

USE OF OBJECTIVE TEST MATERIALS TO IDENTIFY MALE
PUPILS FOR THE TECHNICAL COURSE OFFERED IN CERTAIN
MALAWIAN SECONDARY SCHOOLS

F.G. Lockwood
Soche Hill College, University of Malawi

Summary

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Malawi Government Development Plan 1965-69 recognised the need for technically trained personnel essential to the development of the country and allocated 63 per cent of its education vote specifically for secondary and technical education at secondary level. The total number of pupils engaged in technical and craft courses were to be increased from 250 in 1969 to 3384 in 1974.

Only 15 per cent of pupils who completed the primary school leaving examination gained places in secondary schools. Not all secondary schools offered technical courses, and not all students, who enter those that did, followed a technical course. The need for a selection device to prevent wastage at every stage of education was urgent.

This study developed a battery of tests to identify pupils for technical courses. The battery was standardised and subjected to tests of reliability and predictive validity.

Report

The acute shortage of trained manpower for the technical and craft sectors is a serious handicap to the economic development of Malawi (Brown 1967, Malawi Government 1969). Individuals who ultimately form the middle and high level technical manpower groups have been under-produced and could only be produced via the State Education System (Plowden 1964). It is obvious and vital to the needs of the country that the best possible results be obtained from the technical courses that are in operation (Hahn 1964).

The recognition of the urgent need for skilled manpower which can only be produced by the State Education System, and which is essential to the development of the country, was evident in the Malawi Government Development Plan 1965-1969. Within this Development Plan 63 per cent of the total expenditure on education was to be used for the expansion of secondary schools and technical education at a secondary level. (Malawi

Government 1965); secondary technical education was to be available for those who showed aptitude for it (Malawi Government 1966). (However, at this time no guide was available as to how such aptitude should be identified). An attempt to provide a source from which trained manpower possessing a technical background could develop was initiated in May 1967 (Malawi Government 1967). The scheme, supported by the International Development Association (IDA), aims to provide additional facilities and technical courses within certain secondary schools. The total number of pupils engaged in such courses (woodwork, metal work and technical drawing) is to be increased from approximately 250 in 1969 to a target of 3380 in 1974 (Malawi Government 1967). This increase in enrolment in secondary schools, and in technical courses in particular, is considered to be the minimum necessary to meet the anticipated demand from the public and private sectors. Future manpower requirements are now under study with a view to provide the Ministry of Education with definite information on which to base future plans for the expansion of both secondary and secondary technical education (Malawi Government 1971). However, even this great improvement still means that the majority of pupils in secondary school and eligible for these technical courses will not be able to benefit from them, since only twelve of the fifty-seven secondary schools currently have technical departments.

Competition for entry into secondary school is fierce, only 15 per cent of those who complete the Primary School Leaving Examination are able to gain a place in Secondary School (Malawi Government 1970). This selection is based on the Primary School Leaving Examination Results which may not be the best selection device for identifying those individuals who are best able to benefit from the technical courses that are offered. It is possible that potential engineers, technicians, and craftsmen are lost to the country because the Primary School Leaving Examination does not identify the particular talents that these people possess. Furthermore, only 12 schools offer technical courses, so it is possible for an individual, while gaining entry to secondary school, not to have the chance to follow technical courses. Even within the school that does have technical facilities it is possible that not all pupils at the school will follow these courses, and that not all those selected for such courses will be those most likely to profit from such instruction. It is obvious that some selection procedure for identifying those male pupils who are best able to benefit from the technical courses offered be initiated. This would decrease the tragic waste of talent, finance, and time which the country cannot afford.

The construction and development of test material in the African context, for use on an Inter-African basis, was undertaken by a team of American Institutes for Research (A.I.R.) specialists working in Nigeria (Schwarz 1961, 1962). After exhaustive studies twenty one tests were finalised, made ready for large scale use, and termed ID Tests. From this comprehensive battery tests could be combined in a smaller battery for the prediction of specific aptitudes (Schwarz 1964, 1964b). The tests had been designed to cover a wide range of ability from upper primary school to late secondary school. A battery for the prediction of technical aptitude was among the first to be developed (American Institutes for Research 1962), and later shown to be applicable in African States other than Nigeria (Schwarz 1963, Irvine 1963). Selected ID Tests were included in the Northern Rhodesia Mental Ability Survey (MacArthur, Irvine and Brimble 1964) with other test material, and demonstrated their potential in predicting success in technical courses. In a survey of the feasibility of testing in Malawi (Nichols 1965) the ID Tests were again used, validity studies conducted with the instruments against performance in technical courses, and the usefulness

of the instruments reinforced. Attempts in East and Central Africa to combine and contrast objective test material with more traditional measures of ability (a broad National Examination), in an attempt to select those most able for secondary school courses, have been made (Irvine 1964, Silvey 1964); and while these investigations were mainly concerned with entry into the general secondary school course, the procedures and methods used are of value and a guide to the production of a device for selection into specific courses. However, a preliminary investigation conducted in 1970 to identify the procedures used to select pupils at a Standard 8 - Form 1 level for technical courses, in East and Central Africa, revealed that none were in operation. The need for a selection device to identify male Malawian pupils, at a Standard 8 - Form 1 level, who are most likely to succeed in the technical courses offered in certain Malawian secondary schools, was urgent. Consequently, a research programme was structured to use existing test material, combined in a battery, to meet the immediate needs of the country. The preliminary investigations had revealed that this approach was likely to have value and could assist present selection methods. The adaptation of existing test materials would also limit the high cost and lengthy validation period involved in constructing devices specific for Malawi.¹

The investigation had revealed fifteen tests which showed a logical relationship to technical skills and which had either demonstrated validity and reliability in the African context or which were supposedly culture-fair.

- Viz,
1. ID Test No. 2 Verbal Analogies (Low))
 2. No. 4 Reading Comprehension (Low))
 3. No. 7 Mechanical Information)
 4. No. 9 Boxes)
 5. No. 10 Figures) (Schwarz 1964a)
 6. No. 14 Arithmetic)
 7. No. 19 Manual Dexterity)
 8. National Foundation for Educational Research in England and Wales.
Spatial Test 3 (Smith and Lawes 1959)
 9. Revised Minnesota Paper Form Board Test
(Likert and Quasha 1970)
Educational Testing Service. Tests of Cognitive Factors
 10. Identical Pictures
 11. Paper Folding
 12. Hidden Patterns (French, Ekstrom and Price 1963)
 13. Ravens Progressive Matrices (1938)
(Raven 1960).
 14. General Verbal Ability Test (El-Abd 1969)
 15. Lule Non-Verbal Intelligence Test (El-Abd 1967).

A majority of these tests were ID Tests, the instructions of which were designed to be as simple and as similar as possible, thus allowing several tests to be used in a battery with a minimum number of changes in the instructions. The words and word patterns in these instructions had been carefully chosen to ensure optimum understanding at all the various ages

1. It appears that no single aptitude test has been constructed to identify those attributes associated with success in technical subjects. However, the investigation revealed that several separate tests, combined in a battery may offer the researcher a possible solution.

and intelligence levels for which the tests may be used (Schwarz 1964a). A decision was taken to modify the instructions of other tests, where possible, to bring them in line with those of the ID Tests. Care was taken NOT to risk losing the sense or meaning of the other tests by making all instructions for administration similar. Precise and detailed instructions were prepared for each test, a comparison between these instructions (Lockwood 1972) and those recommended by the publisher will reveal what modifications were made and the minor nature of them. Since the intention was to achieve maximum predictive validity minor modifications to the directions were deemed acceptable. This initial and rather large test battery was administered to a representative sample of 121 Form 1 boys drawn from two urban secondary schools in the Blantyre/ Limbe area as part of a pilot/feasibility project. These pupils were following technical courses similar to those that would be in operation within the country when all centres in the LDA Development Project were fully operational. The predictive validity of the test battery could only be calculated when a criterion was established against which it could be compared. The ultimate criterion is the performance exhibited by an individual in the technical/craft sectors of industry, but the adoption of such a criterion was thought to be unrealistic in this context. For an individual to enter the middle and high level manpower categories he must have completed a formal education, without this it is highly unlikely that he will be considered as eligible. Consequently, the ability of each pupil in technical subjects as indicated by coursework and examination marks obtained in the first year at the secondary school was considered to be the most objective method of assessing performance. If a pupil cannot perform at above the average level within the first year of the secondary school (the validation period) it is unlikely that he will be among those continuing their education in the State Education System. Coursework and examination marks for each pupil in technical subjects were correlated against performance on each aptitude test in the battery.

Every attempt had been made to select a sample which was representative of the population from which it was drawn. It was possible to pool all the data from the classes within a school since there was no significant difference between sample means. However, there was a significant difference between the two schools which prevented all the data within the sample from being combined; each school was treated separately. An inspection of the correlation matrices between performance on the aptitude tests and the criteria established for technical subjects, for the two schools, indicated a general positive and mainly significant relationship. These were further inspected with a view to identify those tests which appeared to be among the better predictors of technical ability. An attempt was made to:-

- (a) pick out tests which correlate highly with the criteria but lowly among themselves, since such a combination is the most likely to produce a high multiple correlation coefficient (Sax 1968)
- (b) include tests which seem to represent the aptitudes associated with technical ability.

An inspection of the correlation matrices revealed ten tests which appeared to fulfil the two guidelines adopted. These were combined into battery A and a multiple correlation coefficient calculated for each of the criteria variables (beta weights and resultant Multiple R are indicated in Tables 1 and 2). Tables 1 and 2 indicate the standard partial regression coefficient and the multiple regression coefficients for the batteries A and B

for both Chichiri Secondary School and Soche Hill Secondary School. It has been mentioned that the performance on the aptitude tests between the two schools was significantly different, consequently two tables are given. The multiple correlation coefficients calculated for the selected test variables at the two secondary schools were based on a small number of cases. The calculation also took advantage of all the chance variance arising and thus led to a biased estimate of the Multiple R. If the Multiple R calculated was to be used to estimate population parameters the estimate would need correcting for this bias. However, the information obtained in the pilot project was to be used solely as a guide to the suitability of tests for inclusion in a final battery. A comparison of the multiple correlation coefficients in the two tables for batteries A and B indicates that the multiple R is not significantly reduced by reducing the number of test variables in the battery. At Chichiri Secondary School three of the four multiple correlation coefficients rise as a result of reducing the battery. However, at Soche Hill Secondary School the four multiple correlation coefficients dropped a little. But the administrative gains by reducing the battery to eight tests outweighs the statistical gains in having a large battery.

Table 1. Standard Partial Regression Coefficients, Multiple Regression Coefficients, and F-Values for Test and Criteria Variables at Chichiri Secondary School. N=59

No.	TEST	<u>Battery A</u>				<u>Battery B</u>			
		BETA WEIGHTS				BETA WEIGHTS			
		IIIEWW	IIICWW	IIETD	IICTD	IIIEWW	IIICWW	IIETD	IICTD
1	VAL	.036	.104	-.088	-.004				
2	RDL								
3	MEC	-.305	-.053	.089	-.382	-.317	-.047	.041	-.339
4	BOXES	-.141	-.142	-.012	.075	-.190	-.202	.002	-.124
5	FIG								
6	ARITH	.186	.072	-.070	.152	.193	.158	-.076	.216
7	MAN								
8	SPATIAL	.825	.896	.523	.773	.733	.762	.538	.663
9	MPFBT	-.224	.082	-.110	.069	-.015	.076	-.117	.096
10	ID PIC								
11	PAP FD	.066	-.075	-.140	.055				
12	HID PAT					.289	.300	-.073	.252
13	RAVENS	-.095	.038	.197	.106	-.111	.013	.170	.107
14	GVAT	.072	.208	-.094	.258				
15	LULE	-.125	-.360	.281	-.240	-.044	-.269	.190	-.143
	MULTI R	.569	.546	.768	.661	.612	.564	.752	.662
	F VALUE	2.296	2.043	6.921	3.730	3.738	2.914	8.118	4.878

Table 2. Standard Partial Regression Coefficients,
Multiple Regression Coefficients, and
F-Values for Test and Criteria Variables Soche Hill
Secondary School. N=55

No.	TEST	<u>Battery A</u>				<u>Battery B</u>			
		BETA WEIGHTS		BETA WEIGHTS		BETA WEIGHTS		BETA WEIGHTS	
		III EWW	III ETD	III EWW	III ETD	III EWW	III ETD	III EWW	III ETD
1	VAL	-.042	-.221	-.105	-.189				
2	RDL								
3	MEC	.052	-.159	.150	.215	.097	-.186	.144	.412
4	BOXES	.009	.197	.207	.240	.081	.172	.218	.220
5	FIG								
6	ARITH	-.143	-.226	.100	.017	.043	-.169	.072	.004
7	MAN								
8	SPATIAL	-.063	.166	.061	.250	.006	.225	.119	.248
9	MPFBT	.204	.343	-.027	.177	.217	.366	.004	.193
10	ID PIC								
11	PAP FD	-.010	-.071	.120	-.027				
12	HID PAT					-.069	-.026	-.012	.065
13	RAVENS	.085	.291	-.276	.081	.144	.309	-.285	.046
14	GVAT	.253	.255	.045	.096				
15	LULE	.166	.164	.122	.199	.187	-.201	.096	.136
	MULTI R	.565	.623	.422	.810**	.540	.575	.409	.798**
	F-VALUE	2.065	2.786	.953	8.416	2.368	2.837	1.153	10.089

The resultant battery B included tests designed to measure :-

Mechanical Information
Spatial Ability
Arithmetic
Perceptual Speed
Non-Verbal Ability.

The tests discarded were ones that appeared to be contributing little to the overall multiple correlation coefficients - those which supplied information which overlapped with and duplicated that provided by those tests selected.

The reduced battery was administered to a larger sample of 325 Form 1 pupils following recognised technical courses in five secondary schools throughout the country. There was no significant difference between forms within a school. However, it was not possible to combine the data from each school as significant differences between one school in the sample and the the remainder were found; the two groups would have to be treated separately as in the pilot project. The degree of the relationship between individual tests in the battery and between the tests and the established criteria was determined. These eight test variables and the variable AGE were combined in a battery and a multiple correlation coefficient calculated against each criterion variable which had been established (Table 3, battery A, D, F.,

Table 4 battery A, C, F.) The beta weights for the nine variables were inspected and those which appeared to be contributing little to the overall multiple correlation coefficient were omitted. Subsequent multiple correlation coefficients were calculated (Table 3 battery B, C, E, G, H, Table 4 battery B, D, E, G.). It will be noted that the variable AGE assists the predictive validity of the tests for four of the six resultant batteries (Table 3 batteries E, H, Table 4 batteries E, G.), and its use as a predictor in the context of this study emphasised.

The size of the multiple correlation coefficient was reduced by three factors, the reliability of the tests, the reliability of the criterion and the restriction in range of the sample (Ghiselli 1964). To some extent this has been compensated for by the tendency of a multiple correlation coefficient to capitalize on all the chance variances which favour a high value, or biased estimate of the Multiple R (Guildford 1956).

Table 3. Standard Partial Regression Coefficients, Multiple Regression Coefficients, and F-Values for Test and Criteria Variables for the Combined Data at Dedza, Masongola, Malosa and Mzuzu Secondary Schools.

No.	TEST	BETA WEIGHTS BATTERY FOR TECH. DRAW N=197			BETA WEIGHTS BATTERY FOR WOODWORK N=149		BETA WEIGHTS BATTERY FOR METAL WKN=99		
		A	B	C	D	E	F	G	H
1	MEC	.14	.14	.14	.17	.20	.36	.38	.33
2	BOXES	.02	.03		-.01		.18	.19	.19
3	ARITH	-.02	-.02		.11	.10	.08	.08	
4	HID PAT	.14	.14	.14	.12	.14	-.01		
5	RMPFBT	.02			.05		-.19	-.19	-.22
6	RAVENS	.02			.04		-.01		
7	LULE	.12	.12	.13	.05		.08		
8	SPATIAL	.23	.24	.26	-.14	-.09	-.11	-.08	
9	AGE	-.02	-.03		-.10	-.11	-.29	-.29	-.28
MULTI R		.54**	.54**	.54**	.29	.28	.51	.51*	.50**
F-VALUE		8.75	11.35	20.02	1.46	2.51	3.44	5.27	7.66

* SIG < .05

** SIG < .01

Table 4. Standard Partial Regression Coefficients,
Multiple Regression Coefficients, and
F-Values for Forms IE and IM at
Henry Henderson Institute. N=44

No.	TEST	BETA WEIGHTS BATTERY FOR TECH. DRAW.		BETA WEIGHTS BATTERY FOR WOODWORK			BETA WEIGHTS BATTERY FOR METAL WORK	
		A	B	C	D	E	F	G
1	MEC	.01		-.01			-.30	-.28
2	BOXES	.27	.27	.32	.34	.26	.09	
3	ARITH	-.01		.14	.15	.15	-.13	
4	HID PAT	-.14	-.15	-.13	-.13		.26	.29
5	RMPFBT	.38	.38	.10			-.21	-.22
6	RAVENS	.12	.12	.38	.43	.39	.62	.61
7	LULE	-.01		.10			.01	
8	SPATIAL	.25	.27	-.19	-.08		-.24	-.24
9	AGE	-.04		-.29	-.30	-.27	-.14	-.21
MULTI R		.80*	.80**	.74*	.74*	.72**	.65	.64*
F-VALUE		6.86	13.70	4.65	7.30	10.74	2.81	4.33

* SIG < .05
** SIG < .01

Table 5. Standard Partial Regression Coefficients, Multiple Regression Coefficients, and F-Values for Primary School Leaving Examination Results and Criteria Variables for the Combined Data at Dedza and Mzuzu Secondary Schools. N=88

	TD	WW	MW
ENGLISH	.06	.02	.01
MATHEMATICS	.01	-.14	-.06
GENERAL	-.18	.07	.08
SCIENCE	.27	.35	.20
MULTI R	.29	.42	.23
F-VALUE	1.86	4.48	1.37

* SIG .05
 ** SIG .01

This bias in an estimate of the Multiple R is more pronounced on small samples (Henry Henderson Institute N = 44) than large samples (other four schools N = 197). The interplay of these separate factors is responsible for the size of the multiple correlation coefficients represented in Tables 3 and 4.

The present selection of pupils into secondary schools is based on the results of the Primary School Leaving Examination (P. S. L. E.) which includes measures of English, Mathematics, Science, as well as a General Paper. The combination of the scores on these measures gives an indication of general ability, which is deemed essential for success in further academic courses of the secondary school type. Pupils who have a high 'general ability' are likely to do well in a pure academic course, they are also likely to do well in a practically oriented course. The value of the battery of tests to identify male Malawian pupils at a Standard 8 - Form I level for the technical courses offered in certain Malawian secondary schools has been shown. It is possible to compare the results from the test battery with the results obtained by pupils in the sample on the P.S.L.E.

The scores on individual measures within the P.S.L.E. were obtained for the sample at Dedza Secondary School and Mzuzu Secondary

School, as these two schools formed the largest group for which all criteria variables, in technical subjects were available. The predictive validity of the P.S.L.E. measures for each technical subject were calculated and are indicated in Table 5. None of the multiple correlation coefficients are significant even though they are conservative estimates of the predictive validities of the Primary School Leaving Examination. If the results were cross-validated (Cronbach 1970) the coefficients were corrected for shrinkage (Guildford 1956) the validities for Technical Drawing, Woodwork and Metalwork (TD, WW, MW) in Table 5 were .23, .38, and .14 respectively.

It is apparent, that while the P.S.L.E. may identify pupils for further academic courses, the measure is inferior to the test battery which has been developed to identify pupils for the technical courses offered in certain Malawian Secondary Schools.

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