ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 2. No. 1. February 2013

SECONDARY SCHOOL STUDENTS' PERCEPTIONS OF MATHEMATICS FORMATIVE EVALUATION AND THE PERCEPTIONS' RELATIONSHIP TO THEIR MOTIVATION TO LEARN THE SUBJECT BY GENDER IN NAIROBI AND RIFT VALLEY PROVINCES, KENYA

Bernard Nyingi Githua

Department of Curriculum, Instruction and Education Management,
Egerton University, Njoro,
KENYA.

bgithua2002@yahoo.com

ABSTRACT

In the 21st century, more than ever before nearly all fields of knowledge are dependent on mathematics for solving problems, stating theories and in the prediction of outcomes. Despite the importance of mathematics to individuals in their daily lives as well as in industry, Business, governance, science and technology, students' performance in the subject has persistently been poor internationally and in Kenya. Some of the reasons advanced for students' low achievement in the subject are the specialized language used in the subject, ineffective teacher-centered teaching methods, learners' low mathematics self-concept and anxiety of the learners during mathematics tests. This study analyzed secondary school students perceptions of Formative evaluation in learning mathematics and the relationship to their motivation to learn the subject. The target population was all students in secondary schools of Kenya's Nairobi province, Nakuru, Kericho and Koibatek districts. A sample size of 649 students from 32 secondary schools (320 boys and 329 girls), stratified by class level, school category, gender and social set up (mixed sex or single sex schools) was used for the study. A 16-item Students' Perception of Formative Evaluation (SPEM) Questionnaire and a 28-item students' motivation to learn mathematics (SMLM) Questionnaire with reliability coefficient alphas of 0.81 and 0.89 respectively were used to collect the data. The results indicated that relationship between SPEM and SMLM was strong and significant (r=0.750) at α=0.01 significant level. Some aspects of students perception of mathematics formative evaluation had gender differences significant at α=0.05 level. The implications of the findings of the study have been indicated and recommendations made for mathematics educators and for further research.

Keywords: Students' perceptions, Formative Evaluation, mathematics, learner's motivation, Secondary school students, Gender, Kenya

INTRODUCTION

Mathematics is perceived by society as the foundation for scientific and technological knowledge that is cherished by societies worldwide. It is an instrument for political, socio-economic, scientific and technological developments (Githua & Mwangi, 2003). Mathematics is a compulsory subject for all learners in Primary and Secondary schools in Kenya (KIE, 2002). It is also used by Universities to filter secondary school learners for entry into the prestigious science-based degree programmes (Kenya Universities Joint Admissions Board, 2006)

Despite the importance attached to mathematics by society there has been low achievement in the subject in Kenya (Kenya National Examinations Council-KNEC, 2003, 2004) and in

ISSN: 2186-8492, ISSN: 2186-8484 Print
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other parts of the world as indicated by the Third Trends in Mathematics and Science study (TIMSS) of 2004 (Gonzales, Guzman and Jocelyn, 2004).

A multiple of causes for the students low achievement in mathematics has been attributed to: difficulty in understanding the specialized mathematical language (Barton, 2002; Oyaya & Njuguna, 1999; Battisa & Clements, 1996; O'connor, 2000), ineffective, teacher-centered teaching methods and learners' negative attitudes towards the subject (Miheso, 2012; Ngeno & Changeiywo, 2007), Learners lack of motivation to learn the subject(Githua & Mwangi, 2003) and lack of mathematics syllabus coverage (Shikuku, 2009).

This study analyzed secondary school students' perceptions of formative evaluation in mathematics classrooms in order to determine whether those perceptions have any relationship with students' motivation to learn mathematics. Gender differences in the student's perceptions of evaluation in mathematics were also studied because it could be an indicator of the gender differences in mathematics achievement that exist among secondary school students in Kenya.

In this study students' perception of formative evaluation in mathematics referred to their opinions, feelings, emotions and judgments of the importance, usefulness and meaningfulness of teachers' actions, procedures, practices and social climate in which they assess and monitor students' mathematics learning.

Evaluation of students' mathematical work involves teachers' qualitative judgment of how well or how satisfactorily a student is performing or progressing in learning mathematics tasks (Hamachek, 1995). According to Dembo (1994) there are different types of instructional evaluation that a teacher can carry out. They include: placement evaluation which is aimed at finding out students' entry behavior before beginning instruction; formative evaluation which provides ongoing feedback to teachers and students regarding successes and failures during instruction; diagnostic evaluation which attempts to find out specific learning difficulties that a student may have on specific mathematical facts, algorithms, concepts, principles or problem solving.

There is also summative evaluation, which comes at the end of instruction in a school term or year. It assesses the extent of attainment of instructional objectives, provides information to guide grading of students and evaluates teacher effectiveness (Dembo, 1994).

This study focused on formative evaluation in which mathematics teachers give oral written comments and grades as feedback, to indicate misconceptions, or correctness/incorrectness of mathematical performance (Dean, 1982). Formative evaluation requires that the teacher collects a lot of information on learners' performance through observations, classroom oral questioning, homework assignments, quizzes as well as informal inventories (Ebee & Frisbie, 1991).

Operationally in this study students' perceptions of formative evaluation in mathematics was defined as a composite variable represented by a mean score of the non-missing students responses on 16 items which were used to measure the construct on a 1 to 5 point Likert-type survey instrument.

Students perception of formative evaluation in mathematics included: perceptions of difficulty/ease of mathematical tasks; importance, usefulness, meaningfulness and contribution of mathematical assignments and tests to mathematics learning; students' liking/dislike of teachers' posting of mathematics grades on notice boards; stiff competition in mathematics performance; pressure of time to complete mathematical tests; pressure of

time to complete mathematical assignments; and students' experience of worry or anxiety created by mathematical tests.

Motivation to learn subject matter in this study referred to the internal drive or external force that initiate, maintain or causes to cease a learner's behaviour towards learning subject matter that is targeted and is the learner's goal. (Husen & Postlethwaite, 1985). There are two types of motivation to learn: intrinsic; and extrinsic motivation (Biehler & Snowman, 1997; Good & Brophy 1995).intrinsic motivation is a response to individuals internal needs for example personal enjoyment in learning a task, or interest in a subject that is inherently interesting (Good & Brophy, 1995).

Extrinsic motivation is directed towards getting rewards that are external to the learner such as teachers' encouragement, positive feedback on learner's performance on skills or tasks. Due to the importance educators attach to motivation in the learning process this study wanted to find out whether students' perception of formative evaluation in mathematics which goes on in secondary school mathematics classrooms are related to learners motivation to learn mathematics.

Studies conducted in other parts of the world indicate that one of the purposes of evaluation is to cultivate motivation in learners (Shiton, Kenwood, Moss and Phimpton, 1985; Berliner and Cassanova, 1988). There is however limited such studies that having been carried out in Kenya. The present study was therefore warranted.

STATMENT OF PROBLEM

The importance of mathematics to an individual and society is acknowledged worldwide. Unfortunately, learners' performance in the subject at national examinations at the end of primary and secondary schools education is worrying all over the globe. Among the reasons given for the dismal mathematics achievement is lack of students' motivation to learn mathematics and hence their low achievement in it. In an attempt to seek reasons for learners' low motivation this study investigated whether students' perception of formative evaluation in mathematics has any relationship with their motivation to learn the subject by gender.

PURPOSE OF THE STUDY

The study sought to analyze secondary school students' perceptions of formative evaluation in mathematics classrooms by gender and find out whether those perceptions are related to students motivation to learn mathematics.

OBJECTIVES OF THE STUDY

1. To find out whether students' perceptions of formative evaluation in mathematics is related to the achievement in the subject.
2. To establish whether there are genders differences in students' perception of Formative evaluation in Mathematics.

NULL HYPOTHESES

The following are the two hypotheses of the study which were tested at 0.05α – level.

$H_0$1: There is no statistically significant relationship between secondary school students' perceptions of formative evaluation in mathematics classrooms and their motivation to learn mathematics.

$H_0$2: There are no statistically significant gender differences in students' perceptions of formative evaluation in mathematics classrooms.

ISSN: 2186-8492, ISSN: 2186-8484 Print
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Conceptual Framework

The conceptual framework of the study shown diagrammatically in Figure 1 was based on systems theory as espoused by Ayot and Patel (1987) as well as Gerlach and Ely (1980). The influence of students' motivation to learn mathematics (dependent variable) by their perceptions of formative evaluation in mathematics classrooms (independent variable) was hypothesized to be a dynamic systematic process in which there was also an extraneous variable of students' of gender which could affect students' motivation to learn mathematics. The hypothesized relationship of the variables is shown in Figure 1.

METHODOLOGY

Research Design

The expost-facto research design was used in this study in which correlation/regressional analysis were employed to analyze the data. This design was appropriate for the study because the study aimed at obtaining important information on the status of specific phenomenon after some naturally occurring treatment without any manipulation of the situation (Koul, 1993).

Population

The target population of the study was all students in secondary schools (Forms I – IV) in Nairobi province, Nakuru, Kericho and Koibatek districts in Kenya.

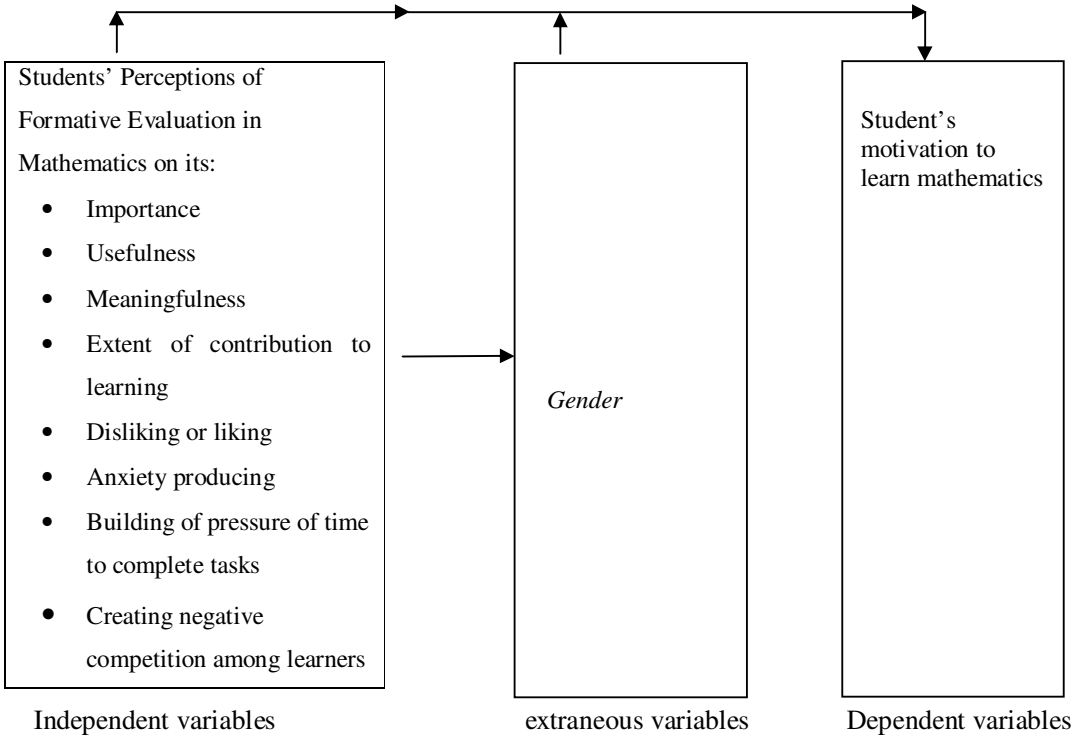

Figure 1. The conceptual Framework of the relationship of variables in the study

Sampling Procedure and Sample Size

A sample of 649 students (320 boys, 329 girls) was obtained from 32 secondary schools (19 public, 13 private) stratified by school category (provincial or district) sponsorship (public, private) and by gender (single-sex or co-educational) and class level. Table 2 and Table 3

show how the schools and the students were sampled from rural, urban and the different categories of schools respectively.

Table 2. Distribution of Sample Schools in the Twelve Strata of Secondary Schools in Nairobi Province and Rift Valley Province (Nakuru, Kericho and Koibatek Districts)

Provide/ District	*No. of Schools*	*No. In Sample of Each Stratum of Public Schools*						*No. In Sample of Each Stratum of Private Schools*						
		RURAL			URBAN			RURAL			URBAN			
		Boys	Girls	Mixed	Boys	Girls	Mixed	Boys	Girls	Mixed	Boys	Girls	Mixed	Total
Nairobi	82	-	-	-	2	2	2	-	-	-	2	1	2	11
Nakuru	104	1	1	2	-	1	1	1	1	1	-	1	1	11
Kericho	51	1	1	2	-	-	-	-	1	1	-	-	-	6
Koibatek	19	1	1	1	-	-	-	-	1	-	-	-	-	4
TOTALS	*256*	*3*	*3*	*5*	*2*	*3*	*3*	*1*	*3*	*2*	*2*	*2*	*3*	*32*

Table 3. Distribution of Sampled Students in the Twelve Strata of Secondary Schools in Nairobi Province, Nakuru, Kericho and Koibatech Districts

Provide/ District	*No. of Math Students in Province/District*	*No. In Sample of Each Stratum of Public Schools*						*No. In Sample of Each Stratum of Private Schools*						
		RURAL			URBAN			RURAL			URBAN			
		Boys	Girls	Mixed	Boys	Girls	Mixed	Boys	Girls	Mixed	Boys	Girls	Mixed	Total
Nairobi	26,245			-	57	40	42	-	-	-	36	24	39	238
Nakuru	36,959	16	16	65	-	16	16	32	16	25	-	17	21	240
Kericho	12,897	20	16	40	-	-	-	-	16	17	-	-	-	109
Koibatek	5,340	12	14	24	-	-	-	-	12	-	-	-	-	62
TOTALS	*81,441*	*48*	*46*	*129*	*57*	*56*	*58*	*32*	*44*	*42*	*36*	*41*	*60*	*649*

Source: M.O.E (1999) Provincial Education Officer records (Nairobi and Rift Valley Provinces)

Instruments

A 16 – item, 5 point liker type instrument was used to measure students' perceptions of formative evaluation in mathematics (SPEM) classrooms. A 28-item, 5 point liker type instrument was also used to measure students' motivation to learn mathematics (SMLM). Both instruments were validated by five experts from the department of Curriculum, Instruction and Education Management of Egerton University. The two instruments had reliability coefficients alphas of 0.81 and 0.89 for SPEM and for SMLM respectively. Data was analyzed by calculating Pearson's moment correlation coefficient between SPEM and SMLM, regression analysis and the ANOVA procedure.

ISSN: 2186-8492, ISSN: 2186-8484 Print
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RESULTS

Out of a total of 649 students who were involved in the study, 648 responded to the 16 items, which were used to measure their perceptions of formative evaluation in mathematics.

Relationship between Students' Perceptions of Formative Evaluation in Mathematics and Their Motivation to Learn Mathematics

Table 4. Relationship between SPEM and SMLM.

	SMLM	*SPEM*	*(N=648)*
SMLM	1	0.750**	
SPEM	0.750**	1	

**Shows that r, the correlation coefficient is significant at α = 0.01 level.

Results from Table 4 indicate that there is a strong and statistically significant relationship (r=0.750) between students perceptions of formative evaluation in secondary school mathematics classrooms and their motivation to learn mathematics at α = 0.01 significance level. The hypothesis of the study that there is no statistically significant relationship between SMLM and SPEM was therefore rejected. This finding is supported by research studies in USA (Berlinger and Cassanova, 1988) which showed that evaluation in subject matter in the course of instruction enhances and is related to student's intrinsic motivation.

To determine the proportion of variance in student's motivation to learn mathematics explained by their perceptions of formative evaluation in mathematics, students' motivation to learn mathematics was regressed (stepwise) on students' perceptions of evaluation in mathematics.

Using a probability of F-to-enter less or equal to .50 and a probability of F-to-remove greater or equal to 0.1 the regression output of the independent and the dependent variables as shown in Table 5.

Table 5. Regression of Students' Motivation to Learn Mathematics on their Perceptions of Formative Evaluation in Mathematics-Stepwise Entry (N=646, valid listwise)

Variables	*R*	*R-square*	*Adjusted R -square*	*Beta*	*t*	*Sig (P)*
Constant				0.63	5.74	0.000
Students' perceptions of evaluation in mathematics	0.75	0.56	0.56	0.82	28.75	0.000
F=826.547	R^2=0.5625	AdjR^2=0.56	Prob(>)=0.000		df=(1,644)	

The simple linear regression output shown on table 5 suggests that the linear equation relating students' motivation to their perception of formative evaluation in mathematics is of the form:

$$\text{SMLM} = \underset{(t = 5.742)}{0.63} + \underset{(t = 28.750)}{0.82 \times (SPEM)} ...Equation1$$

Adjusted R^2 = 0.562 suggesting that students' perceptions of formative evaluation in mathematics explains 56.2% of the variance in SMLM. The values of t for the corresponding values of constant and beta (coefficient) in the equation are significant at 0.01. The F – value

from ANOVA undertaken for the whole equation is 826.547, significant at 0.01, df = (1,644) suggesting that R^2 is significantly different from zero and the coefficients in the equation are different from zero. The equation therefore, exists and defines a linear relationship between SMLM and SPEM. This further led to the rejection of hypothesis one of the study. This suggests a strong significant relationship between students' perception of formative evaluation and their motivation to learn mathematics.

Gender Differences In Secondary School Students' Perceptions Of Formative Evaluation In Mathematics Classrooms

Table 6 shows results for hypothesis two of the study. The table shows mean scores, SD on student's perceptions of Formative Evaluation in mathematics by gender.

Table 6. Mean Scores and Standard Deviations on Students' Perceptions of Formative Evaluation in Mathematics by Gender (16 items)

Gender	*Mean*	*SD*	*N*
Male	3.86	0.51	319
Female	3.84	0.50	329
Total			648

Table 6 shows mean scores and SD for 648 students. Overall boys had higher mean scores in SPEM than girls.

The F-value undertaken from ANOVA for mean gender differences in SPEM for all the 16 items taken together was 0.516 at $\alpha = 0.473$ significant level; df = (1,646) which was not statistically significant at .05 level of significance. This suggested that overall; there is no statistically significant gender differences in students' perception of formative evaluation in mathematics.

Analyzing the 16 items that measured students' perceptions of Formative evaluation in mathematics item by item however revealed that there were gender differences in the following five items on students' perceptions of Formative evaluation in mathematics scale:

a. I find mathematics tests easy (in favour of boys).
b. I find mathematics assignments meaningful (in favour of girls)
c. mathematics assignments contribute a lot to the learning of mathematics (in favour of girls)
d. I usually worry over mathematics tests and assignments (in favour of boys).
e. I rarely find time for mathematics assignments (in favour of boys).

The responses to the positive items in the scale were scored as strongly agree = 5, agree = 4, undecided = 3, disagree = 2 and strongly disagree = 1.

Negative items were scored in the reverse order. Therefore higher scores indicated positivity of students' perception of Formative evaluation in mathematics learning. The results showed significant gender differences for the five items at $\alpha = 0.05$ significance level.

The results for items one, three and five which were in favour of boys suggests that girls find mathematics tests hard compared with boys, they have more mathematics anxiety to succeed in the subject than the boys and girls rarely find time to do mathematics assignments at home

ISSN: 2186-8492, ISSN: 2186-8484 Print
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due to domestic chores (Mureithi,2000). Items two and three which favoured girls suggests that girls feel comfortable when they are given mathematical tasks in form of assignments than the boys do.

DISCUSSION

Students' Perceptions of Formative Evaluation in Mathematics and their Motivation to Learn Mathematics

Mathematics educators (Fraser & Gillan, 1972; Shiton, Kenwood, Moss and Phimpton, 1985) agree that among other purposes of evaluation in mathematics, the provision of motivation to learn mathematics is critical. The findings of this study revealed that there is a strong and statistically significant ($\alpha = 0.01$) relationship ($r = .750$) between SMLM and SPEM in secondary schools. Furthermore, there is a linear relationship between students' motivation to learn mathematics and their perceptions of evaluation in mathematics. The variation in SMLM accounted for by SPEM was 56.2% when no other relevant variables were considered.

The findings in this study are consistent with those in USA by Berliner & Cassanova (1988) and Butler & Nissan (1986) which showed that evaluation and giving of grades does much to enhance student's extrinsic motivation to learn subject matter but can also have a strong negative effect on students' intrinsic motivation if evaluation is improperly carried out. The findings of this study concur with the arguments of Chinn & Ashcroft (1993) that evaluation in mathematics is an essential and important component of learning mathematics. Mwangi & McCaslin (1994 in their findings on agricultural extension agents in Kenya's Rift Valley Province found out that evaluation was one of the factors that was related to job motivation for agricultural extension agents in Rift Valley Province.

Elsewhere, for example, the frequency of teacher evaluations, the time teachers spend correcting tests and exercises were fournd to be related to academic achievement of upper primary school pupils in Argentina and Columbia (Lockhead & Verspoor, 1991). The time that teachers spend on monitoring and evaluating students' performance was found to be related to student's mathematics achievement in upper primary schools in Swaziland (Lockhead & Verspoor, 1991). This study has clearly demonstrated that formative students' perceptions evaluation in mathematics in secondary schools is related to students' motivation to learn mathematics which would lead to higher levels of mathematics achievement (Hemke, 1990). Secondary school mathematics teachers should therefore plan carefully for mathematics quizzes, homework, classroom supervised mathematics work, end term mathematics tests and end-year mathematics examinations in order to increase students motivation to learn mathematics.

CONCLUSIONS

On the basis of the findings of this study, the following conclusions were reached.

1. There is a strong and significant relationship between students' perception of formative evaluation in mathematics classrooms and their motivation to learn mathematics.
2. Students' perception of formative evaluation in mathematics classrooms accounted for 56% variation in students' motivation to learn mathematics when no other independent variable were considered.

3. There are gender differences in the way boys and girls perceive some aspects of formative evaluation in mathematics classrooms.

IMPLICATIONS

The implications of the findings are that teachers should carefully plan and administer mathematics quizzes, out of class assignments, supervised classroom mathematics assignments, end term and end year mathematics examinations. The environmental and social conditions in which teachers handle mathematics formative evaluations and their feedback to learners should be conducive for both boys and girls. This would enhance the learners' motivation to learn mathematics.

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ISSN: 2186-8492, ISSN: 2186-8484 Print
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