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Class Size and Quality Academic Achievement Among Girls in Mathematics in Secondary Education in Kisumu County

Josephine Adhiambo Agunda, Henry Onderi, Jack Ajowi
Jaramogi Oginga Odinga University of Science and Technology

ABSTRACT

Female students tend to take fewer mathematical courses at higher education level due to low performance in mathematics at secondary school level. A number of studies both qualitative and quantitative have attempted to find out causes of low achievement in mathematics among females, Researchers have majorly focused on school environment, biological factors and attitude. There was therefore need to conduct a study to establish the influence of class size on academic achievement among girls at form four level in public secondary schools in Kisumu County. The objective of the study was to determine the influence of class size on academic achievement among girls in mathematics at form four level. Correlation research design was applied to examine the degree of influence that exists between class size and academic achievement in mathematics. The study was conducted in Kisumu County of Kenya. The target population of the study consisted of 142 public secondary schools which presented female candidates for KCSE examinations between 2010 and 2014, 142 Principals, 142 Heads of mathematics department and 390 mathematics teachers who taught the girls under study. Stratified random sampling technique was applied whereby schools were categorized as girls' secondary schools and mixed secondary schools. Purposive sampling was done to select all the 18 girls' secondary schools in Kisumu County while random sampling was applied to select 38 out of 124 mixed secondary schools in Kisumu County. Data was collected using questionnaires, interviews and document analysis. Instruments of data collection were validated by the researcher's supervisors and reliability of the instruments was established through test retest method by carrying out a pilot study in 5 schools which were not part of the study sample. Quantitative data was analyzed by use of descriptive statistics in form of frequency counts, percentages, means, Pearson's Product Moment Correlation and regression analysis. Qualitative data from interview schedule was analyzed by using thematic analysis. Statistical Package for Social Sciences (SPSS) version 22 was applied to assist in analyzing data. The findings of the study concluded that there exists a positive relationship between class size and academic performance in mathematics. The study recommended a class size of 40 to enable teachers cater for individual interests of all learners.

Keywords:
Class size, Quality Academic achievement, Public secondary schools.

***Correspondence to Author:**
Josephine Adhiambo Agunda
Jaramogi Oginga Odinga University of Science and Technology.

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INTRODUCTION

Research findings by Runhare and Gordon (2004) noted that certain school subjects like mathematics and science have been known to be men's subjects. Girls are known to develop speech at an early age and are superior in the linguistic skills of reading, writing, spelling and grammar than in science oriented subjects. The researchers argued further that there is a special need to attend to education of women and girls not only so that they may discover themselves but because of the increased contribution which education will enable them to make to the economic, social and political development of their countries.

Spielhofer et al (2002) points out that girls do not enjoy the subject as much as boys, lack of confidence in their ability in mathematics, and ultimately, fewer numbers of girls than boys choose to study mathematics at tertiary level.

This may in part be due to the stereotypical beliefs that many students, parents and teachers have that mathematics is a masculine subject (Ruhnare et al, 2004). Given that its usually the highest performing students that are likely to go on to higher education or into jobs in science and technology, this has huge implications for initiatives. The scenario has since encouraged girls to venture into math field and reduce gender discrimination (Freeman, 2004). In recent decades, women's participation in the workforce and pursuits of high education has increased substantially, but there continues to be striking sex differences in college majors and careers choices; for example, under 3% of Nobel Laureates in science are women and no woman have so far received one of the top three awards in mathematics, the Fields Medal, the Abel Prize and the Wolf Prize (Spencer, 2001).

Noraini (2015) in Newzealand postulates that mathematics is a crucial skill in the information age. The achievement in mathematics must be improved to maintain the economic leadership. The writer addressed the point that while technology advances at high speed, poor mathematics performance in schools shortchanges the students' further and endangers the prosperity and nation's security towards technological advancement. Feminist researchers have tried to make meaning of the experiences of girls in the mathematics classroom and to interpret female performance. Their findings revealed that girls are often marginalized and given subordinate status in mathematics class in co-existing high schools.

The perception of teachers is that girls' performances in mathematics are dependent on rote learning, hard work and perseverance rather than natural talent, flexibility and risk taking which are the learning styles of boys (Zhu 2007).This is in a similar agreement with Bassey, Joshua and Asim (2007) in a study conducted in Nigeria on gender differences in mathematics achievement who attributed the difference to cognition and brain lateralization. These researchers emphasized that most mathematics classroom discourse is organized to accommodate male learning patterns and low motivation in girls making girls achieve low in mathematics. There is importance of gender equality within the international goal setting as evidenced in the Education for All (EFA) goals and Millennium Development Goals (MDG's).

Senior decision makers of the 15 Ministries of Education in Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) have also been concerned with gender equality issue not only in access and participation but also in learning achievement (Mollis et al 2008). In Industrialized countries, the gender gap with domination by girls has been widened throughout the years for reading and for mathematics, strong boy's domination (Lopez-Claros 2014). The choice of gender as variable for this study is predicted on the current world trend and research emphasis on gender issues.

Mathematics is seen by the society as foundation of scientific and technological

knowledge that is vital in socio-economic development of any nation. There is a general agreement that in any society, every child should study mathematics at school to acquire skills for adult life hence due to this significance, there is greater pressure for girls to succeed in mathematics more than any other subject. Mathematics is compulsory for all students in Kenya due to its major objective of development of thinking ability and logical thought. It aims at developing numerate and rational citizens who are useful in the home, society and nation. It is important in the learning of other subjects and its application in industry and performance in mathematics is of great concern to education stakeholders (KNEC 2015).

Mathematics is used at the university as a filter of students into Science and related careers. It is used as a basic entry requirement into any of the prestigious courses such as medicine, architecture and engineering among other degree programmes KNEC (2015) report confirmed that despite the important role that mathematics plays in society, there has always been poor performance in the subject among girls in national examinations. Due to low achievement of girls in Mathematics and Science related subjects in Lesotho, a project Gender-sensitive training of teachers and school principals for girls and women's access, participation and advancement in Mathematics, Science and Technology education was initiated in March 2011 to improve girls and women's access and advancement in the learning and teaching of Sciences, Mathematics and Technology (Saito, 2010).

LITERATURE REVIEW

In a compilation of studies examined by Education Research Service in Florida by Hoxby (2000), it concluded that research does not support the expectations that class size will of themselves result in greater academic gains for students. The author observed that the effect of class size on students learning vary by grade level, pupils' characteristics, subject areas, teaching methods and other learning interventions.

The study concluded that small classes are most beneficial in reading and mathematics in primary grades and that students who are economically disadvantaged or from some ethnic minorities perform better academically in smaller classes. In sub-Saharan Africa, studies conducted established that average class size in public primary schools ranges from 26 pupils in Cape Verde to 67 in Chad. In four out of ten countries reporting data, there are on average 50 or more pupils per class. This is much higher than average class size in European Union (UNESCO 2010).

A research carried out by Chingos, (2013) in Florida state schools analyzed girls perception of the classroom size and settling on academic achievement in mathematics and found a standardized regression coefficient of R = 0.41 and concluded that a supportive class size influenced girls' achievement in mathematics. Wossmann and West (2006) in several districts in New York, North Carolina and Sandiego states carried out studies focusing on class size and the studies focused on class size and achievement at high school level. The data availed for multiple years reveal a negative relationship between class size and student achievement as measured by standardized test scores, indicating that the bigger the class size and the lower the test scores. In other words, the research typically concludes that smaller classes are associated with higher student achievement. (Wosseman et al 2006).

In Europe the most influential studies use the maximum class-size rule. In Sweden, a one student reduction in class size in grades four to six is associated with an increase in performance. (Chingos 2013). Similarly, in France numerous researchers have applied this technique and identified a smaller, positive relationship between smaller classes and

student achievement both at elementary and secondary grades (Chingos 2013). However, the findings from Europe are far from universal. A study of 11 countries predominantly in Europe shows substantial cross-country variation in the relationship between class size and student achievement, with most countries having a small or no benefits from smaller class sizes (Frederickson 2013). Two studies in Denmark using different data sets and statistical techniques also demonstrate small benefits of reduced class sizes for test scores. In Norway, two studies using the maximum class size rule obtained different results with one finding a positive effect of smaller class sizes on student achievement in the early years of secondary school whereas another study using similar methods on a larger data set essentially finds no effect (Wossmann 2006).

Christopher (2015) opined that smaller classes are associated with high achievement in fourth and sixth grades, but there is no evidence of a positive relationship to the authors best knowledge, no studies on class size in Canada, Australia or New Zeal and in the main database of economics literature. Blatchford et al (2011) carried out an observational study involving nearly 700 students in 49 schools in UK and found that in both the early and later grades, smaller classes lead to students receiving more individual attention from their teachers and having more positive interactions with them. They established that classroom engagement decreases in large classes and this is particularly in large classes and this is particularly marked for struggling students at the secondary level. Students are engaged in active interactions with their teachers two to three times hence perform better in tests. Benton (2012) collected data in 490,196 classes from 2002 – 2011 and observed that small classes had better student preparation, student enthusiasm and effort than those in large and very large classes. The smaller the classes the higher was students' achievement in mathematics at high school levels. Monks et al (2010) in Cornell University, USA found that both class size and student load negatively impact student assessments of courses and are correlated with less critical and analytical thinking, less clarity in class presentations and low achievement.

Omari et al (2010) point out that there is a great increase of enrollment in secondary schools in Tanzania leading to problems, such as high teacher to pupil ratios which in turn have lowered quality of secondary education. As a result, it was difficult for teachers to teach and assess students' academic performance effectively. One teacher according to Omari, disclosed during the interview that the teacher just teaches only one stream and then asks students in the rest of the streams for the respective class to copy the notes from fellow students from the stream in which the teacher taught. The foregoing differing findings, opinions and observations call for further investigation into the influence of class size on girls' academic achievement in mathematics which this present study is focused on. Yara (2010) in a research in senior secondary schools observed that very few studies favoured either smaller or larger class sizes and many showed no significant difference in performance between small and large class sizes in secondary schools. Wambua (2010) in a study in Central province of Kenya observes that small class size makes teachers work less strenuous and effective as opposed to a large class size which may limit the teachers' ability to cater for individual differences as well as proper class management.

While the general finding is that smaller classes are associated with increased student achievement, a few high-quality studies find no relationship (Christopher 2015).These conflicting findings necessitated a rigorous analysis of the causal relationship between class size and achievement in mathematics among girls at secondary school level. Lydia et

al (2013) in their studies in Kenyan secondary schools in Kitui district investigated the determinants of girls' performance in science, mathematics and technology and confirmed that there has been incessant low academic performance in these subjects especially among girls at form four level in Kitui Central District over the years as a result of large class sizes of a population greater than 45 students.

There is no clear association between class size and students' performance in mathematics since the level of performance in any one given school varies despite the fact that the class size remains relatively constant. These conflicting findings necessitated a rigorous analysis of the causal relationship between class size and achievement in mathematics among girls at secondary school level. The literature regarding how class size affects classroom management, including student discipline, is fairly consistent in its results, showing that as class sizes increase, time spent handling non-instructional tasks also increases (Blatchford et al, 2007).

RESEARCH METHODOLOGY

The researcher adopted a Correlation research design which was applied to explore the extent of variance between two variables. (Creswell 2008). The design represents a general approach to research that focuses on assessing the co-variation among naturally occurring variables. The target population consisted of 142 Public secondary schools which presented female candidates for KCSE examination between 2010 and 2014 in Kisumu County, 142 Principals, 142 Heads of mathematics departments and 390 mathematics teachers.

Out of this population 38 mixed schools, 56 Principals, 56 Heads of mathematics departments and 194 teachers of mathematics who taught between 2010 and 2014 were sampled for the study using stratified sampling technique. Systematic sampling was applied within the stratum for mixed public secondary schools to select 38 schools and random sampling technique was applied to select 8 schools from each sub-county in Kisumu County. Purposive sampling technique was used to select 18 girls' schools, KCSE examination results of form four female students who sat for the examinations between 2010 and 2014 and the five years under study.

Questionnaires, interview schedules and document analysis guides were used for data collection in the study. Questionnaires were self-administered to enable respondents seek clarification on issues not clear. Interviews were conducted to obtain information from heads of mathematics department to seek individual interpretation and responses (Mellenberg, 2008). Document analysis guide was meant to obtain records on girls' mean grades between 2010 and 2014 and the records of textbook ratio in the schools studied. Face and Content validity was used to estimate the degree to which the purpose of the test is clear to the respondents and the transparency of the entire test as in Fraenkel & Wallen (2014). Test retest method was applied to test the stability and reliability of the instruments applied in data collection.

Both quantitative and qualitative methods for data analysis were employed. Quantitative data was analyzed by use of descriptive and inferential statistics with aid of Statistical Package for Social Sciences version 22. Descriptive statistics was used to summarize data in tables, frequencies and percentages. Thematic analysis was applied in analyzing qualitative data where data was transcribed while retaining the original verbatim quotes of the participants (Hay, 2009).

Area of study was Kisumu County which constitutes 7 Sub- Counties namely Kisumu East, Kisumu West, Kisumu Central, Nyando, Muhoroni, Nyakach and Seme. The population of the study consisted of 142 public secondary schools which presented female candidates for KCSE examinations between 2010 and 2014 in

Kisumu County, 142 Principals of the above schools, 142 Heads of mathematics department and 390 mathematics teachers who taught in the period under study. Sample size of 39% of the study population of Principals and Heads of mathematics department was studied. 100% of girls' public secondary schools and 37% of mixed public secondary schools constituted the sample for study whereas teachers of mathematics sampled were 50%. The sampling techniques applied were purposive sampling technique to select all the girls' schools, five years studied and KCSE examination results of form four female students. Stratified and systematic sampling techniques were applied to categorize schools according to school type and to improve the representativeness of the sample respectively. In selecting the 8 schools from each sub-county in Kisumu County in order to constitute the 56 schools studied, random sampling technique was applied.

Instruments of data collection comprised questionnaires for Principals, Heads of mathematics department and mathematics teachers sampled for the study. Interviews were conducted to obtain in-depth information from Heads of mathematics department. Document analysis guide was employed to obtain information from the records kept in the Sub-County Education Offices and the sampled schools. The researcher used face validity to estimate the degree to which the instruments clearly measured what they were designed for. Content validity was to ensure that all items in the instruments were representatives of variables and objectives of the study. Test retest method was applied to confirm the stability and reliability of the instruments applied in data collection.

According to Saunders (2012), data analysis is a process of transforming and scrutinizing data with objective of discovering useful information, suggesting conclusions and supporting decision making. The collected data was organized and prepared for analysis by coding and entry into the Statistical Package for Social Sciences (SPSS) Version 22 Soft Ware. The data were then edited before being classified and summarized according to the variables and objectives of the study. Data summary and classification were done using descriptive statistics and presented using tables, graphs and charts. In order to answer specific research questions statistical procedures were used including Pearson's Product Moment Correlation Coefficient, and simple regression. The researcher used both qualitative and quantitative data analysis methods to analyze data in an attempt to confirm and validate the findings in the study while covering fairly all aspects of the phenomena under investigation.

According to Norman (2008) quantitative method is appropriate in analyzing data that are expressed in numerical form. Quantitative data was analyzed with the assistance of Statistical Package for Social Sciences (SPSS) version 22 to calculate frequency counts, percentages and mean scores. Pearson's Product Moment Correlation (r), and Simple regression was also being used to establish the relationship between independent variables and dependent variable. The hypothesis was tested at P-Value = 0.05 (5%). If P-Value is less than 0.05 then Ho (null hypothesis) is rejected and Ha (alternative hypothesis) accepted implying that the independent variable is significant in affecting the academic performance and if P-Value is greater than 0.05 Ho is accepted and Ha is rejected which means the independent variable is not significant in affecting academic performance.

R^2 (Coefficient of determination) which is the proportional change in the dependent variable which is accounted for by the independent variables was obtained from the computer printout. r (Coefficient of Correlation) which is the degree of linear relationship was also obtained from the computer printout (Braun and Clark,2006). Mugenda and Mugenda (2003) cited the purpose of descriptive statistics as to

enable the researcher to meaningfully describe a distribution of scores of measurements using a few indices of statistics.

A thematic analysis was employed to analyse the data from the interviews where data was coded and common themes identified (Hay, 2009). Mathematics achievement was assessed using document analysis of the schools' KCSE results for the years between 2010 and 2014. During coding the questionnaire for Principals was assigned P, for heads of mathematics department H and for teachers of mathematics was assigned T. The codes were given meaningful names that gives an indication of the idea or concept that underpins the theme or category. Parts of the data that related to a code topic are coded with the appropriate label. For questions which attracted qualitative information, data coding process was applied whereby verbal data was given numeral values as 1, 2, 3 and 9 so that data could be entered into computer for analysis.

FINDINGS, INTERPRETATION AND DISCUSSION.

The objective of the study was to investigate the influence of class size on academic achievement among girls in mathematics in public secondary schools at form four level. The correlation of class size and academic performance is shown in table 1.

Table 1 of coefficient shows that text book ratio is significant to academic performance. Further, the regression model for the relationship between these independent variable and dependent variable is shown in the equation below:

In this model: $Y = 4.692 - 1.226x_1 + e$ equation 3

Where;

Y is the Academic performance

x_1 is Textbook ratio

e is the precision error (0.05)

The final objective of the study was to investigate the influence of class size on academic achievement among girls in mathematics in public secondary schools at form four levels. The correlation on class size and academic performance is shown in Table 1.

Table 1: Correlation of Class Size and Academic performance in Mathematics Correlations

		Class Size	Academic Performance
Class Size	Pearson Correlation	1	.281**
	Sig. (2-tailed)		.000
	N	180	180
Academic Performance	Pearson Correlation	.281**	1
	Sig. (2-tailed)	.000	
	N	180	180

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

The results of correlation analysis revealed a moderate positive (r =.281; p value < 0.05) relationship between class size and academic performance, as indicated in the SPSS output in table 2. Hence from these findings it was reasonable to conclude that there was a positive significant relationship between the class size and academic performance. The coefficient of determination was calculated, r^2 = 0.0786, indicating that the two variables share about 7.86% of their variance. The regression analysis was carried out to establish the significance level between the study variable. The finding of the study is shown in the table 2 below.

Table 2Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.281[a]	.079	.074	.57096	.479

a. Predictors: (Constant), Class Size

b. Dependent Variable: Academic Performance

The model summary recorded in table 2 reveals that r square is .079, meaning that 7.9% of the academic performance is influenced by the class size while the rest (93.1%) is influenced by other factors not in the study.

Table 3 ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.956	1	4.956	15.202	.000[b]
	Residual	58.027	178	.326		
	Total	62.983	179			

a. Dependent Variable: Academic Performance

b. Predictors: (Constant), Class Size

The ANOVA table 3shows that the p value of 0.000 is less than .05; therefore, the class size is significant to the academic performance.

Table 4 Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.031	.307		.101	.920
	Class Size	.442	.113	.281	3.899	.000

a. Dependent Variable: Academic Performance

Table 4of coefficient reveals that class size significantly contributes to the academic performance. Further, the regression model for the relationship between these independent variable and dependent variable is shown in the equation 4.

In this model: $Y = .031 + 0.442x_1 + e$ equation 4

Where;

Y is the Academic performance

x_1 is Class size

e is the precision error (0.05)

Class size had a positive influence on academic achievement among girls in mathematics in that teachers with students less than 40 had opportunity to provide individual attention to weak performers and improved their grades in mathematics.

CONCLUSION

There was a positive relationship between class size and academic performance in mathematics though its contribution to academic achievement was only 7.86% which is weak. Class size should therefore be reasonably maintained at a target of a maximum of 40 to enable a teacher provide for several assignments, mark and correct promptly to enhance good performance in mathematics at secondary level.

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