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Analysis of students' mathematical achievement in grades 3 and 6 in Uganda: Factors affecting test scores and curriculum performance

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Abstract

This study aims at determining factors affecting students' mathematical achievement based on the curriculum, and finding out common errors and the reasons for them. Tests and questionnaires were conducted on grade 3 and grade 6 students. The results revealed: (1) the number of meals, living with mother, and socio-economic status (radio, table and kerosene lamp) positively affected scores in grade 3 and living with younger sisters negatively affected scores in grade 6, (2) student achievement was different in the contents of the curriculum, and (3) students were not able to solve applied questions without acquiring cognitive skills.

1. Introduction

The improvement of the quality of education has been a challenging issue in Uganda. A lot of research has been carried out to find factors affecting student achievement. However, few studies have been conducted to investigate the relationship between the curriculum performance and student, family and school factors. The successful ? result of the Primary Leaving Examination (PLE) has been around 80% in the last decade. On the other hand, the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) reported that Uganda was 11th out of 15 countries in mathematics achievement. Therefore, this study aims at investigating: (1) factors affecting students' mathematical achievement based on the curriculum, (2) what are students' mathematical achievement differences in the contents of the curriculum, and (3) what errors do students make in their calculations and the reasons.

2. Literature review

Finding factors that affect student achievement has been a debatable issue. In developing countries, some studies have revealed that school factors had more influence on student achievement than student and family

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factors. This is because school inputs were not sufficiently supplied in developing countries (Heyneman, 1976; Heyneman and Jamison, 1980). On the other hand, other studies revealed that student and family factors affected student achievement in developing countries in the same way as developed countries (Lockheed, Fuller & Nyirongo, 1989; Hungi & Postlethwaite, 2009). Nannyonjo (2007) reported that school inputs accounted for seven percent of the variance in mathematics achievement. However, these studies used the national examination in the final grade for determining student achievement (Heyneman, 1976; Heyneman & Jamison, 1980; Fuller & Nyirongo, 1987) or the international examination (Nannyonjo, 2007; Kasirye, 2009). In Uganda, survival rate was 57% in grade 5 and 31% in grade 7, and Primary Complete Ratio (PCR) was 58% (MoEST, 2011). Therefore, it is necessary to measure student achievement in other grades to find factors influencing student achievement.

To improve the quality of education it is important to find out what kind of errors students made in theircalculations. While the National Achievement Progress in Education (NAPE) was a test for measuring continuous student achievement in Uganda, it only showed the weak points of students in mathematics (UNEB, 2011). Thus, it is necessary to analyze which points students have difficulty with in mathematics.
It is necessary to obtain knowledge, comprehension and application to solve questions in mathematics (Bloom, 1956). Students are required to have the basic ability of acquiring knowledge and comprehension to solve applied questions. Many studies have been carried out to find out how students acquire comprehensive skills (Smith, et al., 1996; Siegler, 2003). However, in developing countries, almost no research has been conducted to analyze this point.

3. Research methodology

This study selected 10 public primary schools in Mpigi district in Uganda, as shown in Table 1. The results of PLE were used as an indicator for the selection of schools.

Table 1 Sampling schools

School	PLE Pass Rate (%)					
	Ave.07-11	2011	2010	2009	2008	2007
A	94	100	100	90	97	84
B	94	100	83	97	96	94
C	92	100	85	92	93	91
D	83	91	89	91	59	86
E	77	86	88	86	53	70
F	77	75	96	75	52	87
G	75	91	100	74	46	65
H	71	67	65	71	62	91
I	60	48	63	67	54	70
J	58	53	75	71	29	60
National Ave.	86	86	88	86	81	87

Source: EMIS 2007-2011

Mathematics tests for grades 3 and 6 were developed by the authors based on the curriculum. The curriculum consisted of 10 topics. Textbooks and past PLE papers were used for making tests. The tests consisted of 31 items in grade 3 and 40 items in grade 6. The detail of items in the tests is shown in Table 2. After pre-tests had been conducted with students, tests were modified with district education officers, head teachers and teachers in primary schools. Three hundred and sixteen students in grade 3 and 329 students in grade 6 took the tests. The questionnaires consisted of 17 items, which were related to student and family factors. They were administered to all students who took the tests. The field research was carried out from May to August, 2012.

Table 2 The contents and number of items in the tests

	Contents	Grade 3			Grade 6		
		Knowledge/Comprehension	Application	Total	Knowledge/Comprehension	Application	Total
1	Set Concepts	2		2	2		2
2	Numeration Systems and Place Value	6		6	4		4
3	Operations on numbers	8		8	8		8
4	Number patterns and Sequences	2		2	2		2
5	Fractions	3		3	7		7
6	Graphs and interpretation of information	2		2	1	3	4
7	Geometry	2		2	3		3
8	Integers			0	4		4
9	Measures	2		2	2		2
10	Algebra		4	4		4	4
	Total	27	4	31	33	7	40

Source: Developed by the authors, based on the curriculum in Uganda (1999) and Bloom's Taxonomy (1956)

4. Results

4.1 Factors affecting students' achievement

Factors affecting students' achievement were found in this study. The number of meals, living with mother and socio-economic status (radio, table and kerosene lamp) positively affected scores in grade 3. Living with younger sisters negatively affected scores in grade 6.

Table 3 Factors affecting test scores in grade 3

	Unstandardized Coefficients		Standardized Coefficients
Model	B	Std. Error	Beta
(Constant)	15.463	3.561	
Sex (0=Girl, 1=boy)	-0.756	0.912	-0.059
Age	-0.243	0.298	-0.058
Number of meals	0.864	0.436	0.138*
Living with father	-1.207	1.101	-0.088
Living with mother	2.322	1.174	0.163*
Repeat	-0.599	0.45	-0.097
Transfer	0.375	0.459	0.061
Father's educational level	0.419	0.278	0.106
Textbooks at home	-1.082	0.964	-0.085
SES (Car, TV, motorcycle)	-0.537	0.584	-0.067
SES (radio, table, kerosene lamp)	1.687	0.646	0.186*
R^2		.106,	
$\triangle R^2$		.044	

Note. *$p < .05$

Table 4 Factors affecting test scores in grade 6

	Unstandardized Coefficients		Standardized Coefficients
	B	Std. Error	Beta
(Constant)	32.103	4.634	
Sex	0.777	0.705	0.069
Age (0=Girl, 1=Boy)	-0.506	0.312	-0.106
Ethnicity (0=Others, 1=Luganda)	0.952	1.090	0.053
Experience of Nursery	1.394	1.084	0.079
Living with elder brothers	0.860	0.817	0.065
Living with younger sisters	-2.248	0.818	-0.169 *
Living with father	-1.141	0.841	-0.097
Living with mother	1.247	0.921	0.094
Father's educational level	-0.239	0.326	-0.054
Mother's educational level	-0.261	0.309	-0.060
Textbooks at home	-0.696	0.826	-0.057
Dictionary at home	1.138	0.946	0.081
SES (table, chair and cellphone)	0.518	0.493	0.066
SES (Charcoal cooker, kerosene lamp and stove)	-0.372	0.474	-0.049
SES (mosquito net)	-0.691	0.499	-0.087
R^2		0.091	
$\triangle R^2$		0.038	

Note.*p<.05

4.2 Curriculum performance

The reliability of the tests was α =0.848 in grade 3 and α =0.793 in grade 6. The average of the scores were 16 out of 31 items (52%) in grade 3, and 25 out of 40 items (61%) in grade 6. The level of student achievement was different in the contents of the curriculum, as shown in Table 5. The strength and weakness of the contents of the curriculum in these tests was the same as the results in the NAPE. Students understood calculation of integers, such as 'numeration systems and place value' and 'operation on numbers'. Students were not able to understand 'fractions', especially the problems of adding and subtracting different denominators. In 'algebra', the achievement was not low in grade 6; however, students were not able to write formulae on word problems.

Table 5 The results of curriculum performance

	Content	Grade 3 (%)			Grade 6 (%)		
		Knowledge/Comprehension	Application	Total	Knowledge/Comprehension	Application	Total
1	Set Concepts	67		67	50		50
2	Numeration Systems and Place Value	52		52	90		90
3	Operations on numbers	69		69	89		89
4	Number patterns and Sequences	61		61	61		61
5	Fractions	32		32	54		54
6	Graphs and interpretation of information	61		61	86	36	61
7	Geometry	30		30	53		53
8	Integers			N/A	34		34
9	Measures	69		69	42		42
10	Algebra		29	29		72	72
Total		55	29	52	62	54	61

Source: Developed by the authors, based on the curriculum in Uganda (1999) and Bloom's Taxonomy (1956)

The achievement of the same items, excluding 'Tell time on hours', was significantly improved from grade 3 to grade 6, as shown in Table 6. This is because students practiced similar questions in the extra classes in grade 6. Students had problems in the calculation of integers in grade 3. They solved the problems with adding and subtracting 2-digit numbers, using sticks for counting the numbers until 2-digit numbers, without binding ten sticks. They could not understand the meaning of the digit. The percentage of correct answers of 'Tell time on hours' decreased from grade 3 to grade 6. This is because students did not understand how to read the long and short hands of a clock as they rarely saw a clock in a daily life.

Table 6 The results of the same items in the tests of grade 3 and 6

Item	Grade3	Grade 6	Improvement rate (%)
Add two-digit numbers without carrying	62	98	58
Subtract two-digit numbers without borrowing	43	90	109
Count an object tens in word	54	90	67
Write an object tens in number	43	94	119
Draw unit fractions with deminator less than 10	50	90	80
Mulitply a one-digit number by a one-digit number	66	94	42
Divide a one-digit number by a one-digit number	42	88	110
Arrange number according to the size	32	88	175
Represent informainton in a pictogram	68	86	26
Name object	33	70	112
Tell the time on the hour	67	31	-54

Source: Developed by the authors

5. Conclusion and discussion

This study found factors affecting student' mathmatical achievement based on the curriculum in Uganda. The number of meals, living with mother and social economic status (radio, table and kerosene lamp) positively affected scores in grade 3. Living with younger sisters negatively affected scores in grade 6. Factors affecting students' achievement explained about 10%, both in grades 3 and 6 in this study. One reason would be that self-esteem of students is not included in the student factor in this study. Other studies clarified student and family factors affecting students' achievement at a similar percentage. Therefore, future studies are expected to find other factors.

This study also revealed that students' achievement was different in the contents of the curriculum. Students' achievement in mathematics improved from grade 3 to grade 6 in terms of calculation of integers, but students were not able to understand the meaning of the digit in grade 3 and fraction in grade 6. Students had difficulty in solving questions in applications because of the lack of knowledge and comprehension.

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