Utilization of Aptitude Test Scores in Improving the Allocation Process at the End of Class VIII-A Validity Study

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The purpose of the present investigation was to find out how much improvement could be attained in the allocation process after class VIII by taking into consideration the class VIII annual examination marks on different subjects in addition to aptitude test scores.

In an earlier study (2) it was found that scores on the "Aptitude test battery for differential prediction" constructed by the authors for the purpose of allocating students to different streams after class VIII had high predictive ability against class IX annual examination marks as the criterion. This battery consisted of the following tests.

(i) English (*a*) spelling (=Ek-I) (*b*) usage (=EK-II) (*c*) comprehension (=EK-III).

(ii) Clerical Aptitude (*a*) matching (=CA-I) (*b*) coding (=CA-II).

(iii) Abstract Reasoning (=AR).

(iv) Verbal Reasoning (=VR).

(v) Mathematics Knowledge & Comprehension (=MK)

(vi) Scientific Knowledge & Aptitude (=SA).

(vii) Mechanical Comprehension (=MC).

In another study by the present authors ( ) it was observed that the school examination mark could also be used in predicting future performance in different streams, but at the same time the "results obtained from all the sample schools however do not point to the existence of a consistent trend..... considering the lack of uniformity in the predictive capacity of the school subjects it is suggested that wherever possible some objective measure should be used in addition to the school marks for allocation purposes, instead of blindly running after the face validity of the subjects concerned (1)."

On the basis of the information obtained from these two studies, it was felt worthwhile to study whether the prediction that the aptitude tests were making could be improved by adding the other dimensions measured by the class

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VIII school examination marks. There was every possibility that the predictions would go up, and in any case it could not be lower than the ones already obtained on the basis of aptitude scores. Accordingly it was decided to use the marks obtained by the students on seven of the school subjects (these were common for all the schools) viz., English, Bengali, History, Geography, Mathematics, Sanskrit and General Science along with the ten aptitude test scores, and to obtain regression equations with these 17 scores as the 17 independent variables and the annual total marks at class IX as the dependent variable. The calculations were done with the help of IBM 1401 EDPM System.

The multiple correlation, the regression coefficients the residual sum of squares etc., were calculated. As there were 17 variables to deal with, the total number of regression coefficients to be calculated was 18. Hence all the school groups which were used in the earlier two studies could not be utilized here as those groups where the numbers of cases were either equal to or less than 18 had to be eliminated for obvious reasons. Hence this study was based on 13 school groups where the numbers of cases were more than 18. Out of these 13 groups there were six from science, of which again one was from a girl's school and the remaining five were from boys. There were five humanities groups, of which one belonged to a boys' school and the remaining groups were from girls' schools. There were only two commerce groups. The obtained regression coefficients, multiple R values are presented in Tables 1 and 2.

It can be seen from Table 1 that the regression coefficients developed for the science stream varied from group to group. It is also to be noted that this variation was not confined to the aptitude scores only but was evident also in the case of class VIII school examination marks. For simplyfying the calculations the aptitude test scores which generally consisted of two integers and two figures after the decimal point, were scaled up by shifting the decimal points two places to the right. This made the aptitude test scores larger in comparison with the school marks and consequently the obtained regression coefficients for the aptitude test scores appear to be small when compared with those for the school marks. But this would not affect the predictive ability of the test as the aptitude test scores could be used by shifting the decimal places to the right before obtaining the weighted total score.

From Table 2 it can be seen that for the humanities groups the regression coefficients varied widely among themselves from group to group both for the aptitude tests and the school marks. This was true in the case of the two commerce groups also. It is also evident from Tables 1 and 2 that with 17 variables the multiple correlations were extremely high specially for the science groups. Out of the 13 R values calculated 9 turned out to be statistically significant of which 6 were significant at the 1% level and the remaining 3 at the 5% level. On the whole it could be concluded that the obtained values were high enough and had the number of cases been higher the multiple R values for the other 4 groups would perhaps also become significant.

TABLE 1

Regression coefficients for different aptitude tests and school subjects in the science streams of different schools

Regression Weights \ Schools	GIRLS	BOYS				
	C	F	H	J	K	L
b_1 (English)	.07	—.30	—6.01	.59	.87	3.33
b_2 (Bengali)	.04	4.45	1.12	.47	.72	—2.88
b_3 (Mathematics)	—.23	2.54	1.79	2.40	2.19	1.04
b_4 (History)	.68	—1.57	4.03	1.22	—2.26	2.06
b_5 (Geography)	1.21	—.72	—11.72	4.11	—2.42	.75
b_6 (General Science)	—.67	—2.49	—.87	—1.07	5.42	5.40
b_7 (Sanskrit)	2.49	.57	6.70	.74	4.41	—.18
b_8 (EK—I)	.01	.02	—.04	.00	.04	.00
b_9 (EK—II)	.03	.02	.01	.00	—.02	.01
b_{10} (EK—III)	.03	.09	.52	.09	.12	.15
b_{11} (CA—I)	.00	—.10	—.65	.05	—.12	—.04
b_{12} (CA—II)	—.02	.12	.36	—.08	.03	.07
b_{13} (AR)	—.02	.00	—.11	—.01	—.02	.00
b_{11} (VR)	.02	.04	.34	—.01	—.02	.00
b_{15} (MK)	—.02	.06	—.04	—.03	—.20	—.01
b_{16} (SA)	.04	—.02	—.14	.06	.00*	.02
b_{17} (MC)	.11	—.03	—.13	—.03	—.06	.00
a	—126.25	—80.67	—318.66	59.36	—174.15	—138.66
Multiple correlation	.95**	.90**	.99	.92**	.78	.93**
Number of case	27	48	20	35	36	31

* Indicates significant at the 5% level.
** Indicates significant at the 1% level.

TABLE 2

Regression coefficients for different aptitude tests and school subjects in the Humanities and Commerce Streams in different schools

School / Regression Weights	GIRLS Humanities				Boys Humanities	Boys Commerce	
	A	B	C	D	K	J	L
b_1 (English)	.91	.45	.47	1.70	.40	1.08	4.93
b_2 (Bengali)	.72	.52	3.35	1.10	1.55	1.02	9.60
b_3 (Mathematics)	.24	1.08	.26	.38	—1.51	2.01	3.59
b_4 (History)	3.14	1.60	.22	3.14	—1.56	3.12	—.84
b_5 (Geography)	.51	.72	—.54	—.16	—6.67	.61	4.93
b_6 (General Science)	.08	.34	—2.11	.44	—1.82	3.99	—6.38
b_7 (Sanskrit)	1.12	1.46	—.54	.14	1.53	3.07	—6.99
b_8 (EK—I)	.00	.01	.01	.01	.03	.00	.02
b_9 (EK—II)	—.02	.01	—.08	—.01	—.02	.05	—.05
b_{10} (EK—III)	—.02	—.03	.02	.02	.02	.07	.01
b_{11} (CA—I)	.06	.03	.11	—.01	—.10	—.13	—.10
b_{12} (CA—II)	—.03	—.01	—.16	.03	.12	.10	.04
b_{13} (AR)	.02	—.01	.01	.00	—.03	—.01	.02
b_{14} (VR)	.00	—.01	—.02	—.02	—.01	.00	—.03
b_{15} (MK)	.07	.03	.04	.04	.00	.01	—.08
b_{16} (SA)	—.03	.03	.04	.01	—.01	—.05	—.06
b_{17} (MC)	—.01	—.02	.01	—.01	.01	.02	—.01
a	—29.42	13.58	195.60	—85.42	296.66	—299.99	—182.52
Multiple correlation	.76*	.93**	.83	.85**	.80*	.87	.96*
Number of cases	48	42	33	39	40	27	25

* Indicates significant at the 5% level.
** Indicates significant at the 1% level.

Testing the gain in multiple R by using school examination marks in combination with the Aptitude Test scores :

It was necessary to compare the multiple R values obtained by using the aptitude test scores only (2) with those obtained on the basis of aptitude scores and school examination marks. The numbers of cases in the corresponding groups of these two sets were slightly different (as some of those who took the aptitude tests did not appear at the class VIII annual examination of the school) and hence they could not be directly compared. so only those students who took both the aptitude tests and the school examination at class VIII were picked up for the nine groups where the multiple correlations on the basis of 17 variables were significant either at the 5% or at the 1% level, and the regression coefficients etc., were calculated on the basis of the aptitude scores only again. Multiple correlations obtained with ten variables (i.e., aptitude scores only) and 17 variables are presented in Table 3.

TABLE 3

Multiple correlations obtained by using the aptitude scores alone and those obtained by using both aptitude and school marks

Schools	Girls Science		Boys Science		Girls Humanities			Boys Hum.	Boys Com.
	C	F	J	L	A	B	D	K	L
Multiple R with 17 variables	.95**	.90**	.92**	.93**	.76*	.93**	.85**	.80*	.96**
Multiple R with 10 variables	.88**	.82**	.74*	.72	.54	.79**	.71*	.65	.76
Number of cases	27	48	35	31	48	42	39	40	25

It is evident from Table 3 that in all the cases there was some increase in the multiple R when the school marks were used in combination with the aptitude scores. So it was necessary to check whether this increase in the R values were statistically significant or not. The following procedure was used to test the null hypothesis that the increase in the predictive ability by adding seven more variables was not significant. This procedure is described by Johnson and Jackson (3).

The sum of squares due to regression with 17 variables was divided into two parts (a) the sum of squares due to regression with 10 variables and (b) the remainder obtained by subtracting (a) from the sum of squares due to regression with 17 variables. The sum of square due to regression obtained separately with 10 variables was used for making this division. The analysis of variance was of the form as presented in Figures 1 where S_{17} and S_{10} were the sum of square due to 17 and 10 variables respectively.

TABLE 4

Analysis of variance for testing the significances of the increment in the multiple R by using school marks along with the aptitude test scores

Variance due to	Degrees of freedom	Sum of squares	Mean squares	F-value
REGRESSION	17	S_{17}	$\frac{S_{17}}{17}$	
(i) 10 variables	10	S_{10}	$\frac{S_{10}}{10} = M_{10}$	$\frac{M_{10}}{R}$
(ii) Remainder	7	$S_{17} - S_{10}$	$\frac{S_{17} - S_{10}}{7} = M_{17-10}$	$\frac{M_{17-10}}{R}$
RESIDUAL	$n-17-1$	$Y^2 - n\bar{Y}^2 - S_{17}$	$\frac{Y^2 - n\bar{Y}^2 - S_{17}}{n-17-1} = R$	
Total	$n-1$	$Y^2 - n\bar{Y}^2$		

Following the procedure described above the calculations were done with the nine groups and the obtained F values with corresponding degrees of freedom are presented in Table 5.

TABLE 5

Showing the Degrees of freedom and F values obtained for different school groups

School Group	Degrees of freedom for F values due to 10 variables	F value corresponding to 10 variables	Degrees of freedom for F values due to 10 variables	F value corresponding to remainder
SCIENCE :				
School C	10 and 9	7.34**	7 and 9	1.67
School F	10 and 30	10.55**	7 and 30	3.22*
School J	10 and 17	5.80**	7 and 17	4.29**
School L	10 and 13	4.76**	7 and 13	4.64**
HUMANITIES :				
School A	10 and 30	2.05	7 and 30	3.00*
School B	10 and 24	11.82**	7 and 24	6.51**
School D	10 and 21	3.92**	7 and 21	2.38
School K	10 and 22	2.53*	7 and 22	1.92
COMMERCE School L	10 and 7	4.81*	7 and 7	3.97*

* Indicates significant at the 5% level.

** Indicates significant at the 1% level.

Considering the results presented in Table 4 (see last column) it is evident that in six out of nine groups the use of school marks in combination with the aptitude test scores significantly increased the values of the multiple correlation. It indicated that for purposes of guidance it is better to consider the school marks along with the aptitude scores as this procedure would help in making better prediction in many occasions.

Observating the nature of the regression weights for different schools for the comparable streams, it is evident that the regression weight which could be used with specific institutions or with specific groups of institutions for the same stream of study, have to be determined by obtaining similar weights for successive years and then by finding out a set of weights that is best suited for the purpose. Because it is well known that the validity and specially the relative importance of predictor factors vary from school to school depending on the peculiarities of the institutions concerned and those of the population from which the student group of that institution is drawn.

It is certain on the basis of this investigation and the two earlier ones that,

(i) the use of school examination marks alone for allocation purposes is not sufficient;

(ii) aptitude tests scores used in this context have served well in making differential prediction of success later on,

(iii) the use of school examination marks along with the aptitude score definitely improves the accuracy of the allocation process.

REFERENCES

1. CHATTERJI, S. & MUKERJEE, M. (1966) "The School Examination marks and their predictive ability for allocation purposes", *J. Voc. & Educ. Guidance* 12, (1).

2. CHATTERJI, S. & MUKERJEE, M. (1967) "Predictive ability of an aptitude test battery used for differential prediction", *J. Voc. & Educ. Guidance* 13, (1), February 1967.

3. JOHNSON, P. O. & JACKSON, R. W. B. (1959) *Modern Statistical Methods : Descriptive and Inductive*, Rand McNally & Co., 381-83.