determined by the percent caucasian in the school is moderately related to achievement. Thus, this factor needs to be taken into consideration when revising curriculum, planning teaching strategies, predicting student achievement, and the like. However, whether or not differences in poverty or race caused achievement differences or whether the variables were commonly related to other variables was not determined in this study. Non-the-less, it seems logical that variables such as IQ might have this commonality.

The multiple correlations when predicting post-achievement scores were quite high, with only one of the 16 being below .70. The obtained correlations were about equally split between the .70's and .80's. The cross-validation correlations between obtained and observed scores tended to be just slightly lower than the original correlations. Furthermore, t-tests and Chi-squares run on subsamples of students indicated that similarities between means of predicted and actual scores and similarity between score distributions could be expected.

The variables that emerged as significant predictors in the multiple regression equations were (1) pre-achievement, (2) IQ, (3) sex, and (4) ADC. Pre-achievement and IQ loaded as the first two variables in every equation. ADC and sex each loaded on eight equations. This latter result was particularly interesting since sex demonstrated only low simple correlations with post-achievement.

TABLE 1

SIMPLE CORRELATIONS OF INDEPENDENT VARIABLES WITH THE DEPENDENT VARIABLES

		INDEPENDENT VARIABLES								
Grade	Dependent Variables	Pre Ach.	IQ	Sex	SM	ADC	Age	Race	YS	Rate
5	VOC2	.7011	.6521	-.0493	-.1607	-.3446	-.1187	.3028	------	------
	RD2	.7012	.6566	.0004	.0007	-.3398	-.1004	.3111	-.1859	.2401
	L2	.8105	.6564	.1780	-.1419	-.2822	-.0883	.2251	-.1668	.2269
	ART2	.7278	.6321	.0643	-.1085	-.3048	.0551	-----	-.1676	------
6	VOC2	.7625	.6704	-.1138	-.1228	-.3670	-.0716	.3464	-.1334	.2035
	RD2	.7452	.6932	------	-.1003	-.3380	-.0822	.3191	-.1205	.1775
	L2	.8522	.6732	.1548	-.1382	-.2536	-.1178	.1966	-.1221	.1883
	ART2	.7849	.6445	-.0037	-.1303	-.3059	-.1120	.2906	-.1400	.1805
7	VOC2	.7045	.6234	-.0515	-.1659	-.2951	-.1480	.2062	-.0571	.1238
	RD2	.8013	.7312	.0116	-.0710	-.3738	-.2057	.3484	-.0999	.1495
	L2	.8787	.6837	.2307	-.0619	-.2375	-.1880	.2158	------	.1346
	ART2	.8007	.6321	.0703	-.0459	-.3235	-.1621	.3322	-.0995	-----
8	VOC2	.5914	.5155	------	-.0682	-.0981	-.1132	.0295	.0059	.0446
	RD2	.7953	.7191	-.0273	-.0393	-.3537	-.1337	.3257	------	.1389
	L2	.8340	.5944	.2212	.0143	-.2084	------	.1895	-.0128	.0689
	ART2	.7685	.5556	-.0187	.0141	-.2309	-.1467	.2416	-.0138	.0788

TABLE 2

MULTIPLE CORRELATIONS OF ITBS CRITERION SCORES WITH SUCCESSIVE SETS OF PREDICTOR VARIABLES

		PREDICTOR VARIABLES							
Grade	Criterion Variables	Pre Ach.	IQ	Sex	SM	ADC	Age	Race	YS
5	VOC2	.7011(1)*	.7384(2)	.7423(3)	.7454(4)	.7466(5)	.7468(6)	.7469(7)	--------
	RD2	.7012(1)	.7528(2)	.7556(6)	.7549(4)	.7544(3)	.7557(8)	.7557(7)	.7553(5)
	L2	.8105(1)	.8354(2)	.8370(3)	.8380(4)	.8382(7)	.8383(8)	.8381(6)	.8381(5)
	ART2	.7278(1)	.7762(2)	.7775(7)	.7770(4)	.7768(3)	.7774(6)	--------	.7772(5)
6	VOC2	.7625(1)	.7898(2)	.7943(3)	.7974(5)	.7969(4)	.7977(7)	.7976(6)	.7978(8)
	RD2	.7452(1)	.7800(2)	--------	.7810(3)	.7816(4)	.7819(6)	.7820(7)	.7819(5)
	L2	.8522(1)	.8594(2)	.8636(5)	.8618(3)	.8640(7)	.8639(6)	.8630(4)	.8640(8)
	ART2	.7849(1)	.8036(2)	.8072(6)	.8063(3)	.8073(7)	.8067(4)	.8070(5)	.8073(8)
7	VOC2	.7045(1)	.7346(2)	.7426(6)	.7406(3)	.7422(5)	.7428(7)	.7411(4)	.7428(8)
	RD2	.8013(1)	.8338(2)	.8381(7)	.8381(8)	.8380(5)	.8376(4)	.8366(3)	.8380(6)
	L2	.8787(1)	.8839(2)	.8868(3)	.8883(6)	.8882(5)	.8883(7)	.8875(4)	--------
	ART2	.8007(1)	.8131(2)	.8146(3)	.8162(5)	.8162(6)	.8162(7)	.8162(4)	.8163(8)
8	VOC2	.5914(1)	.6136(2)	--------	.6399(6)	.6395(4)	.6398(5)	.6390(3)	.6399(7)
	RD2	.7953(1)	.8289(2)	.8299(3)	.8315(6)	.8314(5)	.8310(4)	.8316(7)	--------
	L2	.8340(1)	.8418(2)	.8465(3)	.8470(5)	--------	--------	.8470(5)	.8468(4)
	ART2	.7685(1)	.7753(2)	.7764(8)	.7764(7)	.7757(3)	.7764(6)	.7763(4)	.7764(5)

* Number in parenthesis denotes the order in which the variable was added to the regression equation.

TABLE 3

MULTIPLE CORRELATIONS OF ITBS CRITERION SCORES WITH SUCCESSIVE SUBSETS OF PREDICTOR VARIABLES

PREDICTOR VARIABLES

Grade	Criterion Variables	Pre-Ach. Scores R	Pre-Ach. Scores F	Pre-Lorge-Thorndike IQ R	Pre-Lorge-Thorndike IQ F	Sex R	Sex F	ADC R	ADC F	Learning Rate R	Learning Rate F
5	VOC2	.7011(1)*	1482.681#	.7384(2)	181.050	.7423(3)	19.768	.7444(4)	10.595	--------	0.003
	RD2	.7012(1)	1483.556	.7528(2)	265.515	.7552(5)	1.430	.7544(3)	8.662	.7550(4)	3.060
	L2	.8105(1)	2938.061	.8354(2)	207.745	.8370(3)	13.751	.8371(4)	0.645	.8371(5)	0.041
	ART2	.7279(1)	1728.169	.7762(2)	280.228	.7769(4)	0.711	.7768(3)	3.546	--------	0.004
6	VOC2	.7625(1)	2228.936	.7898(2)	180.720	.7943(3)	30.866	.7969(4)	18.505	.7970(5)	0.448
	RD2	.7452(1)	2004.235	.7800(2)	217.420	--------	0.001	.7809(3)	6.064	.7812(4)	1.545
	L2	.8522(1)	4258.906	.8594(2)	75.458	.8600(3)	6.229	.8601(4)	0.769	.8601(5)	0.234
	ART2	.7849(1)	2574.755	.8036(2)	135.065	.8038(3)	1.481	.8039(5)	0.197	.8039(4)	0.183
7	VOC2	.7045(1)	1616.283	.7346(2)	154.092	.7350(3)	2.135	.7353(4)	1.495	.7354(5)	0.423
	RD2	.8012(1)	2941.013	.8338(2)	286.485	.8366(5)	0.104	.8365(3)	24.607	.8366(4)	0.259
	L2	.8787(1)	5554.931	.8839(2)	69.404	.8868(3)	38.888	.8868(4)	0.130	.8868(5)	0.064
	ART2	.8007(1)	2930.697	.8131(2)	96.777	.8146(3)	11.873	.8155(4)	6.857	--------	0.000
8	VOC2	.5914(1)	753.623	.6136(2)	60.085	.6262(5)	0.408	.6251(3)	32.731	.6261(4)	2.723
	RD2	.7953(1)	2411.361	.8289(2)	243.729	.8299(3)	7.714	.8304(4)	3.473	.8304(5)	0.157
	L2	.8340(1)	3201.307	.8418(2)	62.258	.8465(3)	39.921	.8471(5)	0.943	.8470(4)	3.692
	ART2	.7685(1)	2021.149	.7753(2)	37.007	.7758(5)	0.077	.7757(3)	2.068	.7757(4)	0.108

* Number in parenthesis denotes the order in which the variable was added to the regression equation.

F is the F-test value for significance of a variable at the point it first entered the equation.

TABLE 4

ORIGINAL AND CROSS-VALIDATION CORRELATIONS

Grade	Criterion Variables	Original Analyses R	Original Analyses SE	Cross-Validation R	Cross-Validation SE	Cross-Validation D*
5	VOC2	.7444	.9138	.7190	.8825	0.687
	RD2	.7544	.7948	.7544	.7513	0.596
	L2	.8370	.6925	.8383	.6261	0.516
	ART2	.7768	.6893	.7718	.6894	0.532
6	VOC2	.7969	.9030	.7656	.9040	0.708
	RD2	.7809	.8420	.7743	.7687	0.624
	L2	.8600	.7611	.8477	.7848	0.589
	ART2	.8036	.7784	.7850	.7811	0.611
7	VOC2	.7346	1.1918	.7565	1.2015	.828
	RD2	.8365	.7920	.8400	0.8709	.622
	L2	.8868	.7330	.8914	.7353	.560
	ART2	.8155	.8290	.8019	.8644	.662
8	VOC2	.6251	1.3885	.5582	1.3898	1.103
	RD2	.8304	.8426	.7794	.8259	0.693
	L2	.8465	.8599	.8378	.7913	0.646
	ART2	.7753	.9744	.7536	1.0144	0.798

*D = Mean absolute difference between predicted and obtained scores.

TABLE 5

MEDIAN STATISTICAL TEST VALUES FOR 15 SUBSAMPLES OF 35 STUDENTS

Grade	Criterion Variable	Difference between Means					Difference between Distributions		
		Obtained	Predicted	SE	t	No. of Sig. t's, α = .05	X^2	DF	No. of Sig. X^2, α = .05
5	VOC2	5.3	5.3	.130	.026	1	5.663	3	4
	RD2	5.1	5.1	.117	.539	2	3.784	3	4
	L2	5.1	5.0	.096	-.155	2	6.483	3	5
	ART2	5.5	5.5	.142	-.007	3	4.939	2	1
6	VOC2	5.5	5.6	.206	.169	3	5.269	2	4
	RD2	5.7	5.7	.149	-.149	0	4.788	2	3
	L2	6.2	6.2	.142	.368	5	4.550	3	4
	ART2	5.9	5.9	.155	-.140	3	6.233	4	4
7	VOC2	7.2	7.4	.180	.903	5	3.085	3	1
	RD2	6.7	6.7	.120	-.065	0	4.243	4	3
	L2	8.0	8.0	.106	-.386	1	2.555	3	1
	ART2	7.2	7.3	.152	.404	2	4.849	4	4
8	VOC2	8.8	8.7	.320	-.236	5	8.400	4	8
	RD2	7.5	7.5	.178	.023	3	6.984	3	4
	L2	9.0	8.8	.167	-1.38	2	4.008	3	2
	ART2	8.3	8.3	.181	-.152	2	7.492	4	6