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Gender Differences in Participation in Elective Mathematics of Senior Secondary School Students in Ghana

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Abstract
This paper aims at contributing to the body of knowledge that exists in the area of differences in participation in elective mathematics, between boys and girls in Secondary Schools in Ghana. A sample of 738 respondents from five Secondary Schools was purposively selected using purposive sampling technique. All the respondents were final year students and had studied extensively more than a half of the elective mathematics syllabus. The selected schools were made up of two single-sex female schools, one single-sex male school and one mixed-sex schools from Cape Coast municipality in the central region and one mixed-sex school, from Sekondi in the western region of Ghana. Relevant data were gathered using a set of questionnaire and an interview schedule prepared by the researchers. The analysis of the personal interviews with some of the female respondents revealed various reasons why some females were attracted to the study of elective mathematics. The study revealed that the participation of males in elective mathematics was 50.5% while that of females was 27.2% giving an indication that females participated in elective mathematics less often than their male counterparts. Suggestions for increasing female participation in senior secondary school elective mathematics were made and areas for further research on the topic have also been suggested.
Keywords: Senior Secondary School, Participation, STME Clinics, Mixed Sex Male, Mixed Sex Female, Single Sex- Female, Single Sex-Male.

1. Introduction

Researchers in mathematics education have found low participation of females in elective mathematics studies. Lamb (1997) found out in a study that 37% of girls studied advanced mathematics compared to 60% of the boys in the final year of the Secondary School (year12). Lamb therefore concluded that girls studied the harder option mathematics much less often and they were much more likely to drop the study of mathematics altogether when the subject becomes elective.

The quest for finding solution to this problem has influenced researchers to express concern about the antipathy to mathematics exhibited by female students in Secondary Schools. Considerable evidence exists that the female proportion of all students taking elective mathematics examination, in the final year of school, decreases yearly. In fact, many of those girls who pursue a career in an area with large quantitative elements are highly successful but their actual number is far lesser than their male counterparts; a situation which rarely exist in the non-quantitative fields like English language and French. According to Nash (1979) as quoted by Fabricant, Svitak & Kenschaft (1990) when the number of girls in non required advanced mathematics classes becomes very small, the remaining girls tend to drop out. Some studies have also shown that the education of girls in mathematics, whether core or elective, is generally not encouraged in Secondary Schools (Eboutou, Quaisie, Masanja & Mulemwa 1997; Opyene-Eluk&Opolut-Okurut,1995). These situations demonstrate that girls are being neglected in elective mathematics studies at the Secondary School level.

To offset the problem of girls' antipathy to mathematics, especially to elective mathematics, many governments have instituted programmes to encourage female participation in schools including a redesign of the school curricula, where all students are offered equal opportunities of participation. For example, Ghana in 1987, Nigeria in 1989, and Bostwana in 1990, accepted the common wealth secretariat educational ministers' recommendation and organized various workshops in science, mathematics and technology that encouraged girls to be interested in and enter careers in science, mathematics and technology.

In Ghana, the Science, Technology and Mathematics Education (STME) clinic is organized yearly to address the problem of low participation in mathematics related courses for girls. In spite of these efforts and the relevance of mathematics, girls' participation in elective mathematics at the Secondary School level is not encouraging. There is low participation for girls (Eboutou et al, 1997). Further to that, in co-educational institutions, male and female students study in the same environment and under the same conditions of learning. They interact so well to a level that at the terminal point of the secondary education (SSS 3), they could see each other as equals in the academic pursuit particularly, in these days that the changing roles of women is taking a new dimension.

Blum-Anderson (1992), in a related study found that girls were not likely to enroll in mathematics classes once it becomes an elective if they did not understand the relationship between higher level mathematics and their future educational and career opportunities. Girls are under-represented in the study of elective

mathematics because more boys than girls follow the policy of studying both elective and core mathematics as prescribed in all schools. Thus the more advanced the mathematics course become, the greater the proportion of males enrolled. (Fennema, 1978). Other studies, have found that larger differences existed between male and female students' participation in higher level mathematics option needed for entry into the physical sciences, engineering and technology in the university (Dekkers, 1991; Teese 1994 as quoted by Lamb1997).

On the issue of female role model, the lack of these role models in the study of elective mathematic reinforced girls' belief that elective mathematics was a domain preserved for males.

Riordan's (1985) investigation placed greater emphasis on the assumption that female teachers, as role model, promoted more positive attitudes in female students. Research has shown that attitudes are related to participation (Armstrong & Price1982; Shaughnessy, 1983) and that the traditional view of mathematics as a male domain has contributed to the decline of females in high school mathematics (Ernest 1976; Fennema 1981, 1984; Sells 1980).

In view of these, any differences observed among boys and girls in participation in elective mathematics studies at the senior secondary school (SSS) level can be related to the differences of the characteristics, sociological and job preferences of the two sexes.

2. Statement of the Problem:

In Ghana, Eshun (2000) reported that the participation of girls in elective mathematics in 1995 was 4.1%. This rose up to only 13.9% in 1999 while that of boys rose from 14% in 1995 to 34.8% in 1999 at the national level. This picture shows that girls' participation in elective mathematics has been far below that of boys up to 1995 in the senior secondary schools. This situation was found by Nkani (1993) that girls participate less than boys in Additional Mathematics (the harder option mathematics) in forms four and five of the old secondary school system in Ghana.

This situation is not different in the USA, where Sherman and Fennema (1978) found in studies in mathematics enrolment that, fewer girls than boys enrolled in high school mathematics course. There is therefore the problem of low participation of females in elective mathematics in the country. This evidence is disturbing when we (the researchers) consider the fact that the country is suffering from a shortage of skilled and professional personnel in the areas of engineering, industry and teaching and in a time of severe youth unemployment.

There is therefore the need to investigate the participation of females in elective mathematics after 1995 and the factors that influence their participation. Also, as the national data reveals low participation for females, there is the need to investigate whether there is anything intrinsic or peculiar about girls that makes them less mathematically able than boys. Further to this, it is important to investigate the factors that hinder or facilitate girls' participation in elective mathematics studies.

3. Significance of the Study:

The study intends to explore and describe the participation of girls in elective mathematics at the SSS level. The findings would provide more understanding on the theories underlying the paper. It will assist both mathematics teachers and parents to change their attitude toward labeling participation in elective mathematics as a domain preserved for males.

The view of the researchers is that information obtained in the study will be used to improve the participation in elective mathematics by females at the SSS. It will also help change girls attitude towards the subject particularly demystifying girls' misconceptions about elective mathematics.

Furthermore, the findings would assist classroom teachers of mathematics to encourage many females to study high level mathematics by creating a classroom environment that is open and supportive for all students and not for a few number of exceptionally talented students.

4. Justification of the Study:

In the view of the researchers, little or no empirical works has been done to analyze gender differences in participation in elective mathematics in many countries and since no such empirical works exist, the paper intends to fill in this gap. Since mathematics is a necessary stepping stone to many lucrative careers in today's increasingly technological society, when many girls participate in elective mathematics other girls may develop high self-confidence of their own abilities in mathematics at high levels and become aware of the increased educational and occupational opportunities that the study of high level mathematics could bring to the individual.

5. Purpose of the Study:

The study intends to:

1. Investigate the participation of male and female students in elective mathematics from 1995 to 1999 at the national level and also in a number of selected senior secondary schools in the year 2000.

2. Identify factors that facilitate or hinder girls' participation in elective mathematics.

6. Research Questions:

The research questions investigated were as follows:

1. What is the level of participation of male and female students in elective mathematics
   (a) at the national level?
   (b) in the study sample?
2. What are the factors that influence or hinder female participation in elective mathematics at the SSS level?

7. Limitations:

The findings of this study are limited to the responses of the respondents (students) in SSS3.These students who were busy preparing for their final examinations, and were unwilling to respond to the questionnaire and the personal interview. However, repeated attempts were made to obtain their co-operation. Since the study was limited to only SSS3 students, the conclusions of the study could not be generalized to cover all students of the senior secondary schools who are enrolled in elective mathematics.

A second limitation was about the level of co-operation of teachers and school administrators in the five schools visited. Some administrators were reluctant to allow their students to participate in the study. Although, confidentiality was guaranteed, possible students' and teachers' reluctance to participate in the study might influence the conclusions that were drawn.

Furthermore, the differences between male and female regarding their needs, competencies and variations between school types such as socio-economic status, cultural diversity and region affected the generalization of the study results. This is due to the fact that all the schools, which were used in the study, were all in an urban setting.

Finally, the problem of bias normally associated with studies which uses questionnaire and interview schedule as instrument in data collection could not be ruled out completely.

8. Scope of the Study:

The paper focuses on the participation of female students in elective mathematics at the SSS level. This subject area seem difficult for girls to access in their numbers irrespective of whether they are capable of studying the subject.

9. Research Methodology

The research design for the study was a descriptive survey. The descriptive survey was used as the design to collect data to answer the questions concerning the status of the study. This fits the description by Gay (1987). The study will provide information on the status quo as regards the participation of students in the study of elective mathematics.

The sample was based on purposive sampling technique of 738 respondents. Primary data was collected using a self-designed questionnaire administered and a personal interview of some of the girls who studied elective mathematics during the visit. Four out of the five schools were selected because all the respondents from the single-sex male school were not allowed to respond to the questionnaire and the personal interview since attention was focused on female participants.

The personal interview was based upon significant information not covered by the questionnaire. Its rationale was to probe into responses from the participants on the factors that influence girls' participation in elective mathematics at the SSS level.

The female participants were selected to be interviewed by virtue of their outstanding performances in an achievement test conducted during the study and by the social class of their parents. Participants' fathers or mothers' occupation was used to determine their social classes.

A total of 40 SSS3 female students who were interviewed, were selected from 4 of the schools which had female students. 10 girls were selected from each school. All together, 20 girls whose parents belonged to the professional class, 10 girls each from the skilled workers and the working class background were selected to be interviewed (See table 1).

Table 1 Percentage distribution of students (respondents) interviewed by school and by social class of parents

School	Social class of parents						
	Professionals	%	Skilled Workers	%	Working	%	Total
A	3	30	3	30	4	40	10
B	4	40	3	30	3	30	10
C	6	60	2	20	2	20	10
D	7	70	2	20	1	10	10
Total	20		10		10		40

Apart from the use of questionnaire and the personal interview, two secondary sources of data were utilized in the study. These secondary sources of data were;

(i) The SSSCE results of all SSS3 students from 1995 to 1999 in elective mathematics (nationwide)

(ii) The SSSCE results of the selected schools from 1995 to 1999 in elective mathematics examination conducted by the West African Examination Council (WAEC). These secondary sources of data were obtained with the permission from the WAEC headquarters, Accra.

10. Results and Discussion

10.1 Demographic features of respondents.

The study investigated the participation of SSS3 students in elective mathematics. The survey comprised 114 (27%) males and 308 (73%) females. Fifty-five (55) male and one hundred and sixty (160) female respondents representing forty-eight percent (48%) and fifty-two percent (52%) respectively belonged to the age group of 18 years whereas the males were followed by twenty-nine (29) representing (25.4%) in the age group of 19years, the females were followed by one hundred and four (104) representing (33.8%) in the age group of 17 years. Only 1 (0.9%) of the male respondent was twenty-one years old while all the female respondents were below twenty-one years old. There were 3 (2.6%) male and1 (0.3%) female missing responses.

Majority 310 (73.46%) of the respondents studied General Science followed by 105 (24.88%) in the General Arts while only 7 (1.66%) in the Business. On social status, 152 (36%) of the respondents' mothers were in the fourth level occupation. This was made up of 61(53.5%) males and 91 (29.6%) females, followed by 132 (31.3%) whose mothers were in the third level occupation with 27 (6.4%) in the first level occupation. 141 (33.4%) of the respondents' mothers held teachers certificate with 127 (30.1%) having the middle school leaving certificate (MSLC). While 15(3.6%) of the respondents had mothers with doctorate degrees, 10 (2.4%) of the respondents' mothers were illiterate.

With regards to the respondents' fathers occupation, 130 (30.8%) were in the first level occupation comprising 20 (17.5%) males and 110 (35.7%) females. While 72 (17.1%) of the respondents' fathers were in the first level occupation, consisting of 46 (40.4%) males and 26 (8.4%) females. Only 10 (8.8%) of the male respondents as against 91 (29.6%) of the female respondents' fathers did the fourth level occupation.

On the respondents' fathers level of education, 123 (29%) held masters' degree while 46 (10.9%) held doctorate degrees with only 30 (7.1%) being illiterate.

Concerning the respondents' preferred highest educational qualification, 397 (94.1%) comprising 110 (96.4%) males and 287 (93.2%) females wanted a degree. None, of the females preferred the SSS Certificate but only one of the male respondents wanted the SSS Certificate.

10.2. Results from the Interview with the Girls

10.2.1. Respondents' knowledge about mathematics education at the SSS level.

This part of the study presents a qualitative analysis of the data collected for the study. The interview revealed that the female students were aware of the types of mathematics studied at the SSS level and the group of students who studied each type of mathematics. All the respondents indicated that core mathematics and elective mathematics were the two types of mathematics that were studied at the SSS level. They pointed out that core mathematics was compulsory for every SSS student but elective mathematics, which is the higher option, was restricted to all students who studied General Science, and some students who study Business or General Arts. Some of the respondents added that students who studied vocational subjects do not study elective mathematics at all.

On the question of who they (the participants) thought should study elective mathematics, the girls expressed a feeling that they were studying elective mathematics due to the fact that it was either compulsory for them or a decision they had made to study the subject. There was a mixed feeling here. While three-quarters of the respondents indicated that the subject was compulsory for them, the other 25% said it was their own decision to study elective mathematics because of the career they anticipate entering in future.

It is important to stress that students are streamed into different subject areas as they move from the JSS to SSS at the end of the basic education in Ghana. The choice of subjects is mainly dependent on one's performance in the BECE, parents' and/or teachers' advice or one's own interest in the subject. With this policy

direction in mind, the participants mentioned good grades in the BECE mathematics and their future careers as factors that contributed to their participation in elective mathematics.

Reacting to the question of whether they (girls) knew there were few girls who studied elective mathematics in mixed secondary schools and why they thought this was the case, most (60%) of the participants pointed out that they (girls) faced a lot of problems in the JSS mathematics that made them avoid elective mathematics completely at the SSS level. A good number of the girls mentioned that their teachers told them that mathematics is so difficult that only boys could study it at the SSS level.

As people tend to do what they feel capable of doing and avoid activities that arouse anxieties and lowers their confidence, such negative comments, about mathematics often made by teachers, as girls were about to enter SSS drive girls out of the elective mathematics classroom. The interview revealed that the decline of girls, in elective mathematics participation is ascribed to the following:

(i) Mathematics foundation at the basic level of education is poor for girls;
(ii) Girls have preconceived notion that elective mathematics is difficult;
(iii) Awareness was not created that STME clinics were aimed at encouraging girls to study Science and Mathematics at SSS level;
(iv) Girls fear Mathematics so they opt out of Elective Mathematics studies when there options;
(v) Elective Mathematics teachers' negative attitude towards girls discourages girls from studying the subject;
(vi) The lack of female role models for SSS girls in Elective Mathematics reinforces the belief that Elective Mathematics is for their male counterparts.

10.3. Results from the Questionnaire

Contemporary educational research has suggested several factors that increase females' participation and success in high option mathematics. These factors include the following characteristics, Clinics/Workshops, Career influence, a supportive family background, methodology on elective mathematics teaching, Curriculum, Effective motivation, Usefulness of elective mathematics and available female role models in elective mathematics.

The views of the respondents who were already studying elective mathematics but felt that these variables might encourage other students who would want to participate in elective mathematics were examined. A scale of five responses was assigned to the responses as, Very Much Encouraged (VME)= 5, Much Encouraged (ME)=4, Little Encouraged (LE)=3, Very Little Encouraged (VLE)=2, Not Encouraged (NE)=1. Any variable that received a mean score more than 3 was regarded as a viable area that encourages participation while a mean score less than 3 was regarded as not viable. The maximum and minimum scores were 5 and 1 respectively.

Results from the questionnaire showed that the mean of the scores ranged between 3.42 and 4.74 (see table 2) indicating that all the factors were viable but despite that, males in mixed-sex school had little need for female role models, with females in single-sex schools following closely. However females in mixed-sex schools needed female role models in mathematics education.

Table 2 Mean score of factors influencing participation in elective mathematics by sex and school type

Variable	MSM	MSF	SSF
Curriculum influence	4.25	4.58	4.60
Clinics/ Workshops	4.17	4.55	4.52
Career influence	4.58	4.71	4.74
Methodology	4.29	4.71	4.66
Effective motivation	4.64	4.72	4.67
Female role model	3.42	4.06	3.82
Parental influence	4.72	4.69	4.68
Clubs/ Associations	4.28	4.54	4.35
Usefulness of math	4.52	4.69	4.68

The study revealed that the participation in elective mathematics by girls in SSS3 had been lower than that of boys since 1995 and in the year 2000, 50.5% of the boys in SSS3 studied elective mathematics compared with 27.2% of girls (See table 4). This finding is consistent with Lamb's (1997) finding. Lamb found that 60% of boys studied mathematics B while 37% of girls studied mathematics B confirming the fact that girls were much less likely than boys to study mathematics when it becomes an elective subject. Although the actual number of boys and girls enrolled in elective mathematics increased steadily yearly from 1995 to 1999 (See table 3) the rate at which girls enrolled in the subject was lower when compared with that of boys in SSS. This confirms the fact that at the post compulsory years of schooling, females' participation rate in elective mathematics is lower than

that of males.

Table 3 Percentage distribution of SSS3 Students Participation in elective mathematics from 1995 to 1999 at National level.

Year	Sex	All Stds	No. of Stds studying elective maths	% of Stds participating in elective maths
1995	M	40078	5611	14.00
	F	21621	882	4.10
	All	61699	6493	10.5
1996	M	47041	7266	15.40
	F	27071	1211	4.50
	All	74112	8477	11.70
1997	M	45296	7477	16.50
	F	28108	1386	4.70
	All	73404	8811	12.00
1998	M	46717	8109	17.40
	F	30958	1473	4.80
	All	77674	9582	12.30
1999	M	35370	12302	34.80
	F	24879	3450	13.90
	All	60249	15752	26.10

Source: The data was obtained by the permission of WAEC headquarters, Accra.

The percentage of students participating in elective mathematics was obtained by dividing the number of students studying elective mathematics by the corresponding number of students who entered the SSSCE in a particular year and the quotient then multiplied by 100%

Table 4 Percentage distribution of SSS3 students' participation in elective mathematics in the study sample in the year 2000.

Sex	No. of students in SSS3 in the five Schools	No. of students studying elective mathematics.	% of students participating in elective mathematics
M	852	430	50.50
F	1131	308	27.20
All	1983	738	37.20

Source: Field Work

Even though some of the girls interviewed claimed that they had little or no idea about the STME clinics, the researchers are of the view that the clinics have had positive impact on girls' participation in elective mathematics learning at the SSS. The clinics had enlightened girls on the numerous career opportunities that are opened to girls who participate and perform well in elective mathematics. As a result of this exposure to information by the clinics, the career aspirations in the life of girls had been modified and had been directed towards achieving high academic laurels in Mathematics and Science. The researchers believe that it is this unprecedented intervention and the bravado of the clinics that had seen the slightly increased participation of girls in the study of elective mathematics.

Parental support and encouragement also enhanced girls' participation in elective mathematics. This finding is also consistent with that of Farbricant et al (1990) who found that all the twenty two (22) black women with doctorate degrees in mathematics, interviewed reported that they had a highly supportive member of the family who willingly sacrificed for their education. This finding contradicts the finding of Leder (1984) that many women and girls face opposition from their families, or had to fit their mathematical studies around domestic duties. As found by Fennema (1981) and Shaughnessy (1983), that positive attitudes lead to greater participation, all the girls who participated in the study and had high self esteem in mathematics also reported of better grades at the BECE as a factor that encouraged their participation in elective mathematics.

On the possible factors that adversely influence girls' participation in elective mathematics, the study found that some girls feared mathematics, some lacked interest in the subject while some found the subject difficult and boring. These findings supported that of Isaacson (1986) that women and girls continue to devalue their ability in mathematics and other Scientific Subjects and were far too easily convinced of their inability to tackle what they saw as difficult subjects.

The study found that there were no female teachers to serve as role models for the female participants. This finding is in agreement with those of Riordan's (1985) investigation and Farbricant et al (1990) that female role model strongly affect the participation of women in mathematics. They opined that when girls meet female mathematicians and read about their contributions to mathematics, they also get to believe that women can succeed in mathematics.

The study revealed that mathematics teachers, and counselors often discourage girls from studying elective mathematics. This finding is in consonance with Leder's (1990) finding. Leder found that teachers make neither special effort to attract female students nor any special adaptation to make mathematics more attractive to girls.

Few girls in the study reported that they encountered difficulties in elective mathematics studies but most of them had confidence in themselves as mathematics students, they enjoyed the subject and they were interested in it.

Finally, it was revealed that socio-economic background of the female respondents in the study positively influenced the girls' participation in the study of elective mathematics. Girls from the professional class were twice likely as those from the skilled workers and working class to elect mathematics as an elective subject which is in agreement with that of Lamb (1997), that the material and cultural advantages of a high status family background protected girls from selection out of the advanced option mathematics stream which had proved very difficult for girls to access.

11. Conclusions and implication

Based on the study, the following conclusions were drawn:

(1) The disparity between boys and girls participation in elective mathematics study at the SSS level favoured males. The gap in participation between male and female students who studied elective mathematics increased from 10% in 1995 to 20.9% in 1999 and further increased to 23.2% in the year 2000.The gender difference in participation in elective mathematics in 2000 per the study also favoured males.

(2) Girls participated in elective mathematics because of;
   (i) The influence of their social background,
   (ii) Their outstanding performances in the BECE mathematics,
   (iii) The importance of elective mathematics in their future careers,
   (iv) The support and encouragement they received from their parents.

(3) Finally, it is clear from the findings that gender selection occurred through the study of elective mathematics, not all girls were affected in the same way. The advantages of having a high status family background influenced some girls to study elective mathematics which appears difficult for girls.

The policy direction of the Ghana Education Service that the study of elective mathematics starts during the second year of duration in secondary schools implies that only good students in mathematics (those who are capable of passing the final examination in the subject) will participate in it to the neglect of the less able students of which girls form the majority. It is our belief that if this policy is relaxed, the less able students who fear that they cannot pass the subject with only two years of study, would participate more in the study of elective mathematics and hence increase the participation of girls tremendously.

Further research should focus on other regions to explore the relationships existing between them and the perceived levels of participation of girls in elective mathematics.

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