Factor Analysis in Modeling Low Achievement of Mathematics Among 2nd Year Secondary School Students in Khartoum State

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ABSTRACT

This work studied the low achievement of mathematics among second year secondary school students in Khartoum state. The central question addressed in the study was: what is the common factors cause low achievement of mathematics in second year secondary schools in Khartoum state? The study used factor analysis procedure to build statistical model for low achievement of mathematics.The results of this study found that number of factors were extracted, which explained 79% of the total variance. School environment is the first factor, which represents 13% of the total variance explained, the second factor is mathematics achievement, which represents 10.7% of the total variance explained, and the third factor is the education of parents, which represents 5.39% of the total variance.

المستخلص

هذه الدراسة تتناول تدني مستوى التحصيل الدراسي لمادة الرياضيات لدى طلاب الصف الثاني بالمرحلة الثانوية.   فالسؤال المحوري لهذه الدراسة هو: ما هو العامل الاساسي الذي يتسبب في تدني مستوى التحصيل الدراسي لطلاب الصف الثاني بالمرحلة الثانوية في ولاية الخرطوم؟ في هذه الدراسة تم استخدام التحليل العاملي كأسلوب احصائي لبناء نموذج احصائي لتدني مستوى التحصيل الدراسي لمادة الرياضيات. فقد أوضحت نتائج الدراسة عن وجود عدد من العوامل تفسر 79% من التباين الكلي، البيئة المدرسية كانت هي العامل الاول والاساسي إذ يمثل 13% من التباين الكلي، العامل الثاني كان التحصيل الدراسي والذي يمثل 10.7% من التباين العام، أما العامل الثالث هو تعليم الوالدين إذ يمثل 5.39% من التباين الكلي.

KEYWORDS: school environment, common factor, factor loadings.

INTRODUCTION

Low achievement in Mathematics at secondary school level is a long standing problem in Sudan. A few statistical studies that have attempted to look into the causes of the problem have not come up with a satisfactory answer and given the importance of the subject so there is a need for more statistical researches. The aim of this study was to determine the factors that cause low achievements in Mathematics among second year secondary school students in Khartoum state.

Back studies showed that learning strategies factor has positively and statistically significant effect on achievement of

mathematics [1]. The study of Zeyad Barakat & Husam Haraz-alla , found the following results "Weak health of students; Psychological problems; non belonging to school ; non desire towards school; most teachers are not aware of educational theories" [2].

In this study the researchers tried to answer this question: (What are the main factors that cause low achievement of mathematics in the second year secondary schools at Khartoum state), through answering the following branch questions: Are the main factors which affect low achievement of mathematics in Khartoum state related to the type of school? Are they related to the school environment?

MATERIALS and METHODS

This study was carried out in Khartoum state. This area was selected because of its importance in Sudan; Khartoum is the capital of Sudan which is divided into seven localities.

The population of each locality comes from different states of Sudan so the population of Khartoum represents the population of Sudan. As well as schools are divided into private and public, where public schools are divided into general and model schools, male and female.

Population and sample size

Population of this study were 48313 students from second year secondary schools in Khartoum state according to the records of ministry of education in Sudan in 2009 [2], students at night schools were not included. Cluster sample was designed to collect numeric primary data about education from schools in the state in order to study low achievement of mathematics among second year secondary schools students, therefore students in second year represent the population frame of sampling.

The chosen sample size was about 1450 students collected from 50 (Model, General and Private) schools, divided through localities according to this equation:

$$n = \left[\frac{(Z_{\alpha 12})^2 . p.q}{d^2} \right] . def \ldots\ldots\ldots\ldots(1)$$

where n is the sample size, $Z_{\alpha 2}$ = 1.96 p 0.35, q =1-p = 0.65 where p+q = 1, d = 0.03, def = 1.5.

A questionnaire in this study was designed and filled by students.

The researchers used cluster sampling method. The selected sample of 1450 students issued the questionnaire, 1150 questionnaires returned back, 189 invalid questionnaire appeared and subtracted, there were 954 questionnaire retrieved. 507 of participants were male and 447 were female. Among the participants 353 were from General schools, 355 were from private schools and 246 were from model schools. The average age was ranged from 16 to 17 year and the percentages of different genders were much closed.

Data analysis

Factor analysis was applied to study the low achievement of mathematics among second year secondary school students in Khartoum state and to determine the factors that cause low achievement of mathematics.

Measurement instrument

The questionnaire was designed and tested by two experts, the questions were written in Arabic, 44 variables were included in the questionnaire. All the items in the questionnaire adopt four or five point Likert scale, some were three.

For reliability of data, Cronbach α analysis was calculated (α = 0.56) [3].

Forty four items of student questionnaire were relevant to the study. First, the correlation matrix was checked to determine the appropriateness of factor analysis, KMO value that was 0.791, and associated significant level was (0.000), the determinant of the correlation matrix was 0.0001. It was concluded that these data did not produce an identity matrix, see table (1). The data were then subjected to principal component factor analysis with Varimax Rotation. Based on the Ascree test, and Guttman - Kaisar rule [4,5], eleven factors were extracted and accounted for 79% of the total variance.

Table (2) lists the total variance explained. Figure (1) shows the graph of each eigen value (Y-axis) against the factor with which it is associated (X-axis), the breaking points was at 7, 8 and eleven [6], The results of rotated component matrix consist of eleven components that account for 59.529% of the variance.

Table 1: Kaisar – Meyer – Olkin Measure of sampling adequacy

	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.791
Bartlett's Test of Sphericity	Approx. Chi-Square	5691.831
	Df	561
	Sig.	.000

Table 2: Total variance explained (Rotation Sums of Squared loadings)

component	Initial eigen values			Rotation Sums of Squared loadings		
	Total	Percent of variance	Cumulative percent	Total	Percent of variance	Cumulative percent
1	4.432	13.034	13.034	1	4.432	13.034
2	3.425	10.075	23.109	2	3.425	10.075
3	1.834	5.393	28.503	3	1.834	5.393
4	1.593	4.686	33.189	4	1.593	4.686
5	1.440	4.236	37.425	5	1.440	4.236
6	1.275	3.751	41.176	6	1.275	3.751
7	1.247	3.668	44.844	7	1.247	3.668
8	1.131	3.327	48.171	8	1.131	3.327
9	1.095	3.222	51.393	9	1.095	3.222
10	1.052	3.094	54.487	10	1.052	3.094
11	1.034	3.042	57.529	11	1.034	3.042
12	.992	2.918	60.448	12	.992	2.918

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| 13	.919	2.703	63.150	13	.919	2.703
14	.887	2.608	65.758	14	.887	2.608
15	.837	2.461	68.219	15	.837	2.461
16	.824	2.424	70.644	16	.824	2.424
17	.784	2.304	72.948	17	.784	2.304
18	.750	2.207	75.155	18	.750	2.207
19	.736	2.166	77.322	19	.736	2.166
20	.716	2.105	79.427	20	.716	2.105
21	.685	2.014	81.441	21	.685	2.014
22	.669	1.966	83.407	22	.669	1.966
23	.623	1.832	85.239	23	.623	1.832
24	.599	1.761	87.001	24	.599	1.761
25	.576	1.695	88.695	25	.576	1.695
26	.532	1.565	90.260	26	.532	1.565
27	.513	1.508	91.768	27	.513	1.508
28	.496	1.458	93.226	28	.496	1.458
29	.489	1.438	94.664	29	.489	1.438
30	.415	1.222	95.886	30	.415	1.222
31	.400	1.175	97.061	31	.400	1.175
32	.355	1.043	98.104	32	.355	1.043
33	.331	.973	99.077	33	.331	.973
34	.314	.923	1.000E2	34	.314	.923

Source: SPSS output.

Scree Plot
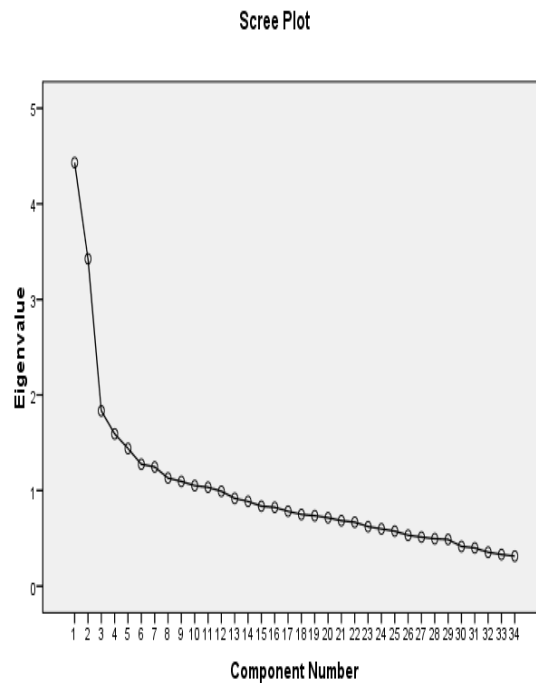
Figure 1: The graph of each eigen value against the factor with which it is associated

Factor structure of student's data

Table (3) indicates the structure of factors that caused low achievement of mathematics in 2nd year secondary school taken from student's data.

Table 3: Structure of factors

No.	Factor 1		Factor 2		Factor 3		Factor 4	
	Variable	loadings	Variable	loadings	Variable	loadings	variable	loadings
1	Suitable seating	0.745	Math degree at second year secondary school year	0.836	Mother education	0.806	Hours for studying math	0.671
2	Lighting; cooling the class room	0.694	Math degree at eight grade	0.814	Father education	0.781	Solving H.W. in the class	0.604
3	Lack of toilets	0.672	Math degree at first secondary school year	0.808	Father situation	0.533	Solve problems in class in group work	0.538
4	Capacity of the class room	0.637	School Type	0.591	Family income	0.507	Loving Mathematics	0.490
5	Lack of drinking water	0.591						
6	Teaching method is clear and easy	0.365						
7	Evaluate your teacher	0.313						
No	Factor 5		Factor 6		Factor 7		Factor 8	
	Variable	loadings	Variable	loadings	Variable	loadings	variable	loadings
1	I solve math work at home without assistant	0.616	Class room is not wide enough	0.744	Hours of T.V. viewing	0.639	Locality	0.713

No	Variable	loadings	Variable	loadings	Variable	loadings	Variable	loadings
2	Teaching method is clear and easy	0.589	I feel that the near classes are noisy	0.719	Sheeting solution at school	0.534	transport to school	0.517
3	Evaluate your teacher	0.471	Some students make noise in the class	0.519	Some students make noise in the class	0.494		
4	No. of days absents from school	0.461						
No	Factor 9		Factor 10		Factor 11			
	Variable	loadings	Variable	loadings	Variable	loadings		
1	Father situation	0.732	School gender	0.739	father occupation	0.864		
2	Student resident	0.728	Arrival to school	0.421				

The items with loadings greater than 0.3 were considered, the first three obtained factors were named as follows:

1 - School environment with seven items loadings between 0.313 and 0.745.

2 - Mathematics achievement with four items loading between 0.591 and 0.836.

3 - Education of parents with four items ranged between 0.507 and 0.806.

RESULTS and DISCUSSION

From the result of factor analysis for low achievement of mathematics in Khartoum state form the data of students and the underlined structure of low achievement in table (2), eleven variables, which explained 57.529% of the total variance, were extracted.

The most important three factors were school environment, mathematics achievement and education of parents. The first one was "school environment", which represents 13.034% of the total variance.

Seven variables were constructed this factor, which were: suitable seating, lighting and cooling of the class room, lack of toilet facilities in the school, capacity of class room (class size) [7,8], lack of drinking water, teaching method is clear and easy, and evaluate your teacher were significantly loaded on this factor. The second factor was "mathematics achievement", which was 10.075% of the total variance. Four variables were loaded on this factor, mathematics degree at second year secondary school, mathematics degree at 8th grade primary school, mathematics degree at 1st year secondary school and the type of the school, all were significantly loaded on this factor.

The third factor was "Education of parents" which amounts to 5.393% of the total variance. Four variables were included in this factor, "mother education", "father education",

"father situation" and the last one was "family income". The three above factors represent more than 28% of the total variance, which approximately was equal to the variance stated by the remaining factors.

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