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Standardization and Validation of the Advanced Progressive Matrices (APM) Scale for use in Nigeria

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Abstract: **Raven's Advanced Progressive Matrices (APM) test is a leading global non-verbal measure of mental ability, helping to identify individuals with advanced observation and clear thinking skills who can handle rigorous study programmes as well as the complexity and ambiguity of the modern workplace. A standardization sample of 2100 in Nigeria was randomly drawn to answer six research questions. Triangulation research design, adopting classical test theory (CTT) guided the study. The APM scale is now standardized with norms and other statistical parameters for local use in Nigeria. APM had a split half reliability of 0.89. The Kuder-Richardson KR_{20} internal consistency reliability of the APM scale in Nigeria is 0.93 and KR_{21} is 0.91. The construct cum concurrent validity of APM using culture fair intelligence test (CFIT) as criterion reference is 0.701 in Nigeria. The APM test is bias-free and very suitable for use in Nigeria.**

Keywords: **Advanced Progressive Matrices, Standardization, Classical Test Theory, Test Bias, CFIT, Nigeria.**

1. INTRODUCTION

The mission of this study is to standardize, validate and norm the Advanced Progressive Matrices (APM) in Nigeria. Standardization is a process of test development wherein the test is administered to a representative sample of test-takers under clearly specified conditions and the data are scored and interpreted, to establish a context for future test administrations with other test-takers. APM is one of Raven's Progressive Matrices tests. The first of the Raven's progressive matrices named Standard Progressive Matrices was developed by John C. Raven in 1936 and published in 1938. Raven's tests exist in three different forms that are progressively more difficult in contents intended for different populations. They are the Standard Progressive Matrices (SPM), the Coloured Progressive Matrices (CPM) and the Advanced Progressive Matrices **(APM).** APM scale is the most difficult of the three and it is the main instrument of this study. APM test is a leading global non-verbal measure of mental ability, helping to identify individuals with advanced observation, high-level imagination including the domain of duty and clear thinking skills who can handle rigorous study programmes as well as the complexity and ambiguity of the modern workplace. APM test offers information about someone's capacity for analyzing and solving problems, abstract reasoning, logical reasoning, quick recognition of differences and similarities, intellectual capacity and the ability to learn. The APM scale assesses the ability or capacity to detect a certain order or structure in a chaos or chaotic situation and the ability to find meaning of apparently randomly compiled elements. It reduces cultural biases with a nonverbal approach. It is very suitable for individuals whose native language is not English. The test when administered untimed, differentiates between people at the high end of intellectual ability. When administered under timed conditions, the APM can be used to assess intellectual efficiency - quick and accurate high-level intellectual work and the ability to be sharp and quick at decision making. Items on all forms ask the examinee to identify the missing component in a series of figural patterns. Grouped in sets, the items graduates in the

difficulty index from very easy items to very difficult items. Therefore the items require increasingly greater skills in encoding, analysing, recognizing patterns and identifying the right answers. The Raven's APM produces a single raw score as well as percentile rank to indicate the candidate's educative ability or the ability to make sense of complex situations, compared to a norm group (Raven, Raven and Court, 2012). Evers (2011) presented the report of a large survey conducted in nineteen European countries by several members of the International Test Commission (ITC) at the 12th European Congress of Psychology that held in Istanbul in the month of July 2011. He asserted that "the Raven's Matrices are in the fourth position among the ten most used tests in Europe." The report further stated that "among them the Advanced Progressive Matrices are widely employed for assessing fluid ability in adolescents and adults." Evers (2011) also reported that "the Raven's Advanced Progressive Matrices (APM) scale has also been recommended as a useful measure for identifying academic potential." Thus the APM is in high demand as an instrument of choice among researchers in America, Europe and Asia because of its utility value in psychological research works. Meanwhile, the instrument is hardly known let alone effectively employed in psychological research works in Africa, particularly Nigeria.

Problem of the study:

There exists a dearth of well validated, standardized instruments with norms for psychological testing in Nigeria. This has severely affected decisions being made about people's capacity for analyzing and solving problems, abstract and logical reasoning, quick recognition of differences and similarities, intellectual capacity and the ability to learn within and outside the education sector in Nigeria. Thus this study was designed to validate and standardize the APM for use in Nigeria by establishing its temporal consistency, consistency of equivalence, internal consistency, construct validity and norms.

Purpose of the Study:

The study was designed to use Classical Test Theory (CTT) framework to establish the APM's:

1. Temporal consistency
2. Coefficient of equivalence
3. Internal consistency
4. Construct validity
5. Norms and
6. Percentile rankings in Nigeria.

Research Questions:

The following research questions guided the conduct of this study:

1. Within the frame work of CTT, what is the Split–half reliability of APM?
2. Within the frame work of CTT, what is the parallel forms reliability of APM?
3. Within the frame work of CTT what is the Internal consistency of APM, using the Kuder-Richardson's estimates?
4. Within the frame work of CTT what is the Construct Validity of APM in Nigeria, using multiple correlation evidence?
5. Within the frame work of CTT what is the construct validity of the APM test through hypothesis testing evidence?

a) There is no significant influence of ethnicity on the APM scores of Hausa, Igbo, Yoruba and Minority.

b) There is no significant influence of age on the APM scores of university undergraduates and senior secondary school students in Nigeria.

6. Within the frame work of CTT what is the

a) Normalized standard score and

b) Percentile ranks of the normalized score of APM in Nigeria?

7. Within the frame work of CTT what is the Classification of APM IQs of Nigerian university undergraduate and senior secondary school students?

8. Within the frame work of CTT what is the concurrent validity of APM, using Culture Fair Intelligence Test (CFIT) as the criterion in Nigeria?

Significance Of The Study:

1. The use of the APM in Nigeria will enhance the identification, placement, acceleration and enrichment of the gifted/talented students in Nigerian and ability selection and placement within and outside the education management climes.

2. The study has invariably conferred on the APM instrument a "Naija" status. APM now has "address in Nigeria" with norms, ranks, validity, reliability and full standardization. It is no more a foreign instrument. It is now a Nigerian instrument available to the research community in Nigeria for research work-especially research works in the areas of intelligence and ability testing.

Scope of the Study:

1. The study was carried out in Nigeria and was limited to samples drawn from among university undergraduates and senior secondary school students.

2. Participants were males and females, whose ages range between twelve and forty years old and spread over four main cultural groups (Hausa, Igbo, Yoruba and Minorities) within four geopolitical zones randomly selected in Nigeria.

3. The study applied only CTT and its related models to the exclusion of other test theories.

2. METHODOLOGY

Multiple triangulation research design which Kpolovie (2010) described as "the highest and most comprehensive and all-embracing form of triangulation research" was employed in this study. This design was used because "it allows for multi-method approach in studying psychometric properties of an instrument and some aspects of human behaviour. It helps to map out or explain more fully, the richness and complexity of a psychometrical instrument and/or human characteristics by studying it from more than one stand point" (Kpolovie, 2010). This research design enabled this researcher to apply various methods including the t-test Correlations, analysis of variance, (ANOVA) Kuder-Richardson's estimates (KR_{20} and KR_{21}), normalized standard score and percentile ranks, Factor analyses using the data reduction option among many other statistical procedures. The study was carried out in Nigeria. The population of the study comprised all the university undergraduates and all the senior secondary school students in Nigeria though records from the Federal Ministry of Education to specify the number was not available. Through "cluster (area) and stratified random sampling" (Ukwuije, 2003) techniques, a total sample of two thousand, one hundred (2100) participants, males and females, whose ages range between twelve and forty years old and spread over four main cultural groups (Hausa, Igbo, Yoruba and Minorities) was randomly drawn from four geopolitical zones (clusters) in Nigeria. Eight research assistants were engaged, trained to administer the tests and accompanied the researcher to the four geopolitical zones to conduct the tests to the various participants. The APM scale with 36 items was the test instrument administered to the participants. A total of 1000 university undergraduates and 1100 senior secondary school students took part in the APM test which lasted for 40 minutes in each centre. The APM scale comes in two sets. Set 1 and Set 2. Set 1 contains 12 items while Set 2 contains 36 items. The Set 1 items were used as practice test. The set 2 which is the main scale of this study was the real test. Each item has eight options from which the participant is expected to select one option. The SPSS was used to perform dimension reduction analysis, reliability analysis, correlation analysis, etc. The Microsoft Excel software was used for scoring the responses of the tests, normalized scores analysis, percentile ranking analysis, etc.

3. REULTS OF THE ANALYSIS

The Statistical Package for Social sciences (SPSS) and Microsoft Excel software were used to perform the analyses for this study.

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Table 1: Descriptive Statistics for the APM scores of UN and SSS1-3 students

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
APMSCORE	2100	1	36	52021	24.77	7.847	61.578
Valid N (listwise)	2100						

Table 1 shows the descriptive statistics of the scores obtained in the APM test by the university undergraduates and the senior secondary school students in Nigeria. The mean and standard deviation displayed above were used for the computations of reliabilities and the subsequent transformation of the full APM raw scores to normalized standard score.

Research Question 1

Within the frame work of CTT, what is the Split–half reliability of APM?

ANSWER:

TABLE 2: Split-Half Reliability

Cronbach's Alpha	Part 1	Value	.885
		N of Items	18[a]
	Part 2	Value	.872
		N of Items	18[b]
	Total N of Items		36
Correlation Between Forms			.865
Spearman-Brown Coefficient	Equal Length		.783
	Unequal Length		.783
Guttman Split-Half Coefficient			.893

a. The items are: ITEM1, ITEM2, ITEM3, ITEM4, ITEM5, ITEM6, ITEM7, ITEM8, ITEM9, ITEM10, ITEM11, ITEM12, ITEM13, ITEM14, ITEM15, ITEM16, ITEM17, ITEM18.

b. The items are: ITEM19, ITEM20, ITEM21, ITEM22, ITEM23, ITEM24, ITEM25, ITEM26, ITEM27, ITEM28, ITEM29, ITEM30, ITEM31, ITEM32, ITEM33, ITEM34, ITEM35, ITEM36.

The Split-half reliability analysis for the APM scores obtained from the responses of the 1000 university undergraduates and 1100 senior secondary school students is presented in **Table 2** above. The reliability estimate of the first half of the test is 0.885 or 0.89 and that of the second part of the test is 0.872 0r 0.87 and when corrected to the full test, using the Guttman Split-half coefficient, the APM scale has a split-half reliability (r) of 0.89 in Nigeria.

Research Question 2

Within the frame work of CTT, what is the parallel forms reliability of APM?

ANSWER:

TABLE 3: Parallel Form Reliability

Common Variance	.475
True Variance	.385
Error Variance	.90
Common Inter-Item Correlation	.822
Reliability of Scale	.893
Reliability of Scale (Unbiased)	.903

From **Table 3,** the parallel forms reliability of the APM scale (r,) in Nigeria is 0.90.

TABLE 4: Cronbach's Alpha Reliability

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.883	.902	36

The reliability was also computed using the Cronbach's Alpha, it was found to be 0.88 while the Cronbach's Alpha based on standardized items gave a value of 0.90 as shown in **Table 4** presented above.

Research Question 3

Within the frame work of CTT what is the Internal consistency of APM, using the Kuder-Richardson's estimates?

ANSWER:

The Internal consistency of APM, using the Kuder-Richardson$_{20}$

TABLE 5: KR_{20}

TOTA NO	TOTAL SCORE	Mean X	Standard Deviation	Variance	K	Σpq	KR_{20}	KR_{21}
2100	52021	24.77	7.85	61.58	36	6.17	0.93	0.91

From **Table 5** shown above, all the participants in the APM test have a sum of 52021, a mean of 24.77, standard deviation of 7.85 and variance of 61.58. The number of items on the APM scale (K) is 36, sum of proportion of examinees answering each item correctly and wrongly (Σpq) is 6.17 and that the Kuder-Richardson, KR_{20} internal consistency reliability of the APM scale in Nigeria is 0.93. When computed with KR_{21} the result yielded a value of 0.91 as can be seen in **Table 5** above. The detail of this computation is contained in Appendix 25 in the main work.

Research Question 4

Within the frame work of CTT what is the Construct Validity of APM in Nigeria, using multiple correlation evidence?

ANSWER:

MULTIPLE CORRELATIONS EVIDENCE OF APM IN NIGERIA

Table 6: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.893[a]	.798	.797	4.735

a. Predictors: (Constant), INST, ETHNIC, GENDER

Table 7: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	662.518	3	220.839	49.922	.062[b]
	Residual	9272.044	2096	4.424		
	Total	9934.561	2099			

a. Dependent Variable: APMSCORE

b. Predictors: (Constant), INST, ETHNIC, GENDER

The **Tables 6** and **7** shown above the multiple correlations computations yielded an R value of 0.89 which represents the construct validity of the APM scale in Nigeria. And from the ANOVA table output that followed the multiple correlations computation, type of institution which represents the age group in this study (i.e. university undergraduates and senior secondary school students), ethnic or gender are not predictors of the outcome of the APM scale test in Nigeria because at $F(3, 2099) = 49.922$, $P > 0.05$ ($P = 0.062$) and this is not significant.

Research Question 5

Within the frame work of CTT what is the construct validity of the APM test through hypothesis testing evidence?

a) There is no significant influence of ethnicity on the APM scores of Hausa, Igbo, Yoruba and Minority.

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b) There is no significant influence of age on the APM scores of university undergraduates and senior secondary school students in Nigeria.

a): Dependent Variable: APMSCORE.

TABLE8: TEST OF BETWEEN-SUBJECTS EFFECETS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	67.514[a]	7	9.645	2.045	.046
Intercept	1918616.392	1	1918616.392	406782.834	.000
ETHNIC	30.722	3	10.241	2.171	.089
GENDER	4.034	1	4.034	.855	.355
ETHNIC * GENDER	41.154	3	13.718	2.908	.033
Error	9867.047	2092	4.717		
Total	2134111.000	2100			
Corrected Total	9934.561	2099			

R Squared = .87 (Adjusted R Squared = .83)

Table 8 above shows the ANOVA summary of the ethnic influence on the score of undergraduate and senior secondary school students who took the APM scale test in Nigeria. The F-ratio obtained for the ethnic influence on the APM in Nigeria is 2.171, and this is statistically not significant at 0.089 probability; $F(3, 67.514) = 2.171$, $P > 0.05$. That of gender is 0.855 in Nigeria and this value is also statistically not significant at 0.355 probability; $F(1, 67.514) = 0.855$, $P > 0.05$. The interaction between ethnic and gender is however significant at $F(3, 67.514) = 2.908$, $P < 0.05$.

b): Dependent Variable: APMSCORE.

TABLE 9: TESTS OF BETWEEN-SUBJECTS EFFECTS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	690.049[a]	7	98.578	22.308	.000
Intercept	1943985.415	1	1943985.415	439916.932	.000
ETHNIC	28.330	3	9.443	2.137	.094
SCHTYPE	641.274	1	641.274	145.118	.065
ETHNIC * SCHTYPE	7.708	3	2.569	.581	.627
Error	9244.512	2092	4.419		
Total	2134111.000	2100			
Corrected Total	9934.561	2099			

a. R Squared = .89 (Adjusted R Squared = .86)

From **Table 9**, the F-ratio obtained for the ethnic influence on the APM in Nigeria is 2.137, and this is statistically not significant at 0.094 probability; $F (3; 690.049) = 2.137$, $P > 0.000$. That of school type or age category (according to the working definition in this thesis: that is, university undergraduates and senior secondary school) is 145.118 in Nigeria and this value is also statistically not significant at 0.065 probability; $F(1, 690.049) = 145.118$, $P > 0.05$. The interaction between ethnic and gender in this output is not significant at $F(3, 690.049) = 0.581$, $P > 0.05$. The inference from the above is that neither age nor gender had any influence over the APM test items. That means the APM scale is not biased towards age or gender in Nigeria. This is very much in tandem with the stated objective of the constructors of the scale and it is therefore a good news for APM scale in Nigeria.

Research Question 6

Within the frame work of CTT what is the

a) Normalized standard score and

b) Percentile ranks of the normalized score of APM in Nigeria?

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ANSWER:

Table 10: Normalized Standard Score, Rank Order and Percentile Summary Table

SCORE	FREQUENCY	CUMULATIVE PERCENT	RANK ORDER	PERCENTILE	ZSCORE	NORMALIZED SCORE (IQ)
1	6	.3	3.50	.14	-3.03	52
2	7	.6	10.00	.45	-2.90	54
3	9	1.0	18.00	.83	-2.77	56
4	9	1.5	27.00	1.26	-2.65	58
5	8	1.9	35.50	1.67	-2.52	60
6	14	2.5	46.50	2.19	-2.39	62
7	12	3.1	59.50	2.81	-2.26	64
8	19	4.0	75.00	3.55	-2.14	66
9	32	5.5	100.50	4.76	-2.01	68
10	25	6.7	129.00	6.12	-1.88	70
11	17	7.5	150.00	7.12	-1.76	72
12	34	9.1	175.50	8.33	-1.63	74
13	26	10.4	205.50	9.76	-1.50	76
14	26	11.6	231.50	11.00	-1.37	78
15	30	13.0	259.50	12.33	-1.25	80
16	27	14.3	288.00	13.69	-1.12	82
17	25	15.5	314.00	14.93	-.99	84
18	44	17.6	348.50	16.57	-.86	86
19	51	20.0	396.00	18.83	-.74	88
20	117	25.6	480.00	22.83	-.61	90
21	142	32.4	609.50	29.00	-.48	92
22	77	36.0	719.00	34.21	-.35	94
23	136	42.5	825.50	39.29	-.23	96
24	139	49.1	963.00	45.83	-.10	98
25	93	53.6	1079.00	51.36	.03	100
26	38	55.4	1144.50	54.48	.16	103
27	47	57.6	1187.00	56.50	.28	105
28	34	59.2	1227.50	58.43	.41	107
29	44	61.3	1266.50	60.29	.54	109
30	116	66.9	1346.50	64.10	.67	111
31	142	73.6	1475.50	70.24	.79	113
32	185	82.4	1639.00	78.02	.92	115
33	86	86.5	1774.50	84.48	1.05	117
34	175	94.9	1905.00	90.69	1.69	127
35	93	99.3	2039.00	97.07	1.94	131
36	15	100.0	2093.00	99.64	2.13	134
	Total: 2100					

Table 10 sums up the performances of the university undergraduates and senior secondary school students on the APM scale in Nigeria. The table shows the score, the frequency of the score, cumulative percent of the score, rank order, percentile, fractional rank percentile, z-score and the normalized standard score using the IQ computation of IQ=16z+100. Where

$$Z = \frac{X_i - \bar{X}}{SD}$$

X_i=a given APM raw score of a particular examinee.

$\bar{X}$=mean of APM scores.

SD=Standard Deviation

The normalized standard score IQs of the APM test scores have been converted into percentile ranks for it to be more readily understood by all. "Percentile rank is the percentage of scores at or below the midpoint of a particular score" (Kpolovie, 2010: 255). This single percentile ranks table is suitable for all undergraduate and senior secondary school students in Nigeria because all the likely differences in the raw scores have already been evened out with their transformation into normalized standard score. **Table 10** can very easily be used to transform the raw score of any university undergraduate or senior secondary school student in Nigerian who takes the APM scale test to normalized standard score. For instance a raw score of 25 which was obtained by 93 examinees has a standard score IQ of 100 and belongs to the 51.36 percentile. The percentile rank of 51.36 means that the person who has it, is better than 51.36 percent (51.36%) of other Nigerian university undergraduate or senior secondary school students in terms of intelligence. Therefore **Table 10** compares the intelligence of a person with that of all other Nigerian university undergraduates and senior secondary school students, irrespective of gender, ethnicity or age (within the age of 12 to age 40) to know his/her relative standing. The details in the table above is again represented in the pie-chart below:

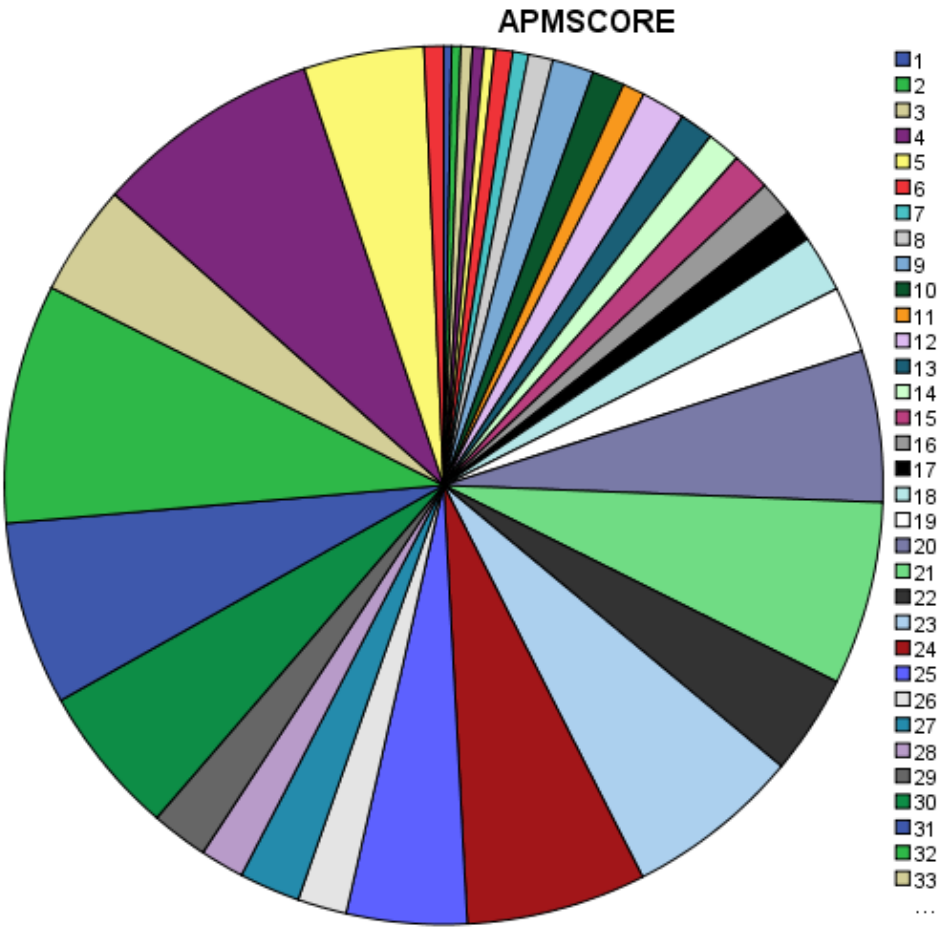

Figure 1

Research Question 7

Within the frame work of CTT what is the Classification of APM IQs of Nigerian university undergraduate and senior secondary school students?

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Table 11: Classification of APM IQs of Nigerian university undergraduate and senior secondary school students

IQ	Percentage of Population	Brief description
130 and above above	5.14	Very superior
120 -129	8.33	Superior
110 -119	25.19	Above average
100 -109	12.19	High average
90-99	29.10	Low average
80-89	8.45	Slow or dull learner
70-79	6.10	Borderline
69 and below	5.53	Intellectually deficient

As shown in **Table 11** above, the very superior students form approximately the best or topmost 5% of Nigerian university undergraduate and senior secondary school students. That is, out of every 100 university undergraduate and senior secondary school students of this country, when randomly sampled, 5 are gifted in the area of fluid ability. About 8% of the targeted population fall into the group identified as the superior class, 25% are very well above average, 12% belong to the high average group while 29% occupy the low average group. Others are the slow or dull ability students 8.5%, borderline 6% and intellectually deficient 5.5%. Thus it can be surmised from the above results that although the APM did not show any evidence of culture biases in Nigeria, it however showed overwhelmingly significant differences between mentally retarded students (MRS), normal students (NS) and gifted students (GS) with the GS significantly higher than the NS, and the NS significantly higher than the MRS (Kpolovie, 2015). The information in the above table is presented in the pie chart below:

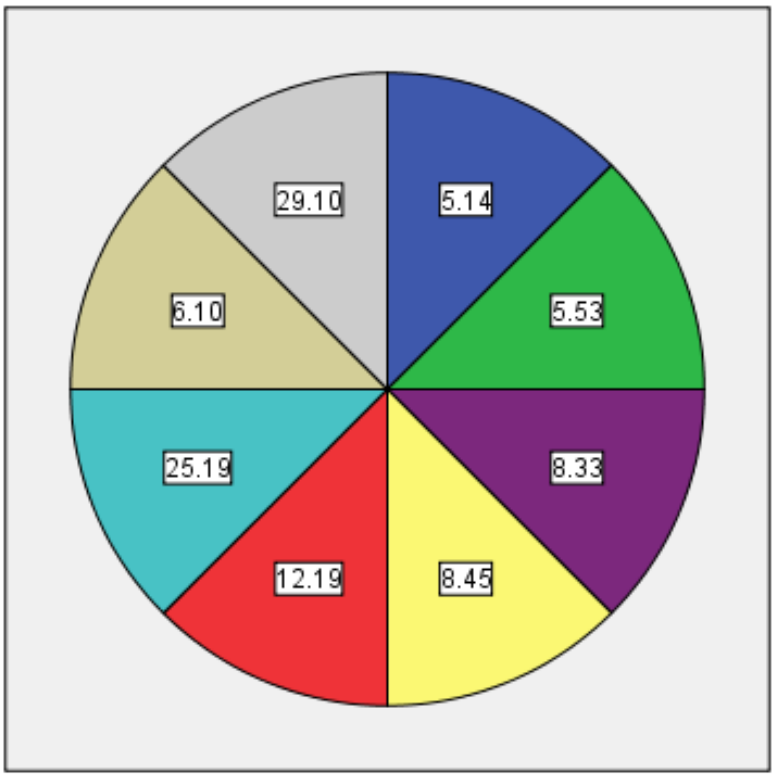

Figure 2

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Again the same information is presented below as a normal curve histogram:

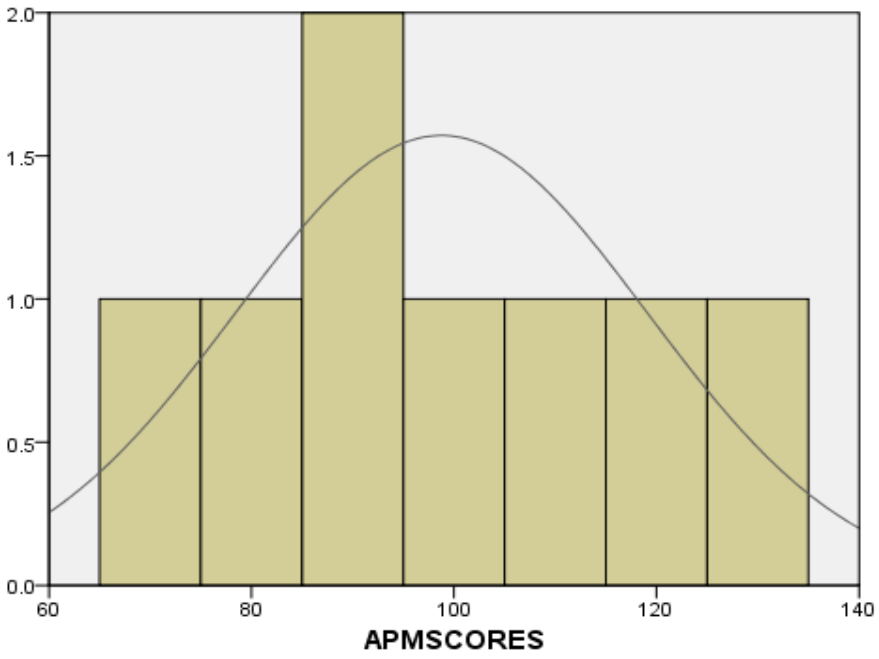

Figure 3

Research Question 8

Within the frame work of CTT what is the concurrent validity of APM, using Culture Fair Intelligence Test (CFIT) as the criterion in Nigeria?

ANSWER:

CONCURRENT VALIDITY OF APM, USING CULTURE FAIR INTELLIGENCE AS THE CRITERION:

Concurrent validity of a test under validation (in this case, the APM) or under development is simply established by correlating it with another test that validly and reliably measures the same trait or domain in the population that the test is being validated or developed for. It was for this reason that the CFIT that validly and reliably measures Fluid General Intelligence in Nigeria (Kpolovie, 2015; 2005; 2003; 1999) was simultaneously administered with the APM to the subjects of the current study. The correlation coefficient between the APM and CFIT is the concurrent validity of the APM.

Table 12: Concurrent Validity of APM

		CFIT	APM
CFIT	Pearson Correlation	1	.701**
	Sig. (2-tailed)		.000
	N	1509	1509
APM	Pearson Correlation	.701**	1
	Sig. (2-tailed)	.000	
	N	1509	1509

** Correlation is significant at the 0.01 level (2-tailed)

The results have shown that the correlation coefficient between the two tests (CFIT and APM) is 0.701, and therefore the Advanced Progressive Matrices has a concurrent validity of 0.701 in Nigeria. Out of the 2100 subjects of the study, only

1509 completed the two tests. This accounts for why the number of cases (N) in the output is 1509 rather than 2100. A correlation coefficient of 0.701 for a sample that is as high as 1509 is a very strong correlation and a stunning indication of very high concurrent validity of the APM that was under validation in this investigation.

Contributions:

The Raven's Advanced Progressive Matrices (APM) scale, even though constructed in 1936 by John C. Raven, is not yet a very popular scale in Africa. Therefore it is not commonly employed for research works in the area of intelligence investigation in the African continent, particularly Nigeria, whereas the APM instrument is reputed to be in high demand in America, Europe and Asia. The APM scale is internationally well acclaimed, well known and highly patronized in research work across the globe. Evers (2011) had attested to the fact that "the Raven's Matrices are in the fourth position among the ten most used tests in Europe." According to him "they are widely employed to assess fluid ability in adolescents and adults and have also been recommended as a useful measure for identifying academic potentials."

The reliability of the APM scale within the framework of IRT as indicated by the Alpha value for the full test with 36 items conducted by this researcher is 0.95. This is very much in tandem and consistent with the reliability published by the Raven's company. According to their 2012 manual, set 2 APM with 36 items has consistently yielded a reliability value of 0.70 and above. The test authors indicated in their manual that "the consistency coefficients of the APM has been between r=.83 and r=.87 in recent times." They stated that "the retest-reliability amounts to rtt=.91 (interval of 2-8 weeks)." The results from this study is therefore an affirmation of the above submission.

The Split half reliability estimate of the first half of the APM test yielded a value of 0.89 and that of the second part of the test was 0.87. When corrected to the full test, using the Guttman Split-half coefficient, the APM scale had a split-half reliability (r) of 0.89 in Nigeria. The reliability was also computed using the Cronbach's Alpha, it was found to be 0.88 while the Cronbach's Alpha based on standardized items gave a value of 0.90. The KR_{20} internal consistency reliability of the APM scale in Nigeria is 0.91. When computed with KR_{21} the result yielded a value of 0.90. The construct validity of the APM scale through multiple correlations yielded a value of 0.89. These values are congruent with Ablard& Mills' (1996) report in the second part of their study which was a cross-validation of the psychometric properties of the two short forms with an independent sample of academically talented students using the Classical Test Theory approach. They reported that "APM Set 2 scores ranged from 6 to 36, with a mean of 21. 7 and a standard deviation of 5.1 with and a Cronbach's alpha that was moderately high at 0.78." This was similar to the alpha reported in the first part of their work *(a* = 0.81). The R value of 0.89 is a value that depicts the construct validity of APM via multiple correlations evidence in Nigeria. The authors and promoters of the Raven's APM test-the Raven and Raven's company, have reported consistency coefficients between of r=.83 and r=.87 and the retest-reliability value of rtt=.91 for interval of 2-8 weeks. The ANOVA summary of the ethnic influence on the score of undergraduate and senior secondary school students who took the APM scale test yielded the following result: the F-ratio obtained was 1.554, and this is statistically not significant at .0000 probability; F (3,362) = 1.554, P >0.0000. This indicated that the APM scale was not ethnically biased within the different cultural groups in Nigeria. "A wide range of norms derived from the paper-and-pencil version is available if so desired according to the test producers." Unfortunately, from the one purchased by this researcher from the test producers, there were no reports of any study (or studies) from or about Nigeria. And therefore no norms were reported for Nigeria. As a matter of fact, the only country in Africa for which norms were reported is Kenya, not even the more developed South Africa. This makes the present study not only unique but very timely. Various studies showed that the paper-and-pencil and the computerized versions yield the same results. The APM scale has now been standardized in Nigeria with reliability, validity and norms. Therefore the outcome of any future test on the APM scale by any university undergraduate or senior secondary school student in Nigeria can be easily transformed from the raw score to the normalized standard score. The single percentile ranks table generated through this research work is suitable for undergraduate and senior secondary school students in Nigeria because all the likely differences in the raw scores have already been evened out with their transformation into normalized standard score. The validation of the APM for use in Nigeria demands-establishment of it reliability and validity. The standardization on the other hand requires that its norms be established, using a Nigerian sample. For any test to be considered a good test, it must possess a high reliability. Therefore reliability is an important quality that scores on tests must possess for the test to be reliable. Reliability is the extent to which a test measures consistently what it purports to measure. Technically, reliability is a coefficient which indicates the proportion of variance in observed scores on a test from the true score. That is each score on a test consists

of a true component and an error component; and the more reliable a test is, the closer its observed scores are to the true scores. There are four ways of establishing reliability, each which is a type of reliability. The forms include test-retest, parallel or equivalent forms, split-half and internal consistency. All the above except test-retest were employed in this research work. Validity is the most important quality of a test, and it deals with how well the test measures what it purports to measure. There are three main types of or ways of establishing validity: content, criterion-related (predictive and concurrent) and construct validity through subtest-total correlation. Test standardization is basically concerned with uniformity of procedure for administration (standard instructions) and norms (scoring) of the test. The standard instructions that must be rigidly adhered by all examiners and examinees to ensure uniformity of testing conditions; and is analogous with the need for controlled conditions in every scientific experiment. Test norms refer to establishment of the average or normal performance on a psychological test: and which serves as a standard against which all scores on that test must be compared and validated for a given population. Norms also indicate the relative frequency of varying degrees of deviation above and below the average and thus allow for evaluation of different degrees of superiority and inferiority with respect to the trait measured by the test. In fact, psychological tests do not and cannot have any predetermined standards of passing or failing other than the norms derived from standard comparison of scores obtained by all the examinees from a particular national population. It is crystal clear from the foregoing that validation and standardization of the APM must first be done with samples drawn from a target population in Nigeria before the test can appropriately be used in this country to pass decisions on any Nigerian who takes the APM (Anastasi, 1982, Kpolovie, 2010).In a validation study conducted by Rushton, Skuy & Bons (2004) titled "Construct Validity of Raven's Advanced Progressive Matrices for African and Non-African Engineering Students in South Africa" with a primary concern to test the hypothesis that the Raven's Advanced Progressive Matrices has the same construct validity among African university students as it does in non-African students, they examined data from 306 highly brilliant of 17- to 23-year olds in the Faculties of Engineering and the Built Environment at the University of the Witwatersrand (177 Africans, 57 East Indians, 72 Whites; 54 women, 252 men). Analyses using the CTT models were made of the Matrices scores, an English Comprehension test, and the Similarities subscale from the South African Wechsler Adult Intelligence Scale, end-of-year university grades, and high-school grade point average. Out of the 36 Matrices problems, the African students solved an average of 23; East Indian students, 26; and White students, 29 (po.001), placing them at the 60th, 71st, and 86th percentiles, respectively, and yielding IQ equivalents of 103, 108, and 118 on the 1993 US norms. For the Raven's Advanced Progressive Matrices, all calculations were based on raw scores, with each of the 36 items scored as 0 (incorrect) or 1 (correct). Internal consistencies based on Cronbach's alpha were 0.86 for the sample as a whole (n5306), 0.86 for the Africans (n5177), 0.79, for the East Indians (n557), and 0.75 for the Whites(n572). The SPSS output for the percentile computations for this present study contains the normalized standard scores on the APM test that have been converted into percentile ranks for it to be more readily understood by all. Details of which is contained in the appendix section of the main report of this work.

In summary this work applied the classical test theory (CTT) on the APM scale in Nigeria. From the review of literature and as it has now been confirmed by this current research work, the Raven's Advanced Progressive Matrices (APM) is a non-verbal multiple choice measure of the reasoning (or, better, 'meaning-making') component of Spearman's ***g***. The Spearman's ***g*** is often referred to as "general intelligence" (Raven, Raven & Court, 2003, updated 2012). Raven's Progressive Matrices are largely employed by researchers and practitioners in the field of psychometrics, education, medicine and the social sciences. This present study has also confirmed that the instrument is indeed very suitable for cross-cultural studies of intelligence, appropriate for measuring cognitive ability free of verbal interference, helpful in assessing ethnically diverse populations and serves well as an intelligence test that detects "sub-optimal performance" especially the discovery of gifted or talented individual. It is an instrument that has no biases towards gender or age groups. The instrument was designed to serve adolescents of age 12 and above as well as the adults of any age. True to the intensions of the test maker, this study revealed an even performance between the adolescent and adult samples of this study. The adolescent sample was made up of 1100 senior secondary school students while the adult sample comprised of 1000 university undergraduates. The results of the analysis of scores collected from the respondents to the APM scale's test confirmed the fact that the instrument serves to minimize the impact of language skills and cultural biases and therefore they are particularly well suited for measuring the intelligence of individuals whose native language is not English, as well as those who may have reading problems or hearing impairment. It was also found out from the review of literature that the APM test helps in determining managerial skills amongst executives of corporate organizations,

intellectual efficiency amongst learners, the speed and accuracy of high level cognition work, cognitive processes or organic dysfunction amongst children and the elderly. Raven, Raven and Court (2012) said the "Raven's Advanced Progressive Matrices (APM) measure two complementary components of general intelligence: the capacity to think clearly and make sense of complex data (educive ability); and the capacity to store and reproduce information (reproductive ability)". The Advanced Progressive Matrices (APM) is in high demand as an instrument of choice among researchers in America, Europe and Asia. Meanwhile, the instrument is hardly known let alone employed in research work in Africa, particularly Nigeria. One of the likely reasons might be due to the fact that it has never been standardized with norms in Nigeria. Therefore this research work was focused on standardizing the APM scale by locally generating norms, validity, reliability, etc in Nigeria. This it is hoped will make it available to the research community in Africa, particularly Nigeria as an instrument of choice for intelligence related research work. Thus the huge task of validating and standardizing the Raven's Advanced Progressive Matrices (APM) for use in Nigeria was embarked upon by the current researcher. The result of this exercise has effectively brought about the establishment of the relevant temporal consistencies, consistencies of equivalence, internal consistencies, construct validities, norms, etc for the APM. The APM which is an important and powerful tool for measuring intelligence can now be incorporated into the Nigerian educational system. The APM has been found to be reliable, valid and bias-free; and is in use in several foreign countries. In each country where the instrument is effectively in use, it was first standardized and validated. Its use in Nigeria or any country without first validating and standardizing (i.e. establishing its reliability, validity and norms, using that country's sample), will amount to abuse of the test. This is because it is psychometrically wrong to use a test standardized on one population for another population.

Six research questions were posed with the ultimate goal of determining the reliability, validity and norms of the APM in Nigeria for it to be appropriately put to use in this country. Multiple triangulation research design, which permits flexible and robust approaches in establishment of psychometric properties and norms of the test was employed. Stratified random sampling was adopted to obtain 1000 university undergraduates within the age category of 16 to 40 years and 1100 senior secondary school students with the age category of 12 to 20 years from four ethnic groups (Hausa, Igbo Yoruba and Minority). The SPSS together with Microsoft excel were deployed for the analysis of the data generated for this work. The resulting correlations: Kuder-Richardson's estimates, t-test, ANOVA, norms and percentile ranks. The Split half reliability estimate of the first half of the test yielded a value of 0.89 and that of the second part of the test was 0.87. When corrected to the full test, using the Guttman Split-half coefficient, the APM scale had a split-half reliability (r) of 0.89 in Nigeria. The reliability was also computed using the Cronbach's Alpha, it was found to be 0.88 while the Cronbach's Alpha based on standardized items gave a value of 0.90. The KR_{20} internal consistency reliability of the APM scale in Nigeria is 0.91. When computed with KR_{21} the result yielded a value of 0.90. The construct validity of the APM scale through multiple correlations is 0.89. This value depicts the construct validity of APM via multiple correlations evidence in Nigeria. The ANOVA summary of the ethnic influence on the score of undergraduate and senior secondary school students who took the APM scale test yielded the following result: The F-ratio obtained for the ethnic influence on the APM in Nigeria is 2.171, and this is statistically not significant at 0.089 probability; $F(3, 67.514) = 2.171$, $P > 0.05$. That of gender is 0.855 in Nigeria and this value is also statistically not significant at 0.355 probability; $F(1, 67.514) = 0.855$, $P > 0.05$. This indicated that the APM scale was not biased towards the ethnic or age groups. The stated purposes of this research endeavour abinitio included a thorough and detail application of psychometric analysis on the Advanced Progressive matrices (APM) with a view towards establishing its concomitant psychometric properties in Nigeria and provide relevant and usable norms and standardization modules that can be used by experts in the field of psychometrics as well as non-experts including those who are not familiar at all with the language of testing. The results of this investigation will certainly mark an eon in the chronicles of educational development and Psychological testing in Africa, particularly Nigeria. This is an explicit investigation that is total in its mission and delivery. It will serve as a milestone in the psychometrics and testing industry in Nigeria and beyond. In the past in this country, perhaps the only internationally acclaimed instrument for measuring intelligence available to the psychometric community might be the Culture Fair Intelligence Test (CFIT) standardized with norms and other statistical parameters in Nigeria by Kpolovie in 2001 (Kpolovie, 2010). This will be an additional valid and scientifically proven measure of intelligence in this country. Based on the discussions above, the following recommendation were made:

1. That the Raven's Advanced Progressive Matrices (APM) scale, a very popular and reputed measure of intelligence, be incorporated into the pool of research instruments in Nigeria.

2. A deliberate efforts should be made by psychometricians in Nigeria to promote the use of this measure of fluid ability.

The implications of this study are profusely in abundance. This study was carried out here in Nigeria by a Nigerian. Thus the study has invariably conferred on the APM instrument a "Naija" status. APM now has "an address in Nigeria" with the norms, ranks, validity, reliability and full standardization. It is no more a foreign instrument. It is now a Nigerian instrument for research work-especially research works in the area of intelligence. As opined above, the APM scale now has locally generated norms, ranks, standard deviations, internal consistencies including reliability and validity coefficients. Thus the high reliability of the APM scores in this country can be employed in the determination of variance in the distribution of scores obtained on the APM which is attributable to the true scores. With the reliability of over 0.88 for the APM in Nigeria, over 88% of the variance in the observed scores on the test is accounted for by true scores (i.e. the extent to which Nigerian students actually differ in their intelligence), and the error variance accounts for only less than 12% of the scores. Moreover the APM reliability coefficient can be used for finding standard error of measurement (SE_m) in the entire scores obtained on the test in this country. The SE_m is the standard deviation of each examinee's scores. It indicates how his/her scores disperse across the testing continuum. Thus this study holds practical implication and benefits because the validity and reliability are already established. Confidence intervals within which the true score of each examinee lies at a given percentage of certainty can only be determined when the reliability coefficient and standard error of measurement of the APM in our country are known. Now these are known. This, it is hoped, will enhance the identification, placement, acceleration and enrichment of the gifted/talented students in Nigerian. The APM belongs to a family of other progressive matrices-namely the standard progressive matrices and the coloured progressive matrices. The APM is the most difficult of the three. Within the learning and training environment or the citadel of learning, the APM scale can be used for educational and professional placement. When administered under timed condition, it assesses in the individual the intellectual prowess and efficiency on one hand and the speed and accuracy of high level cognition on the other hand but concurrently. The most common application of IRT is in education and human resources sectors where psychometricians use it to develop and refine examination items and hence maintain banks of examination questions or items. This allows for the comparisons between outcomes of examinations over time so that discrepancies and extraneous variables can be detected and eliminated so that decisions made or judgment passed by such bodies on their examinees will not be faulty.

5. CONCLUSION

The stated purposes of this research endeavour abinitio included a thorough and detail application of psychometric analyses on the Advanced Progressive matrices (APM) with a view towards establishing its concomitant psychometric properties in Nigeria and provide relevant and usable norms and standardization modules that can be used by experts in the field of psychometrics as well as non-experts including those who are not familiar at all with the language of testing. The results of this investigation will certainly mark an eon in the chronicles of educational development and Psychological testing in Africa, particularly Nigeria. This is an explicit investigation that is total in its mission and delivery. It will serve as a milestone in the psychometrics and testing industry in Nigeria and beyond. In the past in this country, perhaps the only internationally acclaimed instrument for measuring intelligence available to the psychometric community might be the Culture Fair Intelligence Test (CFIT) normed and standardized in Nigeria by Kpolovie in 2001 (Kpolovie, 2010). This will be an additional valid and scientifically proven measure of intelligence in this country. This, it is hoped will help decision makers within and outside the education sector in Nigeria.

6. CONTRIBUTION TO KNOWLEDGE

From the study on the application of psychometric analyses on the Advanced Progressive Matrices (APM) scale, the following contribution to knowledge have been made:

1. The study used CTT framework to establish the APM's temporal consistency, consistency of equivalence, internal consistency, construct validity, norms and percentile rankings in Nigeria.

2. An instrument of international reputation, the APM, that will enhance the identification, placement, acceleration and enrichment of the gifted/talented students in Nigerian as well as ability selection and placement within and outside the education management climes is now available to the research community in Nigeria. This is definitely a great

contribution. The study has invariably conferred on the APM instrument a "Naija" status. APM now has "address in Nigeria" with norms, ranks, validity, reliability and full standardization. It is no more a foreign instrument. It is now a Nigerian instrument available to the research community in Nigeria for research work-especially research works in the areas of intelligence and ability testing.

3. Now the norms for the APM scale in Nigeria can be reported. A wide range of norms derived from the paper-and-pencil version of the APM were published by the test producers. Unfortunately, from the copy purchased by this researcher from the test producers, there are no reports of any study (or studies) from or about Nigeria. And therefore no norms were reported for Nigeria.

4. The APM did not discriminate the test outcomes in terms of groups, whether gender, age or ethnic or cultural affiliations in Nigeria. This succinctly confirmed the fact that APM is indeed a perfect measure of fluid ability among those whose native language is not English.

5. The study also confirmed the fact that with eight response option the possibility of guessing will be greatly reduced in multiple choice examinations. Examination bodies in Nigeria might want to validate this inference.

7. RECOMMENDATIONS

1. That the Raven's Advanced Progressive Matrices (APM) scale, a very popular and reputed measure of intelligence, be fully incorporated into the pool of research instruments in Nigeria.

2. A deliberate efforts should be made by psychometricians in Nigeria to promote the use of this measure of fluid ability.

3. That public examination bodies such as Joint admission and matriculation board, West Africa Examinations Council, National Examination Council and other similar bodies to earnestly consider adopting the 8-response option in the answers to their objective tests.

Suggestions For Further Studies:

1. Further research is required in the area of using the APM to identify academically talented students.

2. Similar studies as the current research work are also required for the Standard Progressive Matrices and the Coloured Progressive Matrices.

REFERENCES

[1] Abad, F. J., Colom R., Rebollo I.,& Escorial, S. (2004) Sex differential item functioning in the Raven's Advanced Progressive Matrices: Evidence for bias, Personality and Individual Differences, 36 (2004), pp. 1459–1470

[2] Ackerman, P. L., Beier, M. E., & Boyle, M. O. (2005). Working memory and intelligence: The same or different constructs? *Psychological Bulletin,131*, 30–60

[3] Cattell, R. B. (1963). Theory of fluid and crystallized intelligence: A critical experiment.*Journal of Educational Psychology, 54, 1-22.*

[4] Chiesi, F., Primi, C., &Morsanyi, K. (2011). Developmental changes in probabilistic reasoning: The role of cognitive capacity, instructions, thinking styles and relevant knowledge. *Thinking & Reasoning, 17,* 315–350 Retrieved June 3, 2012, from http://www.sciencedirect.com/science/article/

[5] Çikrikçi-Demirtaşli, N. (2000) A study of Raven Standard Progressive Matrices Test's item measures under Classical and Item Response Model Paper presented at 31st European Mathematical Psychology Congress, Austria: Graz. Retrieved June 3, 2012, from http://www.sciencedirect.com/science/article/

[6] Colom, R., Florez-Mendoza, C., &Rebollo, I. (2003).Working memory and intelligence. *Personality and Individual Differences, 34,* 33–39

[7] Evers, A. (2011) Testing practices and attitude towards tests and testing: The results of a global survey Paper presented at the 12th European Congress of Psychology, Istanbul (2011, July). Retrieved July 15, 2012, from http://my.apa.org/portal

[8] Field, A. (2005). Discovering statistics using SPSS for windows. London: Sage Publication.

[9] Gallini, J.K., (1983) A Rasch analysis of Raven item data The Journal of Experimental Education, 52 (1) (1983), pp. 27–32.Retrieved July 15, 2012, from http://my.apa.org/portal

[10] Georgiev, N., (2008) Item analysis of C, D and E series form Raven's Standard Progressive Matrices with Item Response Theory two-parameter logistic model Europe's Journal of Psychology (2008) http://www.ejop.org/ archives/2008/08/item_analysis_o.html

[11] Gilovich, T., Griffin, D., &Kahneman, D. (Eds.). (2002). *Heuristics and biases: The psychology of intuitive judgment.* New York, NY: CambridgeUniversity Press.

[12] Joe, I. A. (2000).Fundamental Statistics for Education and the behavioural sciences. Ibadan: Kraft Books Ltd.

[13] Kpolovie, P. J. (2012) Education Reforms without Evaluation Designs: Nigeria at Risk, New Owerri: Springfield Publishers Ltd.

[14] Kpolovie, P. J. (2011), Statistical Techniques for Advanced Research. New Owerri: Springfield Publishers Ltd.

[15] Kpolovie, P. J. (2010) Advanced Research Methods, New Owerri: Springfield Publishers Ltd.

[16] Morsanyi, K., Primi, C., Chiesi, F. & Handley, S.J., (2009).The effects and side-effects of statistics education. Psychology students' (mis-)conceptions of probability Contemporary Educational Psychology, 34 (2009), pp. 210–220

[17] Muñiz J., (2011), International strategies to improve tests and testing. Paper presented at the 12th European Congress of Psychology, Istanbul (2011, July)

[18] Muñiz, J., (2009), The role of EFPA in setting standards for tests and test use Paper presented at the 11th European Congress of Psychology, Oslo (2009, July). Retrieved June 3, 2012, from http://www.sciencedirect.com/ science/article/

[19] Orluwene, G. W. (2012). Introduction to Test Theory and Development Process.

[20] Orluwene, G. W. (2012). Fundamentals of Testing and Non-Testing Tools in Educational Psychology.

[21] Raven, J. (2000). The Raven's Progressive Matrices: Change and stability over culture and time. *Cognitive Psychology*, *41*(1), 1-48. Retrieved June 15, 2012, from http://www.wpspublish.com

[22] Raven, J.C., (1962) Advanced progressive matrices, London: Lewis & Co. Ltd.

[23] Raven, J. C., Court, J. H., & Raven, J. *(1983). Manual for Raven's Progressive Mamas and*

[24] *vocabulary scales, section* 4: *Advanced Progressive Matrices, Sets I and II.* London: H. K. Lewis.

[25] Raven, J.C. Raven J. (Eds.), (2008) Uses and abuses of intelligence: Studies advancing Spearman and Raven's quest for non-arbitrary metrics, Royal Fireworks Press, Unionville, New York.

[26] Raven, J., Raven, J. C., & Court, J. H. (2003). *Raven manual section 1: General overview*. Oxford: Oxford Psychologists Press.

[27] Raven, J., Raven, J. C., & Court, J. H. (2012). *Raven manual section 1: General overview*. Oxford: Oxford Psychologists Press.

[28] Raven, J, Raven, J.C. & Court, J. H. (1997). *Mill Hill Vocabulary Scale: 1998 Edition.* Oxford: Oxford Psychologists Press.

[29] Raven, J., Raven, J. C., & Court, J. H. (1993). *Raven manual section 1: General overview*. Oxford: Oxford Psychologists Press.

[30] Raven, J., Raven, J.C. & Court, J.H. (1998). Advanced Progressive Matrices. Oxford: Oxford Psychologists Press.

[31] Rushton, J. P. Skuy, M &Bons, T. A. (2004) Construct Validity of Raven's Advanced

[32] Progressive Matrices for African and Non-African Engineering Students in South Africa.

[33] International Journal of selection and assessment volume 12 number 3 September 2004, Retrieved May 23, 2012, from *www.charlesdarwinresearch.org/Ravens%20inIJSA04.pdf*

[34] Spearman, C. (1927).*The abilities of man*. London: Macmillan.

[35] Thompson, B. (2004). Five methodology errors in educational research: The pantheon of statistical significance and other faux pas. In B. Thompson (Ed.), *Advances in social science methodology* (pp. 23-86). Stamford, CT: JAI Press.

[36] Ukwuije, R. P. I. (2003), Introductory Research Methods and Statistics in Education. Port Harcourt: Celwil Nigeria Limited.

[37] Western Psychological Services California (www.wpspublish.com).