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An assessment of core mathematics performance of selected single-sex schools in the Cape Coast Metropolis, Ghana

Gideon Mensah Banson [1]*, Ernest Osei [1], Frank Koduah [2], Francis Ekow Bediako [3]

[1] Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Kumasi, GHANA
[2] Donkorkrom Agric. Senior High School, Donkorkrom, GHANA
[3] University of Cape Coast, Cape Coast, GHANA
***Corresponding Author:** bansongideon@gmail.com

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ABSTRACT

This cross-sectional study was designed to compare gender difference in mathematics achievement in four selected single-sex senior high schools in Ghana. Results of 18,781 students from the selected schools were analyzed based on the final examinations, West African senior school certificate examination (WASSCE) data for 2009, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018-year groups. In 2010, there was no examination; thus, the data analyzed excluded that of 2010. The results are graded from grade A1 to F9 so to ensure clarity in the results, grades were coded from 1 to 9. The grades were coded to correspond with the codes, ranging from the highest grade (A1) to the lowest (F9). The findings indicated that girls performed better than boys and the independent sampling t-test also showed there was a significant difference in the performance of girls and boys. This indicates that there is no equality in core mathematics performance of boys and girls. Teachers of mathematics are encouraged to identify underlying factors that account for the disparity in performance and also to ensure that students of both gender exhibit excellent performance in mathematics.

Keywords: core mathematics, single-sex school, performance, Ghana

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INTRODUCTION

Mathematics has a significant impact in every nation's growth. Without mathematics, the development of any nation will be in jeopardy as the application of mathematical concepts cut across all the stages of development. Well recognized international societies, for example, program for international student assessment (PISA) and trends in international mathematics and science study (TIMSS) have conducted series of reports on mathematics and gender in relation to performance in several countries (Mullis et al., 2012). Sometimes when the studies in mathematics are carried out, the difference in performance vary based on countries and sometimes these differences are same on gender basis. Hanna (1989) indicated that differences in countries are often larger than differences in gender. All the same, if there exist academic differences, the magnitude of the difference does not justify what area priority should be given to. When there is a more substantial disparity in mathematics achievement among countries than we have for the difference in gender, it does not insinuate that the difference in gender does not matter. A more extensive study should be carried out on gender basis. A country like Norway has educational goals of ensuring equal teaching and learning opportunities for both males and females hence difference in gender connotes a great deal of academic challenge. Aside a country like Norway, other countries in the northern islands, like Denmark, Finland, Iceland, and Sweden obtain significant higher scores above OECD means (OECD, 2004). For the countries that take part in PISA, reports show that males significantly always outperform females. Considering the countries in the northern islands, although only Norway obtained lower mathematics scores as in relation to the OECD means, findings also showed that males performed better than females with exception of Iceland, where female scores were better in all areas of mathematics than males (OECD, 2004). The differences in performance for some countries like Sweden and Finland was not substantial.

For some countries, studies in performance normally bring out findings based on a test conducted after a short period (example a day test, a test after an academic intervention, an end of academic semester exam) but few investigations have gone into performance of students in Sub-Saharan African countries taking into consideration five-year performance or even longer years. A period-long assessment of the performance of students needs to be clarified and that is what this study seeks to bring out.

Statement of the Problem

In some countries, roles are shared on gender basis however this idea should not be the case for mathematics learning. Mathew Smith, a lead data journalist, in 2018 revealed that some people are of the view that some subjects are for boys and others are for girls. Outcomes from research have outlined that gender differences in mathematics achievement up to the high school grade have shown inconsistent findings (Goodchild & Grevholm, 2009). Perceptions and hearsays must not be tolerated in academia as it affects students' learning in mathematics (Dowker et al., 2019). Globally, there are several issues surrounding the study of mathematics as a subject. One aspect is gender issues by which this study seeks to examine. Questions on the academic achievement of males and females keep mounting up within the academic space. The facts need to be clear as the educational sphere tends to be transformed occasionally.

An investigation into the performance of students in mathematics is of much precedence. Mathematics at the pre-tertiary level in Ghana, has been grouped as core mathematics and elective mathematics. Since the core mathematics is mandatory for every student at the senior high school, this study intends to focus on this aspect. Thus the study assesses students' performance in core mathematics and also examines the gender difference in core mathematics performance of these students, taking into consideration a 10-year compilation of their mathematics results.

Development of Hypothesis

This study is centralized on the mathematics achievement of learners in four selected senior high schools. Mathematics performance truly varies across different basis, whether it being background of students, age of students or the gender of students. The issue of gender stands tall in this study as students' performance in mathematics is examined to identify which gender outperforms the other. The yearly comparison of their grades are explained and based on that the statistical test on the difference in performance is carried out to make grounds for the study.

LITERATURE REVIEW

Mathematics Achievement

Mathematics achievement is usually assessed by tests, examinations or continuous assessment (Bull & Lee, 2014). In terms of measuring the achievement of students, the best standard may be ignored and hence cannot measure required competency of the student. For instance, the school setting always deny the measure of psychomotor domain and the affective domain but always measure only cognitive domain thereby making the examiner not to achieve the right measure of students' ability. Due to this, the true quality of learners' achievement cannot be measured appropriately. This challenge has not been majorly tackled because the standards for assessment for the cognitive domain has proven to be more reliable and highly measurable. Hattie (2009) also states that mathematics achievement is the consequence of learning that gives evidence of the level to which a learner, teacher or an organization has attained their educational aims that were the center of activities in instructional surroundings, specifically in school, college and university. These outcomes from instructions in the mathematics class clearly match up and measure the level of accomplishment with the objectives set before the beginning of every lesson.

The student has always been the recipient in the mathematics classroom hence outcome of lessons mostly account for that of students. They are meant to inform the teacher or instructor on how much students have achieved from the classroom instructions. Students' achievement may also be used for prognosis purposes.

In the prognosis purposes, it is used to predict how well a student may profit from future training. According to Weidinger et al. (2019), school system mostly defines cognitive goals that either apply across multiple subject areas (example, mathematics and science) or include the acquisition of knowledge and understanding in a specific intellectual domain (e.g., numeracy, literacy, science, history). The goal is used to assess knowledge, skills and other characteristics that serve to determine success in learning.

Gender Differences in Mathematics Achievement

Reports from studies organized in different countries have depicted that boys performed better than girls do in mathematics (Fennema, 2000; TIMSS, 2011). Asante (2010) posited that boys always achieved higher than girls on standardized mathematics tests at the pre-tertiary levels. There always exist differences taking into consideration several samples of study but different samples going in favor for boys are well-known in mathematically gifted distributions (Frost et al., 1994). The disparities also deviate in accordance with mathematical sub skills. Boys seem to perform better than girls on activities that require application of algebraic rules or algorithms and activities in which the comprehension of mathematical concepts and number relationship is required. Marked differences between the sexes going in favor for boys have been seen at the outstanding ends of the distribution on numeracy tasks. Boys' and girls' achievement is subjected to some study areas such as number and relation and using of mathematical algebraic methods and rules in working out mathematics. From this, we can say that the achievement of boys in core mathematics may vary from country to country.

Generally, some basic facts have been more or less generated in the research of the last two decades on gender differences in mathematics and science throughout different grade levels. Gender differences that favor boys in mathematics tend not to appear until high school–in beginning grades, differences are either non-existent or considers girls as favorites (Goodchild & Grevholm, 2009). Thus in pre-schools and lower primary schools, girls perform or do better than boys do. Various activities performed at pre-school levels are related to concrete materials and at this stage, based on this study, girls perform very well than boys do. At the fourth and eighth grades, girls perform better than boys on activities involving reading graphs, calculation and problem solving involving a lot of rules.

Concerning body of global literature depicts that girls (female students) perform better than boys (male students) (Hydea & Mertzb, 2009). A comprehensive study in the USA by Hydea and Mertzb (2009) shows that girls have attained level of equality with boys in mathematics accomplishment, including at high school, where a gap existed in former years. Hydea and Mertzb (2009) noted that girls are doing better than boys are that girls are even performing tasks that require compound problem solving. The study in the USA therefore suggests to us that the females' performance have progressed to a level, where they are at par with the males. They also stressed the fact that girls are not only good at making simple computations, but they also perform better, when it comes to tasks that require complex problem solving.

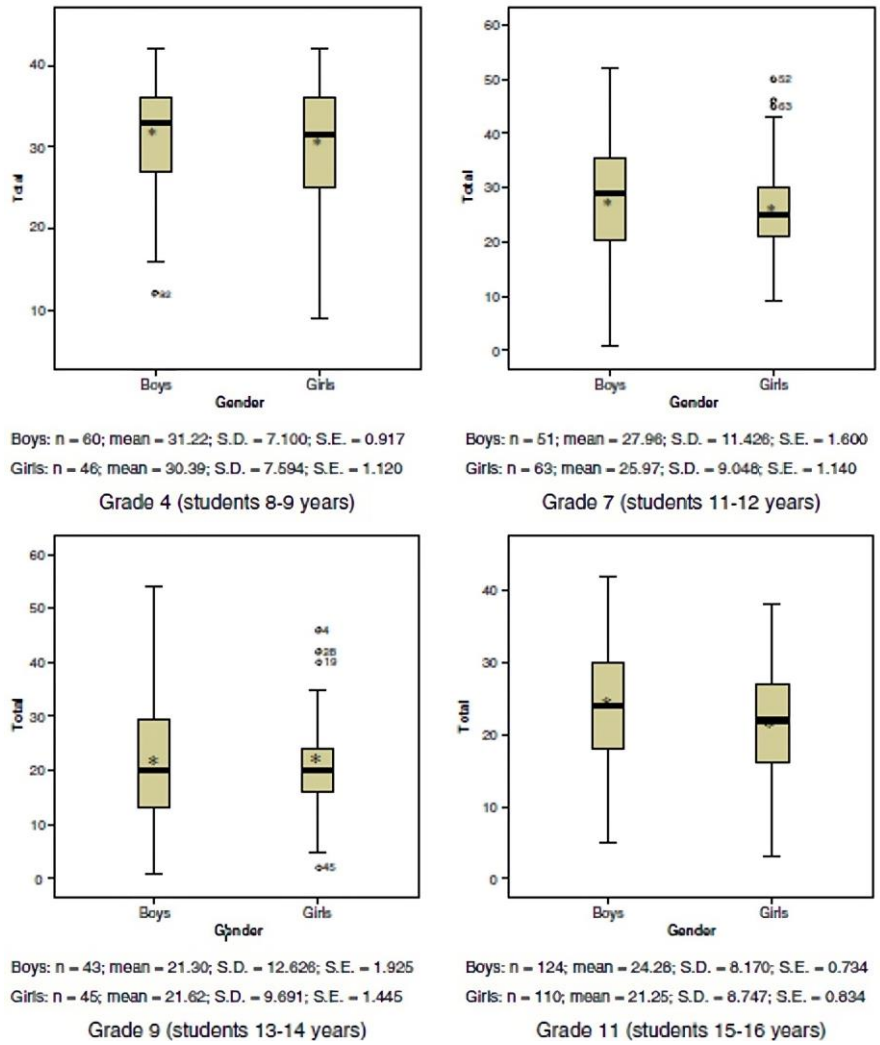

Figure 1. Gender difference in performance across grade levels (Goodchild & Grevholm, 2009)

Table 1. Code of grading system

Grade letter	Coded grades
A1	1
B2	2
B3	3
C4	4
C5	5
C6	6
D7	7
E8	8
F9	9

An exploratory study by Goodchild and Grevholm (2009) sampled students across different grade levels and ages, with the sole aim of determining the gender difference in mathematics performance. The mean score varied across all grade levels (grade 4, grade 7, grade 9, and grade 11). The variability in scores for the females decreased whilst that of the males increased across grade levels (**Figure 1**). At the final grade, that is grade 11, it was recognized that the sequence of variability changed as that of boys decreased. Goodchild and Grevholm (2009) explains that at grade 11, mathematics is not compulsory for students at that level as compared to the other lower grade levels, where mathematics is a core subject for all students (with age ranging from eight to 14 years). Further discussion on the outcome revealed that the mean scores for boys and girls were different. Taking into consideration grade 4, boys performed better than girls and for grade 7 the boys still performed better than girls. At grade 9, the girls outperformed the boys at a very small margin but with grade 11, the boys yet again performed better than the girls. In all grade levels it was only at the grade 11 that the difference in performance was significant. A graphical layout is presented (**Figure 1**).

METHOD

This study is a cross-sectional study, which sought to explicitly assess the performance difference among boys and girls from four selected schools. The study investigates core mathematics achievement of boys and girls in four selected single-sex senior high schools in Cape Coast Metropolis, Ghana. For the four selected senior high schools, two of them are boys' schools and the other two are girls' schools. Students' grades from 2009 to 2018 from West African senior secondary certificate examination (WASSCE) in core mathematics was used. The number of students within the year range was 18781. This study excluded 2010 results since there was no WASSCE written in that year. In the school system, letters were used to grade student's final results. The grades range from A1 to F9 but were coded into numerical values, as shown in **Table 1**.

Table 2. Core mathematics achievement of boys & girls

Grade	Boys	Girls
A1	2,334	2,723
B2	1,282	988
B3	3,106	1,704
C4	822	379
C5	919	476
C6	1,448	728
D7	712	393
E8	283	271
F9	80	133
Total	**10,986**	**7,795**

Table 3. Descriptive statistics on performance

Gender	n	Mean	SD	Standard error mean
Boys	10,986	3.528	2.056	.0196
Girls	7,795	3.103	2.222	.0252

The grades as seen in **Table 1**, are arranged from the highest or excellent grade (A1) to the least grade (F9). This means that a grade A1 with a coded grade of 1 is higher than a grade B2 with coded grade of 2. The mean grades for boys and girls were also analyzed. For calculation and analyses, the independent sample t-test, which is an inferential statistical tool was employed to test the hypothesis.

RESULTS AND DISCUSSION

The core mathematics performance of students in the selected schools has varied in 10-year based results. As shown in **Table 2**, more girls (2,723) attained the highest grade, that is A1, as compared to boys (2,334). However, for the other grades, there were varying instances as the performance tends to vary from across grade levels. For the least grade, that is F9, there were more girls (133) attaining this grade as compared to boys (80). The different number of students across the grade levels does provides a base through which the means of the grades are determined.

From **Table 3**, the mean grades of boys and girls are presented and clearly, we have the mean grade for boys to be 3.5280 as well as a standard deviation (SD) of 2.0560 and a standard error of 0.0196. This means that, the mean grade of the boys stands approximately at C4 with the deviation closely distributed around the mean. Also, the mean recorded for the girls is 3.1030 and an SD of 2.2220 with a standard error of 0.0252, which indicates that the mean grade for the girls approximately lies at B3, where their deviation is widely spread over the mean.

Studies regarding gender in relation to academic performance in mathematics have always resulted in varying viewpoints and findings. Studies carried out in countries of the north have shown that boys performed better than girls in mathematics (Fennema, 2000; Kaiser-Messmer, 1994; Muthukrishna & Kwela, 2010) but this study shows otherwise as girls attain a higher grade than the boys (**Table 3**). Literature also suggests that girls perform better than boys (Hydea & Mertzb, 2009). Hydea and Mertzb (2009) showed that girls have gotten to a level of equality with boys in mathematics performance. This does not exclude high school grades, where a gap existed in previous years. They supported that girls are performing better than boys as girls are additionally able to execute tasks that demand complicated problem solving.

Table 4. Independent sample t-test on performance difference

Gender	n	Mean	SD	T	df	Sig.
Boys	10,986	3.530	2.056	13.472	18,779	.000
Girls	7,795	3.100	2.222			

An independent sample t-test (**Table 4**) was performed to compare the difference between the attainment levels of boys and girls in the selected schools in the Cape Coast Metropolis. The results show a substantial difference in the grades for the boys (M=3.53; SD=2.056) and girls (mean [M]=3.10; SD=2.222) at p=0.000 (<0.05) at 95% confidence interval, which is lesser than 0.05 significance level. This therefore gives a basis for us to reject the null hypothesis, which states that there is no significant difference in achievement of boys and girls in core mathematics considering the selected schools in Cape Coast Metropolis. This study depicts the existence of a significant difference in core mathematics performance of boys and girls. This coincides with other studies, which also found that there is gender difference in mathematics performance (Muthukrishna, 2010; TIMSS, 2011).

CONCLUSIONS

Following the results of the study, there is a statistically significant difference in the gender achievement of boys and girls in core mathematics. The findings also revealed that girls outperformed boys as they (girls) attained a higher mean grade than the boys. Conclusion can therefore be drawn that girls performed better than boys in core mathematics in single-sex schools. Teachers can do better to ensure quality passes among students. Research can be done to search out for the factors that account for the higher performance of girls than boys in single-sex schools. There might be underlying factors or conceptions that need to be identified and tackled by educational authorities.

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