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Trend Analysis of Gender Enrolment and Performance in the West African Senior School Certificate Examination (WASSCE) Elective Mathematics

Yaw Efa[1], Dorcas Shiela Baiden[2], Kwabena Ofori Mensah[3], Dennis Offei Kwakye[4*]
[1]Ghana National College, Cape Coast, Ghana
[2]Ghana National Basic Inclusive School, Cape Coast, Ghana
[3]Metro Education Office, Examination Unit, Cape Coast, Ghana
[4*]Fairmont Middle School, 402 Iona Street, Fairmont, NC 28340, USA

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Abstract

Purpose: This study looked at gender enrollment and performance in senior high school mathematics electives in the Ghanaian Cape Coast Metropolis.

Materials and Methods: A descriptive ex-post-facto design was used for the investigation. Within Ghana's Cape Coast Metropolitan Area, Ghana National College was carefully chosen using the purposive sample approach. Secondary data, or 6,820 students' results from 2016 to 2022, was gathered. A trend graph and descriptive statistics, such as percentages and frequencies, were used to analyse the data.

Findings: The results of the survey showed that more women than men took elective mathematics courses, with the proportion of students offering such courses rising from 45.2% in 2016 to 57.3% in 2022. The survey also discovered that pupils did exceptionally well in mathematics electives. It was noted that throughout the period, more female students than male students passed the elective mathematics course. Additionally, the trend analysis indicated that although female enrollment may decline, students' performance and enrollment in mathematics electives will continue to improve.

Implications to Theory, Practice and Policy: In order to increase interest in STEM education, the study suggested that the Ghanaian government offer more scholarships and incentives to individuals pursuing STEM degrees, particularly to women.

Keywords: *Elective Mathematics, Gender Enrolment, Participation, Students' Performance, STEM Education, Trend Analysis*

1.0 INTRODUCTION

The United Nations (UN) (2015) asserts that by the year 2030, the primary objective of Sustainable Development Goal 4 (SDG4) is to guarantee equal and high-quality educational opportunities for both girls and boys. This will enable them to attain meaningful and impactful learning outcomes. This include the provision of comprehensive early childhood development, care, and pre-primary education to guarantee that individuals are well prepared for their primary school.

The objective is to guarantee equitable opportunities for both genders to get inexpensive and high-quality technical, vocational, and tertiary education, encompassing university-level education. To facilitate socioeconomic progress and align with the United Nations Sustainable Development Goal 4, it is imperative to effectively utilise science, technology, and innovation (STI) within the context of Ghana. The National Science, Technology and Innovation Policy of Ghana for the period of 2017-2020 establishes a framework for the establishment of essential institutions and the cultivation of human resources to effectively harness STI. The primary objective of this strategy is to facilitate the generation of wealth, mitigate poverty, enhance competitiveness in the business sector, foster sustainable environmental stewardship, and stimulate industrial expansion. According to the Ministry of Environment, Science, Technology and Innovation (2017),

Furthermore, efforts will be made to enhance science education across all levels and aspects of the education system. This includes the promotion of technical and vocational education and training, fostering innovation in science and technology within the education system, and expanding the country's capacity to train personnel in emerging technologies. Utilising mass media as a means to promote the widespread awareness and understanding of sexually transmitted infection (STIs). According to the Ministry of Environment, Science, Technology and Innovation (2017), the inclusion of elective mathematics as a subject of study at the senior high school level has the potential to contribute to the realisation of the National Science, Technology and Innovation Policy in Ghana, aligning with the objectives outlined in UN SDG4.

As stated by the Ministry of Education (2010), the subject of elective mathematics encompasses the process of reasoning through analogies, the ability to make informed decisions by discerning values, the analysis of facts, and the transmission of one's thinking through the use of symbolic expressions and graphical representations. Furthermore, it functions as a prerequisite or fundamental basis for individuals aspiring to pursue advanced studies in engineering, scientific inquiry, and various disciplines within tertiary education and other institutes of higher learning. This implies that anyone pursuing careers in engineering, scientific research, statistics, economics, and related fields would benefit from possessing a foundational knowledge of elective mathematics. This necessitates that all parties involved recognise the importance of prioritising the instruction and acquisition of elective mathematics. Elective mathematics, alternatively referred to as extra mathematics in certain nations, constitutes one of the elective disciplines available for study under the West African Senior School Certificate Examinations (WASSCE). It is therefore important to delve much into the factors that hinder their performance in the mathematics (Abdul-Razak et al., 2022) at this level.

According to the National Accreditation Board (2013), students in Ghana are required to achieve a minimum grade of C6 in order to gain admission into any tertiary institution. However, due to the competitive nature of the admissions process, aspiring students must attain a grade of at least B3 in elective mathematics to be eligible for enrolment in highly competitive courses. According

to the University of Ghana (2022), prospective students interested in pursuing STEM programmes, including mathematical sciences, information technology, and various engineering courses, are mandated to achieve a minimum grade of B3 as stipulated by WAEC. This grade is regarded as satisfactory by the aforementioned examination council.

The study of STEM, including elective mathematics, is considered crucial for the socio-economic development of a country, leading the government of Ghana to prioritise its importance. at 2013, the Ghanaian government implemented a sponsorship plan for scientific students at senior high schools as a means to promote STEM education. This initiative was undertaken by the Ministry for Environment, scientific, and Technology in Ghana. The Ministry of Education in Ghana has implemented a pre-engineering programme to facilitate the admission of students who did not pursue optional mathematics throughout their high school education but aspire to pursue engineering studies at the university level. According to Iddrisu and colleagues (2022), school physical resources which includes classroom materials will as well facilitate their learning when admitted.

Notwithstanding the efforts made by the government of Ghana, there is significant room for improvement in the academic performance of students in the subject of elective mathematics. Based on the findings of WAEC in the field of Information and Communication Technology (ICT), as referenced by Abotowuro (2015), an analysis of the performance of students in optional mathematics between the years 2012 and 2018 reveals a varying pass rate. In the year 2012, the pass rate stood at 36.5%, indicating that out of a total of 37,502 tests administered, 13,685 were successfully completed. The percentage decreased to 35.7% in 2013 and subsequently increased to 68.1% in 2015. The pass rate experienced a decline in 2016, reaching 75.2%, followed by a further decrease in 2017, reaching 47.0%. The pass rate for the year 2018 was recorded at 20.5%, indicating that out of a total of 75,619 exams administered, 15,484 exams were successfully passed.

Active engagement and exemplary achievement in a particular academic discipline can exert a profound influence on the overall academic performance of pupils across many topics. Several studies have demonstrated a positive association between the choice to study mathematics as an optional and performance in other academic disciplines. In a study conducted by Oluwatusin and Dele-Rotimi (2017) in Nigeria, the researchers investigated the impact of the further mathematics curriculum on students' academic achievement in science-based subjects, namely mathematics, biology, chemistry, and physics. The findings of the study provided evidence that students who included further mathematics in their curriculum performed significantly better in the senior secondary certificate examination compared to their peers who did not study further mathematics. Yusif (2015) did a study in Ghana to examine the relationship between elective mathematics and economics as a major at Kwame Nkrumah University of Science and Technology (KNUST). The study revealed a significant link between these two topics.

In a study conducted by Olatoye (2007) in Nigeria, the focus was on examining the impact of further mathematics on students' performance in mathematics, chemistry, and physics. The findings indicated that there was no statistically significant disparity in achievement between the groups of students taking further mathematics and those not taking it in each subject individually. However, it was observed that students enrolled in further mathematics exhibited significantly

higher overall academic achievement. As a result, the study recommended that all science students should be encouraged to pursue further mathematics.

In a study done by Boateng (2015), the objective was to investigate the potential impact of mathematical proficiency on the academic achievement of senior high school students in financial accounting topics within the Central Region of Ghana. The findings of the study indicated that individuals who hold a favourable opinion of mathematics tend to exhibit enhanced academic achievement in the domain of financial accounting. These studies underscore the significance of optional mathematics in fostering the growth of other academic disciplines, thereby advocating against its trivialization.

According to the data obtained from WAEC for the year 2023, it has been observed that there has been a consistent increase in the number of female candidates registering for WASSCE in the Central Region of Ghana, starting from the year 2018. This phenomenon is depicted in Table 1. According to the data presented in Table 1, it can be observed that between the years 2016 and 2022, the overall proportion of males and females who participated in the external examination was 48.6% and 51.4%, respectively. The presence of a higher proportion of females than males in high schools is a promising development for a developing nation such as Ghana. However, it is important to investigate if this gender balance is also reflected in the enrollment and performance of female students in STEM disciplines, particularly elective mathematics.

Table 1: WAEC Results in Elective Mathematics from 2016-2023 by Gender

Gender	2016	2017	2018	2019	2020	2021	2022	Total
Male	14,856	15,350	15,905	18,004	21,009	24,551	22,753	**132,428**
Female	14,615	15,195	16,975	19,856	21,937	25,770	25,724	**140,072**
Total	**29,471**	**30,545**	**32,880**	**37,860**	**42,946**	**50,321**	**48,477**	**272,500**

Field Source: WAEC (2023)

According to the education sector report released by the Ministry of Education (2018), it is noted that the Central Region has attained a gender parity score of 0.98, indicating a relatively equal representation of males and females. Additionally, the study highlights that female enrolment in the region stands at 50.1%. Does this pertain to the examination of optional mathematics within the context of senior high schools, a subject that falls under the umbrella of STEM education? In the context of Ghana, it is mandatory for students pursuing science disciplines to undertake optional mathematics as part of their curriculum. Conversely, students enrolled in other academic programmes, such as arts or visual arts, are afforded the flexibility to choose from a range of elective courses. Based on the findings of the Ministry of Education (2018), it can be observed that disciplines such as visual arts, agricultural science, and technical topics have garnered limited enrollment among students.

In 2014, the arts programme experienced the highest enrollment, accounting for 44.1% of total enrollment. This number was over four times greater than that of the scientific programme. The enrollment distribution between arts and business degrees and science and applied science programmes is approximately 59.6% and 40%, respectively. The aforementioned situation failed to adhere to the enrollment policy set by the Government of Ghana, which stipulates a 60% enrollment rate in science and a 40% enrollment rate in arts and humanities. Consequently, this

non-compliance poses challenges to the effective execution of the policy at the tertiary level. According to data from the MoE, the enrolment rates for sciences and arts at the postsecondary level during the academic year 2017-2018 were 31% and 61% respectively. The potential correlation between the limited participation in science-related programmes during senior high school and the subsequent scarcity of scientific students at the university level warrants consideration.

Based on the findings of García-Holgado et al. (2022), the proportion of women in Colombia's tertiary education system who opt for STEM fields stands at a mere 13.76%, whereas their male counterparts account for 35.12% of STEM enrolments, resulting in a gender gap score of 0.39. The gender gap scores in Spain, Finland, and Ireland are 0.33, 0.25, and 0.38, respectively. Similar to the findings in Colombia, Appiah-Castel et al. (2020) documented that the proportion of students pursuing engineering at Ghana's inaugural STEM institution, KNUST, was a mere 13.71% during the years 2003 and 2018.

According to a study conducted by Women in STEM (2010), it has been observed that in the United States, the representation of women in the fields of science and engineering is on the rise. However, it is still evident that men outweigh women, especially when considering the upper echelons of these professions. In elementary, middle, and high school, there is a somewhat even distribution of math and scientific course enrollment between girls and boys. Additionally, a comparable number of girls and boys successfully complete high school with the necessary skills and knowledge to pursue science and engineering disciplines at the collegiate level. According to the findings of Appiah-Castel et al. (2020), there is a gender disparity in the enrollment of students at Ghanaian universities, namely in the fields of physical sciences and engineering. The study reveals that male students are more prevalent in these disciplines, while female students are more represented in the health sciences.

According to the National Household Survey (NHS) conducted in Canada, it was observed that in 2011, women constituted 39% of individuals aged 25 to 34 who had obtained a university degree in a STEM field. In contrast, women accounted for 61% of university graduates in non-STEM programmes (Hango, 2013). Within the cohort of STEM graduates aged 25 to 34, it was observed that women constituted 59% of individuals enrolled in science and technology studies. However, women comprised just 23% of graduates in engineering programmes and 30% of graduates in mathematics and computer science programmes.

According to Ping et al. (2021), there has been a notable shift towards digitalization in the contemporary world. This transformation has led to technology assuming a more prominent role in fostering innovation and driving economic growth. Consequently, there is a growing recognition of the potential rise in the need for STEM skills within the labour market. This implies that it is imperative for governments to enhance their efforts in providing education and training in the fields of STEM to adequately address the demands of the evolving job market. The exclusion of females from STEM education could result in their lagging behind in digital advancements and experiencing economic disadvantages, as they may be excluded from opportunities in the technology-driven labour market.

According to the research conducted by Ping et al. (2021) in the United Kingdom, there exists a gender disparity in the enrollment and completion rates of STEM programmes. The study found that, in comparison to their male counterparts, women who have completed high school are 29.8%

less inclined to pursue postsecondary STEM education immediately after graduation. According to Rahman et al. (2018), it has been found that whereas wealthy and industrialised nations have attained gender parity in STEM education, there is a widespread gender inequality in underdeveloped and low-income countries, including Ghana. According to Wall (2019), the underrepresentation of women in STEM programmes can be attributed to the lower initial enrollment of girls in STEM programmes during their postsecondary education. The potential ramifications of limited involvement among females or males can have significant implications for nations.

The Ghana Education Service (GES) is now implementing a four-year gender-responsive pedagogy initiative in Ghana, with financial support from the Korea International Cooperation Agency (KOICA), aimed at increasing the participation of girls in STEM fields. The primary objective of the project is to enhance the proficiency of female students in STEM education at the junior high school (JHS) level. This initiative will be implemented in two distinct regions, namely Central and Eastern, encompassing a total of 10 districts. Each region will consist of five districts. The current initiative provides benefits to a total of 400 junior high schools, evenly distributed with 200 schools from each participating region (GES, 2023). Are these girls sufficiently motivated to pursue enrollment in STEM education during their high school years? In order to enrol in any STEM course or programme at a higher institution in Ghana, it is a prerequisite to actively engage in, complete, and achieve a passing grade in the elective mathematics examination administered by WAEC during senior high school.

The study conducted by Nyala (2005) examined the factors influencing the inclination of JSS students in Ghana to engage in elective mathematics. The researcher employed the purposive sampling technique to carefully choose nine junior secondary schools within the Cape Coast Municipality, encompassing a total of 581 children. The findings of the investigation revealed that there was a favourable inclination among both genders to engage in elective mathematics at the SSS level. Yarkwah et al. (2020) did a study examining the preparedness of senior high school elective mathematics students to undertake advanced mathematics at the university level. The research was carried out on a sample of 317 senior students, consisting of 196 girls and 121 males.

The following research questions guided the cause of the study: What is the trend of the participation of students in WASSCE elective mathematics from 2016 to 2022? What is the trend of participation of students in WASSCE elective mathematics by gender from 2016 to 2022? What is the trend of performance of students in WASSCE elective Mathematics? and What is the trend of differences in performance of students in WASSCE elective Mathematics in terms of gender?

2.0 LITERATURE REVIEW

The study undertaken by Yarkwah (2020) aimed to examine the extent of female students' engagement in mathematics education within the context of higher education. The study encompassed a sample size of 99 female students who were pursuing mathematics education at the University of Cape Coast and the University of Education, Winneba. The research employed a descriptive survey methodology to examine a combination of qualitative and quantitative data collected from participants. The findings of the study indicate a decrease in the enrollment of female students in mathematics education, among other observed trends. Additionally, the findings of the study indicated that female students engage in mathematics education due to factors such as

the pleasure obtained from studying this subject, the potential job prospects in the field of mathematics education, the aspiration to pursue further studies in mathematics education, and a genuine interest in the subject itself.

In their study, Ojating and Udobong (2019) conducted an analysis of the enrollment patterns in mathematics among male and female students at Cross River University of Technology over a span of ten academic sessions, specifically from 2008 to 2009 and 2017 to 2018. The individuals under scrutiny were pupils who shown predispositions in the realm of mathematical education as well as in the fields of mathematics and statistics. There was an absence of a statistically significant disparity between male and female enrollment patterns in the subject. It has been suggested, among other recommendations, that those who have undergone appropriate professional training and possess expertise in mathematics should be exclusively authorised to teach the subject. This may pertain to discrepancies related to teachers' dispositions towards students and the subject matter, which eventually impact enrollment in the latter.

In their study, Olarewaju and Yusuf (2019) employed a descriptive research design of ex-post facto to evaluate the academic performance of male and female students in SSSCE Further Mathematics in Kwara State, Nigeria. The study focused on the population of senior secondary schools in Ilorin Metropolis that offered Further Mathematics. The data utilised for analysis were the results of the WASSCE and the National Examination Council (NECO) from the years 2007 to 2016. The data underwent examination through the utilisation of percentage calculations and the application of auto-regressive (AR) processes in order to facilitate the modelling of time series analysis. The findings indicated that male students achieved higher credit scores than their female counterparts in both examinations. Based on the findings, it was recommended that educational policymakers should employ more qualified Further Mathematics teachers and that female participation in Further Mathematics should be encouraged by the school principals and teachers.

In their study, Mireku et al. (2015) sought to investigate the gender disparities in mathematics engagement and achievement within high schools in Ghana. The researchers aimed to explore the potential influence of individuals' intrinsic attitudes towards mathematics on their aptitude for teaching and learning the subject. The overall performance of candidates in mathematics in WASSCE in Ghana exhibited a notable decline within the specified period of analysis. In both 2012 and 2013, the male students enrolled in elective mathematics courses exceeded the female students by a factor of more than two. However, it is important to note that in the year 2012, a greater number of girls experienced academic failure compared to boys. However, it was shown in 2013 that a greater number of male students experienced academic failure compared to their female counterparts. This as well has an effect of the teacher-teacher relationships at the work place (Tindan et al., 2023).

In a recent study conducted by Zalmon et al. (2020), the researchers examined the mathematics grading of students in the senior secondary certificate examinations administered by WAEC and the National Examination Council (NECO). The findings revealed that female students obtained higher grades than their male counterparts in WASSCE. Conversely, in the National Senior Secondary Certificate Examination (NSSCE), male students achieved higher grades compared to their female counterparts. However, it is important to note that there was no statistically significant difference observed between the mathematics grades of male and female students in both examinations.

A study was conducted by Baah-Korang and colleagues (2013) to find out the difference between male and female students' involvement in the study of elective mathematics at the SHS level skewed towards the male. Several female participants who were interviewed during the research were asked about their reasons for being attracted to elective mathematics. Some of the responses included the support and consistent encouragement they received from their parents. Additionally, they expressed a fear of the perceived difficulty of elective mathematics, leading them to believe that it was not worth investing their time and energy in studying it.

The Daily Graphic (2021) reported that a seven-year trend analysis of the four core subjects has improved from the year 2015 to the year 2021. According to a report published in the Daily Graphic, there is evidence of a notable improvement in the academic achievement of students in the subject of core mathematics. The trend showed that with a percentage pass of 32.4% in 2015, which dropped to 32.12% in 2016, there would be 54.11% in 2021. The pass rates for the years 2017, 2018, 2019, and 2020 were recorded as 41.66%, 38.15%, 64.23%, and 65.71% accordingly.

Musa and Dauda (2014) analysed the trends of students' mathematics performance in May/June at WASSCE in Nasarawa State, Nigeria, from 2004 to 2013. The objectives of the study were to investigate the pattern of students' performance for ten (10) years (2004–2013) in Nasarawa State and to infer the implication of the observed and predicted mathematics performance on Nigeria's vision of 20:2020. The study discovered that mathematics performance in Nasarawa State has been persistently poor over the years reviewed, similar to what has been reported for the whole nation, and could continue from 2014 to 2020 based on the forecast.

Abreh et al. (2018) conducted a study on trends in the performance of WASSCE candidates in science and mathematics in Ghana: perceived contributing factors and the way forward in Ghana. They examined the trends in students' performance in science and mathematics at the secondary school level within a decade-long interval in Ghana. They used WAEC data from approximately 20% of schools countrywide. The findings of the study showed that the results did not provide a definitive pattern. Factors such as teachers' inability to complete between 50% and 75% of the curricula, insufficient time to enact and complete the curriculum, a lack of qualified teachers, and the use of poor teaching approaches accounted for the trends. This study in Ghana has implications for teacher recruitment deployment in general as well as the duration of secondary education globally to examine their efficacy. The trend analysis reviewed also showed that there is no pattern. This study seeks to confirm or otherwise.

3.0 METHODOLOGY

The study adopted a descriptive survey design ex-post facto. Ghana National College was purposively selected out of the 11 public senior high schools in the Cape Coast metropolis. The convenience sampling technique to select the period from 2016 to 2022 for this study. Sample plays a very significant role in successful research (Maylor & Blackmon, 2005). A sample covers a fraction of the entire population from which a moderately accurate estimate of the entire population can be derived (Ghauri & Gronhaug, 2010). Therefore, the basic objective of sampling is to get a representative sample from the larger population (Ghauri & Gronhaug, 2010). In this study, the census was used for the selection of the students, thus all students who sat for elective mathematics were used.

4.0 FINDINGS

Table 2 shows a survey was conducted to gauge the participation of students in elective mathematics over the years 2016 to 2022.

Table 2: Students' Enrolment in Elective Mathematics

Year	Total Enrolment	Total Who Sat for Elective Mathematics		
		Male	Female	Total
2016	972	201(45.8)	238(54.2)	**439(45.2)**
2017	899	168(38.1)	273(61.9)	**441(49.1)**
2018	936	211(45.8)	250(54.2)	**461(49.3)**
2019	918	206(44.5)	257(55.5)	**463(50.4)**
2020	911	192(36.4)	336(63.6)	**528(58.0)**
2021	1306	394(52.0)	364(48.0)	**758(58.0)**
2022	878	238 (47.3)	265(52.7)	**503(57.3)**
Mean (%)		**44.3**	**55.7**	**52.5**

Source: Field Data (2023)

A survey was conducted to gauge the participation of students in elective mathematics over the years 2016 to 2022. In 2016, the total enrolment was 972, out of which 439 (45.2%) students sat for elective mathematics, with 201 (45.8%) male students and 238 (54.2%) female students. In 2017, 899 students were enrolled, of which 441 (49.1%) students sat for elective mathematics, comprising 168 (38.1%) male students and 273 (61.9%) female students. In 2018, 936 students were enrolled, with 461 (49.3%) students sitting for elective mathematics, of which 211 (45.8%) were male and 250 (54.2%) were female. In 2019, 918 students were enrolled and 463 (50.4%) students sat for elective mathematics, 206 (44.5%) male and 257 (55.5%) female.

Lastly, in 2020, 911 students were enrolled and 528 (58.0%) participated in elective mathematics, with 192 (36.4%) male students and 336 (63.6%) female students. In 2021, 1306 students were enrolled and 758 (58.0%) participated in elective mathematics, with 394 (52.0%) male students and 364 (48.0%) female students. The enrolment for 2022 was 878, out of which 47.3% were males and 52.7% were females. Overall, it can be seen that the percentage of students who sat for elective mathematics increased from 45.2 % in the year 2016 to 57.3% in the year 2022. The percentage mean for total enrolment for the period was 52.5% while male enrolment and female enrolment was 44.3% and 55.7% respectively.

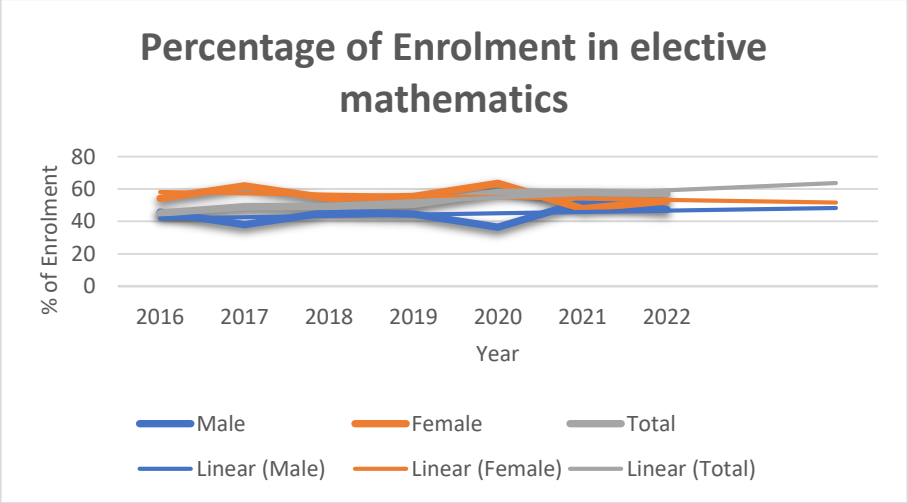

Figure 1: The Linear Forecast Trend Line

The linear forecast trend line shows that the total enrolment of students in elective mathematics would be increasing in subsequent years. For the linear forecast by gender, it was observed that whereas male students' enrolment would be increasing, female enrolment would be decreasing.

Table 3: Students' Performance in Elective Mathematics from 2016-2022

Year	2016 N(%)	2017 N(%)	2018 N(%)	2019 N(%)	2020 N(%)	2021 N(%)	2022 N(%)	Mean (%)
Frequency (Percentage) A1-C6	409 (93.1)	281 (63.8)	335 (72.6)	388 (83.8)	496 (93.9)	750 (99.1)	224 (44.5%)	78.7
Frequency (Percentage) (D7-F9)	30(6.9)	168(36.2)	126(27.4)	75(16.2)	32(6.0)	8(0.9)	279 (55.5%)	21.3

Source: Field Data (2023)

In the period from 2016 to 2022, the average frequency percentage of A1-C6 was 78.7%, while the average frequency percentage of D7-F9 was 21.3% (as shown in Table 3). In 2016, the frequency percentage of A1-C6 was 93.1%, and the frequency percentage of D7-F9 was 6.9%. This trend continued in 2017 with 63.8% of A1-C6 and 36.2% of D7-F9. In 2018, the frequency percentage of A1-C6 was 72.6%, and the frequency percentage of D7-F9 was 27.4%. In 2019, the frequency percentage of A1-C6 was 83.8%, and the frequency percentage of D7-F9 was 16.2%.

In 2020, the frequency percentage of A1-C6 was 93.9%, and the frequency percentage of D7-F9 was 6.0%. In 2021, the frequency percentage of A1-C6 was 99.1%, and the frequency percentage of D7-F9 was 0.9%. Finally, in 2022, the frequency percentage of A1-C6 was 44.5%, and the frequency percentage of D7-F9 was 55.5%.

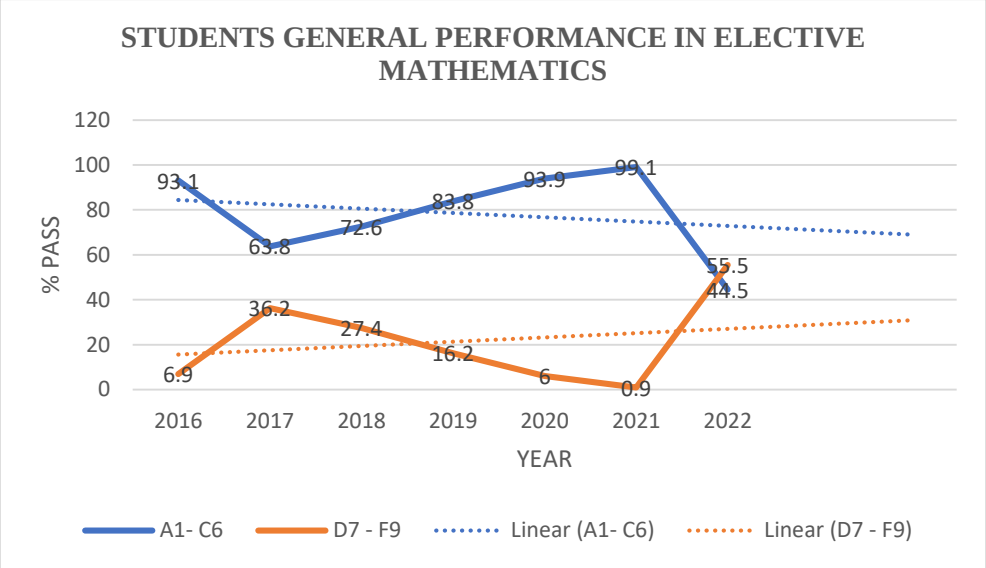

Figure 2: Students Distribution of Performance Rates by Credit (A1-C6), Fail (D7-F9) (2016-2022)

The trend line showed that in the subsequent years, while the pass rate (A1-C6) would decrease, the failure (D7-E8) rate would increase.

Table 4: Students' Performance in Elective Mathematics by Gender

Year	Number of students who obtained A1-C6		Number of students who obtained D7-F9	
	Male N(%)	Female N(%)	Male N(%)	Female N(%)
2016	192(43.7)	217(49.4)	9(2.1)	21(4.8)
2017	99(22.4)	182(41.4)	69(20.6))	99(15.6)
2018	143(31.0)	192(41.6)	68(14.8)	58(12.6)
2019	163(35.2)	225(48.6)	43(9.3)	32(6.9)
2020	177(33.5)	319(60.4)	15(2.8)	17(3.2)
2021	387(51.1)	363(47.9)	7(0.9)	1(0.1)
2022	119 (23.6)	105(20.9)	119 (23.6)	160 (31.8)
Mean %	**34.4**	**44.3**	**10.6**	**10.7**

According to Table 4, the performance of students in elective mathematics by gender from 2016 to 2022 shows an interesting trend. In 2016, there were 192 (43.7%) male students and 217 (49.4%) female students who obtained an A1-C6 grade, while there were 9 (2.1%) male and 21 (4.8%) female students who obtained a D7-F9 grade. In 2017, there was a decrease in the percentage of male students who obtained an A1-C6 grade, dropping to 22.4%, while the percentage of female students who obtained an A1-C6 grade increased to 41.4%. However, there was an increase in the percentage of male students who obtained a D7-F9 grade, from 2.1% to 20.6%. In 2018, the percentage of male students who obtained an A1-C6 grade increased to 31%, while the percentage

of female students who obtained an A1-C6 grade decreased to 41.6%. The percentage of male students who obtained a D7-F9 grade also decreased to 14.8%.

In 2019, the percentage of male students who obtained an A1-C6 grade further increased to 35.2%, while the percentage of female students who obtained an A1-C6 grade increased to 48.6%. The percentage of male students who obtained a D7-F9 grade decreased to 9.3%. In 2020, the percentage of male students who obtained an A1-C6 grade decreased to 33.5%, while the percentage of female students who obtained an A1-C6 grade increased to 60.4%. The percentage of male students who obtained a D7-F9 grade further decreased to 2.8%.

In 2021, the percentage of male students who obtained an A1-C6 grade increased to 51.1%, while the percentage of female students who obtained an A1-C6 grade decreased to 47.9%. In 2021, the percentage of male students who obtained an A1-C6 grade increased to 51.1%, while the percentage of female students who obtained an A1-C6 grade decreased to 47.9%. The percentage of male students who obtained a D7-F9 grade further decreased to 0.9%. while that of females decreased to 0.1%.

Finally, in 2022, the percentage of male students who obtained an A1-C6 grade decreased to 23.6%, while the percentage of female students who obtained an A1-C6 grade decreased to 20.9%. The percentage of male students who obtained a D7-F9 grade further increased to 23.6% while females also increased to 31.8%. On average, 34.4% of male students and 43.3% of female students obtained an A1-C6 grade, while 10.6% of male students and 10.6% of female students obtained a D7-F9 grade.

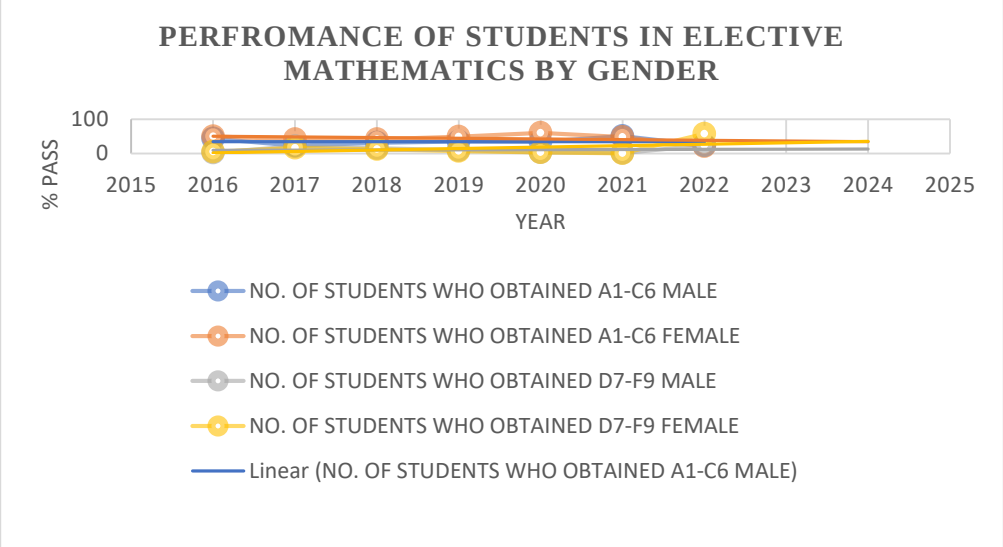

Figure 3: Gender Distribution of Performance Rates by Credit (A1-C6), Fail (D7-F9), Fail from 2016-2021

The trend line depicts that in future examinations, all things being equal, both male and female students rate of pass in elective mathematics would decrease, and male students might perform better than their female counterparts.

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Discussion

Research question one sought to find out the enrolment of students in elective mathematics at the senior high school level. The study observed that there is a continuous increase in the number of students who participate or offer elective Mathematics during the period of review and that enrolment would continue to increase. The percentage number of students participating has reached almost 60% of the total number of students who offer elective Mathematics. This aligns with the government of Ghana's policy on participation in STEM education MoE (2018) which says there should be a 60% population for science-related subjects. This is good because it would also trickle down to the tertiary institutions.

Research question two sought to find gender participation in elective mathematics by senior high school students. The data showed that there are more girls studying elective mathematics than boys. This is contrary to Mireku et al. (2015) who found that there were more boys than girls in WASSCE elective mathematics. The study also contradicts a study Baah et al. (2020) where they observed that more males participated in elective mathematics than females. The study also contradicts Ojating and Udobong (2019) who found that there is no difference in students' participation in elective mathematics by gender. This may be due to the fact that girls are more likely to take up difficult subjects such as mathematics, and are more likely to succeed in them than boys. The trend in enrolment by gender showed that, while male enrolment may be increasing in subsequent years, that of females would be decreasing. This means that more interventions should be introduced to attract more females into the field of STEM.

Research question three explored the trend of students' performance in elective mathematics from 2016-2022. The general performance was very good with a mean percentage of 78.7. Overall, the trend in the data shows that the performance of students in elective mathematics has improved over the past few years and would continue to improve. This can be attributed to the implementation of new teaching methods, such as the use of technology, as well as the introduction of new and innovative learning materials. This is contrary to a study by Abreh et al. (2018) that conducted a study on trends in the performance of WASSCE candidates in the science and mathematics in Ghana: perceived contributing factors and the way forward in Ghana and observed no definitive pattern in students' performance in core mathematics. The study also contradicts a study by Musa and Dauda (2014) who found that students' performance in elective mathematics has consistently been poor. Teachers ought to utilize teaching through problem-solving approach (Acquandoh et al., 2022) in the classroom.

Research question four was on the trend of performance by students in elective mathematics according to gender. The data depicted that female performed better in all the years except 2021 and 2022 when more males passed than females. The overall percentage mean for males and females was respectively 38.6 and 48.01, signifying that in terms of mean percentage, females performed better than their males' counterparts. This contradicts the studies that found that males obtain higher grades than females (Olareju & Yusuf, 2019; Zamlon et al., 2020).

Conclusion

The study sought to identify the trend in gender participation and performance in elective mathematics for a seven-year period. It was observed that from 2016-2022, the participation of

students in elective mathematics increased from 45.2 % to 57.3% with an overall average mean percentage of 52.5%, which is a significant achievement for the Government of Ghana. Further, the study observed that there were more girls than boys studying elective mathematics. also, the performance of the students in elective mathematics is very good. Moreover, there are more girls than boys studying elective mathematics, and performing better as well. Interestingly, the trend showed that general performance in elective mathematics as well as by gender would continue to improve, female participation may decrease in elective mathematics.

Recommendation

It is recommended that the government should continue its efforts to increase participation in elective mathematics and should also focus on providing equal opportunities to both boys and girls. In addition, the government should also provide additional support to students in the form of resources, guidance and mentorship to help them improve their performance in elective mathematics in order to achieve the desired outcome. Moreover, STEM education programs should be introduced in all basic school to motivate both male and females to study science and mathematics related courses at the higher level.

Authors Declarations

Authors Contributions

Efa – Conceptualization, Formal analysis

Baiden – Data curation

Mensah and Kwakye – Methodology

Efa and Kwakye – Writing, review and editing

Baiden, Efa, Mensah and Kwakye – Validation, Formal analysis,

Efa – Investigation, Visualization,

Kwakye – Original draft

Data Availability

Data generated or analysed during this study are available from the authors on request.

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Conflict of Interest

The authors declare no competing interests.

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